Alma Mater Studiorum – Università di Bologna

DOTTORATO DI RICERCA IN

Philosophy, Science, Cognition, and Semiotics (PSCS)

Ciclo XXXII

Settore Concorsuale: 11/E1

Settore Scientifico Disciplinare: M-PSI/01

QUEERING ABSTRACT CONCEPTS.
A GROUNDED PERSPECTIVE ON GENDER

Presentata da: Claudia Mazzuca

Coordinatore Dottorato:
Prof. Claudio Paolucci

Supervisore:
Prof. Roberto Nicoletti

Esame finale anno 2020

Abstract

Concepts are the building blocks of our cognitive system. Over the years, theories of conceptual knowledge have attempted to explain the way in which we acquire and subsequently master concepts by relying on different assumptions. Among several proposals, theories of Embodied and Grounded Cognition (EGC) submit to the idea that our conceptual system is couched in our bodily states and is influenced by the environment surrounding us (Barsalou, 2008). Chapter 1 reviews and critically discusses the debate on conceptual format as developed in cognitive science.

One of the major challenges for theories of conceptual knowledge, and for EGC theories, is constituted by abstract concepts (ACs) like *ethic*. Recently, however, some proposals within the EGC research field have addressed this criticism, arguing that the category of abstract concepts is a multifaced and heterogenous category, encompassing exemplars that differ among them with respect of their grounding sources (e.g. Borghi et al., 2018). According to the WAT theory (Borghi & Binkofski, 2014), for instance, both abstract and concrete concepts are grounded in our bodily states and linguistic system, to different extents. Specifically, abstract concepts are more influenced by social, cultural and linguistic aspects than concrete concepts. Thus, their processing would primary involve the activation of the linguistic system, i.e. orofacial muscles and the mouth effector. In addition, ACs would be more influenced by cultural and linguistic variability. Chapter 2 tackles the issue of abstract concepts from an EG perspective.

In keeping with recent developments of EGC theories of abstract conceptual knowledge, gender can be considered as a special kind of abstract concept. In fact, its grounding sources enclose biological and perceptual aspects–related to one's own sexual embodiment–and social and cultural factors. Whereas previous accounts on gender have stressed one specific aspect over the other (Eagly & Wood, 2013), nowadays the dichotomy opposing sex to gender seems less tenable (Butler, 1990; Hyde et al., 2019). Hence, drawing on the description of abstract concepts offered by Multiple Representation Views such as the WAT theory, this dissertation defends a queer perspective on abstract concepts and gender, that escapes traditional distinctions in order to better account for abstract conceptual knowledge. Along these lines, in Chapter 3, I present a grounded analysis of the concept of gender, illustrating how it can be considered as a queer concept in itself.

Table of Contents

Queer is by definition whatever is at odds with the normal, the legitimate, the dominant. There is nothing in particular to which it necessarily refers. It is an identity without an essence. 'Queer' then, demarcates not a positivity but a positionality *vis-à-vis* the normative... [Queer] describes a horizon of possibility whose precise extent and heterogeneous scope cannot in principle be delimited in advance. (Halperin, 1995, p. 62)

PART I

THEORETICAL TOOLKIT

INTRODUCTION

Writing a doctoral dissertation is hard. During the path you encounter a number of obstacles ranging from practical impediments (e.g., you suddenly run out of coffee and the stores are closed) to more existential crisis (“why am I doing this?”). In my specific case, existential and theoretical dilemmas were very common—dare I say, daily. Writing a doctoral dissertation is hard, but is even harder when you cannot communicate to your parents and to your grandparents what is the object of your inquiry. The fact is that, when I present my work to non-academic, “non-cognitive science” people they are usually confused about my definition. Indeed, concepts are to our cognitive system what air is to our perceptual world. They are everywhere, and yet we notice them just in case there is something “wrong” (e.g., it is windy, or we need to update our concept of money so as to include bitcoins).

Studying concepts is hard, and sometimes you even lose sight of what effectively are you studying. Despite the efforts of the last 50 years of research in cognitive science, in fact, you cannot precisely measure concepts. They are not like other cognitive abilities. Take memory, for instance: you can ask participants to memorize say 50 words, and subsequently to list the items they remember. If participant A would name 25 correct words from the list, we can conclude that she succeeded in the task, remembering 50% of the total list (quite a good result). Alternatively, you can choose to measure visual memory, by presenting participants with a set of pictures, then change the set maintaining only half of the previous images, and ask participants to indicate which ones among the newly presented pictures they already saw.

Now, suppose you are interested in investigating the conceptual knowledge of participant A of *trains*. The first problem is: how would you even start your experiment? We might want to start by assessing categorical knowledge. Hence, we would prepare a set of images showing trains, cars, airplanes and ships, and ask participants to group them together in the way they prefer. Supposedly, slightly more than a half of our sample would pair trains with trains, cars with cars etc.—but be sure there will be someone that will group the items by colors. So, you have your experiment done, and with a bit of luck you can publish your research in a scientific journal. But what exactly have you demonstrated? That people can pair trains with trains. This result says little if nothing about the conceptual representations underlying trains knowledge. I swear I can pair all the metal parts I find in Ikea's boxes without even knowing what purpose they serve, nor even their names, just by looking at them (which is reflected by the fact that afterwards I would usually spend one hour at least reading the instructions pamphlet, trying to figure out what object should I pick first). Looking at the way in which people use objects is insufficient as well. In fact, as the tradition of ecological psychology convincingly showed, objects *afford* certain actions by virtue of their physical constitution. A razor wire would easily stave off unwanted visitors, but the process through which it will become one of the symbols of private property–feature that would certainly take part in the conceptual representation of razor wires–occurs at a different level. Given the difficulty entailed in the study of conceptual knowledge, scholars contrived several methods aimed at accessing it, among which one of the most employed is the feature listing (or free-listing) task. The underlying assumption of these kind of tasks is that, by asking participants to name features related to the concept X, they would rely on their semantic knowledge and list everything they know about that given concept. Thus, if you ask people to list properties or features of the concept train, you would probably end up with a list containing words like “long, speed, travel, railway, seats, grey” etc. This is quite a good sketch of what the concept train could look like, even though you might want to consider that whether certain features are mentioned or not can vary as a function of contexts and of participants.

The concept of train could have been a good example to mention when explaining to my grandfather what am I studying. Unfortunately, the object of my research is something even more general than the general category of trains; and yet, it is the mastering of the topic of my investigation that makes it possible for us to categorize all the different instances of trains into a single category. The study of concepts, and conceptualizations, seems in this sense to set a footprint for the understanding of our most basic cognitive abilities. But what is a concept indeed? To me, as a researcher interested in theories of conceptual representation, it has a very specific and technical meaning. But I noticed that people use the notion of *concept* in everyday language almost automatically, and certainly not in the way I do—writing a dissertation makes you hypersensitive. Therefore, I started to think that probably I didn’t have any idea of what a concept is, and I asked to a set of 51 participants (*M age*= 42; 18 F) to list maximum 15 words they thought were related to *concept*[1]. To give a hint of the topic of the following discussion, take a look at Figure 1, below.

---

[1] For further details on the procedure see Part II of this dissertation.

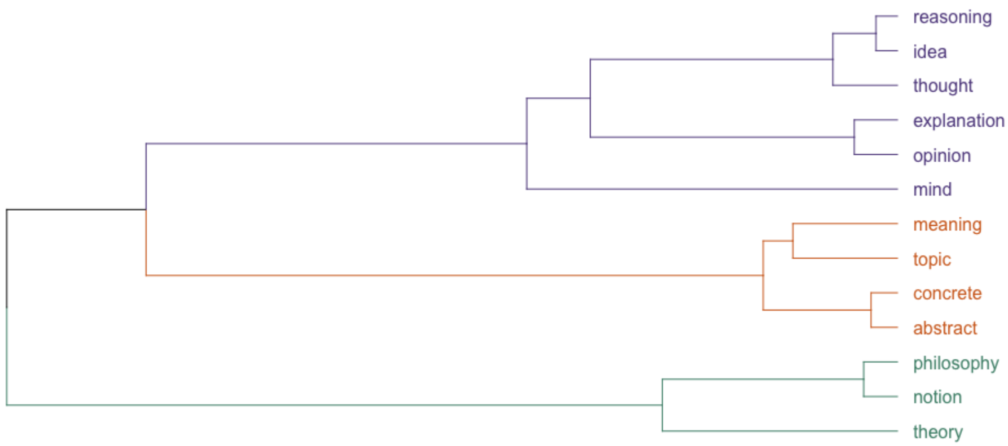

Figure 1. Dendrogram resulting from the Cluster Analysis of items that were listed by at least 10% of participants for the word concept.

According to these results, a concept is something generally pertaining to the domain of mind; among the most prominent features of *concept* there are in fact *reasoning*, *explanation*, *thought*, *idea*, *opinion*, and *mind*. Additionally, a concept is related to *meaning* and generally to *topics*, but the most interesting part of the orange cluster is the one pairing two pivotal notions of this dissertation, namely *abstract* and *concrete*[2]. The green cluster is composed of maybe more philosophical definitions of concept, among which *notion, theory* (proponents of Theory-Theory would have exulted) and *philosophy*. If we look at the frequencies, the most frequently listed item was *idea* (54%), followed by *thought* (50%), and *abstract* (19%). Even though I was positively surprised to notice that the term *abstract*

[2] Note that the measure on which is based the analysis of these data (that will be extensively discussed in Part II) accounts for both within and between participants' co-occurrences. Hence, the fact that the words *abstract* and *concrete* are represented as near in the dendrogram entails that they were frequently listed together across and within participants.

was mentioned by a relevant number of participants, the picture conveyed by the analysis of the frequencies seem to retrace a computationalist approach to concepts. Furthermore, at a first glance, the great absent of this sketch is also one of the greatest absent of modern theories of conceptual representation, until recent developments, namely the body.

So, besides more technical considerations, apparently we all know what we mean by *concept*. The dendrogram above could in fact explain, with some relevant integrations, to my grandfather what is the domain of my research. Nonetheless, scientific literature on what concepts are, what they should be, how do they work–and even on whether they do really exist or not–is overwhelming. Why did concepts caused such a stir?

I suspect the reason why concepts represented the field of battle of cognitive scientists, philosophers, anthropologists, and sociologists has to do with the fact that they are ubiquitous, and yet they are ephemeral. Concepts are ubiquitous in that we employ them in the most basic functions of our cognition (e.g., when drawing inferences, remembering, identifying objects, discussing ideas) but also for much more complicated purposes: think for example of the characterization of the concept *gift* in "archaic societies" developed by anthropologist Mauss (1966). Concepts are ephemeral because, as already mentioned, there is not a unique manner to test them, to describe them and to measure them. Moreover, they change with the passing of time and moving from culture to culture, so it is really difficult to get a fixed and universal representation of a given concept. We cannot take a picture of a concept, or observe it under a microscope. Every attempt to clarify their nature would result in an indirect way of approaching them (note that even neuroimaging studies can be considered to start from a "positioned" perspective, and the portrait of concept that I offered above is greatly conditioned by the idea that one way to access conceptual content is by relying on linguistic descriptions).

Concepts, generally speaking, are abstractions of relevant features of things we encounter in our everyday life, that are collected and collated into a single instance. This instance is what drives us in the multitude of stimuli to which we are constantly exposed. Concepts have been subjected to a burdensome workload, so it is no surprising that in the end they came out "a bit stretched": their nature was thoroughly dissected, and their very ontological existence questioned. At first they were conceived as definitions, forgetting all the experiential domain they rely on. In their journey they were subsequently transformed into prototypes, then exemplars, and also into set of theories. To foreshadow the–momentary–arrival of this journey they were also defined as "multimodal, grounded and dynamic representations". All these accounts greatly contributed to the scientific knowledge of our conceptual system, but each of them has its own limitations. The review of some of the most relevant theories of conceptual knowledge is the topic of the first Chapter of this dissertation.

If you think that studying concepts is a hard work, because they are ubiquitous and ephemeral, studying abstract concepts[3] is even harder. In fact, if there is anything more problematic and more 'abstract' than concepts, this is the category of abstract concepts. It is worth noting that abstract concepts have been the sword of Damocles of almost every theory of conceptual knowledge, and Embodied and Grounded Theories of cognition (which constitute the theoretical framework of this dissertation) made no exception, at least until recently. Here a sample of some of the questions animating the debate on abstract concepts: what is an abstract concept (the inevitable ontological question)? What is the

[3] To spice things up, note that the notion of "abstract concepts" is a theoretical simplification (cf. Barsalou, Dutriaux & Scheepers, 2018). Indeed, as we will see in the course of this dissertation, a neat distinction between abstract and concrete concepts is at least problematic.

difference between abstract and concrete concepts (binary comparisons are always in vogue, as we will see)? If concepts are embodied, how can we account for abstract concepts that are by definition detached from the perceptual world (beware of the a-modal claim)? But above all, is it still useful to distinguish the two categories so sharply (finally, a breath of fresh air)? To these, and other concerns is devoted the second Chapter of this dissertation.

The third, and last Chapter is instead an in-depth analysis of a specific abstract concept, inspired and supported by the theoretical and experimental considerations introduced in Chapters 1 and 2. Specifically, I will address the concept of gender in a grounded perspective, showing how when considered as an abstract concept–in the sense described in Chapter 2–is it possible to unravel its complexity leaving aside traditional dichotomies such as the ones opposing sex/gender, nature/nurture, and abstract/concrete.

To sum up, the present discussion is aimed at providing partial answers to three main questions: (a) what is a concept? (b) what is an abstract concept? (c) what is entangled in the concept of gender?

The reader might know that she will find in the following pages only a selected review of literature, and that scientific debate on each of the abovementioned topic is still flourishing. Nonetheless, I tried to provide–to the best of my capacities–an account of abstract conceptual knowledge and gender informed by most recent developments in the frame of embodied and grounded approaches to cognition. With these remarks in mind, I hope to walk the reader into the journey of concepts until binary and dichotomous constructions will fade away, in light of a more queer conceptualization of abstract concepts and gender.

CHAPTER 1

CONCEPTS. A TROUBLED TALE

1.1. Concepts. What Are we Talking About?

> Locke, in the seventeenth century, postulated (and rejected) an impossible idiom in which each individual object, each stone, each bird and branch had an individual name; Funes had once projected an analogous idiom, but he had renounced it as being too general, too ambiguous. In effect, Funes not only remembered every leaf on every tree of every wood, but even every one of the times he had perceived or imagined it. […] He was, let us not forget, almost incapable of general, platonic ideas. It was not only difficult for him to understand that the generic term *dog* embraced so many unlike specimens of differing sizes and different forms; he was disturbed by the fact that a dog at three-fourteen (seen in profile) should have the same name as the dog at three-fifteen (seen from the front). […] I suspect, nevertheless, that he was incapable of thought. To think is to forget a difference, to generalize, to abstract. (Borges, 1956, pp. 113–114)

Borges' popular short story about Ireneo Funes clearly points to the extraordinary capability acquired by the protagonist of remembering everything, but it also introduces in a fascinating way a central issue in the cognitive sciences, namely categories. In fact, as described in the short story, Funes seems to lack of a crucial human ability: forming and handling coherent categories. Funes' world is constituted by a multitude of details and, for him, each occurrence of a physical entity results to be different from the following one, as the example of the dog shows. In short, he is incapable of categorizing. The process of abstraction is exactly what allows us to interact with the world with a limited energy use; this process is supported by the implicit knowledge of conceptual categories to which things in the world belong. Conceptual categories and their knowledge help us in our everyday life so that we do not need to make new inferences about the function of all the objects that we encounter during the day. If we see a design sofa that does not present the typical features generally associated with sofa, such as legs, arms and cushions, we are still aware of the fact that it is a piece of furniture and that probably its function is to be seated on. As a consequence, differently from Funes, we do not feel the need to attach to it a new name.

Categorization processes have fascinated cognitive scientists, psychologists and philosophers for a long time. As Gardner (1985) stresses, one of the main features of cognitive sciences is the assumption that, for scientific purposes, human activities must be described in terms of *representations*. In fact, if on the one hand it is relatively easy to account for structures and mechanisms of the nervous system in terms of recognizable units, on the other hand investigating mental processes or *representations* seems extremely more problematic. A question arising from this perspective relates to the need of cognitive scientists to postulate this higher level of explanation for mental processes. Apparently, the traditional behaviorist approach according to which only observations of overt behavior are relevant is somehow an oversimplified version of cognitive processes. Likewise, the *content-blind* hypothesis, that assumes the existence of a sort of lingua franca of mental operations capable of performing symbols manipulations independently of their content, appears as an artificial construction detached from physical experience. There must be something accounting for the extraordinary human capacity of abstracting peculiarities of the external world in order to form general ideas. What is then that constitutes the very core of our cognitive processes? Is there a cognitive unit allowing us to interact with the external world the way we do? And if that is the case, what is its nature? What is its specific structure? What its own function?

The most basic units of thought are generally referred to as *concepts*. Concepts, in a renowned definition, are “the glue that holds our mental world together” (Murphy, 2002, p. 1). They enable us to navigate into the stream of different experiences with things in the world that we see, touch, hear, and smell everyday by keeping together past experiences in our mind in order to be prepared to interact with new instances. In Smith and Medin’s words (Smith & Medin, 1981, p. 1), concepts “capture the notion that many objects or events are alike in some important respects, and hence can be thought about and responded to in ways we have already mastered.” This being said, it is not surprising that the debate around conceptual knowledge and conceptual representation animated scientific discussions since Aristotle.

Theories on concepts represent one of the most fruitful achievements of cognitive sciences, and they are still raising proposals and controversies among scholars coming from psychology, philosophy, neurosciences, linguistics, anthropology and artificial intelligence.

In what follows, I will sketch out some of the most influential accounts on concepts. This review of the literature is by no means exhaustive, but is intended to present some of the major issues that render the study of concepts such an exciting field of research. There is a large body of literature that covers the topic of conceptual knowledge both from a philosophical (e.g., Margolis & Laurence, 1999, 2015) and from a psychological (e.g., Murphy, 2002) point of view, thus my discussion will be limited, and aimed at constructing arguments in favor of a specific proposal of concepts representation. I will address four distinct theories before presenting the perspective that will be adopted for the rest of this dissertation. The rationale behind this choice is that to confront weaknesses and strengths of some of the most influential theories of conceptual representation, and finally to argue how embodied and grounded accounts of cognition could resolve much of the controversies entailed in the study of concepts. With this in mind, a good place to start for this discussion is certainly The Classical Theory; in fact, either directly or indirectly much of the theories investigating the structure of concepts can be seen as a reaction to, or developments of, the Classical Theory of concepts. What made this theory deserve the label of *classical*? This question, along with the presentation of some of the crucial tenets and objections related to the Classical Theory, will be the subject of the next paragraph.

1.2. Is the Pope a Bachelor? The Classical Theory

One of the most pervasive accounts of concepts is what Smith and Medin (1981) labelled "The Classical Theory". The origin of this perspective dates back in ancient Greek times, and kept gaining edge until the second half of the twentieth century. Here, I will generally outline the main tenets of the theory and then move to the most compelling set of arguments that contributed to its partial disclaim. For the sake of this dissertation, I will focus on the principal aspects of both claims and objections. I will only report the experimental evidence against the Classical Theory that has been firstly recognized as challenging for the theory itself, although most of the arguments are still inspiring empirical researches. More recent findings will be treated later on in the course of the dissertation, because of their ongoing relevance in the matter.

The basic assumption of the Classical Theory is an "ontological"[1] assumption, in the sense that it relates to the very nature of concepts: concepts are defined as mental

[1] Here, 'ontological' is broadly intended both in the sense of "what there is" and in the sense of "what features do have things that exist"(cf. Hofweber, 2018).

representations having a definitional structure. Importantly, those representations are considered as the result of an abstraction process which leads to a summary description. This summary description doesn't need to coincide with the description of a specific entity, but it applies to all the entities in the class.

The second main assumption directly relates to the categorization process. In a Classical perspective, the definitions that compose a concept are both *necessary* and *sufficient*. That is to say that *a)* every instance of a concept must possess its definitional features in order to be considered as an exemplar of the class and *b)* if an instance possesses features which are associated with a given class, then it has to pertain to that class. The classic example of the concept BACHELOR (Margolis & Laurence, 1999) clearly illustrates these two claims. Following the Classical account, the concept of BACHELOR is composed by a set of representations such as UNMARRIED, MALE, ADULT. Thus, for something/someone to be considered as a BACHELOR, it is necessary to be an unmarried adult male (*a*); in the same way, it suffices for something/someone to be unmarried, adult and male in order to count as a BACHELOR (*b*). In this vein, an item falls under a given category only if it satisfies the defining components of the category, with no in-between cases. As a consequence, there are no good or bad members in the category; there is no difference between items in the same category, as long as they meet the required defining criteria. Note that, by embracing the Classical Theory, we are implicitly assuming that concepts are relatively stable representations in the mind, thus no variability between and within individuals is here acknowledged. For a concept to have a definitional structure means that it is defined by its properties, that bound it in order to be applicable and used jointly by individuals. Those properties have to be the same over time and between users, otherwise the applicability of the concept is compromised.

As Margolis and Laurence (1999) emphasized, one of the main reasons why theories centered around the idea that concepts have a definitional structure have historically been held in great regard is because they have powerful explanatory resources, deriving from their theoretical commitments. In fact, the Classical Theory not only offers a clear account of what concepts are supposed to be, but it also deals with conceptual acquisition, conceptual combination and categorization. Conceptual acquisition logically follows from the (*a*) and (*b*) criteria. As noted by Margolis and Laurence (1999), by endorsing an empiricist version of the Classical Theory, conceptual acquisition can be explained starting from perception. Environmental contingencies form the basis for the correlation of basic perceptual properties, which are in turn combined by the learner resulting in a complex combination of features (the concept). Once the complex concept is formed, the learner who encounters the set of relevant perceptual features will know that every instance satisfying those features will fall under the concept.

Although traditionally considered as one of the most complete accounts on conceptual knowledge, the Classical Theory has faced numerous attacks from scholars coming from different disciplines. Nowadays, its strength is considerably weakened and most researchers are reluctant to adopt such a perspective. The dominance of the Classical Theory was undermined basically through two different kinds of arguments. First, theoretical objections were moved mostly by philosophers, second empirical data coming from experimental psychology failed to support the main claims of the theory (although for a critical review of the arguments see Smith & Medin, 1981).

The most compelling theoretical arguments could be collapsed in what is called the *Plato's problem* (Margolis & Laurence, 1999), and summarized as follows. By sustaining an empiricist version of the Classical Theory, we commit ourselves to the assumption that every concept must be defined by a subset of perceptual features, usually called structural features. As a matter of facts, many entities in the world are primarily characterized by functional features, rather than structural features (e.g., a cup is used to drink something). Moreover, some entities are not definable through perceivable features at all (e.g., *justice*). The shortcoming represented by abstract concepts would rule out the possibility of defining all concepts, thus the theory would be compromised at its basis.

Even if we were to put aside the desideratum of perceptibility, the Classical account would still result problematic. Here is where Wittgenstein's (1953) famous argument takes stance. Using the example of *game*, he showed how difficult is to produce the necessary and sufficient features of real world categories. By looking into what all kinds of games have in common (e.g., board-games, card-games, ball-games etc.) and trying to find a definition that encompasses all of them (e.g., are they all amusing? Do they all imply winning or losing? Do they all presuppose skills? Or is it luck?), Wittgenstein argued that a concept like game can't be defined in those terms. What he suggested then is that we can handle the knowledge of concepts by recognizing similarities and relationships between entities which he famously labeled as *family resemblances*. It has been objected that the fact that is so difficult to find defining properties for real world categories doesn't mean that they don't exist at all, but rather that maybe our means of analysis are not adequate for the quest (Smith & Medin, 1981). That could be the case, but as almost 30 years later Murphy (2002) puts it:

> It is incumbent on someone who believes the classical views to explains what the defining features are, *and* why we can't easily think of them. If our concept of a dog is a definition, why are we so bad at saying what it is even when we know the concept? (p. 18)

In addition, when available definitions are often subjected to strict counterexamples. One of the paradigmatic counterexamples is the one that refers to the concept of BACHELOR. According to the aforementioned criteria of definitional properties of the concept (UNMARRIED, ADULT, MALE), every entity satisfying those conditions necessarily counts as a bachelor. Therefore, the Pope should also be considered as a bachelor (Fillmore, 1975, 1982). This is clearly not the case, and as fictitious and unreasonable this example could appear, it points out one of the biggest flaws of the Classical Theory, namely the disregard of contextual factors (which we will see, play a crucial role also in "conceptual fuzziness").

As shown in the discussion above, the first tenet of the Classical Theory appeared to be more problematic than its elegant formulation initially portrayed. In principle, not all concepts can be defined by a set of features. But sometimes, empirical demonstrations provide unexpected insights on phenomena that are theoretically considered as implausible. Unfortunately, that was not the case for the Classical Theory, as experimental results happened to discredit also the second assumption of the Classical view. Given the definition of a category, the assumption claims that either an item falls under a certain category, or it doesn't, with no in-between cases. That resulted to be an untenable commitment when applied to natural and psychological world. Disagreement between participants asked to categorize members of categories (e.g., kitchen utensils, vegetables) appeared to conflict with the notion of a clearly bounded category (Hampton, 1979). What was even more striking, is that the same individuals changed their category judgments on "borderline-cases", such as olives, over time (McCloskey & Glucksberg, 1978). In-between cases clearly put in jeopardy the Classical version of category membership, but possibly the most critical argument came from Eleanor Rosch and her colleagues. In a wide range of data collection, they identified what was later called “typicality effect”. In sum, they found that some exemplars in categories were considered as more *typical* than others, in the sense that they were rated as more typically pertaining to the given category (Rosch, 1975). In addition, items that were rated as more typical by one group of participants were also more often produced by a different group of participants performing a production task (Mervis, Catlin, & Rosch, 1976). Typicality effects have also an impact on the speed in which people categorize items. When asked to determine whether an exemplar pertains to a given category, participants were faster in responding to a typical probe than they were with respect to atypical members (Rosch, 1973; Smith, Shoben, & Rips, 1974). That measure also correlated with error rates, which were lower for typical items than for atypical ones.

These kinds of effects proved to be robust evidence, and hardly reconcilable with the Classical view, that posits no good or bad examples in the categories. Although some proponents have tried to reshape the Classical view in a way that partially deals with phenomena of typicality (for an overview see Murphy, 2002), nowadays most of the proposals regarding conceptual knowledge are not related to this definitional perspective. Nonetheless, its importance is undeniable, and it’s testified by the fact that most of the following theories on concepts were partly conceived as responses to the Classical Theory.

1.3. Monotrematous Trouble. The Prototype Theory

As discussed in the previous paragraph, the predominance of the Classical Theory on concepts was partially weakened by strong empirical evidence emphasizing the existence of unclear examples and the fuzziness of categories’ boundaries. This work is generally acknowledged to Eleanor Rosh and her colleagues, even though she wasn’t the only one who was not persuaded by the idea that a concept could be sharply defined in terms of propositional attributes. As a matter of fact, from the beginning of the 70s, a growing number of proposals have been developed as a reaction to the Classical Theory. All of these proposals somehow aimed at accounting for what the Classical Theory failed to acknowledge, namely the psychological empirical evidence of typicality effects and the existence of graded categorical structures. Note that, as in the case of the Classical Theory, there is not a single and consistent view that can be precisely named "Prototype Theory"; rather, there is a set of proposals sharing a similar perspective. In the case of the theories that can be ascribed to the Prototype Theory, they all maintain that a concept is a complex representation structured as a function of the probability that its properties also pertain to a given category. This mainly implies that (*a*) concepts don't *necessarily* have some properties, rather they *tend* to have them; and (*b*) if a concept satisfies a sufficient number of features associated with a given category, then it falls under that category (even though some properties are more crucial than others, because they have different weights). Scholars treated and elaborated on the aforementioned assumptions in different ways. Some of them stressed the role of statistical processing (see Smith & Medin, 1981), others highlighted the role of typical items (e.g., Rosch & Mervis, 1975).

Nonetheless, the general assumptions underlying this perspective seem to be immune to at least some of the objections moved to the Classical Theory. First of all, given that the Prototype Theory doesn't have a definitional approach, the general difficulty of finding definitions fitting for all the concepts is avoided. This can be considered as a great advantage for the Prototype Theory, and one of the credits for this can be certainly ascribed to the resonance of the proposal with Wittgenstein's argument of *family resemblances* (which inspired and gave name to one of the most influential paper from Rosch and Mervis, 1975). In this vein, the ontological commitment of the Classical Theory to definitions is resolved by positing that concepts are complex relations interacting with each other is some meaningful way.

Remember the famous *game* example (Wittgenstein, 1953). In a classical perspective, it was extremely difficult to find a definition encompassing all of the possible games, given their differences in aims, rules, and intentions. How to conflate, for example, card games, board games, ball games and solitaires into the same category? Suppose that the proposed definition is “something you play with someone else”. That would work for board games and card games for sure, and usually for ball games too. But, as noted elsewhere, you can be playing with the ball by yourself throwing it against the wall, and also solitaires are by definition played by one person. The same applies to a definition like “something that is governed by rules”. Is there a specific rule in throwing a ball against the wall? Or in the famous example of *ring a ring o'roses* (as many other children games)? Not to mention that with the advent of technology a great amount of virtual games (such as the eGames) made the definition of game even more problematic. The examples could go on for some time.

Drawing on Wittgenstein's proposal of *family resemblance*, in a Prototype Theory perspective what these items have in common is a set of relationships which allow them to be placed under the category of games. Those relationships are not *necessary* for the item to be part of a category, but they are *sufficient*. So that, for example, it is sufficient that playing a solitaire involves some kind of rule (e.g., knowing which card has to be discovered firstly) and that the game is generally played for one's own amusement to let it fall under the *games* category (if the latter encodes rules and amusement as salient features). What this perspective entails then, is that a category is represented as a summary description encoding the more frequently encountered features of the concepts it comprehends. In the category, some features are more salient than others, and those features are more likely to appear in the given category rather than in other categories.

As a consequence, the most salient features acquire a predominant weight, while less encountered features weight less in the category representation[2]. Such a tenet plays a crucial role in explaining typicality effects. In fact, prototypical items are defined as those members presenting the highest adherence to the structure of the category. Results coming from Rosch and Mervis' (1975) experiments demonstrated how the more prototypical of a category an item is rated, the more attributes it has in common with other members of the category. Conversely, the less an item is judged as prototypically representing a category, the fewer attributes it shares with other members of the category. As it was the case for the Classical Theory, the Prototype Theory on concepts gained much of its reliability because it did not only offer a clear account on what concepts are supposed to be, but it also dealt efficiently with cognitive processes such as categorization, conceptual acquisition and conceptual encoding. By introducing the notion of a statistical structure rooted in the weight of properties, the Prototype Theory managed to overcome the assumed difficulty of storing all the definitions needed in a classical account in order to possess a concept. Here, there is no need to store all of the possible pieces of information, but only those considered to be statistically relevant for the representation of a category.

[2] As Hampton (1993) points out, a prototype is constituted by a set of attributes, that can have different weights, corresponding to their "contribution" to the concept's definition. "Thus, for example, apples may have a range of possible colours (that is, values for the attribute colour), each with an associated weight for determining 'appleness' […] information will thus be included on the permitted variability across category members in the value of each attribute. Weights will also vary between attributes […]. For example, the weight given to the best value for colour may be greater than the weight given to the best value for size, indicating that coulour is more critical in determining the similarity to the prototype." (p.73).

Conceptual acquisition is assumed to rely on perceptual properties recognition, much like in the classical perspective. As in the latter, the general idea is that we acquire a concept by assembling perceptual and distinguishable features. The main difference in a prototypical approach is that the process of conceptual acquisition is treated as a statistical process, whose goal is to verify whether certain properties *tend* to co-occur, not *necessarily* always for all the possible concepts included in the category. Those properties are considered to be "statistically prominent" for the concept. This process is directly related to the process of categorization, in that the statistically prominent features of a concept are compared to those of the category, and in case a sufficient number of features corresponds, then the concept is considered to be a member of the category. Rosch (1975) explicitly rejected the idea according to which prototypes constitute a particular model of processing, representation or learning. Rather, they have to be considered as judgments on degrees of typicality, mirroring part of the structure of real-world categories.

Nevertheless, a great amount of perspectives inspired by her seminal studies contributed in many ways to the advancement of theories on concepts. Part of the appeal of a prototype inspired theory is its acknowledgment of the fact that it is almost impossible for a category to have a clearly bounded structure. This statement, combined with the idea of weighted features, justifies by itself the existence of in-between cases (that were a major problem for the Classical Theory). For example, an item judged to be highly atypical for a category is more similar to exemplars of the contrast category, but can still be considered as part of the first category. Moreover, even if standing with the claim that attributes gain weight as a function of frequency of occurrence, it is possible to explain why different individuals mention different properties for the same concepts (e.g., see Barsalou, 1987). It is clear how, by frequently encountering particular exemplars of a given category, an individual will abstract and consider as salient those features that the item displays. This will eventually result in judging that exemplar as highly prototypical.

The prototype approach has constituted the basis for different accounts inspired by the notion of concepts as probabilistic structures and relations. Some scholars have stressed the importance of exemplars (e.g., Medin & Schaffer, 1978), others that of features (Collins & Loftus, 1975; Hampton, 1979; McCloskey & Glucksberg, 1979), others have highlighted the role of dimensions (Rosch, Simpson, & Miller, 1976), and others have favored a holistic approach (for an extensive discussion see Smith and Medin, 1981). Even though those accounts differ in what they consider essential for the representation of a concept, they all share the idea that concepts are processed in a probabilistic fashion, and judgment about the belonging of a concept to a category are computed in terms of similarity judgments (see Tversky, 1977; Komatsu, 1992; Medin & Schaffer, 1978; Nosofsky, 1984).

Although richer than the Classical Theory, also the Prototype Theory has been a target of many criticisms. Given its initial explanatory power for empirical findings, we will firstly consider the most important empirical-based objections, and then we will move to theoretical arguments. Armstrong, Gleitman and Gleitman (1983) claimed that typicality effects can be extended to all concepts, and they focused specifically on clearly bounded concepts such as “even numbers”, which are supposed to have a precise definitional structure. They found that subjects responded to the four well-defined categories they presented as they would have presumably responded to “graded” categories such as fruit. In particular, some numbers were judged as more prototypical than others for a given category (such as “even numbers”) just like an apple is traditionally considered as a more prototypical fruit than a tomato. This applied to error rates and to the speed of categorization, which are usually considered the most important direct measures of typicality effects. By arguing that if the Prototype Theory can't distinguish between two markedly different categories such as *fruit* and *even numbers*, the authors concluded that the theory is uninformative of conceptual structure.

A general argument, partly resonating with the argument raised against the Classical Theory, is that it is difficult to think of a prototype that could encompass all the instances of a category. Given the extreme variability of exemplars that real-world categories contain, the representation of a category in terms of prototypes seems to exclude massive information implied in the category. It is not clear how, for example, the prototype of a category like "birds" comes to be formed, a category into which different and sometimes disjunctive features are comprehended (e.g., big and small, flying and not flying, silent and singing; cf. Murphy, 2002). This is also true if we stand with the exemplar proposal, i.e. one of the proposals derived by similarity-based accounts. If we were to pick up a representative exemplar of the "bird" category, such as a canary, we would be misled in the presence of e.g., a penguin. Much in the same vein, it has been noted (Fodor, 1981), that some concepts don't have relative prototypes, and those are generally very specific concepts such as "American cities situated on the East Coast just a little south of Tennessee". Moreover, sometimes people possess concepts without having in mind a specific set of features that are connected to the concept.

A related, even though slightly different, argument takes into account the so called "complex-concepts". Accounting for concepts such as pet-fish might seem just a philosophical concern, but complex concepts are taken to be representative of one of the most extraordinary human abilities, namely the compositionality of thought and its creativity. The argument goes like this: according to prototypes-like approaches, prototypes of complex concepts are supposed to be inferred from prototypes of their constituent concepts. So that, for example, the prototype of a pet fish (that would presumably be a goldfish), is supposed to be the sum of prototypes of fishes and pets. Features included in the prototype of fishes are gills, colors and swimming skills, resulting in something like a bass. Features relevant for the prototype of pets are for example fur, trained, maybe fluffy and affectionate, and usually dogs or cats are among the best prototypical candidates for the category of pets. It is then difficult to account for how the prototype of a complex concept relates to its constituent parts. On this point, Hampton (1987) introduced an interesting variable. He argued that, for some complex concepts (such as pet-fish or wooden-spoon) what may be crucial is the experience with those concepts and instances, rather than some form of idealized and abstracted representation.

A problem that both the Classical Theory and the Prototype Theory failed to disentangle is related to the relation with non-perceptual entities, the former in the definitions of a concept, and the latter in the features that are salient for the formation of a prototype. Since talking about features is somehow analogous to talking about definitions, in the sense that they are the most important components of both perspectives, the argument raised against the Classical Theory applies also to the Prototype Theory. There are no such things as prototypical features that can be easily mentioned when thinking about a concept such as *freedom*. Henceforth, abstract concepts seem to be a pitfall for Prototype Theory as well as they were for Classical Theory.

I would like to conclude this paragraph with an exciting example, which shows both the inadequacy of a strictly definitional approach and the partial incompleteness of a sharply prototypical approach.

Suppose you are endorsing the Classical Theory on concepts, thus you are convinced that the definitional features of a category are both necessary and jointly sufficient for a concept to fall under a given category. Now imagine you see a platypus (cf. Eco, 1997) and you observe some physical properties of the animal, such as the bill and the webbed-feet and also, if you are lucky enough, you might attend to a platypus laying eggs. Now those three properties together should be sufficient for you to infer the pertaining category of the platypus. And, as a matter of facts, those three properties happen to be defining properties of e.g., ducks (and birds in general). Going through a process of similarity judgments between the properties of the platypus and those of i.e. ducks, you might find that the platypus fulfills all of these three defining properties, which are also duck-defining properties (much in the same way as the Pope is an unmarried, male adult and then possibly a bachelor). You might therefore conclude that a platypus is a duck. This is the first scenario that could arise from the endorsement of a Classical perspective on concepts; note that this is still an empiricist-based scenario, in which the observer extracts perceptual properties in order to categorize the entity considered. But even if we were to put aside the empiricist approach within the Classical Theory, we would face some relevant problems. In fact, by solely relying on propositional definitions, such as those provided by dictionaries, the commitment to the jointly sufficient character of features would still be the basis of our misrepresentation of the platypus. As the definition goes, the platypus is, among other things, a “small, semiaquatic, egg-laying animal which frequents lakes”. Those features are likely to be applicable to a large set of amphibious, such as frogs, toads, salamanders etc. Allegedly then, the propositional features encoded in the definition of a platypus might lead us to think that a platypus is some kind of frog.

Clearly, as already discussed in the previous paragraphs, a strict definitional approach to concepts is too problematic to be fully embraced. Things are not necessarily better when a prototypical or exemplar approach is at stake. In that case, in order to categorize the platypus, you would compare salient features of the platypus with those of either a prototypical item of a category or an exemplar of a category (depending on the approach). Now, what are the most visually salient features of a platypus? You might note that the animal has a dense fur, and a beaver-like shape (then, is it a beaver?). Surprisingly, however, you will also note that it has a bill and webbed feet (is it a duck?). According to the prototypical view, we might conclude that the platypus is either a highly untypical beaver, or a highly untypical duck, and just accept that this animal is another good example of an in-between case. Or, we might find ourselves in the exact position of Shaw, who in 1799 firstly described the platypus as a kind of mammal to which a bill and webbed feet were artificially implanted by sewing them to the body of the beaver (cf. Eco, 1997, p. 308). Unfortunately, none of the aforementioned options seem to be the right one.

Although in some broad sense the platypus can be considered as some strange kind of beaver or duck (here we will rule out the artificial option for the sake of the reasoning), the platypus is neither a mammal in the strict sense, nor an oviparous. Unlike a whale, which even though perceptually highly atypical is nonetheless classified as a mammal, the platypus is classified in the order of *Monotremata*. Monotremes lay eggs instead of bearing live young, and much in the same fashion of marsupials they store their puggles in a pouch. What is even more surprising, given that, for example, platypuses have beaks, is that like all the other mammals the female of the platypus feeds her puppies with milk. If we were to add some more noise in the categorization process, we might want to consider the fact that platypuses are venomous animals, which is a very uncommon characteristic for both mammals and birds, but not i.e. for a reptile or an insect. Given the misjudgments implied in both the proposals we discussed, we might consider the possibility that categorization needs to be implemented differently, both from a purely definitional process, and from a feature comparison one.

As I will discuss in the next paragraph, similarity-based approaches such as the Classical Theory or the Prototype Theory have proved to give an incomplete sketch of human conceptual system. The case of the platypus suggests that, at least in some cases, our concepts should benefit from other forms of *knowledge*, which do not necessarily or not only follow a comparison path.

1.4. Wilma, Apples, and Prime Numbers. The Theory-Theory

As already pointed out, “similarity-based” accounts on categories and concepts have partly proven to be insufficient to represent conceptual structure. The main problem that these accounts face is related to what is generally called *conceptual coherence*. In a nutshell, “similarity-based” accounts have been criticized for not being able to explain intra and inter-concepts relations, and more generally, world and contextual knowledge interfering with processes of categorization. As the example of the platypus suggested, natural world categories can’t always be thought of only as a set of correlated features. Two related lines of criticisms to featural approaches can be summarized as follows. First, even if we were to accept the notion of a concept as a set of weighted features, it would not always be clear what features are supposed to enter the comparison process, and what renders those features eligible for the comparison instead of others. This criticism is known as the “feature selection problem” (Jones & Smith, 2002), and has been addressed in the developmental literature by appealing to two sets of theoretical assumptions. A more general argument against the focus on attributes and features is that concepts, to put it roughly, are conceived as the sum of their constituent components, as already discussed in the example of "complex-concepts". This view somehow rules out the role of goals, interests, human activities and contextual factors in the categorization system. As we shall see, contextual constraints play instead a pivotal role in the processes of categorization.

From the beginning of the 80s, in order to account for these theoretical criticisms and to deal with experimental evidence showing what was later called "knowledge effect", some scholars have started to investigate the possibility of adopting explanations-based accounts on concepts.

The basic assumption underlying this set of proposals is that concepts are structured mental representations, consisting in–and containing–their own relations with other concepts. These relations are made coherent by some kind of knowledge (or theory) that we master of the world. These proposals have been grouped together under the label of "Theory-Theory", or "Knowledge-Theory".

To illustrate this point, consider the following example[3]. The category of *apple-or-prime numbers*. At a first sight, we would think that this is a completely incoherent category, in that features commonly associated with apples, such as eating, round, maybe red, don't really overlap with features of prime numbers. And yet, a possible pattern of coherence might be drawn when taking into account contextual and–let's say–social factors. Imagine that there is a colleague in the math department, Wilma, that has only two main interests: prime numbers and apple farming. At this point we might construct and accept the category of *apple-or-prime numbers* as being "topics of conversation with Wilma". The main point of this argument is that, by taking into account knowledge or

[3] The example is taken from Murphy and Medin (1985) and it was developed by the authors with the help of Lawrence Barsalou.

theories we might be able to supply for the lack of information regarding links between features in the world, thus enabling us to conceive and explain categories that might seem apparently incoherent. This is an important mark for knowledge-based accounts with respect to similarity-based accounts, because it elegantly justifies conceptual combination and conceptual flexibility. By rejecting the idea that complex concepts are but an overlap of salient features, knowledge-based accounts are able to deal with the compositionality of thought. In this vein, background knowledge of the world explains why when talking about a finger cup we are aware that the object of conversation is not a *cup-shaped-finger* (although in some metaphorical sense it is), but an object specifically designed for sewing.

Much of the strength of a theory-based approach comes from the reliability of experimental evidence documenting the tendency toward a sort of *psychological essentialism* both in children and in adults. Specifically, people tend to form coherent beliefs regarding the essence of entities in the world, despite the fact that those entities are subjected to massive changes. For example, when told that scientists discovered an animal that has internal organs of a skunk but external physical appearance of a raccoon, and that she could also give birth to baby skunks, people would be still prone to categorize the animal as a skunk, ignoring the fact that she looks like a raccoon (Keil, 1989; Rips, 1989). Those kinds of findings have somehow undermined the centrality of similarity and typicality in categorical judgments, showing that entities that have undergone substantial featural changes, which may lead to consider them as belonging to a different category, are still categorized accordingly to their “essence”.

In another set of studies, Rips (1989) presented participants with creatures or artifacts which metamorphosed into something else, e. g., a bird that, after eating contaminated vegetation, turns out to acquire insect-like physical characteristics.

Participants were asked to decide whether the entity in the “middle” stage between a bird and an insect was more similar and more typical to one or the other category, and additionally they were also asked to decide whether the entity was actually a bird or an insect. Results show that people would judge the animal as more similar to an insect, and also more typically related to insects, but they would still consider it a bird. This type of “essential knowledge” was found to be part of children’s conceptual system as well. Gelman and Wellman (1991), for example, in a set of studies demonstrated that even preschool children categorization system might not only rely on phenomenal qualities. Children are instead sensible to the fact that the insides of some entities (such as dogs) may be more essential to the entity’s identity and functioning with respect to the outsides. This evidence, corroborated by other studies on children (Gelman & Markman, 1986, 1987), was taken as a proof that ontological kinds are more salient than perceptual features in categorization, and therefore that theories or knowledge are more crucial in categorizing than physical cues. Besides the debate that these studies raise about the supposed innateness of concepts, certainly they concurred to the partial dismissal of a strict similarity and featural approach to categorization. However, the main criticism that this kind of approaches elicited, namely that of assuming an a-priori knowledge driving conceptual categorization, led some scholars to revise some aspects of similarity-based accounts. Researchers contrasting the ‘theory-based’ approach underscored the importance of perceptual learning in the process of extracting relevant regularities from the environment (Sloutsky, 2003). Importantly, the way in which an agent comes to select which perceptual correspondences are important is conceived as the result of development and learning. Sloutsky (2003), for instance, claimed that some perceptual features are “natural attention grabbers” (p. 249) due to their own characteristics, while the salience of others might be enhanced by the context. In the context of perceptual learning, one aspect might affect featural selection, that is *diagnosticity*: for example (Sloutsky, 2003) if we are presented with a red triangle and a red circle, shape is a more perceptually salient feature than color. On the contrary, if we are presented with a red triangle and a blue triangle, color would be more salient than shape. As a matter of facts, diagnosticity was found to be an important component of children categorization processes (Jones & Smith, 2002). Therefore, according to this line of research, early in development induction and categorization rely on perceptual similarity among entities, whereas conceptual knowledge is a product of learning and development (see e.g., Fisher & Sloutsky, 2005; for a recent discussion see Clapper, 2019).

Another line of research, independent from strictly knowledge-based accounts, showed instead how the coherence of some categories is guaranteed by other salient characteristics than just features matching. One of the major contributions of this inquiry has been to evidence the role of contextual constraints in categorization. In a seminal paper, Barsalou (1983) noticed that unlike common categories such as birds, *ad hoc categories* such as “things to take from one’s home during a fire” appear to violate the correlational structure of the environment. That is to say, usually common categories are referred to a distinct set of entities sharing some correlates properties (e.g., birds have feathers, bills and usually fly) which distinguish them from other categories that don’t share this set of properties. Conversely, a category such as “things to take from one’s home during a fire” contains heterogeneous members, as “children”, “dog”, “stereo”, which apparently don’t share correlational features. This being said, it appeared that people still think about this set of entities as a unitary category. Results coming from Barsalou’s experiments showed that common categories had an advantage in memory associations with respect to *ad hoc* *categories*. What was interesting, however, was that when provided with “relevant contexts”, participants would agree more with each other in categorizing items of *ad hoc categories*. This was not the case for common categories, whose items were as available in the absence of a relevant context as they were with a context. Bringing the discussion to more general terms, Barsalou demonstrated that ad *hoc categories* exhibit graded structures, like common categories. Specifically, they are comprised of members that vary in typicality to the same extent of items in common categories. This is taken as evidence of the fact that the degree in which a category reflects correlational structure is not central for its processing. Both *ad hoc* and common categories might be well or poorly established in memory due to prior processing of their members. Moreover, the traditional emphasis on similarity as a determinant of typicality has proven to be insufficient for *ad hoc categories*: Barsalou (1981) suggested that instead, for categories that violate correlational structures the relevant dimension accounting for typicality might be the *goal* the category serves.

One way to account for typicality phenomena found in *ad hoc categories* is to introduce the notion of *ideals* (Barsalou, 1985). Ideals are defined as “characteristics that exemplars should have if they are to best serve a goal associated with a category” (p. 630). In this vein, items appear to be more typical of a category not because they are more similar to its prototype, but because their properties are more relevant to the accomplishment of a goal. For example, in the category of *things to take from one’s home during a fire*, finding items near the ideal of *highest possible value* is relevant to the goal of *minimizing loss* (Barsalou, 1985). Therefore, in this case, the property of *highest possible value* determines the graded structure of the category, so that presumably human beings would be better exemplars than, for example, furniture.

Studies on the graded structure of categories should be also given the credit of showing that other factors besides typicality and central tendency are crucial in the representation of categories. In particular, this line of research revealed that graded structure is a complex and flexible phenomenon, also depending on ideals, frequency of instantiation and consequently contexts. To mention one of the most relevant studies, Barsalou and Sewell (1984) found that both common taxonomic and goal-derived categories showed flexibility and changes in typicality judgments when examined through different points of view. When asked to judge the typicality of exemplars in the category of birds, for example, American undergraduates reported *robin* and *eagle* as typical exemplars from the point of view of an average American. When asked to judge typicality from the point of view of an average Chinese citizen, on the other hand, they mentioned *swan* and *peacock* as more typical birds. Studies such as the one briefly described above clearly pointed to the extreme flexible character of categorization processes. More specifically, they invalidated the notion of a category as a monolithic structure composed of invariant properties. Instead, it appeared that categorization is a highly flexible process, which dynamically interacts with external contexts and internal motivations.

As firstly sketched out by Murphy and Medin (1985), the aim of the Theory-Theory was to present a possible account of what is the “glue” that holds concepts together. Based on this purpose, the authors developed a conceptual theory organized around the notion of *theory* indicating any kind of mental explanations, rather than a complex scientific account (although for a more “science” oriented version of the Theory-Theory see Gopnik & Meltzoff, 1999). In the light of this characterization of the theory, the first objection generally raised against such kind of “explanation-based accounts” can be partly circumvented. The argument usually attacks the Theory-Theory for being circular. In fact, how is it possible for a mental theory (read "explanations") to explain concepts if the mental theory in itself is made out of concepts? The authors faced this argument by claiming that mental theories are not supposed to replace concepts; rather that they have to be considered as constraining concepts, and additionally concepts and mental theories influence each other in a bidirectional way.

If on the one hand experimental evidence supports an explanation-based account on concepts, on the other hand this same evidence shows a potential shortcoming for the same theory. As discussed before, one great advantage of the Theory-Theory is that it is able to account for the high flexibility of conceptual structures by relying on personal background knowledge of the world. This implies that categories are not considered as stable entities over time and across different people. It has been objected (Margolis & Laurence, 1999) that as a consequence of the fact that different people might have different theories of the world, the extension, and consequently the usability, of concepts could be undermined. Another criticism directed towards a complete explanation-based account is that the information that people possess regarding a given category might be rather inadequate, including false beliefs.

Crucially, however, explanation-based accounts gave rise to the interest in the phenomenon of conceptual flexibility (see par. 1.6.4). Moreover, the idea that we are able to form coherent categories sometimes even partially circumventing perceptual features might be useful for explaining some cognitive phenomena. Murphy (2016), for instance, pointed out that we might have specific knowledge of things in the world even without necessarily associating them with specific exemplars. For example, we know that mammals evolved from ancestor dinosaurs, even though we do not have a clear exemplar in mind. The main point of this discussion is that, in order to best investigate conceptual knowledge, one ought not to overlook neither perceptual cues (that clearly drive categorization in some relevant respects), nor the role of previously stored knowledge and the context of appliance of concepts. We will see in the next paragraph how the dismissal of those aspects turned out problematic for some accounts of conceptual knowledge.

1.5. No Cognition Without Computation. Computational Theories

The accounts of conceptual knowledge canvassed in the previous sections focused, among other things, on the necessity to find and describe a reliable structure for concepts. This structure should have explained cognitive phenomena such as categorization, conceptual acquisition, and conceptual processing.

A slightly different point of observation is reserved to those theories and accounts that have been labeled as "Computational Theories of Mind" (CMT). From the beginning of the 50s, when studies on Artificial Intelligence blossomed, a number of scholars started to be fascinated by the insights that "thinking machines" could have offered in the understanding of human cognitive processes. Those researchers went far beyond the simple analogy between minds and computers, stating that cognitive processes are, indeed, computational processes. In particular, mental processes were deemed as computations performed over *symbols*. In this paragraph, I will be treating CTM as a vast asset of proposals, regardless of their specific differences, in order to highlight some of the main assumptions linked to conceptual representation. The discussion will be therefore limited to models of cognition developed until the early 90s, in order to evidence the historical influence they exerted on subsequent theories of cognition, that critically contrasted the main assumptions of a-modal theories.

Computational theories are nowadays understood as the basis of traditional cognitive science. As already mentioned, much of the excitement for this kind of approaches came from the development of artificial intelligence, that envisaged insightful understandings of the intelligent human behavior. Hence, inspired by the observation of the capacity of computers to manipulate information, scholars started to define the mind in terms of a system able to perform complex operations with symbols. To illustrate this point, consider one of the seminal works of Pylyshyn (1973), in which the author claims that cognition must be mediated by something different from both images and words. The substance of the argument is the following: there is an infinite number of images to which the label “rectangle” applies. That is to say that, an infinite number of instantiations of the concept rectangle are possible (e.g., a Lego rectangle, the idealized form of a rectangle, a red brick, etc.). When the corresponding word “rectangle” is activated, it cannot be by virtue of a direct association between the label and the image, since this would imply an infinite number of associations (one for each possible instantiation of the concept). Henceforth, there must be something accounting for the very “rectangleness” that enables our mental processes to go beyond the single occurrence, and thus operating on the “type” rather than on the “tokens”. In Pylyshyn (1973) words:

> As long as we recognize that people can go from mental pictures to mental words or vice versa, we are forced to conclude that there must be a representation (which is more abstract and not available to conscious experience) which encompasses both. *There must, in other words, be some common format or interlingua*. (p. 5, italics mine)

This interlingua is composed by symbolic representations, that are intended as the output of perceptual processes. In other words, our knowledge, far from being constituted by raw perceptual experiences, is always interpreted by the system in symbolic-syntactic terms. In this sense, knowledge is said to be propositional. A notable remark on the last statement is that knowledge, in this perspective, is conceived as propositional in that it acts as an internal symbols structure (Newell & Simon, 1972), and not as expressible in any given language. This point is of crucial importance in different variants of CTM, such as the Representational Theory of Mind (RTM) defended by Fodor (1998), whose theoretical background lays in the Language of Thought Hypothesis (1975).

To put it roughly, Fodor's main thesis is that cognitive processes are computational processes, and in addition, that those processes are performed on representations. Famously, "no computation without representation" (Fodor, 1975, p. 42). The central tenet is made on perceptual processing and conceptual acquisition, and it goes like this: the only available model for decision making and conceptual acquisition is a computational model, which carries out operations of confirmatory explanations on the facts of the world. A computational model presupposes, in Fodor's view, that the organism has access to a language in which computations are carried through. This then implies that representations are necessary. These representations constitute what is labeled as "the language of thought". And why does this language have to be different from any natural language? The answer, in Fodor's perspective, is that there are numerous non-verbal organisms that, anyways, think (although a definition of "thinking" is not provided).

In this first formulation of the Language of Thought, this special kind of language, allowing our minds to perform computational operations, is considered *unlearned*. Starting from the difference between "learning" a language and "knowing" a language, Fodor claims that, in order to acquire a first language, e.g. English, we must possess a language of thought that is capable of recognizing and integrating syntactic patterns. To disentangle this notion, a computer-based analogy is introduced. Computers have two languages, viz. the one of input and output, that is the language allowing them to communicate with the environment, and a ‘machine language’, through which they talk to themselves. These two languages are mediated by *compilers*. Typically though, computers don’t need *compilers* for *compilers*. How is this possible? Fodor (1975) claims that computers are *built* to use the machine language: “the physics of the machine thus guarantees that the sequences of states and operations it runs through in the course of its computation respect the semantic constraints on formulae in its internal language” (p. 74). This is the rationale behind the language of thought, namely it is justified by the organism’s construction itself.

Framed in these terms, computational processes have no access to the represented domain itself, that is, computers do not distinguish whether a symbol represents a cat, a number or Donald Trump. It is then necessary for all the semantic distinctions to be embedded in syntactic distinctions. Pylyshyn (1980), in line with influential proposals (e.g., Newell, 1980) pushed the line further by stating that the physical nature of the device that instantiates the computations is not a direct concern for discovering cognitive regularities. This kind of approaches has been so pervasive over the years that Philip N. Johnson-Laird, in his famous “The Computer and the Mind: an Introduction to Cognitive Science” (1988) claimed that one of the main assumptions in cognitive science is that the mind is a symbolic system.

In a very significant argumentation, Fodor (1998) extended the RTM by directly dealing with conceptual structures. Specifically, once acknowledged that cognition is essentially computation on structured mental representations, he moves to tackle the question “What is the structure of the mental representation of DOG?”. That is to say, what is the structure of concepts? The answer, is that “on the evidence available, it’s reasonable to suppose that such mental representations *have no structure*, it's reasonable to suppose that they are atoms." (p. 22). This thesis became famous as Conceptual Atomism. Interestingly, as the author pointed out, this psychological atomism entails that what concepts you have is metaphysically and conceptually independent of what epistemic capacities you have. Conceptual content, in fact, is simply formed by some sort of mind-world relation (viz., is constructed in a "causal-nomological way").

Conceptual atomism seemed to satisfy the general concern about the systematicity and compositionality of thought (and language) that were considered as shortcomings for prototype and similarity-based models. In fact, systematicity and compositionality are thought to be grounded in the architecture of mental representations: some concepts belong to the primitive basis from which more complex mental representations are constructed.

In keeping with the idea that concepts are symbols, they are supposed to satisfy a type/token relation. A condition for this relation is that of not being too strict as to assign a different type for any token (remember the example of the rectangle). Hence, people living in different environment, cultures and times, should have the same concept of e.g., rectangle. This contrasts with empirical evidence reported in the previous paragraph on conceptual flexibility (e.g., among others, Barsalou and Sewell, 1984, see paragraph 1.6.4 of this dissertation).

Despite their differences, computational theories of mind have largely dominated cognitive science until recent times. Although the complexity of computational theories of cognition is not reducible to one simple statement, the take-home message, for the purpose of this discussion which has strictly expository purposes, is that concepts and meaning are generated by abstract and a-modal symbols (Collins & Loftus, 1975; Newell & Simon, 1981). The mind is here considered as an information-processing device, that operates on the symbols independently of “peripheral” mechanisms such as perception and action. A vigorous presentation of this claim is attributed to Fodor, that in 1985 (Fodor, 1985) labeled perceptual processes as “dumb” processes, and higher cognitive processes such as thinking “smart” processes. Although he recognized that those two sorts of processes must interact somewhere, he still claimed that perception is a highly modular and encapsulated process.

In this perspective then, concepts are represented in mind in a propositional fashion (e.g., they are attributes, properties, statements), and are unrelated to the environment and to the body itself. In the representation of BIRD, for example, is contained the propositional feature “it has feathers”, but not the visual image of feathers, or the tactile information regarding their softness. In this sense, concepts are said to be a-modal: they don’t encompass any relevant modality-specific information. The a-modal and symbolic character of concepts and computation is precisely what led some scholars to reconsider this dominant paradigm.

The celebrated Chinese room thought experiment, proposed by Searle (1980), firstly challenged the established idea that machines can answer questions in a human-like fashion. Searle’s argument was directed towards what he called “a strong version of AI”, that implied that programs were not just psychological tools for the explanation of human intelligent behavior, but rather they were the very explanation. The argument is nowadays world renowned, hence it will not be presented in this section. For the sake of this discussion, it suffices to say that by positing that the mind works as a computer, i.e. following a series of syntactic rules and applying them to a stream of symbols, the only conclusion that can be drawn is that the computer (or the mind) is just providing *uninterpreted* answers. The parallelism goes further claiming that whatever formal principles are introduced in the program running in the computer, those principles are not sufficient for *understanding*, given that a person can follow formal principle as well as a computer without necessarily understand anything, or in Searle's words:

> As long as the program is defined in terms of computational operations on purely formally defined elements, what the example suggest is that these by themselves have no interesting connection with understanding. (p. 4)

Searle assumes that the capacity of understanding e.g. English, is a consequence of the fact that we are a specific kind of organisms, with special biological conditions that enable us to perceive, act and understand.

The same line of arguments was taken up and implemented by Harnad ten years later (Harnad, 1990). The issue raised by Harnad became famous as "the symbol grounding problem", and the criticality of its strength lays specifically in the acknowledgment that for something to be understood in terms of a formal representation, it is necessary to provide some sort of "background knowledge". It is namely necessary to *ground* symbols. Symbolic accounts of concepts posit that words and concepts stand in a nomologic relation, that is a relation connecting them according to some lawful rules. But those rules are only expressed in the formal syntax of the computational device (the mind, in the specific case), thus they are not semantically accessible. The *symbol grounding problem* refers specifically to the necessity to interpret the semantic aspects of symbols. In other words, it concerns the meaning, the referents, of symbols. Henceforth, Harnad advanced the example of a person who is trying to learn Chinese as second language, provided only with a Chinese/Chinese dictionary. What she will obtain as information would only be a circle encompassing meaningless symbols connected with meaningless symbol-strings (the definitions). The situation is quite the same if we consider the case in which the same person is learning

Chinese as first language, but her only source of information is a manual with Chinese instructions. It is evident, as Harnad pointed out, that if the definitions respected the sort of “right-way” relation Fodor supposed, i.e. a “causal-nomological way”, we wouldn’t need the definitions at all to give meaning to the symbols.

Harnad’s proposal is then a solution that recognizes a hybrid symbolic/non-symbolic system, in which symbols are *grounded* in non-symbolic representations. Specifically, those non-symbolic representations select aspects from the sensory environment, that will be used to construct the symbolic representation expressed e.g., by words. For example, the word “horse” is supposed to be grounded in the “projections” that seeing a horse caused in our sensory surfaces plus some categorical representations learned by experience. The same is true for the word “stripes”. To form the category of *zebras* we might rely on a mechanism of the sort “Zebra” = “horse” + “stripes”, where both *horse* and *stripes* are grounded in the representations described above, and as a consequence *zebra* inherits this grounding. As a note, Harnad was very careful in specifying that perceptual experience may not be sufficient for the construction or processing of a concept; in fact, as a caveat on this example he argued that some kind of logical connective such as “not”, “all”, “and” etc. might be needed.

Remarkably, the key question that the whole symbol grounding issue (from Searle to Harnad) triggered is about how and when can symbols be things in the world, and under what conditions cognition is possibly *embodied*.

1.6. How to Avoid *Quixotic Dead Ends*[4]. Embodied and Grounded Theories

Given the importance of computationalist and representationalist theories of mind, they were longwindedly retained as the standard approach in the study of cognitive phenomena. While their importance in the advancement of cognitive science is undeniable, arguments such as the *symbol grounding problem* undermined the dominance of these traditional approaches. As a result, a growing number of researchers from the beginning of the ’90s started to distance themselves from strictly computationalist approaches. They began, instead, to investigate cognition in its broader sense and specifically from a situated point of view. In accordance with Searle’s and Harnad’s suggestions, and in line with phenomenological continental philosophy, some scholars reintroduced a “factor” in the study of human cognition that was implicitly underestimated for a long time, i.e. the body[5].

In this perspective, the world is no longer considered as independent with respect to the knower, rather it acquires its meaning also due to the knower’s specific means of interpreting it. These means are not limited to the knower’s higher cognitive abilities, but include her characteristic body, her perceptual processes and her actions.

Embodied cognition is therefore intended as a current of thought and a research program aimed at challenging the traditional perspective on mind, by acknowledging the contribution of body in cognitive processes. Embodied approaches to cognition encompass

---

[4] Cf. Barsalou (2016a).

[5] Historical antecedents of embodied cognition programmes, challenging the traditionalist view of cognition are considered to be Gibson’s ecological approach to psychology (Gibson, 1979) and connectionism (e.g., Smolensky, 1988). For the sake of brevity, I will not treat these lines of research in this dissertation, although for insights on how Gibsonian psychology and connectionism influenced and paved the way to embodied approaches to cognition see, among others, Shapiro (2011) and Chemero (2009). Philosophical commitments stressing the role of subjective experiences in the emerging of knowledge can be traced back to phenomenological tradition (e.g. Merleau-Ponty, 1945), to which embodied approaches are clearly in debt (see Varela, Thompson and Rosch, 1991 for an early discussion on the philosophical background inherited specifically by enactive approaches to cognition).

a wide and expansive set of research programs, sometimes different among each other (Wilson, 2002; Matheson & Barsalou, 2018); however, the basic assumption is that cognition is highly dependent upon physical features of the human body. In a seminal work, Varela, Thompson and Rosch (1991) suggested that in order to overcome the classic distinction between realism (i.e., the world has pre-given properties, cognitive processes are aimed at interpreting them) and idealism (i.e., the cognitive system projects its own world) we need to study cognition as *embodied action*. In this sense, cognition is intended as embodied because: *a*. it depends upon the kind of experience conveyed by the fact that having a specific kind of body implies, and *b*. the sensorimotor capacities allowed by our bodily structures are themselves embedded in a biological, psychological and cultural context. Cognition is furthermore intended as action because sensorimotor processes, perception and action are inseparable from our lived experiences. Hence, knowledge emerges through the structural coupling of world, brain and body.

According to Shapiro (2011), three main themes are especially prominent in the works of embodied perspectives of cognition:

1. Conceptualization: the properties of an organism's body limit or constrain the concepts an organism can acquire. That is, the concepts on which an organism relies to understand its surrounding world depend on the kind of body that it has, so that were organisms to differ with respect to their bodies, they would differ as well in how they understand the world.
2. Replacement: An organism's body in interaction with its environment replaces the need for representational processes thought to have been at the core of cognition. […]
3. Constitution: The body or world plays a constitutive rather than merely causal role in cognitive processing. (p. 4)

As this list suggests, embodied approaches to cognition explicitly reject the conception of the human mind as a computer; in particular, what is specifically dismissed is the idea of cognition as just computation over abstract symbols. Although the three themes are clearly intertwined, I will specifically cope with the first one, given its relevance for the purpose of this dissertation.

Before moving to analyze what concepts look like in an embodied perspective, some caveats are needed. We have been discussing how embodied cognitive science challenged traditional cognitive science, particularly focusing on the refusal of computationalism and representationalism. As a matter of fact, some variants of embodied cognition are partly compatible with the idea of cognitive processes as computations, and some others are cautious in completely dismissing constructs such as representations in the explaining of cognitive processes. A first distinction among cognitive scientists embracing an embodied approach can thus be drawn on the basis of their more or less "radical" engagement with the notion of representation. The scientific debate concerning the need to employ the notion of representation in explaining cognitive processes is still flourishing, and exceeds the purpose of this dissertation (for an extended discussion on the theme, see e.g., Chemero, 2009).

A second caveat pertains the extension of the label *embodied* itself. So far, I've been using the label embodied to introduce what has become the alternative to the traditional paradigm in the study of mind and cognition; I have put the accent on the centrality of bodily processes in constraining and constituting cognition to show the shift of perspective entailed in these approaches at a general level. Indeed, over the last 30 years, researchers have stressed different versions of embodiment. Hence, in addition to the label *embodied*, cognition has been defined *grounded, situated, enacted* and *extended* to different extents.

Each of these labels conveys a particular sense according to which cognition is embodied, but they all converge on the idea that cognitive processes are not bounded to abstract symbols manipulation.

With the term *enacted* is generally intended the notion according to which perceptual activity is an explorative process, coupled with sensorimotor abilities and some forms of knowledge mediated by experience (Varela et al., 1991; O'Regan & Noë, 2001). The thesis of *extended cognition*, initially put forward by Clark and Chalmers (1998), posits that cognition is not wholly contained in our mind and brain. The authors developed an account of cognition that incorporate external devices (e.g., artifacts) in the mechanisms underlying cognitive processes; henceforth, cognition is said to be distributed in our brain, body and external devices, which function as complementary tools for our cognitive processes by enhancing them.

The last two notions of *groundedness* and *situatedness* will be treated together in this framework, given their importance in the following of this dissertation. Although they are different in what they aim to stress, I believe their implications are nowadays mostly shared by the majority of scholars endorsing an embodied–and I would say, grounded–approach to cognition. According to the description proposed by some researchers (e.g., Fischer, 2012; Pezzulo et al., 2011), cognitive processes are *grounded* in that they are constrained by some physical laws, including also laws specifically related to the very construction of our sensorimotor systems, but widely encompassing characteristics of the lived environment. The *situatedness* of cognitive phenomena is, on the other hand, precisely related to the relevance of contextual factors in shaping cognitive abilities. As I will show in the following of this dissertation, the implications of this conceptions of cognition are crucial in the explanation provided by embodied and grounded theories of cognition to themes such as conceptual knowledge, conceptual flexibility and abstract concepts.

Now that the main tenets of embodied cognition have been introduced, we can start to delve deeper in this area of research, keeping in mind that it is composed by a multitude of approaches; I will particularly favor throughout this dissertation an embodied, grounded and situated approach to cognitive phenomena. Hence, from this moment on I will use the label embodied, grounded and situated interchangeably, unless specified, to account for the critical intertwinement of sensorimotor, physical, social and cultural information in cognitive processes.

1.6.1. Of monkeys, neurons and simulations. One of the key-concepts in embodied and grounded theories of cognition (from now on EGC) is that of *simulation*. As acknowledged elsewhere (Borghi, 2011), the term simulation encompassed different aspects in the debate of EG theories of cognition, some of them more centered on the neural underpinnings of cognition, and others related more broadly to the relationship body-environment. For the purposes of the following discussion, however, it might be useful to take a step back to the historical antecedent of the concept of simulation, and present a brief overview of the findings in cognitive neuroscience that contributed to underline the centrality of bodily processes in higher forms of cognition. The neuroscientific basis inspiring the notion of simulation is the systematic study of the most anterior region of the ventral premotor cortex of macaques (F5), that led in the late 90s to the discovery of the mirror neurons system. While previous understandings of the functional role of F5 focused on its capability of programming and executing actions, it has been demonstrated that it also serves much complex cognitive abilities. Umiltà and colleagues (Umiltà et al., 2008), for instance, recorded the activity of hand-related neurons in area F5 and in the primary motor cortex areas of monkey trained to grasp objects with two different gripping tools (a normal plier or a reverse plier). In doing so, they intended to disentangle whether the neural activity they registered was directly related to the hand action or if it was connected with the accomplishment of a task. Their results showed that all neurons in F5 area fired when the plier was closed on the object, both when the hand was closed and when it was open. These data suggested that previously considered strictly motor neurons are in fact part of a neural circuit supporting higher cognitive capacities, such as the encoding of goal directed actions. But the importance of F5 area is not limited to these cases. Indeed, area F5 incorporates other two types of neurons, both visuomotor, where the first class has been proven to respond to the size and shape of particular objects, even in absence of a possible action to be performed (Rizzolatti & Fadiga, 1998; Rizzolatti, Fogassi, & Gallese, 2000). The second class, instead, comprises a circuit of neurons that have been labelled “mirror neurons”. Mirror neurons are a special class of visuomotor neurons firstly observed in monkeys’ premotor cortex, which fire both when monkeys perform an action and when they are just observing others performing an action (di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). Given the revolutionary potential in the study of how the mind works, research on mirror neurons has been extended to humans, providing exciting results. In fact, results coming from neuroimaging studies and transcranical magnetic stimulation evidenced how observing actions activated in humans a brain area that was indicated as the homolog of monkeys mirror neuron system (Fadiga, Fogassi, Pavesi, & Rizzolatti, 1995; Gallese, Eagle, & Migone, 2007; Rizzolatti & Craighero, 2004). Thus, neurophysiological and neuroimaging studies indirectly suggested the existence of a mirror neurons system in humans, that would be central not only in the understanding of actions, but could also have an adaptive role supporting language development and comprehension (Fadiga, Craighero, Buccino, & Rizzolatti, 2002).

An essential point raised by the large amount of literature on mirror neuron system (MNS) is therefore the need to "cut across the widely endorsed dichotomy between distinct semantic and pragmatic cognitive domains" (Gallese, 2009, p. 494). In this perspective, meaning–being it the goal of an action, or language comprehension–is the result of situated interactions of the agents with the world. For instance, MNS has been hypothesized to be the neural underpinning of processes of embodied simulation. Embodied simulation is often referred to as an unconscious process (but see Decety & Grèzes, 2006), supported by MNS, that predicts actions (Gallese, 2009). Furthermore, Gallese (2008) proposed that embodied simulation mechanisms involving the activation of motor system, among which the MNS, are at the basis of language comprehension. In this perspective, mirror neuron system activation is considered the underlying process of embodied simulation that occur both at the content level of words (i.e. their meaning) and at the phono-articulatory level. The claim is that a particular class of neurons, originally evolved for sensorimotor integration, subsequently adapted to new purposes such as language processing, while still maintaining their original functions (see also the notion of "neural reuse" in Anderson, 2010). A slightly different approach to simulation focused less precisely on the role of action and prediction purported by simulations. Instead, those approaches put the accent on the body-environment interaction *tout court*, contending that to simulate is to re-enact situations, internal and perceptual states as well as affective ones related to the referent of the interaction. In a classic definition from Barsalou (2008a), *simulation* is defined as

> The reenactment of perceptual, motor, and introspective states acquired during experience with the world, body and mind. As an experience occurs (e.g. easing into a chair), the brain captures states across the modalities and integrates them with a multimodal representation stored in memory (e.g. how a chair looks and feels, the action of sitting, introspections of comfort and relaxation). Later, when knowledge is needed to represent a category (e.g. chair), multimodal representations captured during experiences with its instances are reactivated to simulate how the brain represented perception, action and introspection associated with it. (pp. 618-619)

Over the last three decades, theories of embodied and grounded cognition centered on simulation-based approaches have been assessed through a wide variety of experimental studies. Because simulation has proven to be a powerful explanatory tool in cognition, it has been explored through several tasks. Researches within the EGC panorama focused on the role of simulations in categorization, perception and language processing. The idea that action and cognition interact in a manner that is causally relevant has gained experimental credit thanks to the large amount of studies that EG theories fueled such as those initially performed by Tucker and Ellis (Tucker & Ellis, 1998; Ellis & Tucker, 2000; Tucker & Ellis, 2001).

According to the authors, the representation of a visual object encompasses encodings of possible action-relevant properties of that object, together with descriptions of its visual properties. In a set of experiments, for example, (Tucker and Ellis, 1998) participants were presented with pictures of objects and were asked to judge whether the pictures were displayed in a normal or inverted vertical position. In addition, the objects were portrayed in one of two horizontal positions, where the horizontal orientation determined the optimal hand to use for grasping the objects. Participants responded by pressing a right or a left key. Despite the fact that the horizontal orientation of the objects constituted an irrelevant feature for the task being performed, participants were faster and more accurate in their responses when the hand of response corresponded to the horizontal orientation of the object. For instance, if a cup was presented with its handle on the right side, participants were faster and more accurate when responding with the right key.

This kind of evidence convinced the authors that object processing might involve activations related to the actions usually performed with the objects in an “automatic” fashion. Motor information is thus considered to be a central feature in the conceptual representation of manipulable objects, and this claim has been further investigated in neuroimaging studies. Evidence from fMRI studies indicates that the cortical networks involved when perceiving objects, and specifically tools, have a consistent overlap with regions that are active when actually manipulating objects (for a review see Lewis, 2006; for a neuropsychological approach see Humphreys & Forde, 2001). The coupling between action and perception is also attested by studies demonstrating that task-related intentions affect the perception of stimuli. For example, when asked to reach objects with or without a baton, people tended to rate as more distant the objects when they could just use their hands, while they perceived the objects as closer when they had the tool. The evaluations were instead equals when they were not required to reach objects (Witt, Proffitt, & Epstein, 2005), suggesting that the intention to grasp the object directly influences the perceived spatial representation.

More relevant for this discussion is the claim that as categorization and perception are embodied, so is language.

1.6.2. Embodied and grounded accounts of language. Following Smith (1989), and the majority of literature produced over the years on concepts, we shall distinguish two levels of analysis in the study of conceptual knowledge. The first one is the metaphysical level, which pertains to *how the world is*, while the second is the epistemological level, investigating *how we know, infer and believe the world is*. These two levels of analysis have been traditionally addressed by different disciplines, namely philosophy and psychology; and yet, it seems that theories of concepts have always struggled in defining boundaries between the two levels, as demonstrated by the general disagreement they produced both among scholars within the same discipline, and among scholars with different scientific backgrounds.

Much of the confusion comes from the fact that concepts fulfill several main functions (see Rey, 1983) among which metaphysical, linguistic and epistemological functions. Before moving forward in the analysis of concepts and language in EGC theories, we need to clarify which level we are going to explore and why. In doing so, let's step back for a moment and recall two of the proposals we have presented in the previous paragraphs, the Classical Theory and the Prototype Theory.

The Classical Theory is a metaphysically oriented account of concepts, in that it defines specifically what concepts are, subsequently defining the way of knowing concepts according to their own structure; concepts are definitions, and to possess a concept is to master its definition. The Prototype Theory goes in the opposite direction, and we can say is somehow epistemologically oriented; we master concepts because we are able to compare and collapse relevant features of an object, and concepts are sets of relevant features. It is clear that none of the aforementioned accounts can provide a complete theory of concepts, in that they both miss some crucial aspects of conceptual knowledge: on the one hand the fact that concepts are not entities on their own, that is to say that there is always an interpreter making sense of concepts. On the other hand, even though certainly features are relevant, conceptual knowledge still maintains some kind of stability as a structure: as much variability as there exist in conceptual representations, some of them seem to be more stable than others.

I think one way to disentangle the question whether it is plausible to rely just on the metaphysical level or on the epistemological level is to call into account language. In fact, as Rey (1983) puts it "the most efficient way of representing concepts seems to be by way of language, which fact is well explored by people when they use language systematically to express the content of their cognitive states." (p. 242). Language and linguistic competence, in fact, seems to guarantee the correct functioning of all the basic functions of concepts (e.g., inter and intra-personal stability, linguistic functions and epistemological functions) except from the metaphysical one. But to study concepts only from a metaphysical point of view is to study them in isolation, viz. without considering the fact that if we are studying concepts is because we are certain kind of agents, with a specific kind of body and a specific cognitive structure.

Therefore, although surely some concepts might be pre-linguistic or don't need linguistic descriptions to be employed, from now on we will consider concepts and the linguistic labels they are represented by as the same entity. This is not to take a purely epistemological stance, rather it is to acknowledge the fact that as much as we can strive to understand what is a concept in its own, we can never separate its true essence from our ability to interpret that true essence—after all, we will never know *what is like to be a concept* (cf. Nagel, 1974). And probably, this sharp distinction wouldn't be useful either, given that what really counts is that we employ concepts in our everyday life to perform tasks, to communicate ideas etc. and not just to discuss of their own essence sitting on a comfortable armchair in an ivory tower. Now that we made clear why we will refer to language in our study of concepts, we can move to the core of EGC theories of language processing.

According to classical theories of semantic information and language processing, the meaning of a word is independent from sensory and motor systems. Language was thought to be propositional, and symbolic (Levelt, 1989). Classical theories of semantics mainly focused on the process enabling the comprehension of words, rather than on the content of meaning. In this framework, meaning is arbitrarily linked to its linguistic representation, i.e. the referent of a word in the external world doesn't have a necessary relation with the linguistic form represented in the internal system as a symbol. Since language was considered to be a symbolic and computational process, traditional theories of meaning were particularly interested in explaining what are the processes supporting the translation from external sensory inputs to symbols upon which computations were performed. Pylyshyn (1985), for example, proposed the notion of *transduction*, serving the purpose of transforming sensorial signals into symbols that may eventually be manipulated by the system.

Other accounts specifically addressed the organizational principles underlying the construction of meaning, positing that the meaning of a word is constituted by its relation with semantically related words (Landauer & Dumais, 1997; Landauer, Foltz, & Laham, 1998). Thus, the meaning of e.g. the word "book" is determined by its spatial and semantic proximity with words such as "pages", "reading", "paper" etc. Clearly, the symbol grounding problem affects both distributional theories of meaning and more traditional symbolist accounts, for it posits the question of how symbols gain significance in the first place. To put it roughly, representationalist theories of meaning hold that words *represent* their referents in the sensorial world, i.e. they stand for the objects they refer to, without incorporating any relevant feature of things in the world. As already discussed, these representations were considered to be amodal, for the only condition that they needed to satisfy was to be suited to be manipulated by the computational system. That is to say, what counted was their form, rather than their actual content.

EGC accounts on linguistic processing, instead, stressed the importance of the content of linguistic forms, which was closely related to their elaboration mechanisms. According to embodied and grounded theories of language, semantic coherence is guaranteed by the fact that the content of words is constituted by the reenactment of experiences connected with the referent of the word itself. Therefore, somehow, the form of the representation of the referent matches its content. The notion to which EGC theories appeal to explain how language is understood is that of *simulation*. In line with the definition provided in the previous paragraph, we can conceive the meaning of words in an embodied perspective as the online or offline retrieval of perceptual, sensory and internal features experienced during the encounters of words referents. Following this claim, the meaning of the word “book” would hence be grounded in past experiences with different instances of books, and would encompass aspects specifically related to its perceptual and physical properties as well as sensations derived from the interaction with the object. The major tenet of EGC accounts of language processing is that when hearing or reading a word such as “book”, neural patterns that are usually active when interacting with the object itself are active as if we were actually to perform some action with the object, thus creating a simulation of the same interaction. Those simulations are multimodal simulations, i.e. they are dependent and comprised of specific modalities: for example, in the understanding of a word like “chair”, our visual system, our motor system and our tactile system are employed in the retrieval of the concept (Barsalou, 1999).

The multimodal aspect characteristic of embodied simulations seems thus to be immune to the symbol grounding problem, because it directly relates the “external world” with the “internal world”, without the need to interpret any kind of symbol. Note that, simulation processes are thought to happen unconsciously, and they can occur both in presence of the referent and in its absence. The last point explains why we are able to give meaning to things in the world even when we are not perceiving them, and also for the fact that we can talk about things we have never experienced. In brief, simulations allow for more or less high forms of abstraction.

Let’s consider in turn language and language like structures from a classical and computational perspective and from an embodied and grounded perspective of concepts. According to classical and computational accounts, language and syntactic structures are crucial in that they represent the very essence of concepts (the definitions in the Classical Theory) or the means through which concepts are interpreted by the cognitive system (the mental *lingua franca* in CTM). Embodied and grounded theories of cognition, partially reverse the pattern: in this frame, concepts and language are co-determined and mutually influenced. We can say that, at least in part, there seems to be a juxtaposition of linguistic expressions and concepts in that, as we will discuss soon, the same experience is re-enacted in order to e.g. use a hammer and understanding what the “hammer” word means.

For the purpose of this discussion, one point is noteworthy: while in traditional symbolic accounts of language processing meaning arises from the syntactic combination of abstract and a-modal symbols arbitrarily related to their significant, in EGC theories of language it emerges from the very interaction with the referent in the world. It is also worth noting that the notion of meaning in this context is not an uncontroversial one. Barsalou and colleagues (1993), for instance, resorted to the Fregean (Frege, 1975) distinction between *sense* and *reference* to critically discuss what meaning and concepts are. They contended that, traditionally, cognitive science intended meanings as senses, that could be roughly characterized as modes of presentation of a given reference (e.g., the formal symbols describing entities in CTM). In Barsalou et al. (1993)'s perspective, instead, both reference (i.e. the physical object indicated by the sense) and the sense (the mode of presentation) constitute meaning. They are specifically interested in determining the role of concepts in the constitution of meanings, and in differentiating the two notions. The idea is that concepts (as presented in this early account) can work as senses in determining the reference of a word because they are tailored to different situations, but can also establish domains of reference in specific contexts. For instance, once the terms of a specific utterance are established (e.g., "you should know something about gassing your car", p. 32), one can easily compute the reference of subsequent expressions that could have several referents (e.g., "most gas stations check your *air* when you request a *full service*", where air and full service could have been referred to very different entities in the world). The main point, as I understand it, is here to reject a strictly "mentalistic" conception of meaning, such as the one portrayed by a-modal theories of cognition—note that the structure of this argument partly resonates with the famous Harnad's critique. Recent accounts of meaning in the EGC area, however, have engaged in "internalistic" tenets. Buccino and colleagues (2016), for instance, have claimed that meaning could be explained by relying on recent findings in cognitive neuroscience, that stressed the importance of MNS in language comprehension. In this perspective, we understand language because we are able to neurally simulate internal experiences connected with the referents of the utterances. Importantly, according to Buccino et al. (2016), those experiences have commonalities allowing different individuals to understand each other: those commonalities rest upon a shared biological and neural constitution. Therefore, the experience of grasping a cup is constituted also by one's physical asset (e.g., the effectors) and one's neural structures implicated in controlling those effectors. While the contribution of sensorimotor brain areas in the processing language is nowadays acknowledged as crucial (see next paragraph), I am not favoring this specific account of meaning. Indeed, besides our specie-specific capacity to understand each other through shared embodied mechanisms, I suspect meaning is not exhausted by the neural activation of brain category-specific areas. In this sense, as partly suggested by Barsalou et al. (1993) and as I will discuss in Chapter 3, we might appeal to a more "externalist" view of meaning than the one purported by Buccino and colleagues (e.g., Putnam, 1973). To revive Putnam's claim that meanings "ain't in the head", we could say that neither are they only in the brain. Rather, they emerge from the interaction that we, as agents equipped with specific sensorimotor and neural assets, engage with the environment (being that physical, social, linguistic or cultural).

In what follows, I will sketch out some of the most influential accounts of language processing, advanced in the framework of embodied and grounded research on cognition. The importance of explaining language processing in this frame is twofold. First, it is related to most basic assumption of embodied and grounded cognition, that sees higher and lower cognitive processes as strictly related. Second, explaining how humans understand language, and how they are able to interpret meaning is necessary in order to account for conceptual knowledge.

While classical theories of cognition make a clear distinction between high and low cognitive processes, EGC theories contend that cognition should be considered and studied in its whole; thus, if perceptual and sensorimotor processes were deemed as secondary by traditional cognitive science, EGC holds that they are as crucial as reasoning, speaking and remembering. Taking a leap forward, theories of embodied and grounded cognition argue that language is grounded and embodied in sensorimotor processes. This claim has taken many forms over the years, and it has been extensively scrutinized by both linguists (e. g., Lakoff & Johnson, 1980; Johnson, 1990; Gibbs, 2006) and psychologists. To give a hint about how language embodiment has been treated by scholars, we can start by drawing a distinction between semantic theories according to their being more or less bounded to sensorimotor systems. Meteyard et al. (2012), proposed a classification of theories of language with respect to their "stronger" or "weaker" adherence to embodiment.

Strong versions of linguistic embodiment claim that semantic systems use the same neural and sensorimotor information that is employed in performing actions. Gallese and Lakoff (2005), for example, claim that the understanding of concrete or action concepts (e.g., "to grasp") requires sensorimotor simulations; because sensorimotor simulations happens in the brain, as evidence from neuroscientific researches suggested, sensorimotor system is deemed as necessary in the understanding of concepts. Evidence supporting this position comes both from behavioral studies and from direct observation of brains' areas activated during language comprehension. Glenberg and Kaschak (2002), for instance, asked participants to judge whether sentences they were presented with were meaningful or not (Experiment 1). The authors manipulated the 'direction' of sensible sentences so that half of them implied a direction towards the body and the other half a direction far from the body (e.g., "Open the drawer" vs. "Close the drawer"). Participants responded by using a button box with three different keys: one near the body, the other half way and the third far from the body. Results showed that the interaction between sentence direction (towards the body vs. away from the body) and response direction (near the body vs. far from the body) was significant. Glenberg and Kaschak referred to this interaction as *action sentence compatibility effect* (ACE), and proposed that the execution of a motor action is facilitated by the understanding of sentences implying a movement compatible with the action itself.

Behavioral findings in support of the role of sensorimotor simulation during language comprehension accumulated over time, and started to thoroughly investigate the engagement of sensorimotor system (e. g., Borghi, Glenberg, & Kaschak, 2004; Kaschak & Borreggine, 2008; Scorolli & Borghi, 2007; Stanfield & Zwaan, 2001; Taylor & Zwaan, 2009; for reviews see among others Scorolli, 2014; Buccino et al., 2016). Evidence in favor of this version of embodiment has been provided in imaging and neuropsychological literatures as well. Neuro-imaging techniques, for instance, showed that the processing of linguistic stimuli concerning actions or effectors activates effector-specific sections of the pre-motor and motor cortical area (Hauk, Johnsrude, & Pulvermüller, 2004; Tettamanti et al., 2005). Transcranial magnetic stimulation (TMS) also provided converging evidence for the relation between language processing and action: in a famous study, Pulvermüller and colleagues (Pulvermüller, Hauk, Nikulin, & Ilmoniemi, 2005) compared RTs of words referring to leg actions (e.g., to kick) with those of words referring to movements involving arms and hand related actions (e.g., to pick) in a lexical decision task. TMS was applied both to arm motor areas and to leg motor areas. The stimulation of arm related motor areas led to faster arm than leg word responses; on the contrary, leg related words were responded to faster when TMS was applied to leg areas. Similar activations were also found when the linguistic stimuli were composed of nouns referring to concrete objects, especially manipulable objects (e. g., Chao & Martin, 2000; Buccino, Sato, Cattaneo, Rodà, & Riggio, 2009; Makris, Hadar, & Yarrow, 2011), in line with the literature on affordances (Tucker & Ellis, 2004). To summarize, the embodied cognition hypothesis is corroborated by a large amount of data, coming from different research areas (for reviews see e. g., Barsalou, Simmons, Barbey, & Wilson, 2003; Boulenger et al., 2006; Gallese & Lakoff, 2005; Glenberg & Gallese, 2012; Pulvermüller, 2005, 2018). Although this evidence is not without criticisms (see Mahon & Caramazza, 2008) it is nowadays clear that the sensorimotor system and the linguistic system are closely related.

Forms of "weak" embodiment are those that presuppose that the meaning of words is constituted, to some extent, by sensory-motor information. The most famous of these proposals is certainly the Perceptual Symbol Systems, developed by Barsalou (1999; 2003; 2008). In Barsalou's formulation, perceptual symbols are generated by the perceptual input systems, and are defined as schematic representations of perceptual instances (the things in the world) which stand in a non-arbitrary relation with them. They are non-arbitrary in that they are similar to the objects they represent. How is this similarity implemented? According to Barsalou (2003), multimodal and unconscious states of perceptual systems are neurally specified (viz. are activated) when understanding or retrieving a given word. Barsalou (2008b) refers to these multimodal and unconscious states as *simulators*. Simulators are conceived as distributed, modal representations derived from the experience with category instances, and neurally realized by populations of conjunctive neurons which capture and integrate neural patterns that are active during the same experiencing. Hence, simulators are intended as *types*, that once being established for a given category, are able to extract small subsets of their content as specific simulations.

Forms of "weaker" embodiment (or "secondary embodiment", following the taxonomy proposed by Meteyard et al., 2012) are those still relying on a-modal symbols with respect to the format of semantic representations; in these kind of proposals, the semantic system is independent from sensory and motor information, but directly associated with it (Mahon & Caramazza, 2008; Patterson, Nestor, & Rogers, 2007). To illustrate, Mahon and Caramazza (2008) argued that although evidence coming from neuroimaging, electrophysiological and neuropsychological areas seem to support an embodied version of conceptualization and language processing, at a closer inspection they don't seem to imply the rejection of a disembodied hypothesis.

The main argument is that, in order to completely endorse the embodied claim, one has firstly to provide compelling evidence that the activation of sensory-motor areas is not 'merely' a by-product of lexical processing. For example, the authors suggested an analogy with the automatic activation of phonologically related words in lexical processing; no one would admit that the meaning of a concept is comprised of words that are phonologically related to the concept (e.g., *hammock-hammer*). Nonetheless, studies investigating speech production showed that when participants are asked to name a picture while attending at distractors pictures, they are faster in naming pictures when the preceding distracting picture represented an item that is phonologically related to the target picture (Morsella & Miozzo, 2002; Navarrete & Costa, 2005).

What the analogy with the phonological retrieving processing is suggesting, is that sensory motor information could be activated by semantic elaboration as a sort of 'Pavlovian' reflex, but that it would not be constitutive of conceptual content. Henceforth, the authors proposed an hypothesis that they labeled "Grounding by Interaction Hypothesis", according to which concepts and meanings would be represented symbolically at an abstract level, that interacts with sensory modalities when instances of concepts are elaborated. The sensorimotor information, however, would not be a constitutive part of the semantic content of concepts. To further corroborate their argument, the authors reported a list of neuropsychological findings concerning apraxia (an impairment in using objects that is not explained by basic sensorimotor impairments). According to these results, patients can suffer an impairment for using objects while maintaining the semantic knowledge for the object intact (i.e. they are still able to name the objects, and they can also recognize pantomimes for these objects). Mahon and Caramazza thus conclude that a strong form of embodiment is not supported by these data, since they show that motor processes are not necessary in order to recognize and name an object. In a nutshell, semantic content is supposed to be stored at some abstract, amodal level which is connected to sensory and modal areas that become active once the concept has been instatiated. Although the embodied perspective on conceptualization is still a matter of debate among cognitive scientists–as portrayed by the short review just presented–even more skeptical scholars endorse a position that posits a relevant role for sensorimotor processes in conceptual knowledge.

1.6.3. What concepts look, feel, sound, taste and smell like? Despite differences in the centrality recognized to sensorimotor and perceptual systems, EGC accounts of conceptual knowledge share the idea that concepts are grounded in our bodily systems. Conceptual knowledge is traditionally considered to be the basis of our semantic memory, and thus shedding light on the mechanisms supporting semantic competence should reveal important insights regarding our way to comprehend and master things in the world. This being said, we already expounded on how embodied and grounded theories deal with semantic competence and linguistic processing. In order to support an embodied approach of concepts one has firstly to demonstrate that sensorimotor features are systematically activated when accessing conceptual knowledge, and therefore generally when accessing semantic knowledge. Evidence is growing suggesting that all object categories elicit specific patterns of neural activity that mediate perception of objects themselves. This is not only true when people see objects, but also when they are asked to name them, to answer to written questions about objects or to imagine them (Martin & Chao, 2001).

The scientific literature partly reviewed in the previous section concerning language processing (e.g., among others Hauk & Pulvermüller, 2004; Pulvermüller, 2005) proves that brain modal areas are automatically activated in the elaboration of language, and thus in the retrieving of conceptual knowledge. If that is the case, the other way around, we should need perceptual and sensorimotor features in order to access our semantic knowledge. This claim has been explored via behavioral tasks by relying on the assumption that simulations are a necessary component of conceptual knowledge. For example, if concepts related to different modalities are retrieved and comprehended through the activation of their specific modality, then switching between two modalities when verifying consecutive properties should take longer than not switching modalities.

This hypothesis was addressed in a set of studies (Pecher, Zeelenberg, & Barsalou, 2003, 2004) using properties associated with different modalities (e.g., vision, audition). The authors asked participants to verify if the predication of the property was congruent with the object (e.g., *microwave-beeping*; *eggplant-purple*) and the principal manipulation was whether the modalities of two consecutive properties were the same or different (as in the case of *microwave-beeping*; *eggplant-purple*). In case they differ, the authors hypothesized that the cognitive cost of shifting attention from one modality to another (then employing for example auditory vs. visual simulations) should lead to an increase in reaction times. Their results showed that switching modalities entails a cost, and together with other studies on switching costs (Marques, 2006; Vermeulen, Niedenthal, & Luminet,

2007) they suggested that sensorimotor simulations are not just epiphenomenal activations, rather they underlie conceptual processing.

Multimodal simulations then appear to be the basis of our conceptual structure. To date, scholars scrutinized all the sensory domains in order to verify if perceptual simulations support conceptualization. In a set of studies, Solomon and Barsalou (2001, 2004) investigated the perceptual domain of vision. They intended to test if a task such as the property verification task could have been influenced by the active simulation of a specific shape (Solomon & Barsalou, 2001) or by the simulation of the size (Solomon & Barsalou 2004). In the first study, they found that verifying the property *mane* for *pony* were easier for participants when this couple was preceded by the couple *mane-horse*, but not when it was preceded by *mane-lion*. The authors interpreted these results as evidence that simulations of a detailed shape (e.g., the shape of the mane of a horse, and not of a mane of a lion) was activated during the task, thus facilitating congruent responses.

To further disentangle whether the facilitation occurred precisely due to the re-enactment of perceptual features related to the shape, Solomon and Barsalou (2004) added two more variables. Besides perceptual influence they considered also linguistic associations and expectancy (regarding e.g., the polysemy of words). Using a similar property-verification task, results show that the "perceptual" variable explained the most of variance. Specifically, the dimension of size massively impacted the property-verification task: the bigger were the properties to verify, the longer were RTs. Inspired by the evidence that perceptual variable affect conceptualization, Wu and Barsalou (2009) hypothesized that hidden properties would have been more difficult to produce for items mentioned in isolation than for items with modifiers that could elicit the simulation of these hidden properties. Therefore, to manipulate perceptual properties they manipulated the variable of occlusion: a group of participants produced properties for items in isolation, that were considered as having occluded properties, e.g. *roots* and *dirt* for *lawn* are considered to be hidden properties. Another group of participants produced properties for nouns with modifiers such as *rolled-up lawn*, where *roots* and *dirt* would be unoccluded (evident) properties. If the simulation account is correct, then the rate of “internal” (or occluded) properties produced by participants should have been affected by the presence or absence of the modifiers. Indeed, across all three experiments hidden properties resulted to be more accessible when the target was comprised of a modifier than when it was presented in isolation. Therefore, overall, the experiments suggest that people construct simulations when producing properties: the image of a rolled-up lawn, for example, can more plausibly reveal roots and hidden dirt than the simple image of a lawn, and in fact nouns with modifiers generated more hidden properties than simple nouns.

Is this perceptual influence on categorization only limited to the visual sensory modality? Given the predominance of sight and vision-related language in our cognitive experiences (see e.g., San Roque et al., 2014 for a cross-linguistic comparison) it could be argued that simulations are active for visual experiences due to the predominance of the sense of sight in experiential phenomena. Contrarily to this expectation, González and colleagues (2006) investigated the sense of smell using fMRI. They asked participants to silently read words with a strong olfactory association (e.g., *cinnamon*, *vanilla*, *menthol*) and words with neutral or weaker olfactive associated meaning. Their results show that odor words activated automatically olfactory brain regions, supporting the claim that semantic knowledge relies on perceptual systems. A similar hypothesis was tested by Simmons and colleagues (2005) for the gustatory system: they presented participants either with pictures of food items or with food-related words in a neuroimaging study. They found an activation of gustatory and reward brain areas that simulated reactions to real eating experiences. These results were corroborated by Papies (2013) with a behavioral task. In her study, Papies contrasted features production for tempting and non-tempting food; if concepts are represented as simulations, tempting food should elicit more features referring to eating simulations than non-tempting food (for instance, *cookies* should prompt more eating simulations than *rice*). As expected, participants produced 53% of eating simulations for tempting food, while they only produced 23% of eating simulations for neutral items, such as rice. Consistently, a study by Fernandino and colleagues (2015) explored the cortical representation of word meanings related to five different sensory modalities: sound, color, visual motion and shape. Participants were requested to perform a semantic categorization task while fMRI data were acquired. Their results show that among the five modalities of interest represented by the stimuli, four elicited brain activity in the related sensory-motor areas.

1.6.4. Concepts are flexible representations. Cognition, as portrayed by proponents of the embodied and grounded theories and their applications, is based on modality specific systems, bodily actions, and physical environment. As a consequence of this intertwinement, concepts are conceived as emerging from distributed systems. Think for example of the concept of "bird": in an EGC perspective, brain areas processing modality-specific properties of birds (e.g., auditory regions processing the sound of a bird singing, visual regions encoding the shape and color of the bird) store conceptual knowledge related to birds, together with brain areas processing relevant actions or affective states. Hence, properties representing "birds" are distributed across several neural systems relevant for actions, perception and internal states, allowing for the emergence of the concept "bird". Importantly concepts are thought of as flexible representations, re-enacting relevant information about a given category in a specific situation (Kiefer & Barsalou, 2013). It is worth noting that the term *representation* in this debate refers to a specific, context-dependent and situated instantiation of a concept required or prompted by the task, rather than an a-modal symbol (cf. Connell & Lynott, 2014a). One of the main critiques moved to EG accounts of cognition is, in fact, that of being anchored to the cognitivist paradigm, in making implicit or explicit reference to the notion of representation for explaining cognitive processes (O'Reagan and Nöe, 2001). However, some scholars (e.g., Barsalou, 2016b; Connell & Lynott, 2014a) maintain that the construct of representation, when correctly interpreted, can still offer explanatory potential. Barsalou (2016b) for instance, claimed that:

> 1. There is no permanent static representation of hammers in long-term memory, built from a-modal symbols, that is loaded into working memory identically across different occasions.
> 2. The representation that does reside in long-term memory results from superimposed effects of associative learning distributed across relevant sensorimotor systems, with the resultant network changing constantly after every learning episode (and overlapping considerably with networks of other categories).
> 3. When this distributed network is accessed, it produces one of infinitely many hammers representations dynamically.
> 4. These representations serve temporary representational functions by providing useful inferences in specific situations. (p. 85)

But what is it meant by "situation", "context" and "context-dependent", and which are the implications for conceptual coherence and communicability of the supposed flexibility of concepts?

Conceptual flexibility has been widely investigated even before the "embodied turn", and the very fact that concepts can be influenced by context–thus undermining the notion of concepts as entities having a fixed structure–animated the scientific debate for a long time. As already discussed in paragraph 1.4, in fact, a large body of experimental studies demonstrated that contextual factors play a pivotal role in the conceptualization of certain categories (cf. Barsalou 1981; Barsalou & Sewell, 1984; Barclay et al., 1974). More recently, embodied and grounded approaches to cognition have emphasized how conceptual access and processing varies with context, highlighting the deep interconnection between conceptual knowledge and context at different levels. The simplest way to test this hypothesis in experimental settings was to manipulate tasks conditions. Findings coming from the investigation of the so-called "modality switch effect" (already discussed in the previous paragraph), for instance, showed that the modality in which stimuli are presented to participants affects conceptual activation, even in studies that did not require direct conceptual processing (Van Dantzig, Pecher, Zeelenberg, & Barsalou, 2008). Analogously, contingent changes in bodily sensations conveyed by bodily posture (Dijkstra, Kaschak, & Zwaan, 2007; Havas, Glenberg, Gutowski, Lucarelli, & Davidson, 2010) or direct perceptual stimulation have an impact on subsequent judgement and categorization tasks[6]. For instance, Connell, Lynott and Dreyer (2012) stimulated the haptic system via tactile vibration while having participants comparing small and manipulable objects vs. large and non manipulable objects. Their results showed that the comparison was facilitated for small objects while that was not the case for big ones. The first direct neurocognitive investigation of conceptual flexibility comes from a study by Hoening and colleagues (2008), that

[6] Recently, Matheson and Barsalou (2018) identified phenomena falling under these circumstances as evidence for a "new" embodied hypothesis, to be added to the previous ones formalized by Shapiro (2011). They labelled this perspective the *influence hypothesis*. According to this hypothesis, the state of the body influences cognition, and importantly this influence is bi-directional. Therefore, not only the posture can influence one's own perceptions and categorizations, but for instance voluntarily imagining events can improve behavioral performances (e.g., Bernardi, De Buglio, Trimarchi, Chielli, & Bricolo, 2013).

explored through fMRI and ERPs the degree to which modality-specific brain areas flexibly concur to conceptual processing. Based on previous findings that identified category-related brain areas activations (e.g., Chao & Martin, 2000; Humphreys & Forde, 2001; Martin & Chao, 2001), the authors investigated the activation of visual areas (traditionally found to be active in the processing of natural kinds) and motion-sensitive/motor areas (relevant for the processing of artifacts). In a semantic-fit task, they provided participants with either visual or action related features, and subsequently presented them with target words indicating natural objects or artifacts. Crucially, they hypothesized that since visual properties are less relevant for artifacts with respect to functional properties, when presented with a non-dominant feature to verify, brain activity should be increased. For example, if participants are requested to verify whether the probe "elongated" is semantically related to "knife", they should exhibit higher brain activity than when they are presented with the pair "to cut/knife". Their results showed that semantic category strongly interacted with the type of attribute previously presented, in RTs, fMRI data, and electrophysiological results: participants were slower in verify the semantic fitness of action-related attributes compared to natural features with natural objects. Moreover, they reported cross-over interactions between semantic category (natural kind vs. artifact) and attribute type (visual feature vs. action-related feature) in modality-specific brain areas such as the posterior inferior/middle temporal, ventral premotor and posterior parietal cortex. Importantly, those interactions were shown to emerge as early as 116 ms after word onset, ruling out the possibility that the activation of sensorimotor brain areas is only a consequence of conceptual processing. In their words (Hoening et al., 2008):

> The observed cross-over interactions between category and attribute type clearly show that the functional activation in sensory, motion, and motor regions critically depends both on task-requirements (verification of visual vs. action-related attribute probes) and relevance of the required conceptual feature for a particular category. (pp. 1808-1809)

Further neurocognitive evidence speaking in favor of a plastic modulation of conceptual system is attested by a study from Kiefer and colleagues (Kiefer, Sim, Liebich, Hauk, & Tanaka, 2007), that evidenced how even by simply training participants interactions with novel categories under different training conditions (e.g., by stressing perceptual features on the one hand, and functional or action-related features on the other hand) the same object is differentially processed depending on the sensory-motor interactions during knowledge acquisition. In the training session of the study, participants either mimed a gesticulation toward the detail feature of the novel object or pointed to it. Subsequently, the authors measured the brain activity of participants during a categorization task. Interestingly, the pantomime group was the only one exhibiting early activation in frontal motor regions and later activation in occipito-parietal visual-motor regions, whereas in the pointing training group none of these effects was observed. The authors discussed their results as supporting the idea that action information contributes to conceptual processing depending on the specific learning experience with concepts (see also Kiefer & Martens, 2010).

This brief overview evidenced how contingent task (and context) related constraints affect conceptual processing and representation (for reviews see Lebois, Wilson-Mendenhall, & Barsalou, 2015; Yee & Thompson-Schill, 2016). But are those effects limited to recently encoded information, such in the case of prime paradigms, or does previous stored knowledge also impacts conceptual tasks in a relevant manner? Recent findings showed that relevant knowledge of specific actions to be performed with objects affects categorical judgements even though the actions evoked by the objects were irrelevant for the categorization purposes (Kalénine, Shapiro, Flumini, Borghi, & Buxbaum, 2014). In the same vein, having interacted with an object primarily through one sensory-modality or another in the course of life, has an influence on subsequent cognitive tasks. Connell and Lynott (2014b), for instance, keeping psycholinguistic variables constant (e.g., length, word frequency, orthographical and phonological neighbors), investigated the effects of semantic variables on lexical decision and reading-aloud tasks. Specifically, the semantic variables they considered were auditory and visual strength ratings. Their results showed that the degree to which a concept is visually experienced facilitates lexical decision performances, whereas reading-aloud performances benefits of the strength of both visual and auditory experience with concepts. Along these lines, Connell and Lynott (2014a), in discussing evidence in favor of a more flexible conception of conceptual system, suggested that we cannot represent the same concept twice, in that even though perceptual and linguistic constraints would be exactly replicated on two separate occasions, the representation of the concept could not be the same, given that the retrieving experience and the time itself would contribute to the changing of the concept (for a stronger version of this claim see also Casasanto & Lupyan, 2015). Based on these considerations, one might argue that the process of communication is inevitably doomed to fail, since we would never be able to share concepts not only with our community, but also with past versions of ourselves. However, Connell and Lynott (2014a) elegantly dismissed this potential criticism by explaining that variability does not necessarily entail instability: in particular, language constitutes an important source for coherence, even though it is completely reasonable to assume that when communicating our ideas e.g. to our friends, we are not always referring to the very same entities. Moreover, often words and utterances are embedded in a situational and non-verbal context which facilitates the communication (c.f. the example of “Fire!”, pp. 400-401). It should be noted that, when all of those aspects are missing (i.e. there is no completely adherence between my concept and the concept of my friend, even though we use the same word to denote it and there is nothing in the physical or contextual environment that anchors the concept to relevant experience), we can still negotiate the meanings of concepts through communication and discursive practices.

1.7. Preliminary Conclusions. Against “Black Holes in Conceptual Space”

The presentation of competing theories of concepts displayed so far disclosed how controversial has always been the research regarding conceptual knowledge. Indeed, as Barsalou pointed out (2016a) “it is difficult to think of a domain characterized by so many different views and so much disagreement” (p. 1122). Nonetheless, over the past 20 years empirical evidence of grounding and embodiment increased dramatically, changing the traditional assumptions of cognitive science. Among these assumptions, the one positing a strict separation between higher cognitive processes and sensorimotor or perceptual systems seems nowadays completely outdated. In this framework, concepts and conceptual mastering pertain both to our higher cognitive abilities (such as memory, reasoning and inference) and to our sensorimotor processes. Moreover, although a precise characterization of concepts would possibly never be reached, EG theories of cognition provide some interesting means to tackle the issue of conceptual representation. With respect to strictly representational and computational accounts, for instance, they seem to overcome the problem posited by what have been labeled "black holes in the conceptual space" (cf. Barsalou, 2016a, p. 1127). Specifically, recent proponents of a-modal concepts failed to define what exactly a-modal concepts are and how should they work—except for the assumption that they should be something different from multimodal concepts. And yet, as Barsalou acknowledges, a-modal related claims are still attracting a conspicuous number of scholars.

Stemming from the arguments and the discussion depicted so far, the notion of *grounding* is introduced in this debate as a means to account for conceptual knowledge. Inspired by Harnad's symbol grounding critique to RCTM, some scholars embracing the embodied stance stressed the importance of the coupling of body and environment in the constitution of human knowledge. In this perspective, not only sensorimotor and biological constraints affect our cognition, but also the very fact of being human agents embedded in a specific physical and social context. The notion of grounding has thus a broader extension than the one of embodiment, nonetheless acknowledging the importance of the latter in human cognition. As Barslaou (2016) puts it, grounding refers both to a new way of studying cognition (i.e. refusing traditional approaches that study cognitive processes in isolation), and to the purpose of "establishing specific accounts of how cognitive processes in the brain utilize the modalities, the body, and the environment." (p. 1129). Concepts are, in this sense, grounded in our bodily mechanisms and in our specific neural architecture, but also constrained and influenced by context-specific aspects. This definition of concepts appears, with no doubt, less elegant than some of the previous characterizations; at the same time, however, by not positing an *a priori* construct that explains all the functions of concepts, it seems a more scientifically fruitful tool. This point has been addressed for example by Barsalou and colleagues (Barsalou et al., 2003):

> In the approach we take here, nothing is explicitly called a concept. Instead our goal is to articulate specific mechanisms that produce conceptual processing. […] The difficulty of defining concepts raises the issue of whether it is a useful scientific construct. Perhaps no discrete entity or event constitute a concept. Perhaps conceptual functioning emerges from a complex configuration of mechanisms in both the world and the brain. (p. 83)

What are these mechanisms that explain conceptual functioning? According to Barsalou (2016, p.1134), "a concept utilizes neural resources that represent features in modality-specific systems, together with various kinds of abstract features.". This last claim leads us to one of the two most insidious objections moved to EG theories of concepts. Specifically, what are we talking about when talking about "abstract features"? Historically, explaining any form of abstraction has been a major problem for theories of embodied and grounded cognition, given their high reliance on perception and action. In particular, accounting for the representation of abstract concepts such as *beauty* or *freedom* has been deemed as a shortcoming for EGC theories, together with the accuse of being reductionist theories[7]. In the next Chapter, I will deal with abstract concepts and words (ACWs), being their representation, processing and status the central theme of this dissertation. Following the structure of this Chapter, I will present proposals within the embodied and grounded panorama that strived to account in a grounded perspective for abstract concepts, and I will partly discuss their limitations. I will lastly review Multiple Representations Views (MRVs) of conceptual knowledge, arguing that they are the best

---

[7] The debate concerning the alleged reductionist claim entailed by the embodied and grounded perspective on concepts relates to the fact that some scholars are critical in accepting the neural activations triggered by words as the only constituent of conceptual knowledge. This debate, although extremely interesting and complex, exceeds the purposes of this dissertation. For a careful discussion on the term *grounding* and its implications for theories of conceptual knowledge though, see Leshinskaya and Caramazza (2016) and the response of Barsalou (2016a) in a special issue of *Psychonomic Bulletin and Review* dedicated to the theme.

candidates to explain conceptual functioning and acquisition. The core of the following Chapter will be the presentation of the WAT (Words As social Tools) theory, proposed by Borghi and colleagues in the frame of MRVs. I will discuss relevant tenets on abstract concepts that are entailed in this proposal, in order to show how a theory that is couched in the EG tradition can account for abstract concepts. Afterwards, I will present some considerations regarding possible future strategies to adopt in the inquiry of ACWs.

CHAPTER 2

ABSTRACTION, ABSTRACTNESS, AND BEYOND

2.1. Abstract Concepts. Opening The Pandora's Box

Intuitively, we all know what the terms “abstract” and “abstraction” mean. We use these terms in everyday interactions without paying special attention to their meanings, for example when describing something vague. The word “abstract” has been also used to denote artistic movements such as the abstract expressionism exemplified by Jackson Pollock, that were said to be unrelated to objects in the real world. Therefore, “abstract” seems to indicate something detached from the physical reality, something that is difficult to grasp, even mentally. It is thus not surprise that Embodied and Grounded approach to cognition struggled so much in framing abstract thought.

Maybe, in this discussion it might be helpful to step back for a moment and consider the origin of the word “abstract”. As a matter of fact, the word abstract gains its meaning from the Latin verb ABSTRÀHĔRE[1], which is formed by the two components ABS + TRÀHO, where TRÀHO means “to draw, to pull” and the prefix AB(S) refers generally to the meaning of “away, from”. Consequently, the etymology of the word conveys a precise meaning, which is not vague as it appeared in the first place. The conceptual core of the word is constituted by the verb TRÀHĔRE, that refers to the movement of pulling

[1] Retrieved from https://www.lexico.com/en/definition/abstraction powered by Oxford.

something from somewhere to somewhere else. This is particularly exemplificative of the mechanism of abstraction. Rooted in the term, is the idea of extracting some general features from instantiations, which is also the core function of concepts (see Chapter 1). In this sense, all concepts are forms of abstraction in that they respond to the need of our cognitive processes to store relevant information from the environment in a coherent way, in order to use it when needed. What is then the difference between abstract and concrete concepts, as depicted by cognitive science and philosophy? Specifically, why abstract concepts are so difficult to explain for simulation-based theories?

In order to carefully investigate what is at stake when dealing with abstract concepts, a first distinction we can draw is the one between *abstraction* and *abstractness*, proposed by Borghi & Binkofski (2014). As noted before, in fact, the authors acknowledge the fact that in order to form categories and concepts we need to extract characteristics from the perceptual world, and then to unify them by the mean of words. Borrowing their own example, the concept of dog–although it is a concrete concept in the traditional sense–can be considered as involving a certain degree of abstraction. In fact, the word dog stands for a number of exemplars of the category that are very different one from another (think of a chihuahua and a Siberian husky; they are not so similar after all), but that somehow share characteristics that make it possible for them to be part of the general category of dogs. In this sense, i.e. in representing a higher level of knowledge such as taxonomic classifications, the concept of dog is said to have a high level of *abstraction*. *Abstractness*, on the other hand, specifically refers to the property of a concept of being detached from physical reality. Consider for example this triplet of words: *lust*, *pride* and *avarice*. Clearly, they are not positioned at the extremes of a taxonomy (maybe they can be ordered hierarchically as capital sins), and they are not directly linked to any specific physical experience. Rather, their meaning applies to a wide range of situations, and additionally their range of appliance to situations is susceptible of changes over time and across cultures. Medieval bestiaries, for example, used to represent sins and virtues through drawings of beasts, which allegorically (and symbolically) represented the concepts of sins and virtues. Therefore, by the means of tales or descriptions of beasts' behavior, it was easier to convey meanings that were otherwise too abstract and complex. An illustrative example of this shortcut is provided by the allegory of the three beasts in Dante's Inferno (Canto 1), where lust, pride and avarice are represented as a lynx, a lion and a she-wolf. Why are these kinds of concepts difficult to define, so difficult that we often needed creative ways to explain them? In Borghi & Binkofski's perspective (2014) this has to do with the fact that the *abstractness* of a concept is determined by its lack of a concrete, manipulable and single referent. To illustrate, while *dog* maintains a degree of abstraction, we can still touch, hear, and also smell a dog (being that a chihuahua or a Siberian Husky); on the contrary, we cannot touch, hear or smell pride or lust. We can maybe physically experience their consequences, but their referents remain abstract.

This aspect of physical and perceptual detachment from the experiential world constituted the heart of the problem in explaining abstract concepts that EG theories strived to face in the last decades. Indeed, if concepts are multimodal simulations tied to sensorimotor and perceptual states (see Chapter 1), it is easy to see how abstract concepts, lacking physical referents, can portray a pitfall for multimodal theories of conceptual knowledge. Nonetheless, scholars embracing an embodied and grounded perspective on cognition advanced several proposals aimed at explaining how abstract thought and abstract knowledge emerge from the interaction between our minds and the physical world. In the following sections, I will outline some of these seminal accounts of EGC theories on abstract concepts, with the purpose of addressing their strengths and weaknesses. In the central section, I will instead focus on a specific set of proposals, namely "Multiple Representation Views" (MRVs), claiming that at the state of the art they seem the best candidate for unraveling the complexity of abstract concepts. Specifically, I will describe and discuss in detail the WAT (Words As social Tools) proposal, showing how it can explain abstract concepts in a grounded perspective. The last section of the Chapter is dedicated to some of the most interesting issues posed by MRVs, and to their relevance for the future understanding of abstract conceptual knowledge.

The discussion on abstract concepts will be developed following the criterion introduced in Chapter 1: I will follow a path from theories embracing a fully embodied perspective on abstract concepts, to theories proposing a partial disembodiment of abstract concepts. Ultimately, I will focus on a specific view (the WAT proposal) that takes a slightly different stance in this debate.

2.2. Abstract Concepts are Embodied

2.2.1. Love is a journey. Conceptual Metaphor Theory. In this section I am going to describe proposals that *defended* a full embodiment of abstract concepts. Over the years, evidence in support of these accounts *piled up*, especially due to linguistic and experimental studies. As these first two sentences demonstrate, metaphors are pervasive constructs in our everyday language. Sometimes, we employ metaphorical language without even knowing we are using a rhetoric figure. This observation led George Lakoff and Mark Johnson (1980) to reconsider the role of metaphors, from simple rhetoric artifacts to constitutive of human thought.

Starting from the study of English common expressions, the authors identified several metaphorical structures underlying conceptualization. Unsurprisingly, most of the metaphors the authors investigated were used to describe abstract concepts. Take for example the opening sentence of this paragraph: I used the expression “defended” in relation to theoretical proposals. But ultimately, “to defend” is often (almost always) referred to wars. Lakoff and Johnson described this specific structure with the metaphor “an argument is a war”, precisely because they noted the recursive pattern of this semantic borrowing. The second sentence instead refers to what the authors identified as the metaphor of “more is up”; thus, accumulating evidence (which is an abstract notion) is mapped spatially as something growing vertically (a situation we often encounter in our everyday experience).

The basic idea underlying their proposal is that, since some concepts are too complex to be immediately understood (usually abstract concepts, that they call *topics*), we need to ground them in more concrete concepts (*vehicles*). This process is reflected in linguistic structures, that in this perspective provide a direct window of access to conceptual structures. What is interesting in this approach is that, in order to understand abstract concepts, we need to rely on more concrete, experiential concepts. As a second step, this grounding process is encoded in linguistic structures, conveying specific meanings. Therefore, even though through a process of indirect encoding, in this frame abstract concepts appear to be embodied (Gibbs 2006). Other examples taken from their book are the metaphor of “love as a journey”, which is exemplified by expressions such as “our relationship has come to an end” or “their marriage has hit a dead-end street”.

In detail, Lakoff (1987) claimed that there are some basic conceptual metaphors that are central to human cognition. Among those, “more is up; less is down” is particularly useful in the understanding of how abstract concepts are considered to be embodied. Linguistic expressions entailing this type of metaphor are really common, e.g., prices are said to “rise” and financial resources can be “low”. Lakoff suggested that the metaphor of verticality for describing quantity is formed through empirical observation. Consider a basic example such as pouring water in a glass. The more water is added, the more the glass will be filled with the liquid, until the water will reach the edge of the glass. Therefore, the metaphor collapsing quantity into verticality is based on the observation of a correlational structure between these two domains, one of which is directly related to our experience. This last point allows us to comprehend even more abstract notions, such as financial issues that might not be as intuitive otherwise.

Verticality is commonly employed as a source domain to refer to other abstract entities or concepts, such in the case of “up is happy and down is sad” or “up is good and down is bad”. On the latter, Meier and colleagues (2007) performed a study in which participants were asked to memorize locations of pictures that were god-related, devil-related or neutral. Crucially, pictures were presented either in a high or low location of the screen. Their results show that participants tended to remember god-like pictures at a higher location with respect to neutral pictures, and devil-like pictures at a lower location with respect to neutral ones. Overall, those results point to the existence of a metaphorical mapping that links divinity concepts such as God and Devil (which are highly abstract concepts) to the domain of space that, in being more concrete, can support reasoning about more abstract categories. An abstract domain that greatly fascinated scholars is the domain of time, which has been also investigated in the light of the Conceptual Metaphor Theory. Because time is not perceivable through our senses–again, we can experience consequences of time, but not a minute passing–our linguistic system has evolved to represent the category of time in different ways. One of the most common options is to map the domain of time into the most perceivable domain of space. As complex as it might appear in these terms, our experience is full of linguistic expressions encoding this kind of relation: just to give a hint, consider the world-wide famous song “Don’t look back in anger” from Oasis, which specifically suggests Sally not to regret anything from her past. Therefore, in the Western society, the past is metaphorically conceptualized as something behind us, while the future is understood as something in front of us, mostly because it is unknown.

To test whether the general assumption related to the conceptual metaphor of space-time was generalizable to non-western societies with a different system of values, Núñez and Sweetser (2006) investigated gestures in the Aymara population. The main characteristic of this population is that with respect to the majority of western societies, their spatial mapping of time is reversed: hence, the future is “behind the ego” and the past is “in front of the ego”. The analysis of linguistic and gestural patterns revealed that this time-construction was not limited to linguistic expressions, but it was also encoded in gestures participants produced when narrating stories. Casasanto and Boroditsky (2008) also focused on the spatial relations conveyed by time; they manipulated the movements of dots on a screen and the displacement and duration of that movement in an experiment where participants were asked to estimate the duration of the movements. Their findings show that judgments on time duration were influenced by the spatial distance the dots covered.

Overall, these results suggest that metaphorical thinking plays an important role in grounding abstract concepts, providing the speakers some useful links between abstract domains and more perceivable ones. Importantly, those patterns affect our cognition at a deep level, as attested by experimental studies such as the ones described above.

2.2.2. Grasping ideas. Abstract concepts and action. The Conceptual Metaphor Theory, as sketched out in the previous paragraph, provided interesting insights concerning the mechanisms responsible for the grounding of abstract concepts and language. Nonetheless, this form of grounding seems to be somehow a “secondary” step in the comprehension of abstract entities, in that it is mediated by perceptual experiences and only afterwards encoded in linguistic expressions. On the other hand, evidence supporting a direct embodiment of abstract language has been observed in relation to action sentences. Indeed, the *action compatibility effect* (ACE) described in the first Chapter has been proved to occur not only in sentences involving concrete objects. In the same study by Glenberg & Kaschak (2002) the authors reported a facilitation for responses whose direction was compatible with the direction of sentences presented to participants also for abstract meanings.

Specifically, sentences expressing abstract transfer elicited faster responses when the button to press was compatible with the direction of the transfer. For example, a sentence like “Liz told you the story” facilitated responses towards oneself, just like a sentence like “Jane handed you the ball”, which has a clear manipulable object-referent. These results were further replicated and extended in a study by Glenberg and colleagues (2008) that implemented the original study by measuring motor system modulation through TMS in the reading of transfer sentences. Their results show that larger MEPs (motor system modulation) for the transfer sentences compared to the no-transfer sentences. Therefore, overall, during language comprehension motor areas of the brain are differentially activated according with the linguistic content. Crucially, the size of the sentence type effect resulted to be comparable for sentences that describe concrete and abstract transfer. Hence, the authors interpreted these results as evidence that the motor system is modulated during comprehension of both concrete and abstract language.

It is worth noting that the aforementioned studies directly investigated the motor activity connected both with concrete and abstract meaning. Glenberg and colleagues (2008) explained their findings by referring to what they called “action schema” that in their perspective is developed during infancy: infants learn to represent concrete transfer through the motor system (e.g., throwing a ball, handing a napkin) and subsequently they generalize this schema to more abstract domains. While this explanation is certainly interesting, and can clarify their results, it is important to point out that the sentences presented were specifically related to hand movements or to transfer meaning. Therefore, the generalization of the findings to the more general abstract domain resulted problematic.

2.3. Abstract Concepts and the Role of Emotions

Besides classical accounts on abstract concepts such as the ones reviewed in the first Chapter–among which only some of them expressly dealt with abstract thought–one research branch particularly focused on abstract meaning, viz. psycholinguistics. Two seminal proposals in this panorama are the *Dual Coding Theory*, DCT, advanced by Paivio (1986, 1991) and the *Contextual Availability Theory*, CAT, (Schwanenflugel, Akin, & Luh, 1992; Schwanenflugel, Harnishfeger, & Stowe, 1988)[2]. Both these proposals were aimed at explaining the concreteness effect, namely the advantage in terms of reaction times (RTs) that happened to be specific for concrete terms with respect to abstract terms.

[2] For an in-depth discussion of these proposals see Borghi & Binkofski, 2014.

On the one hand, according to the DCT abstract and concrete terms differ in the richness of their representation, due to their being stored and represented in different systems. Concrete words are thought to be represented in two independent, functionally related systems: *logogen* and *imagen.* The first is a verbal and linguistic system, the second is an iconic and non-verbal system. Abstract words, instead, are only represented in the first one of these two systems. Therefore, the advantage in RTs found during the processing of concrete words over abstract words is the result of the fact that concrete words can exploit a major amount of information.

In the light of the model proposed by the CAT, conversely, abstract and concrete words rely on the same system, i.e. the verbal system. They are processed and stored through the same process of linguistic and semantic associations, and the *concreteness effect* is explained by positing that concrete words possess stronger and more linguistic and semantic associations than abstract words. Specifically, concrete words entail more contextual associations with respect to abstract words, and this render their access easier and faster than for abstract words.

Despite the importance assigned to variables such as “abstractness” and “concreteness” in studies investigating word processing, the evidence is not undisputed (Barca, Burani, & Arduino, 2002). Moreover, in line with more grounded approaches to cognitive processes, it has been objected that words are best described in terms of their emotional valence instead of referring solely to dimensions such as abstractness and concreteness (cf. Matheson & Barsalou, 2018). A line of research, for example, stressed how experiments conducted in order to investigate the concreteness effect failed to take into account the emotional valence of words. In this vein, it has been proposed that abstract words are more emotionally connotated than concrete ones, and that the role of emotions in the initial acquisition and subsequent processing of abstract terms is to provide a sort of bootstrapping mechanism. As Kousta and colleagues (Kousta, Vigliocco, Vinson, & Andrews, 2011; 2009) pointed out by analyzing a large dataset of words, when imageability and contextual availability (which are two psycholinguistic variables typically associated with concreteness) were kept constant, emotional valence resulted to be a negative predictor for concreteness: the more a word was rated as concrete, the less it was emotionally connotated, and conversely, the more a word was rated as abstract, the higher was its emotional valence. Moreover, once critical psycholinguistic variables were controlled, the typical concreteness effect disappeared and instead the authors reported an “abstractness effect”, which they interpreted in the light of the emotional characterization of abstract words.

The proposal advanced by Vigliocco and colleagues (2009) to explain abstract words and concepts can thus be summarized in this way: (a) there are two main sources of information that can be exploited for the acquisition of words, namely an experiential based source, and a linguistic one; (b) differences between concrete and abstract words are the result of the different proportion of information they rely on; (c) specifically, concrete words are anchored in the sensory-motor and experiential system to a greater extent than abstract words, which instead are more anchored to the linguistic and affective system, both in their acquisition and in their subsequent semantic representation. Although this proposal is appealing, in that it spells out not only the role of sensory-motor system, but also the role of other internal grounding mechanisms such as affection and emotion, it is not uncontroversial. Criticisms related to this specific accounts and evidence for a neat distinction between emotional and abstract concepts are presented below, and in the next chapter.

2.3.1. Grounding abstraction and emotions in language[3]. While there is clear evidence that emotion words activate a simulation, the debate on whether emotional words can be considered as a particular kind of abstract words or not is still open. The growing of scientific literature on emotional words has contributed to enlarge the discussion, by supplying contentious evidence.

According to some scholars, emotional concepts can be considered as a means leading the acquisition of more abstract concepts, since they represent the first concepts acquired without the mediation of a specific and single concrete referent. Their results show, among other, that abstract words are processed faster than concrete ones; this is explained by the authors on the basis of a greater affective connotation of abstract words compared to concrete nouns. Emotional valence was proved to modulate processing: words judged to have positive or negative emotional connotation were processed faster than words with an emotionally neutral meaning. Crucially, abstract words tended to be rated as highly emotionally valenced. In a recent study, Ponari et al. (Ponari, Norbury, & Vigliocco, 2018) asked adults to evaluate the age of acquisition of abstract and concrete words, including positive, negative and neutral emotional words. They found out that positive and negative abstract words were acquired earlier than neutral ones, and that both abstract and concrete positive words tended to be acquired earlier than other words. In a further lexical decision task they asked children aged 6 to 12 to discriminate positive, negative and neutral abstract and concrete words. Results showed that accuracy increased with age and valence

[3] This paragraph is part of an essay published in 2017: (Mazzuca, Barca, & Borghi, 2017) "The peculiarity of emotional words" which is available at Rivista Internazionale di Filosofia e Psicologia via https://www.rifp.it/ojs/index.php/rifp/article/view/rifp.2017.0010/767

interacted with age for abstract but not for concrete nouns: children aged 8-9, the age in which abstract vocabulary increases, were more accurate with positive abstract words compared to neutral words. Overall, studies like the aforementioned ones insist on the idea that emotional aspects characterize all abstract concepts and that emotional words are a subset of abstract words and concepts.

Other studies have instead claimed that emotional concepts are to be considered as a clearly distinctive kind of concepts compared both to concrete and to abstract ones. In their studies, Altarriba et al. (1999) have demonstrated that emotional concepts are recalled more accurately than concrete and abstract ones, and that they are rated differently with respect of psycholinguistic criteria such as concreteness, imageability and contextual availability. The results obtained by Setti and Caramelli (2005) using a rating and a definitions production task, also suggest that the conceptual knowledge related to emotional concepts is markedly different from that related to both concrete and abstract ones.

Mazzuca and Borghi (2019) also compared concrete, abstract and emotional words. Participants had to perform a lexical decision task followed by a word recognition task; responses were given pressing a pedal while holding a key with the hand or with the mouth. In the lexical decision task response times with concrete and emotive words did not differ, while responses to abstract concepts were slower. The analysis on accuracy in the recognition task revealed that responses to abstract words were more accurate than those to emotive words and in tendency more accurate than those to concrete ones. The interaction between the effector involved (hand, mouth) and kind of words showed that the recognition was facilitated with the mouth with abstract and emotive words, while it was facilitated with the hand with concrete words. The results of this study in both the lexical decision and the word recognition task are clearly difficult to reconcile with the view according to which abstract concepts and emotional concepts can be assimilated.

Crucially for a perspective that emphasizes the role of the body in cognition, another recent study has shown that emotion related sentences are rated as associated with the mouth and with other bodily effectors. Ghio and colleagues (2013) asked participants to rate the association to the mouth, the hand/arm and the leg/foot of sentences related to mental states (e.g., “she remembers the past”), to emotions (e.g., “she shows her disappointment”) and to mathematics (e.g., “she determines the sum”). Ratings for the mouth scale indicated that emotional sentences were significantly more associated to mouth actions than were either mental states and mathematical sentences; ratings for the hand scale revealed that mathematical sentences and emotional sentences were significantly more associated to hand actions than were mental states utterances. Considering the leg scale, emotional sentences were significantly more associated with leg actions than the other two kind of sentences. These results support the idea that emotions are grounded in bodily states more than different kinds of abstract concepts (mental concepts and numbers), including embodied multi-modal representations.

As highlighted by this brief overview of the literature, interpreting data on emotional words is still a controversial matter. Considering the complexity of the theoretical and empirical evidence about emotion related words, emotional concepts represent a peculiar and intriguing case. Moving from an embodied and grounded approach, we will here contend that emotional concepts hold a special status with respect to concrete and to purely abstract ones.

On the one hand, their direct involvement of the body could render them similar to concrete concepts, albeit concrete concepts (with some exceptions, as concrete concepts referring to food) usually activate neural areas related to the actions performed with manipulable objects (e.g., hand or arms), while emotional concepts elicit a more general bodily activation. On the other hand, there are reasons that can lead to include emotional concepts and words in the semantic domain of abstract concepts. Like abstract concepts, emotional concepts are characterized by a high intra- and interpersonal variability connected to the assignment of meaning: since they lack of a single and concrete referent, they are more subjected to vary across people and spaces than concrete concepts. There are other similarities between emotion and abstract concepts that can be taken into account. An important similarity concerns the fact that, similarly to abstract concepts, emotional ones seem to strongly involve not only the hand/arm but also the mouth motor system (Ghio et al., 2013). Different mechanisms can subtend this activation of the mouth. The first cause underlying the mouth activation could be the fact that emotions involve our body in its wholeness.

A second mechanism is the activation of linguistically conveyed information. This mechanism, that in our view is highly critical for abstract words, is not so crucial for emotional concepts, but it might play some role especially for more abstract emotional terms. Even though basic emotional words like “anger” and “fear” activate a clear bodily pattern, suggesting that they are experienced and stored in conceptual knowledge as complex and multiple representations, other kinds of emotional words are indeed more abstract and not so clearly bounded. For these concepts, similarly to what happens with abstract words the mouth activation could be due to the activation of linguistically conveyed information, contributing to shape and delimit the meaning of some emotion concepts. Consider for example a term like “love” and how language can contribute in contextualizing its meaning. It is reasonable to think that the first experience with “love” of a child –i.e. the love of her/his mother–is considerably different from the subsequent experiences with that feeling. With the growing of experiences and linguistic competences, the child will presumably learn that the feeling that relates her/his parents, or the affection for her/his dog, are all occurrences that can be collected under the linguistic label of "love", even though they have different hues. Anyway, the importance of language in delimiting their meaning and their association with the mouth is not sufficient to completely embrace a vision of emotional terms as part of abstract ones. Certainly, language may play a role in the conceptualization of emotional words, by providing a frame in which to ground all the emotional experiences, but the activation of the mouth effector can have other implications, for example it could be a consequence of the more general bodily activation.

In sum: we propose to reconsider the relation between concrete and abstract concepts, viewing it not as a dichotomy, but as a continuum, in which concepts are organized and represented at a different level of abstractness, and in which emotion concepts represent a peculiar kind of concepts. In line with the suggestion of the Words As social Tools proposal (Borghi & Binkofski, 2014; Borghi et al., 2017), multimodal representations are involved both in the comprehension of a concrete term, and in the comprehension of an abstract one. Words should be considered as social tools, that is, as having a performative aspect, as being useful tools to use in order to operate distinctions in the environment, and to cooperate in the society. According to this proposal linguistic explanations provided by competent speakers could be the basis of the acquiring of abstract meanings, helping to glue the linguistic label to the experience. If concrete concepts activate mostly the sensorimotor system and abstract concepts rely heavily also on linguistic and social experience, what happens with emotional concepts? We propose that embodied words first of all activate an embodied simulation, leading to re-enact the original emotional experience. However, also social and linguistically conveyed information can contribute to shape emotion concepts, especially more complex and sophisticated emotions like “shame”. As the studies mentioned in the previous paragraphs show, emotional words and sentences seem to activate both the hand and arms areas and the mouth; the mouth activation can be either a byproduct of the whole bodily activation or can be due to the activation of the linguistic system. In conclusion, emotional terms seem to be the intermediate level between concrete ones and abstract ones, sharing properties of both, but at the same time maintaining a peculiar status, and being irreducible to both the categories.

2.4. Language and Situated Simulations. Evidence in Conceptual Processing

The Language and Situated Simulation Theory (LASS) is not directly concerned with abstract words or concepts. Rather, Barsalou and colleagues (2008) propose an account of conceptual processing that includes two systems, namely the linguistic system–specifically the system that processes linguistic forms, not the one representing linguistic meaning–and the situated simulation system. The basic assumption is that multiple systems underlie knowledge in the brain, and specifically the two aforementioned systems engage in a dynamic interaction supporting the representation of concepts[4]. Crucially, they are neither incapsulated nor modular, but they stand in a continuous relation: to illustrate, the authors propose that the two systems are both active in linguistic tasks, but linguistic forms would be activated earlier than sensorimotor simulations. Hence, the linguistic system

[4] For a different but related approach on language contribution to conceptual knowledge see e.g. Louwerse, 2008; 2011; Louwerse & Jeuniaux, 2010 that proposed a hybrid approach combining grounded simulations and distributional knowledge gained from recursive linguistic patterns (SI, Symbol Interdependency Hypothesis).

would peak earlier than the simulation system, also serving as a support for the activation of the latter (see Figure 2 for a graphic representation of this process). This last point is explained by the fact that information that is salient during the encoding would be preferentially activated if it is also present during the retrieval. Therefore, given that linguistic forms (note, not meanings) convey patterns of linguistic information, such as co-occurrences, the linguistic system is primary activated in their encoding and retrieving. Nonetheless, once recognized, the word would prime embodied simulations that permit conceptual access. Therefore, words would act as “pointers” to situated conceptual representations.

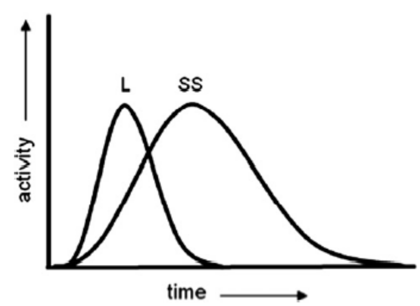

Fig. 1. Hypothesized contributions from the language system (L) and the situated simulation system (SS) during conceptual processing according to the LASS theory. When a word is presented as a cue, word form contributions from the language system precede those from the simulation system. The height, width, shape, and offset of the two distributions are assumed to vary. In response to different words, all these parameters are likely to change (e.g., SS activity could be more intense than L activity). The two distributions in this figure illustrate one of infinitely many different forms that activations of the L and SS systems could take.

Figure 2. Graphic representation of the contribution of both linguistic and simulation systems in terms of time course in conceptual processing (Simmons, Hamann, Harenski, Hu, & Barsalou, 2008)

One central point in the discussion of the activation of linguistic forms is the nature of the task being performed. In fact, as the authors pointed out, if the simple retrieval of linguistic forms and associated statistical information is sufficient for the performance, no deeper conceptual information would be activated. Note that, in the LASS perspective, deep access to semantic content is only guaranteed by the activation of situated simulations, while linguistic retrieving and processing is considered to be a “heuristic” form which can be effective only in certain contexts and tasks. On this point, the authors recognize that their view is incompatible with symbolic theories of meaning because conceptual content about properties and relations resides in simulations rather than in linguistic forms (contrarily to a-modal theories of meaning, see Chapter 1).

In order to investigate the relative contribution of linguistic and simulation systems, Simmons and colleagues (2008) performed an fMRI study in which participants were asked firstly to silently generate properties for a set of words, and after a week to complete a word-association and a situation-generation task. The aim of the study was to address the specific time course of the activation of linguistic neural areas and modal simulation areas, and also to verify if there was a difference in terms of activation patterns depending on the task. Their results show that word association elicited the activation of brain regions implicated in language processing (e.g., Broca’s area and medial inferior frontal gyrus), while generating situations activated brain regions previously found to be engaged in mental imagery, episodic memory, and locations processing (e.g., cuneus, precuneus and posterior cingulate gyrus). As for the time course, the authors posited that the property-generation task could have been divided into two time-sections: the earlier half (first 7.5 s.) and the final half (last 7.5 s.). In accordance with their hypotheses, i.e. that there would have been statistically greater likelihoods of words associations during the first 7.5 half of each trial vs. greater simulations likelihoods in the last 7.5 s. of the trial, areas related to simulations were not significantly active in the first half of time course.

In detail, significant overlap was found between early property generation and word association, and between late property generation and situation generation (p. 116). The authors interpreted their findings in the frame of LASS Theory, evidencing how in line with its predictions both linguistic associations and situated simulation underlie conceptual processing with the former occurring earlier. These results seem to conflict with previous evidence (e.g., Pulvermüller et al., 2005, that indicated that motor simulations are active within 200 ms of word onset); Simmons and colleagues explain this potential inconsistency by appealing to the role of the executive system. Specifically, they claim that when selective attention is focused on a given system as source of information, this system leads the responses while the relevant simulation is activated but not targeted. In the case of the experiment reported in the study, the authors suggest that since the cues of the tasks presented were words, the executive processing focused selectively on the linguistic system. In addition, since participants were to respond with words in many of the tasks, this factor may have further oriented selective attention towards the linguistic system (remember that in the case of e.g., Pulvermüller et al., 2005 the task was a lexical decision task).

Therefore, the authors conclude, conceptual processing is supported by both linguistic processing and situated simulations to different extents. Depending on the conditions (e.g., tasks, purposes) conceptual elaboration might prominently rely on the linguistic system or on the situated simulation system, or on both of them. This step is important in theories of conceptual knowledge, because in the frame of embodied and grounded cognition it acknowledges the importance of language as a means to access conceptual knowledge, without positing the existence of an amodal and symbolic system. Given the stress posited on the distinction between the two systems that are at stake during conceptual processing one might wonder if abstract and concrete concepts are differentially represented and processed, according to the LASS. After all, the other seminal proposal that clearly distinguished between a "verbal and linguistic" and "iconic and non-linguistic" system is the DCT proposed by Paivio, which assigned to abstract and concrete concepts distinct systems.

Indeed, in the LASS, specific claims regarding the representation of abstract concepts and words are presented in relation to the DCT. In fact, according to the authors, although this view seems largely compatible with Paivio's Dual Coding Theory, the LASS theory maintains that for abstract concepts simulations are also necessary. Remember that in Paivio's view abstract words would only rely on the *logogen* system, roughly correspondent to the linguistic system mentioned by Barsalou and colleagues. In addition, while for DCT both the linguistic and the non-linguistic system imply deep processing, in the LASS deep conceptual processing only occurs in the simulation system. Consequently, by positing that in order to access conceptual representation the situated simulation system ought to be activated, and that linguistic system only provide support for shallower tasks, the authors claim that both concrete and abstract concepts are comprised of dynamic situated simulations.

Evidence from a deep processing task (Wilson-Mendenhall, Simmons, Martin, & Barsalou, 2013) showed that abstract concepts elicited situated simulations in the same way concrete concepts did. Using a new paradigm, that they called "match-mismatch" task, the authors asked in an fMRI experiment participants to deeply think to the meaning of four concepts (i.e. *convince*, *arithmetic*, *rolling* and *red*) and to judge if the word applied to the situation depicted in the following scene. Among the four concepts the authors chose, they included *convince* and *arithmetic* as abstract concepts, predicting that they would have elicited specific patterns of activation: precisely, *convince* was thought to be associated with brain regions connected with mental state inferences, social cognition and affective processing, while the representation of *arithmetic* would have been supported by brain regions related to numerical knowledge. Additionally, in the final part of the experiment, participants performed a functional localizer task, aimed at identifying specific regions underlying the understanding of all the four concepts. For instance, regarding the two abstract concepts, participants were instructed to think about what people in the visual scene could be thinking (*convince*/thought), and to count the number of individual entities in the scene (*arithmetic*/numeric cognition). To summarize their main findings, abstract concepts were found to activate distributed patterns in brain areas representing relevant non-linguistic content (just as concrete concepts). As the authors pointed out (p. 930) "brain regions implicated in mentalizing and social cognition were active when participants processed the meaning of *convince*, whereas brain regions implicated in numerical cognition were active when participants processed the meaning of *arithmetic*".

Importantly, no activation for abstract concepts in the left hemisphere language areas was observed. Interpreted in the LASS framework, this finding suggests that when the task is a deep-processing one, linguistic areas traditionally related to abstract concepts are not crucial; rather, abstract concepts activate neural patterns that are linked to their semantic meaning (e.g., social interactive for *convince*), just as concrete concepts do. In this sense, abstract and concrete concepts appear to recruit the same "representational" system, namely a situated simulation one. The difference between the two classes of concepts could be identified in their "content". Crucially, in this study the authors evidenced how even abstract concepts, when studied in isolation and not as a general category, engage different systems and activate different patterns of brain areas. This is pivotal in the study of abstract concepts, in that it suggests that different abstract concepts have unique semantic content, which is reflected in specific patterns of activation; notably, however, these differences are only evident when abstract concepts are studied and processed as embedded in a context. This last point leads us to the next proposal, which is closely related to the LASS, but specifically addresses the content and the specificity of abstract concepts.

2.4.1. Similar but not identical: differences in content of abstract and concrete concepts. As we have seen in the previous paragraph, the LASS theory proposes that abstract and concrete concepts share underlying mechanisms of retrieval and processing, namely the activation of situated simulations system and linguistic system, depending on a series of factors among which the task being performed and the conditions of processing (e.g., in-context vs. isolated). One might therefore ask whether abstract and concrete concepts differ at all, hence challenging the classic distinction between abstract and concrete domains. In this respect, Barsalou and Wiemer-Hastings (2005) advanced some appealing hypotheses. First of all, they contended that both abstract and concrete concepts are tied to situations. In line with studies on contextual availability (see par. 1.4.6), the authors claimed that meanings are never understood in isolation, but rather in the context of interactions with the environment and through the interpretation of relevant situations. This is true for abstract concepts–for which is not surprising given their complexity–as well as for concrete concepts: in fact, as Barsalou and Wiemer-Hastings noted (2005, p. 134) it is not sufficient to know the constituent physical parts of the category of HAMMERS in order to completely master the category.

For instance, knowing that a hammer is constituted by a head and a handle says nothing about when the object is suitable for usage, or for what purposes it is needed. Indeed, we gain a sufficient amount of knowledge of the category HAMMERS through the observation of their usage in relevant settings and situations: in this way, we know that hammers are usually employed with nails and panels, and that their purpose is generally to fix things. Situational context is even more crucial for abstract concepts. Drawing on the semantic analysis proposed by Barsalou (1999) of the concept of TRUE, the authors claim that the representation of abstract concepts resorts to complex situational configurations, encompassing a variety of agents and mental events. This last caveat introduces the second hypothesis proposed by Barsalou and Wiemer-Hastings, which is also the crucial tenet they made on abstract concepts. In their perspective, what differentiates abstract from concrete concepts is the type of situations they evoke: concrete concepts are embedded in background situations widely related to objects, while abstract concepts are more tied to events and introspective states.

As a consequence, the representation of the two classes of concepts differs (Hypothesis 3), in that abstract concepts are more complex, and their representation is widely distributed among different situations. Specifically, while for representing the concept of HAMMER the focus is spatially circumscribed to its parts and its relevant setting of appliance, for the representation of TRUE we must rely on different and not bounded situations and events. The last point of the argument concerns the role of simulations in abstract meanings representation, which as we already discussed in the frame of LASS is thought to be part of the conceptual processing also for abstract entities; in this proposal, in addition to the already developed claims regarding conceptual access and simulation, the introduction of the introspective dimension is crucial in the explaining of abstract concepts. To sum up, Barsalou and Wiemer-Hastings do not discard the embodied claim on abstract concepts (namely, that abstract concepts are grounded in perceptual and sensorimotor states as concrete concepts are), but propose different foci for abstract and concrete concepts.

To test their hypotheses, the authors used a classic property generation task in which they analyzed the content of three abstract, three concrete and three intermediate concepts. Their results offered support for the hypotheses proposed; overall participants generated a large amount of properties related to background situations and contexts. Importantly, a significant interaction was found between concept type (abstract, concrete and intermediate) and general coding category (what kind of properties was elicited), indicating that abstract concepts tended to elicit settings/events and introspective situations (i. e. the mental state of someone in a specific situation: affective and emotional aspects as well as evaluations or cognitive operations consciously recognized), while concrete concepts focused on entities' properties. In general, findings from Barsalou and Wiemer-Hastings show that the content of concrete concepts is mostly related to locations and entities' properties, while abstract concepts mostly rely on social interactions and introspections (such as beliefs), but they are both rooted in situational contexts. Those findings are consistent with a similar study by Wiemer-Hastings and Xu (2005), that extended the results just discussed to a larger set of abstract and concrete words. In their study, Wiemer-Hastings and Xu not only asked participants to produce properties for 36 items with six different levels of abstraction, but they also asked them to mention contexts in which the items usually appear, and situations related to the specific item. In line with Barsalou and Wiemer-Hastings' findings, the authors reported that for abstract concepts less intrinsic properties and more subjective or relational features were generated with respect to concrete concepts. Crucially however, as the authors stressed, those differences were qualitative and not quantitative: both abstract and concrete concepts, in fact, elicited a high proportion of situational contents, but they differed in terms of semantic associations they elicited.

2.5. On the Path of Dis-embodiment and Back. Dove's Proposals

Up to this moment, we focused on proposals of abstract knowledge explicitly or implicitly rejecting an a-modal conception of cognitive processes, in line with the tradition of embodied and grounded cognition theories. In fact, the revolution constituted by grounded accounts of cognition made a clear statement regarding symbolic and a-modal theories of meaning: concepts are multimodal representations tied to perceptual and motoric processes, and thus they cannot be a-modal. But if there was something that could undermine such an open claim–supported by a tantalizing body of evidence–this was precisely the nature of abstract concepts. Given the problems that abstract concepts posit with respect to multimodal and simulation-based theory of cognition, some scholars started to reconsider the possibility that some forms of a-modal knowledge might be implied in the acquisition and processing of abstract concepts.

Specifically, in a seminal essay Dove (2009) argued for what he called "representational pluralism". After reviewing much of the evidence that spoke in favor of simulation-based conception of knowledge, he argued that proponents of perceptual symbols (e.g., Barsalou, 1999) have failed to demonstrate what benefits multimodality confers to the representation of abstract concepts. The standard argument on which his critique relies on concerns the fact that most of the strength of EG accounts came from studies involving highly imageable and concrete concepts. Therefore, Dove claimed that some abstract concepts employ a-modal representations. The heart of Dove's initial proposal is that concepts are couched in two different types of representations, namely modal and a-modal (roughly correspondent to perceptual and non-perceptual). While he is clear on this point, he also points out that his proposal is compatible with both Fodorian-mentalese stances and perspectives more focused on distributed neural networks (p. 413).

To unravel what Dove meant when he revived the notion of a-modal representations, that have been EG researchers' mare for a long time, Dove (2011) appeals to a central topic of both this dissertation and the debate in cognitive science, namely language. In this essay, Dove partly revised his initial thesis, and defines language as a "representational system" that enhances our cognitive abilities by furnishing a context-free and arbitrary system. Importantly, this symbol system is independent from other embodied systems (i.e. perceptual, sensorimotor, simulations) but it interacts with them.

An important caveat that Dove made in this argumentation is worth noting. Linguistic competence, as sketched out by Dove, is intended as the acquired sensorimotor skill of simulating linguistic experiences. These simulations are not dependent on a-modal symbol systems but are contained in a system apt at generating perceptual symbols. One might therefore ask, where are a-modal symbols hidden in this perspective? In Dove's formulation, language itself is an internalized a-modal symbol system, resting on an embodied substrate. Natural language is, in this perspective, a form of "dis-embodied" cognition[5]. In Dove's words (2011) a mental symbol is "dis-embodied" if (a) it is embodied

[5] The term "dis-embodied" is here employed differently from other forms of disembodied cognition, in that it still emphasizes a dependency from the embodied and sensory-motor systems. Nonetheless, Dove is not alone in suggesting a critical detachment from the embodied tradition. Mahon and Caramazza (2008), for example, claimed that the evidence in support of EG theories of cognition does not unequivocally exclude

but (b) this embodiment is arbitrarily related to its semantic content. In this sense, abstract concepts can be explained by considering them as “dis-embodied” symbols, in that they require some forms of ungrounded knowledge that can be provided by linguistic competence. The role of language in this account is therefore twofold: first, it engages sensorimotor simulations (much in the same vein of LASS framework), and second it elicits and prompts symbolically mediated associations such as words, phrases and sentences. Dove’s proposal is certainly appealing, for at least two reasons: first, he acknowledges the importance of language not as a mere communicative vehicle but rather as an embodied system that extends our cognitive abilities. Second, even though by the means of a-modal symbols, he successfully threatened the *parsimony*[6] argument, therefore opening the way for “Multiple Representations” perspectives on conceptual knowledge.

To conclude this schematic sum of Dove’s perspective, I think one point he made more recently deserves attention. The idea that language is not simply a communicative tool, resonates with the proposal I am going to present in the next paragraph (the WAT theory), although with some important differences. Hence, it needs to be examined a little

---

forms of disembodied cognition. In their presentation of the *Grounding by Interaction Hypothesis*, they argued that “there is a level of conceptual representation that is ‘abstract’ and ‘symbolic’ and which is not exhausted by information that is represented in the sensory and motor systems” (p. 68). In this perspective, knowledge of the things in the world would emerge from the interaction between the symbolic level and sensory-motor systems. Abstract concepts would be particularly representative of this tenet, because no significant motor or sensory feature correlates with their instantiations. In a successive essay (Leshinskaya & Caramazza, 2016), non-sensory motor concepts (i.e. abstract concepts) are said to be localized in multiple content-selective brain partitions sharing participation in computations for common goals, and therefore the brain region activated would depend on the kind of concept included in the stimuli. Crucially, those brain regions are considered as non-sensorimotor regions.

[6] The *parsimony* argument can be intended as a reformulation of the Occam’s razor principle; if interpreted in the frame of the debate on conceptual knowledge, as Dove (2009; p. 416) pointed out, there has been a tendency in preferring one explanation (i.e. perceptual representations) over a combination of two possible explanations (i.e. perceptual and a-modal representations). While I am not favoring the a-modal stance taken by Dove in this essay, I believe in line with Dove’s suggestions that positing only one level of explanation as constitutive of conceptual knowledge is somehow reductive. After all, in Dove’s words (p. 417) “parsimony considerations come into play primarily when other things are equal”, and I will discuss in the following sections of this dissertation how and why we do not need to posit equality for abstract and concrete concepts.

bit more in depth. In a recent paper (Dove, 2018) Dove has emphasized how extant accounts of conceptual knowledge treated language either as just another experiential source of information–hence denying its specificity of conveying structural properties–or offering a conception of language which employs a-modal symbols—hence an intrinsically incompatible conception with EGC accounts. What Dove proposes is instead to reconsider the role of language as an extrinsic symbolic system, that augments our cognitive abilities. In this perspective, language is considered as having all the properties traditionally ascribed to a-modal symbol systems, namely computational and combinatorial features, but it serves embodied agents in that it scaffolds grounded conceptual knowledge. Specifically, language is here intended as a neuroenhancement tool, that by the mean of its structural properties creates a new set of perceptual objects and targets for action. As a cognitive tool, the role of language is said to be flexible, context-sensitive and experience-dependent. Importantly, in this light, language is central for concrete concepts but is crucial for abstract concepts. In line with compelling evidence showing how abstract concepts are represented differently from concrete ones in the brain, Dove (in press) advocates for a conception of language as a symbolic medium grounded in sensorimotor systems. This specificity of language partly explains the differences that neuroimaging studies report in the realization of abstract and concrete concepts: the activity of linguistic system in this sense would be crucial for abstract and not for concrete concepts. Language is therefore considered as a pivotal component of our conceptual system.

2.6. Words *are* social Tools. The Importance of Language as Embodied Experience

In Dove's first formulation, linguistic competence is considered to be a form of "ungrounded" knowledge, supporting the processing and representation of abstract concepts. The LASS proposal, instead, holds that the linguistic system acts as a pointer to deep semantic and conceptual knowledge constituted by simulations. Others have claimed that language can serve as a shortcut to the embodied relations in the world, without being necessarily embodied itself (Louwerse, 2008, 2011; Louwerse & Jeuniaux, 2010). While those proposals have a great explanatory potential, they partly overlooked at one crucial characteristic of language, namely its intrinsic social component.

To put it roughly, and quite incontrovertibly, language is a symbolic system. Words are symbols, in a Peircean sense, in that they stand for their referents in the world engaging with them in a conventional relationship (Short, 2007). Furthermore, language is a system in the most trivial sense, because it is organized around a set of rules, and those criteria need to be met in order for an agent to interpret the message. But both the notion of symbols and that of system are insufficient to describe the essence of language specificity. Language has a normative character, i.e. it rests upon some norms that need to be respected for a linguistic event to be realized: if I want to refer to the bird outside my window, I will utter the word "bird" and not "fish", because "bird" is precisely the word that is used to describe the entity I am referring to. If I want to tell my mom that I ate a soup, I need to use the past tense and not the present continuous, or my mom won't understand that I already ate the soup. Crucially, the symbolic and systematic nature of language, and its normativity are all features shared by the community of speakers. These characteristics could are all constitutive of language, along with another central feature, namely its being a social practice.

Without speakers interpreting linguistic messages, language would make no sense at all. Consider the following example: as cognitive scientists we frequently use programming languages, such as R (R Core Team, 2018), which allow us to compute statistical analyses and to graphically represent our outcomes. R is defined as an "environment" that can be easily implemented by users around the world through the addition of updated packages. It is organized around a computer language as a coherent system, so it has its own set of rules. Elementary commands are either expressions or assignments, and the entities R creates and manipulates are referred to as objects; they can be variables, arrays of numbers, character strings and functions. R has its own syntax, that should be respected in order to be "understood" by the software. For instance, if I want to create the most basic data structure, composed by a list of values such as 1, 2, 3, 4, 5 I will use the simplest function "stating an assignment", which is c (), in the following way: >x <- c (1, 2, 3, 4, 5). This is one of the basic functions of R, and as it is clear from the line, the label I assigned to the "vector", i.e. "x", comes first; then R needs to know what I want to create (what manipulation should be done), and ultimately the "object" of the manipulation (in this case my list of numbers). Of course, this is the lower level of programming, but complex statistical operations are carried in R through specific functions, assigning values and setting relevant parameters.

The point of this example is that although R is an environment, and has its own syntax and rules, it needs to be interpreted from an agent in order to be useful. Remember Harnad's *Symbol Grounding Problem* (Harnad, 1990)? Besides perceptual and experiential grounding, which in EG perspectives is crucial in the understanding of language, in cases such as R language symbols need to be grounded in social practices (specifically, in this case they relate to scientific purposes). Even though the output of my analysis maintains its formal sense, being it correct and in turn interpretable and manipulable by the software, what really counts is that I will be using the set of numbers and values for my hypothesis to be tested. In a software like R, a specific syntax and specific symbols are *tools* that allow us to perform complex operations such as mathematical and statistical ones. In addition, they augment our cognitive processes, adding layers to our knowledge. Natural language is somehow similar, in that it rests upon a series of rules that would be useless without a social community using them. The famous Chomsky sentence “Colorless green ideas sleep furiously”, for example, has been taken as an example of how, even when we cannot ground meanings in experiential and perceptual world, we still grasp the sense of the sentence. Shallice and Cooper (2013), for instance, proposed a parallelism between the recursive character of language and the possible computational system involved in the representation of abstract concepts. But are recursive patterns and role-fulfilling properties sufficient for describing language and abstract concepts? As the example of R’s language portrayed, these two features are not enough, neither for a computer-based language. A possible explanation is that natural language is social both in a teleological and in a constitutive sense. It is social in its scopes, because we use language to communicate with people, expressing needs, feelings and so on. Moreover, it also has a social constitutive part, because it is created by a community of speakers and it evolves along with the community’s demands–think for example of all the neologisms emerged from the human interaction with technology, e.g. social networks.

Borghi and Cimatti (2009), for example, claimed that an exhaustive theory of language should incorporate not only the *individual* grounded experience, but also the *collective* human embodied experience of being coupled with and embedded in a social context. The objection they moved to theories strictly based on the mirror neurons system relies on the acknowledgement of language as a “normative thing”. Specifically, they argued, while in a healthy brain mirror neurons are always thought to be activated by specific situations (e.g., the observer and the actor engaging in some form of relation), in a normative context there is not such a logical relation. Language constitutes such a context, in which it can be used only following some rules, that can also be violated. While in the first case there is no exception to the rules of neurological resonance (again, positing that the brains are healthy), in the case of language violations happen very often. This is also due to the fact that mirror neurons responses are automatic processes, while language is a conscious event. Therefore, the authors claimed that thorough embodied theory of language should account for: (a) an embodied theory of human individual experience; (b) an embodied theory of collective human experience intertwined with mirror neuron system; (c) an embodied theory of language as a social fact, and (d) a theory explaining how the very fact that language is a social practice affects individual cognition.

The last point is particularly important, according to Borghi and Cimatti, to provide a compelling embodied explanation of abstract words meanings. Their claim is that, while for concrete words the individual grounding is more relevant, for abstract meaning the interaction with a more collective form of grounding would be crucial. The authors endorsed an embodied and grounded perspective on conceptual knowledge, but their tenets somehow extended traditional EG accounts by considering the importance of social practices. They claimed that abstract meaning is embodied, such as concrete meaning is, but it is embodied in the sense of a particular bodily experience mediated by linguistic social tools that are words or gestures.

The discussion above constitutes the initial formulation of what is referred to as WAT (*Words As social Tools*) theory. The proposal evolved over time, but a clear formulation can be found in Borghi and Binkofski's (2014) book (cf. pp. 20-21). Besides the first claim (abstract concepts are embodied as concrete concepts are) which I will refer to as the "embodied claim", the second central tenet regards the contribution of language in abstract concepts and words representation. Specifically, the authors claim that for abstract concepts language is more crucial than for concrete concepts, for at least two reasons: first, experiences with abstract concepts vary consistently more than experiences with concrete concepts (remember the example of capital sins and dogs in the first paragraph). For this reason, language may contribute to keep all those different experiences together, thus guaranteeing mental coherence. The second explanation concerns the modality of acquisition of abstract and concrete concepts. Since abstract concepts do no refer to single and concrete referents as concrete concepts do, we often learn abstract concepts via linguistic explanations rather than through direct perceptual experience. In support of this second hypothesis, considered as a psycholinguistic variable, Modality of Acquisition (MOA) has been found to be negatively correlated with traditionally employed variables such as Imageabililty (-.64) and Concreteness (-.47) in a study by Wauters and colleagues (2003). The authors analyzed a set of texts from elementary school, and they found that MOA mean ratings, ranging from the lower values representing perceptual modality of acquisition to higher values representing linguistic modality of acquisition, increased over texts used in successive grades of elementary school. In other words, more advanced texts contained a higher proportion of words learned mainly trough linguistic explanations (e.g., *century*) with respect to initial texts. The relation underlying these psycholinguistic variables shows that abstractness and MOA might be positively correlated, availing the idea that abstract words are related to linguistic information to a greater extent than concrete words.

The importance of language in the acquisition and processing of abstract concepts and words meanings (ACWs) has two main consequences, as sketched out by Borghi and Binkofski (2014). On the one hand, the fact that they partly differ in their modality of acquisition from concrete concepts might entail that ACWs are processed and represented differently in the brain from CCWs (concrete concepts and meanings). By way of explanation, while both concrete and abstract concepts are supposed to activate sensorimotor brain regions (see the “embodied claim”), abstract concepts should activate consistently linguistic areas. On the other hand, given their heavy reliance on language, and their intrinsic variability both interpersonally and intra-personally, ACWs may resent more of linguistic variability.

To conclude this introductory presentation of the WAT theory, it is worth going back to what the acronym stands for, and present some preliminary considerations. The authors advanced the idea that words are *social tools*, and in line with their suggestions they operate socially in two different but related ways. First, acquiring abstract words, as partially described before, often requires the presence of others. In the example of Borghi and Binkofski (p. 23) the difference that there is between the acquisition of a verb such as “to pass” and e.g., “to think” is that in the first case the meaning of the verb can be inferred solely by the means of observation, while in the latter this is not the case. Therefore, in the interpretation of the authors, the crucial social dimension of ACWs is not constituted by their content, but rather by the mechanisms of acquisition they rely upon[7]. To sum up, in the words of Borghi and Cimatti (2009)

> […] They [words] are social entities, whose value is external to us, as it lies in the social set of rules that regulates them. […] Think of a word as a tool, for example a hammer. My hand is different from yours, maybe I have a prosthesis, but if I want to hammer a nail in the wall I only have to follow the same rule: that is, the use of the hammer is the same despite the individual differences of our hands. In the very same way a social word does standardize the different concepts of our own minds.

2.7. On the need for Multiple Representations Views. Evidence in Support of the WAT

Recent perspectives on conceptual knowledge all converge in the idea that concepts are grounded in sensorimotor, perceptual systems *and* in emotional, internal and social states; furthermore, there is a growing attention in re-considering symbolic representations derived from linguistic experience as bootstrapping mechanisms helping our cognitive systems. Those new proposals are often referred to as Hybrid Accounts (Bolognesi & Steen, 2018), or Multiple Representations Views (Borghi, Barca, Binkofski, & Tummolini, 2018a), for they aim at acknowledging the relative contribution of both embodied processes such as perception and action, and other mechanisms that might be relevant for human conceptual processing and acquisition. Multiple Representations Views (MRVs), therefore, seem particularly suitable for explaining abstract concepts: they do not posit a single

[7] Note that Borghi and Binkofski specify that the socially mediated way of acquiring abstract concepts is not limited to direct social interactions with people. Rather, this mechanism is extendible to all of the technological supports we might employ when unsure of the definitions of some words (e.g. books, Internet etc.). I will elaborate on this stance later on in this dissertation, with a particular attention to specific forms of social cognition. For the moment, it is sufficient to say that in the WAT proposal social phenomena such as asking to experts when insecure about the meaning of words are crucial features of abstract words acquisition, and may have an impact in their subsequent processing (see also Prinz, 2002, 2012).

underlying mechanism for all concepts, and can benefit from the empirical support coming from both simulation-based research and e.g., distributional approaches to language comprehension. Among those proposals, in the following of this dissertation I will specifically endorse the WAT theory. To this aim, I will present the central tenets of the theory, as recently developed (Borghi, Barca, Binkofski, Castelfranchi, et al., 2018; Borghi, Barca, Binkofski, & Tummolini, 2018b) along with empirical evidence supporting the main claims of the WAT theory.

As already pointed out, the proposal heavily relies on embodied and grounded (EG) approaches to cognition, hence concepts are generally considered as multimodal representations tied to perceptual experience. The novelty of the WAT theory, however, is constituted by a precise characterization of abstract concepts, which are described in positive terms instead of referring to them just in opposition with concrete concepts. In this regard, the four main tenets of the theory concern: (a) the acquisition, (b) the brain representation and the consequent entailments of the specificity of abstract concepts from a sensorimotor (c) and cross-cultural perspective (d). I will address the (a), (c) and (d) points in turn in the following as they are pivotal in for the argumentation of this dissertation[8].

2.7.1. Abstract concepts and the role of social and linguistic experience. Consider a trivial example such as the following one: a child, that we will call Martha, is presented for the first time with a toy train, and she starts to play with it. After a while, she

[8] I will not discuss the point (b) concerning the brain representation of abstract concepts in detail. For the purposes of this discussion, it suffices to say that evidence coming from fMRI and PET studies converges in evidencing a strong activation of language processing network areas in the elaboration of abstract concepts with respect to concrete ones. For a review of differential brain representations of abstract and concrete concepts see Borghi et al., 2018 (for metanalyses see Binder, Desai, Graves, & Conant, 2009; Wang, Conder, Blitzer, & Shinkareva, 2010).

might want to know what exactly is the object she is playing with. Her mom says: "It's a train!". One week later, Martha and her mother are going to visit Martha's grandmother, that lives outside the city. They are in the train station, and Martha is staring at the high-speed train that will bring them to the small town her grandma lives in. Her mom, seeing Martha's excitement, says: "Look Martha, that's a train, just as the one you were playing with!". Martha recognizes the object: in fact, although the dimensions and the shape of the high-speed train are possibly different from her red toy train, they still are somehow perceptually similar. They both have wagons, they travel on railways, and their functions are allegedly similar. Therefore, once at grandmother's home, while watching an old western movie Martha identifies the coal train on the tv screen as a train —even though it is slightly different both from her toy and from the vehicle that brought her to her grandma's place.

Now let's follow Martha during her stay at her grandmother's house. At dinner, Martha is given two pieces of pie, just like her cousin. There is one piece of pie left in the plate, and Martha is particularly hungry that night. Thus, without asking for permission she grabs the last piece of pie. Her grandmother notices the action, and scolds Martha: "Martha, that's unfair! There is only one piece of pie left and two of you. Why would you eat it alone? Share it with your cousin.". The day after, the whole family is at the zoo. In front of the primates section, Martha's mother seems unusually sad. Suddenly she whispers "I just feel bad for these animals. I think it's unfair that they are locked in cages just for our amusement.". On the way back home, in the car, Martha would like to sit in the front seat, but her mother insists she sits in the backseats with her so Martha's cousin sits in the front seat. Martha is upset, and can't see the reason why her cousin deserved the privileged seat, and she screams "That's unfair!".

In few words, she learnt how to use the label “unfair” by merging together different situations, that share some underlying commonalities. She realized that for something to be defined as unfair, some inequality needs to be implicated. More importantly, in order to correctly apply the label to different situations, the clarifications made both by her grandmother and by her mother are crucial: they contribute to define and re-define the range of appliance of the label “unfair” in two different ways. On the one hand, they act in a “bottom-top” way, by aggregating different instantiations of the concept to be collapsed under one label; on the other hand, they serve a “top-bottom” function, in that Martha will know from now on that a situation in which there is only one thing left and two agents interested becomes unfair if one of the two agents take the object for herself.

It is clear that both in the case of the train and in the case of “unfairness” linguistic inputs play a role. Nonetheless, as illustrated by the examples, in the case of the train the role of language can be mainly referential (or indexical), while in the case of “unfairness” it plays a constitutive role in shaping the boundaries of the concept itself. This is partly due to the fact that often when learning a concrete concept the referent of the concept is physically present, while this is not the case for abstract concepts (think for example of a concept such as “ethic”). Moreover, typically abstract concepts are more complex than concrete ones. Gleitman and colleagues (2005), for instance, referred to abstract words as “hard words”. In their perspective, children acquire first concrete concepts, that are “easier” words by relating them to things in the world. Subsequently, when they accumulated a sufficient amount of easy words, more sophisticated forms of lexical knowledge emerge from the interaction between the established knowledge and the linguistic knowledge thereby allowing the acquisition of “hard words” (i.e. abstract concepts).

The *syntactic bootstrapping hypothesis* is based on the idea that syntax and sematic acquisition are interwoven and that they furnish the child with multiple cues for language acquisition. Evidence coming from developmental studies such as the one performed by Bergelson & Swingley (2013) shows indeed that the acquisition of abstract and concrete words differs both ontogenetically and diachronically. In an eye-tracking study where parents and children were shown videos of events, and parents named the events, the authors reported a different pattern of results related to both the age of children and the type of concepts involved. Specifically, before the age of 10 months children did not show an understanding of more abstract concepts (e.g., “kiss”) while they did for more concrete items (e.g., “banana”). After the threshold of 10 months, instead, children started to recognize more abstract entities.

Comparing these results with a corpus of video showing parents-infants interactions, the authors found that concrete words were frequently produced in concomitance with their referents (e.g., “look, a banana!” when a banana was part of the scene). On the contrary, abstract words were not frequently corroborated by their referent (e.g., say “kiss” when there was no kissing scene). Bergelson and Swingley interpreted these results in the same direction of Gleitman and colleagues, claiming that abstract vocabulary would emerge later in life, because the connection between the use of those words in discourses and their referent is more difficult to establish only by the means of observation (as in the case of CCWs). These hypotheses are not entirely new, as Gillette and colleagues (1999) already reported that rather than the grammatical difference between verbs and nouns, what best predicted the early acquisition of words was instead their being imageable and observable. Thus, for example, a verb such as “kiss” was acquired earlier compared to a noun like “idea”. As a matter of facts, studies investigating constructs such as Age of Acquisition (AoA) (Barca et al., 2002) and Modality of Acquisition (Wauters et al., 2003) of words evidenced that AoA and concreteness are negatively correlated: thus, concrete words appear to be learnt earlier than abstract ones. Furthermore, as already discussed, MoA and concreteness are also negatively correlated, showing that more abstract terms are mainly acquired via linguistic explanations (note that MoA and AoA are positively correlated, although the two measures do not overlap) (see Borghi et al., 2018 for a review).

Crucially, the role of linguistic inputs in the acquisition and consolidation of abstract concepts is not limited to early infancy. In two studies mimicking the acquisition of novel words (abstract and concrete) in a sample of adult participants Borghi and colleagues (Borghi, Flumini, Cimatti, Marocco, & Scorolli, 2011; Granito, Scorolli, & Borghi, 2015) presented participants either with novel objects to be manipulated or with groups of interacting objects. First they were required to form categories, and then they were taught the nouns referring to the novel category. Results showed that when performing a subsequent property verification task on both categories, responses with the mouth (using a microphone) were comparatively faster with abstract than with concrete words, while responses with the hand were facilitated more with concrete than with abstract words (Borghi et al. 2011). In a second study, participants who were taught the novel noun earlier were facilitated in mouth responses, confirming an association between acquisition of the linguistic label and engagement of the mouth motor system (Granito et al., 2015). Overall, participants who were significantly more affected by the linguistic training were the ones that initially performed worse with abstract concepts, thus supporting the centrality of linguistic information in consolidating them.

Recently, Borghi and colleagues proposed two possible explanations to frame their hypotheses and the evidence supporting them. In their view, the formation of abstract concepts relies on two previously established abilities: on the one hand, the capacity to construct flexible categories as in the case of ad *hoc categories* (Barsalou, 1982; 1985; see Chapter 1). In this perspective, collecting under the same label heterogeneous referents as in the case of abstract meaning would provide conceptual coherence even in the absence of perceptual similarity—as in the case of concrete concepts. The second explanation refers to the mastering of social abilities such as joint attention and joint actions, that might be crucial especially in the first years of life to co-construct conceptual knowledge.

2.7.2. Abstract concepts and the engagement of mouth-effector. As emerged in the previous paragraph, abstract concepts and meanings tend to be acquired mainly via linguistic inputs. Ratings provided by adults confirmed this prediction, showing that abstract concepts are generally associated with the mouth effector, while concrete concepts usually are related to the hand or other effectors eliciting action patterns. Ghio and colleagues (2013), for example, asked 96 participants to rate a set of more than 200 sentences across several categories covering an hypothetical continuum of abstractness. Crucially, in the “concrete” component were included ratings for hand/leg and mouth relations, while in the more “abstract” component ratings were collected for relations with emotions, mental-states and mathematics. In a second rating study with the same stimuli, evaluations were also collected for typical psycholinguistic dimensions such as concreteness, contextual availability and familiarity. Results showed that abstract sentences with different semantic components (e.g., mental states, emotions and mathematics sentences) were judged as differentially involving body parts. Specifically, mental states meanings (e.g., “she discerns the opinion”; “she determines the fate”; “she pretend an interest”) were significantly associated with the mouth-effector, while emotion-related sentences resulted to involve leg, mouth and hand to the same extent. Mathematical sentences were in turn judged as associated primarily with hand, in line with the hypotheses of EGC and mathematical competence. In keeping with EG perspectives on numerical competence, in fact, the habit of finger counting–which has a pivotal role in numbers acquisition–is understood as the embodied scaffold allowing for higher forms of abstraction, such as number processing. A growing number of studies confirms this association (Fischer & Brugger, 2011; Fischer, Kaufmann, & Domahs, 2012; Tschentscher, Hauk, Fischer, & Pulvermüller, 2012; Wood & Fischer, 2008); in this sense, the study from Ghio and colleagues makes no exception, demonstrating that not only this association is embodied because it is re-enacted automatically in behavioral tasks, but participants also considered mathematical concepts as more related to the hand effector.

A similar pattern of results, stressing the composite nature of the category of abstract concepts, is reported in a recent study by Villani et al. (2019). In an extended rating study in which more than 300 Italian participants rated a set of 425 abstract nouns, the authors included 15 dimensions to be evaluated. Besides traditional psycholinguistic parameters such as concreteness, abstractness, imageability, contextual availability, modality of acquisition and age of acquisition, ACs were subjected to ratings concerning dimensions as engagement with the five sensorial modality (smell, touch, vision, taste and hearing) along with direct relation with both mouth and hand. Moreover, the authors investigated also distinctive components of abstract concepts grounding through the addition of social metacognition, interoception and social valence.

Correlations among the included variables showed that abstractness positively correlated with social metacognition (*r*=.5), modality of acquisition and metacognition (*r*=.4), confirming the (a) tenet of the WAT proposal (i.e. abstract concepts strongly rely on sociality and linguistic inputs). Quite compellingly, in addition abstractness was found to be positively correlated with mouth-effector (*r*=.14), while concreteness held a negative correlation with the mouth (*r*=-.14) but a positive correlation with the hand-effector (*r*=.29). This pattern of results is in line with the assumption that abstract concepts elicit mouth-related areas, as advanced in the (c) point of the WAT theory. It is also worth noting that in the subsequent Principal Component Analysis depicting the relations between and within each component, the dimensions reduction resulted in three main factors. Among these factors, the authors identified as "Inner-grounding and social" a factor including metacognition, social valence, interoception, emotion, and importantly, mouth-effector. In sum, people seem to perceive abstract concepts and meanings as more related to the mouth effector than hands, legs or other action-related body parts, even though those "sensorimotor" factors appear as less relevant in relation to abstractness than e.g., the factor "social metacognition".

Neuropsychological evidence encompassing fMRI and TMS studies further confirmed the primary involvement of linguistic related areas and specifically mouth-motor areas in the processing of abstract meanings. Sakreida and colleagues (2013) for instance, conducted an fMRI study in which concrete vs abstract multi-word expressions were compared, and besides a general activation of the sensorimotor neural network (i.e. left lateral precentral gyrus and medial premotor cortex) elicited by both abstract and concrete expressions comprehension, abstract sentences appeared to be represented by the activation of the anterior part of left middle temporal gyrus (an area considered as part of the language processing system). While specific patterns of mouth areas activations were already found for abstract emotional words (Dreyer et al., 2015; Moseley, Carota, Hauk, Mohr, & Pulvermüller, 2012), recently Dreyer and Pulvermüller (2018) extended and refined previous findings showing sensorimotor activations–and specifically face and mouth areas motor regions activation–for abstract meanings of mental abstract words. In a passive reading task performed while scanning hemodynamic activity within the motor system, the authors found that mental abstract words such as "logic" (generally considered as more abstract than abstract emotional words such as "fear", and therefore potentially less grounded in sensorimotor states) elicited relatively stronger activation in face motor areas, while emotion abstract words activated different foci of motor areas (e.g., hand, leg, mouth) to the same extent.

The involvement of orofacial motor areas, and specifically the activation of mouth effector is also reflected in results coming from behavioral studies. The already mentioned study by Borghi and colleagues (2011) revealed a facilitation of responses given with the microphone (thus directly engaging the mouth effector) for abstract artificial concepts with respect to concrete ones, which in turn were responded to faster with the keyboard. Likewise, in a word-definition matching task, Borghi and Zarcone (2016) presented participants with either concrete or abstract word-definitions pairs and asked participants to respond in the first block with a key on a keyboard and in the second with a device to be pressed with teeth. Importantly, both target words and definitions could be either abstract or concrete (e.g., scientific or general knowledge definitions such as "Element formed at zero degrees and in the solid state" vs. perceptually connotated definitions as "It shapes icebergs and can be found in cubes or cocktails" for the concrete term "ice"; "A soldier executing the orders accomplishes it" vs "moral law imposing the execution of moral or legal obligations" for the abstract term "duty"). The analysis of RTs showed that overall, responses given with the hand were always faster than those given with the mouth effector (possibly also due to the fact that the mouth device was more difficult to press than the key on the keyboard), but this advantage disappeared in the processing of abstract words. Note that, in line with Ghio et al. (2013), Borghi and Zarcone also performed a rating study on the set of words used in the experiment, asking an independent sample of participants whether the words they presented were more related to the mouth effector or to the hand. Their results are in trend with other rating studies on abstract concepts, showing a strong mouth-association for abstract words (D=2.2) and a strong hand-association for concrete words (D=2.1).

This brief review of the extant literature regarding the importance of mouth activation during ACWs processing suggests that, as noted elsewhere (cf. Dreyer et al., 2015), the intertwinement between sensorimotor patterns and the representation of abstract concepts is not merely epiphenomenal. One can thus wonder whether the forced stillness of mouth in early stages of linguistic development could have a subsequent impact on abstract conceptual knowledge.

To this extent, in two different studies, Barca, Mazzuca and Borghi (2017a, b) investigated the effects of the prolonged use of an oral device such as the pacifier on children's abstract conceptual and linguistic competence. In the first study (Barca, Mazzuca, & Borghi, 2017a), focused on the possible interference of the pacifier on the acquisition and consolidation in memory of abstract words. 7-years old children were asked to provide definitions of abstract, emotional and concrete words. Crucially, the sample of children had different history of pacifier use, ranging from children who never used the device to children who used it up to the age of 3 years or more. Responses were collected and coded for accuracy and thematic associations the words elicited. Overall, children were accurate in their definitions, but abstract concepts resulted to be more difficult to define than both concrete and emotional concepts (confirming the need of distinguishing the two conceptual categories, see par. 2.3.1) with no distinctions in terms of pacifier use.

Nonetheless, the pattern of conceptual relations primed by the three kinds of words differed as a function of pacifier use. In fact, children who overused the pacifier (up to three years or more) differentiated less markedly both abstract from concrete concepts as well as concrete from emotional ones. Interestingly, this subsample of children was also the one producing less "free-associations", i.e. quite distinctive conceptual relations of abstract words compared to concrete and emotional ones (percentage of free associations: abstract= 8.59; concrete= 5.43; emotional= 5.54). Therefore, even though the overuse of the pacifier preventing mouth-muscles activation and mimicry during language acquisition did not impact the accuracy of responses, these findings indicate that the overuse of the device could affect negatively abstract conceptual mastering. First of all, the associations elicited by concrete and abstract concepts in children with a long history of pacifier use are less differentiated than the other groups of children. Second, the supposed effect of the impairment caused by the forced inhibition of facial areas related to language acquisition and processing has a long-term impact, considered that the sample of children tested in the study were 7-years old–therefore they allegedly withdrew the pacifier at least two years before the administration of the test.

Further support for these results came from a second study (Barca, Mazzuca, & Borghi, 2020) in which 8-years old children were asked to perform a semantic categorization task. Children were required to discern animal words from non-animal words presented on a computer screen by pressing a key on a keyboard. Target trials were constituted by non-animal words, that were in proportion abstract, concrete and emotional words. In line with the previous study, information concerning the use of pacifier was collected through questionnaires distributed to parents in a precedent phase of the study. In this respect, the same four groups of children were distinguished on the basis of the use of pacifier (never; less than two years; two-three years and three years or more). The analysis of speed of responses revealed a significant interaction between the factors Concept Type (abstract, concrete and emotional) and Pacifier Use (four groups of interest, inserted as a continuous variable). The trend of the interaction shows that children who overused the pacifier (up to three years or more) were comparatively slower in responses to abstract words than the other three groups.

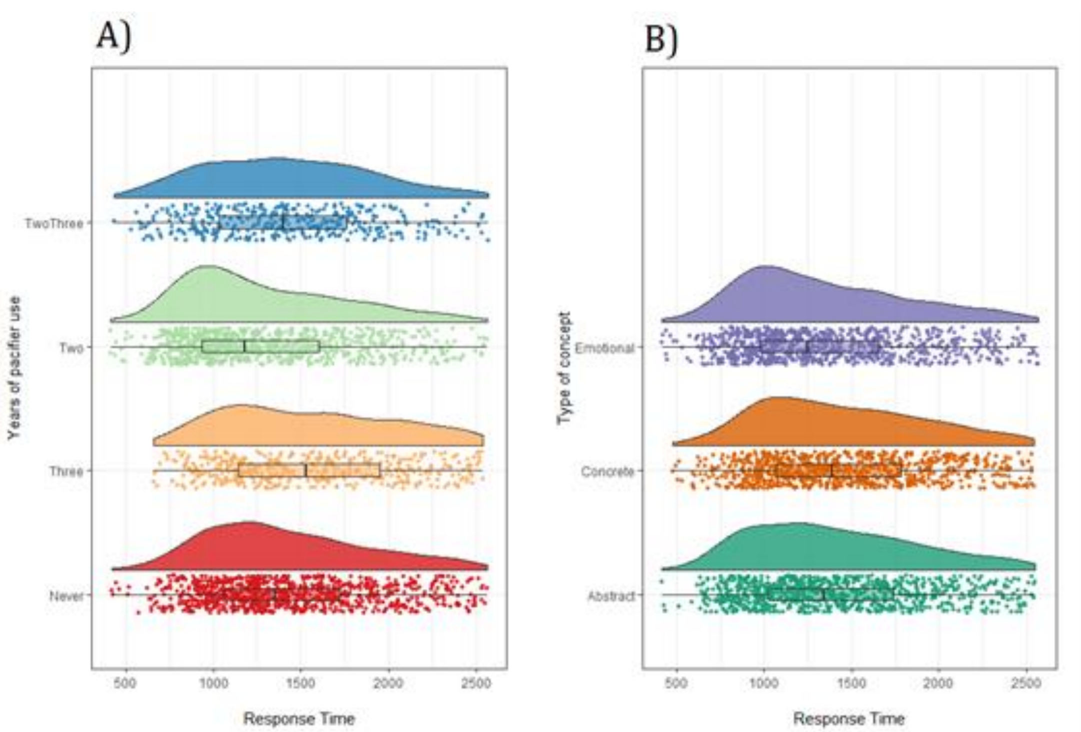

Figure 3. Raincloud plots displaying response times for groups of pacifier (A) and type of concept (B) in Barca et al., 2020.

The plot (panel A) shows that children who used the pacifier for longer (i.e., three years of age and more) tend to be slower in providing their correct responses. Panel B represents response time for three types of concepts. Emotional words were responded to shorter (1425ms ±518 sd) than both abstract (1496ms ±541 sd) and concrete words (1529ms ±535 sd). The interaction resulted from the LMM model is displayed in Figure 4.

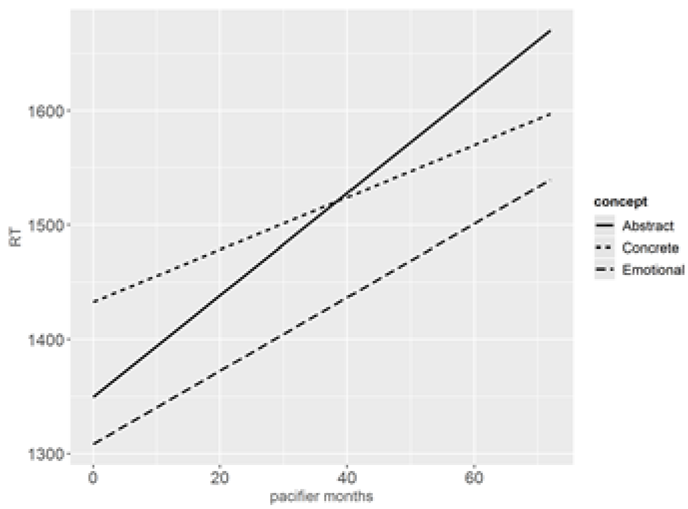

Figure 4. Plot of the interaction effect of the Linear Mixed Model on Response time in Barca et al., 2020.

The plot shows that the response time increases as a function of the increasing number of months of pacifier use. This trend holds for the three types of concepts, but is more marked in the case of the abstract ones. The slope (i.e. the proportional relation between the type of concept and the months of pacifier use), is greater for abstract concepts, while the difference is reduced for the other two kinds of concepts. A progressive slowing is observed also for emotional concept, but the slope of the predictive values suggests that overusing the pacifier is more harmful for abstract concepts than for emotional ones.

Response times for concrete concepts are the least influenced by the time of pacifier use, as indicated by their flat slope. Note that emotional words were processed faster than concrete ones by all four groups of children, clearly suggesting different patterns of elaboration for abstract, concrete and emotional words.

To summarize, the studies on the relation between pacifier use and abstract conceptual knowledge provided additional evidence supporting the WAT claim on the centrality of linguistic information–and the related re-enactment of mouth effector–in abstract words acquisition and processing. Indeed, children who were overexposed to the use of pacifier (thus inhibiting the potential phono-articulatory re-enactment of words during acquisition processes) produced less associations related to the social context, to their experience and less free-associations than children who used the device to a minor extent. Additionally, they yielded longer RTs in the processing of abstract words.

2.7.3. Abstract concepts and linguistic relativity. According to the WAT proposal, abstract concepts are mainly acquired via linguistic and social experience (see par. 2.7.1), and this linguistically and socially mediated modality of acquisition affects subsequent sensorimotor patterns of activation during the elaboration of AWs (see par. 2.7.2). This being said, the last point of the WAT theory (d), contends that ACWs are more influenced by the linguistic variability than concrete ones (Borghi, in press). To dig deeper into the last tenet of the WAT proposal, I will briefly review some of the evidence that supports this claim.

Ever since the work of Whorf and Sapir weaved in academic and public debates (Sapir, 1929; Whorf, 1956), suggesting the idea that language shapes thought, it has inspired a constant and passionate interest for the so-called “linguistic relativity hypothesis”. The claim that our conceptual structure is constrained by the language we speak, which is by the way a radical form of linguistic relativity (i.e. linguistic determinism) has been subjected to criticisms coming from both linguists and psychologist. As a matter of facts, some scholars (Pinker, 1994; Pullum, 1991) contended that the theory of linguistic relativity is “all wrong” (Pinker, 1994, p. 57). Nonetheless, the debate concerning the Whorfian hypothesis (Gentner & Goldin-Meadow, 2003; Gumperz & Levinson, 1996) is still raising interesting questions, that scholars are trying to answer from different perspectives. If on the one hand the idea according to which language and thought stand in a one-to-one relation seems to be a rather strong commitment (Malt & Wolff, 2010), there is nonetheless a growing body of evidence describing how different languages encode elements of experience differently—as well as there are some similarities that cannot be underestimated (Malt & Majid, 2013). Nowadays, besides fierce critics to the Neo-Whorfianism, the central question is not *whether* language affects thought but rather *when* and *how* the effect of language on thought is effective.

Cross-linguistic studies investigating differences and similarities across languages have extensively demonstrated that languages vary dramatically in how they map words with the world. As noted by Malt and Majid (2013), those difference are not just a matter of how fine-grained are the distinctions a language makes, such in the alleged case of the Eskimos (Pullum, 1991). Instead, several conceptual domains vary qualitatively across languages, with some features being expressed more saliently than others. This observation brings forth a legitimate question: are our concepts built as a function of the language we speak? Among the conceptual domains explored by scholars over the last decades, some provided interesting insights on this question. A famous example of how differently languages encodes perceptual relation is constituted by the domain of space (Majid, Bowerman, Kita, Haun, & Levinson, 2004), and specifically on the variety of *frames of reference* (Brown & Levinson, 1993) that different languages employ to describe spatial relations. The three main frames of reference (FoR) identified by linguists (i.e. *relative*: positioning objects according to the viewer-centered perspective, based on body axes; *intrinsic*: positioning objects in the space referring to object-centered location or environment features; *absolute*: locating the object according to pre-given coordinates such as cardinal directions), are used differently across languages, showing that spatial encoding does not follow a universal pattern (Pederson et al., 1998). For example, the description of the position of small-scale objects on a 'table-top space' can assume various forms, depending on the language spoken. The driving distinction pertains the scheme used to describe the relation between the object (i.e. the thing to be positioned) and the landmark (or the ground object). Majid and colleagues (2004) reported that while in languages like English, Dutch, and Japanese the relative FoR is most commonly employed for such descriptions (e.g., one would say that "the cup is to the left of the pen"), relegating the absolute FoR to big-scale geographical distinctions, other languages rely on intrinsic or absolute FoR. Arrernte speakers (Australia), for instance, would use cardinal directions (i.e. absolute FoR) for describing such relation, saying something like "the cup is to the north of the pen". Finally, some languages like Mopan (Belize) do not make any use of either cardinal or relative landmarks, describing spatial relations through an intrinsic FoR (e.g., "the cup is at the nose of the pen").

Likewise, variations in the encoding of spatial categories has been extensively documented. The famous work by Bowerman and Choi (2000) described how in Korean the spatial semantic categories are not containment and support (as represented by the English prepositions *in* and *on*), but rather 'fitting', either tightly (*kkita*) or loosely (*netha*).

Events categorization has also been found to be affected by linguistic structures encoding it, as demonstrated by studies on motion verbs (Slobin, 1996) and on terms for actions such as cutting and breaking (Majid, Boster, & Bowerman, 2008). The conceptual domain of time has already been partly discussed in the course of this dissertation (see par. 2.2.1), but given the impact its study had for the renaissance of a weaker form of Whorfianism in cognitive science, it is worth mentioning some seminal findings concerning time framing across languages and cultures. To illustrate, research from Boroditsky and colleagues (Boroditsky, 2001; Boroditsky, Fuhrman, & McCormick, 2011), drawing on the implicit assumption of CMT regarding the overlapping between linguistic expressions and concepts, compared English and Chinese Mandarin time expressions. They observed that while in English the widespread metaphor of time is a horizontal line (e.g., 'moving the meeting forward'), Chinese Mandarin speakers systematically use a vertical line as a metaphor for describing time. Thus, morphemes corresponding to the English expressions "up" and "down" are used to talk about the order of events in a time window (e.g., "shàng ge yuè": is the expression used to refer to the previous month, where "shàng" is "up"; "xià ge yuè" on the other hand is referred to the next or following month, where "xià" is up).

Henceforth, in order to test if these linguistic differences impact temporal concepts also at a behavioral level, Boroditsky et al. (2011) implemented an experimental paradigm based on RTs, in which a sample of English-speaking and Mandarin-speaking participants were presented with pictures of people at an early and later stage of life (e.g., a young Woody Allen and an old Woody Allen). They were required to indicate whether the picture represented 'earlier' or 'later' versions of the character by pressing two keys on a keyboard. Crucially, the spatial arrangement of the keys was counterbalanced within participants, so that half of the English-speaking sample responded "horizontally" ('early-left' and 'later-right') and the remaining half "vertically" ('early-up' and 'later-down'), and the same applied to the Mandarin-speaking sample. The results showed a "canonicality effect" (i.e. there was always an advantage for responses coded as 'left-early'), which the authors explained as a result of the writing direction of both English and Mandarin; importantly, however, the analysis of responses times of Mandarin speakers revealed that participants were equally fast in responses when 'early' was coded as 'left' and 'up', while this was not the case for English speakers.

As this brief summary indicates, linguistic relativity has been tested on a number of conceptual domains, ranging from more perceptual and concrete ones as body parts (Majid, 2010) and space, to more abstract domains such as odors (Majid & Burenhult, 2014), gender (Boroditsky, Schmidt, & Phillips, 2003)[9], time and events categorization. However, some scholars have been reluctant to completely embrace Neo-Whorfian claims due to what Casasanto labeled the "Orwellian" confusion[10] (Casasanto, 2008). Specifically, Casasanto pointed out that the idea that language and thought are the same thing (the "Orwellian" stance) cannot be conflated with the idea that differences among languages lead to differences in the thoughts of the speakers of those languages (the Whorfian hypothesis). The "Orwellian" claim is what is generally referred to as *Radical Whorfianism* (Reines & Prinz, 2009) which as the label suggest, is probably too radical to be accepted. But there are other options available for the Whorfianists, as Reines and Prinz (2009, pp. 1027-30) evidenced.

[9] For an in-depth discussion on grammatical gender assignment across languages and its implications see next Chapter.

[10] Casasanto refers to a passage in Pinker's famous book *The Language Instinct* (1994), in which Orwell's novel *1984* (Orwell, 1949) is taken as illustrative of linguistic determinism. In the novel, when the government strive to render subversive thoughts unintelligible by making them nameless in the new language, the overlapping between language and thought is made explicit.

First, there is the hypothesis of *Habitual Whorfianism*, according to which language influences our cognitive processes because it prompts habits of thought that drive us to think in ways we wouldn't thought in without language mastering. As Majid (2002) noted, compelling evidence coming from research on expertise showed that reiterated cognitive activities lead to the construction of skills that augment our capacities to relate with the environment (think for example of the difference between an entomologist looking at a bug with respect to a lay person: probably that is not just "a bug".). Hence, in this sense, different languages might habituate speakers to different portions of reality, without necessarily positing an incommensurability of conceptual knowledge among languages and cultures. The second hypothesis, which is slightly different but related to the first one, is the *Ontological Whorfianism*. Precisely, language is here conceived as influencing thought because it leads us to organize the experiences and the world into categories that are different from those we would have discovered without the use of language. In the words of Reines and Prinz (2009):

> The role of language is contingent on this scenario (something non-verbal could make the group salient), but profound. In leading us to habitually group certain particulars together (an effect of Habitual Whorfianism), language shapes the categorical boundaries that constitute our subjective organization of the world. (p. 1029)

At a careful inspection, the last two proposals are not mutually exclusive. As posited by the WAT theory, both abstract and concrete concepts are influenced by linguistic and cultural variability. One hypothesis is that the representation of concrete concepts, like *ring* (see Borghi et al., 2018) is modulated by linguistic variability in an "habitual Whorfian" fashion: this is also what happens when we are comparing groups with different level of expertise in some conceptual domains. To illustrate, a ring will have generally the same perceptual characteristics in Rome and in New Delhi, just like a bug will always be a bug whether it is observed by me or by an entomologist. Nonetheless, the aesthetic value of a ring might be judged differently by an Italian or an Indian, according to their own aesthetic canons, and the entomologist might recognize that the bug is not just a “bug”, but rather a member of the *Endopterygota* sub-class. This is a matter of attention to certain details, that might be conveyed by specific cultural and linguistic practices. On the other hand–trying to avoid “cocktail parties conversation’s examples” (cf. Malt et al., 2015)–“longing, missing or yearning” are not comprehensive and suitable definitions for the well-known Portuguese and Brazilian notion of *Saudade*. This is one of the cases in which possibly, without knowing the word for that particular emotional state, we would have not conceptualized the set of feeling we were experiencing as something at all. And this is when the “Ontological Whorfianism” comes at hand; that is, with respect to abstract concepts and words, linguistic and cultural practices exert a more profound impact on our categorization processes, if other because language binds together the totality of otherwise unrelated experiences constituting some abstract concepts–thus rendering them more intelligible and communicable. In framing the issue of linguistic relativity in the context of the WAT proposal, Borghi (in press) has recently underlined that one possible explanation reconciling different findings in this area might appeal to the level of abstractness of the domains considered. Indeed, studies investigating more concrete domains of experience such as containment objects (Malt, Sloman, Gennari, Shi, & Wang, 1999) or action-related verbs (Majid et al., 2008) showed that although the number of words used for describing both categories consistently varies among languages, the way in which the events of containing and cutting/breaking was mentally represented exhibited a high degree of convergence. An intermediate level is occupied instead by those domains that cannot be considered as completely abstract or as completely concrete. For instance, some sensory modalities have less perceptual strength than others (Lynott, Connell, Brysbaert, Brand, & Carney, 2019; Speed & Majid, 2019) that might result in higher level of abstractness. In this perspective, the auditory and olfactory senses represent paradigmatic examples: in fact, even though they are listed as perceptual modalities, linguistic variability seems to exert a consistent impact in these two domains (Dolscheid, Shayan, Majid, & Casasanto, 2013; Majid & Burenhult, 2014; Majid et al., 2018). On the other hand, words referring to domains such as numbers (Brysbaert, 2018), emotions (Goddard, 2010) and time[11] (Boroditsky, 2018) have been extensively scrutinized in order to assess whether language drives the categorization of these more "abstract" conceptual relations. Those studies suggest that experiential domains such as the ones mentioned above are more subjected to linguistic variation resulting in different conceptualizations. Building on those last considerations, a further impressive aspect of abstract concepts emerges, namely their intra-class variability. In fact, as testified also by studies focusing on linguistic and cultural relativity, the extent to which language and culture affect the way we carve up reality is also a function of the degree of abstractness of the domains taken into account (e.g., action related verbs are more concrete than time concepts, but still more abstract than nouns referring to containment). In the following paragraph I will delve deeper into this aspect,

[11]It is interesting to note that even the well-documented mapping of time related concepts into the spatial domain (Boroditsky, 2018) cannot be considered a "universal". For instance, speakers of Yélî Dnye, a language spoken in New Guinea that lacks of a calendar system, showed no clear time/space association (Levinson & Majid, 2013) when asked to locate temporal sequences in space. In contrast, Dutch speaking participants tended to employ the left-to-right mapping in referring to past, present and future.

and I will present relevant perspectives that can reconcile the heterogenous amount of scientific literature produced over years on abstract concepts.

2.8. (Abstract) Concepts come in Variety

In the previous sections, I focused on proposals within the EG account of cognition that endeavored to explain abstract conceptual knowledge. Among those influential perspectives I chose to deepen aspects of the WAT proposal because, to the best of my knowledge, so far it seems the most reasonable approach to the issue of how to explain conceptual knowledge[12]. Still, abstract concepts are a tricky issue to deal with, when considered as a heterogeneous category composed of sub-classes that can be very different one from the other. I have already illustrated (see par. 2.3.1) how, for instance, the domain of emotional concepts represents a matter of disagreement among scholars. On the one hand, it is contended that emotional concepts are part of the category of abstract concepts (Kousta et al., 2009; Ponari et al., 2018), while on the other hand they are thought of as a distinctive category (Altarriba et al., 1999; Barca et al., 2017; Mazzuca, Barca, & Borghi, 2017). The argument is fueled by the fact that as might seems obvious, a concept such as *love* is more detached from physical and concrete referents than e.g., a concept like *table*. This characteristic detachment–or in keeping with the WAT theory this high level of abstractness–might lead us to think that love is an abstract concept. Nonetheless, love as well as fear (to name two of the most common emotional concepts) convey specific sensorimotor and physical patterns of activation, and both neuroimaging and behavioral

[12]Note that the authors have recently developed a Bayesian-inspired generative model accounting for the acquisition and grounding of both concrete and abstract concepts (Borghi et al., 2018, pp. 20-21), thus partially overcoming traditional critiques generally advanced to EG theories of cognition.

studies testified this specificity with respect to both abstract and concrete concepts (see among others Moseley et al., 2012; Ghio et al., 2013; Mazzuca et al., 2018).

A further illustrative example of the variety of abstract concepts is constituted by the domain of numerical concepts. In fact, the ability to mentally manipulate numbers has been considered for a long time a highly symbolic skill. However, research in the frame of EGC showed that numerical cognition is modulated by sensorimotor capacities, which are specifically related to the habit of finger counting (Lakoff & Nuñez, 2000) consolidated through the modality of acquisition of numerical concepts. Studies addressing the mental representation of numerical cognition have evidenced the role of multiple systems involved in the mastering of numerical domains: numbers processing was found to be grounded in sensorimotor system, and a tight relation with hand movements and spatial cognition emerged from empirical investigations (Fischer & Brugger, 2011; Fischer, Castel, Dodd, & Pratt, 2003; Fischer et al., 2012; Tschentscher et al., 2012; Wood & Fischer, 2008). Therefore, although both emotional and numerical concepts are couched in our sensorimotor systems, the extent to which this relation is re-enacted is different between the two classes, and their inclusion into the class of *purely abstract* concepts is at least blurred.

To better tackle the issue of abstract concepts, Multiple Representations Views among which the WAT theory (Barsalou, Dutriaux, & Scheepers, 2018; Borghi, Barca, Binkofski, & Tummolini, 2018b; Cuccio & Caruana, 2019; Ghio, Vaghi, Perani, & Tettamanti, 2016) have proposed that abstract concepts should be studied not as a monolithic whole, but rather according to the source of grounding[13] of each of their

---

[13] In the whole course of this dissertation I will follow Barsalou's (2016a) definition of grounding, which in his words refers to "establish their [cognitive processes'] relations with the contexts in which they are

kinds/sub-types. Just as for concrete concepts a compelling body of knowledge has demonstrated that their representation vary depending on specific conceptual characteristics (Capitani, Laiacona, Mahon, & Caramazza, 2003; Humphreys & Forde, 2001), the same strategy should be applied to abstract concepts.

When considered in this perspective, the sharp distinction between purely abstract and purely concrete concepts seems to be an artificial oversimplification (Barsalou et al., 2018): as already pointed out in the frame of this discussion, concepts are abstractions on their own, but we can differentiate them on the basis of their higher or lower level of abstractness. Nonetheless, as portrayed by the examples of emotional and numerical concepts, there is at least another dimension to take into account in the study of concepts, namely, their grounding source. The latter factor seems to somehow undermine the well-established distinction between abstract and concrete concepts, in that (as noted before) both the modality of acquisition and the context of usage of concepts elicits subsequent simulations, which are constitutive of conceptual knowledge.

In line with these speculations, some scholars (e.g., Borghi et al., 2018; Barsalou et al., 2018) are recently challenging the traditional abstract-concrete dichotomy. At a careful inspection, in fact, abstract concepts incorporate aspects traditionally deemed as abstract and aspects traditionally considered as concrete. This ambivalence is elegantly illustrated by an example taken from an early study by Hampton on abstract concepts (Hampton, 1981). Think for example of the concept *art*: its multilayered character is immediately explicit, not only because of the semantic ambiguity of the term.

---

embedded and on which they rely. At more specific levels, grounding refers to establishing specific accounts of how cognitive processes in the brain utilize the modalities, the body, and the environment". (p. 1129); see also Chapter 1 of this dissertation.

By way of illustration, Hampton asked participants to produce features of some abstract concepts, among which *art*. According to participants' responses, the concept of *art* included variegated semantic features like "is an artifact", is usually visually experienced, pleasing, arouses emotions, is an object, involves skills or is expensive. Looking at this list, it is evident how those conceptual features comprise aspects that are neither exclusively abstract nor exclusively concrete: *art* encompasses features related to the visual and perceptual presentation of art works as well as features concerning expectations, internal states and intentions.

A more recent example (Barsalou et al., 2018, p. 4) revisits the classic HAMMER example as concrete concept. The authors pointed out that even the most "concrete" situations could easily become "abstract" when considered in a perspective integrating concepts with situated actions. Following the example, the activity of *hammering* (typically conceived as the movement of hitting a hammer on a nail) usually includes a goal (viz. attaching something to somewhere), and could elicit emotions (e.g., accomplishment in doing something or fear of breaking something) or even social interactions (e.g., yelling at the annoying neighbor that hammers things to the wall in the night).

Despite the wealth of research addressing the topic of abstract concepts in EG inspired approaches, then, some vicarious issues are still at stake. On account of this, some promising insights have been recently brought forward by a vast asset of proposals, labelled Multiple Representations Views. In a nutshell, three prominent novelties animate the so-called Multiple Representations Views: first, the idea that the simple distinction between abstract and concrete concepts is not scientifically useful in the inquiry of conceptual knowledge. Second, that abstract concepts cannot be accounted for by considering them as a unitary category, given their dramatic intra-categorial variability. Last, that in order to produce a honest sketch of how the conceptual system works, we need to investigate concepts at a more fine-grained level, that is to say, according to their grounding. These considerations suggest that from a theoretical point of view, searching for a kind of mental representation able to unfold all possible kinds of concepts might be a "quixotic dead end". Thus, a possible strategy might be to acknowledge the role of different representational constructs and their influence in the constitution of concepts. The last sections of this Chapter are dedicated to a critical investigation of these tenets.

2.9. Multiple Representations, Multiple Systems. A Call for Pluralism

The first Chapter of this dissertation was devoted to a general overview of some of the most influential theories of conceptual knowledge. The take-home message from the first Chapter is that, as long as cognitive scientists will strive to tame concepts by framing them in a unitary representational construct, some critical information would always be left aside. One of the reasons of this 'scientific failure' is that among the desiderata for the psychological structures proposed over time, the capacity to coherently explain all kinds of concepts is highly problematic. Moreover, findings from the literature on *conceptual flexibility* (Kiefer & Barsalou, 2013; Kiefer & Pulvermüller, 2012; Pulvermüller, 2018) demonstrated that the activation of relevant features in the encoding of a concept is strictly context-dependent. This last point puts further in jeopardy the notion of concepts as stable and unitary representational structures, in that they have been proven to be flexibly modulated by e.g. changing of points of view (Barsalou & Sewell, 1984), physical context (Boroditsky & Ramscar, 2002), linguistic context (Barclay, Bransford, Franks, McCarrell, & Nitsch, 1974), and cultural and linguistic environment (see par. 2.7.3).

Indeed, the pivotal property of concepts and categories of being highly flexible, along with their 'resilience' to be sharply framed in a unitary psychological structure, suggested some scholars to abandon the idea that concepts are stable entities in our minds. On the contrary, the retrieving and processing of conceptual representations related to words is affected by various components, such as contextual constraints, recency and frequency of instantiation, language specific aspects and also cultural and social factors[14]. Henceforth, experimental findings and theoretical criticisms converge in support of the idea that the existence of a single psychological structure unfolding all kinds of concepts is an untenable commitment.

On this note, Weiskopf (2009) pointed out that it is legitimate to think that the conceptual system is built to employ a variety of different representational tools. Specifically, those tools vary with respect to (a) the kind of information they convey, (b) the ways they are acquired and processed, (c) the domain they favor and (d) the task that promote their use. What Weiskopf is defending is a pluralistic account of concepts, that has some appealing leads over "monolithic theories of concepts" (Rips, 1995; Weiskopf, 2009). As Weiskopf discussed, much of the strength of a pluralistic turn comes from its explicit rejection of two specific assumptions implicitly endorsed by traditional conceptual theories:

[14] Note that a radical version of these claims (Casasanto & Lupyan, 2015) contends that even the most stable categories and concepts are instantiated as those that are generally considered *ad hoc* (cf. Barsalou, 1983, see Chapter 1). Specifically, in this perspective, concepts are thought to vary (a) from one microsecond to another; (b) from one instantiation to the next within an individual and (c) from person to person or group to group depending on people's experiential history. Although I do not endorse this position, I don't fully embrace a perspective only focused on 'conceptual core', or psychological essentialism (cf. Chapter 1 of this dissertation). From my point of view, one of the problems with conceptual knowledge has always been that conceptual representation was conceived in a theoretical scenario where *tertium non datur*. We will see why this solution is probably not the best scientific option.

1. *The Singularity Assumption (SA)*: any occurrence of a concept C is to be considered as pertaining to '*the* concept C'. In other words, the concept C needs to be represented only as '*the* concept C', implying that any other conceptual representation not fitting this requirement cannot be considered as pertaining to the concept.
2. *The Uniformity Assumption (UA)*: all concepts belong to a single unitary psychological kind (in the case of the classical conceptual theory for example this kind is a definition, but it can be a prototype or every other form of mental representation).

Both these claims have been falsified by empirical evidence, showing for example how concepts flexibly adapt to situations, and how their representation vary consistently among different people (hence *SA* cannot be correct). With respect to *UA*, as already introduced in this discussion, a general overview of the history of conceptual theories reveals how this is a rather radical position to accept. In his review of the literature of conceptual processing, Weiskopf showed how conceptual system reliably employs different kinds of conceptual tools, e.g. prototypes (lay people often conceptualize many domains in terms of prototypes: think for example of the concept of tree), whereas depending on the expertise the same domain can be conceptualized by other groups of people in terms of *ideals* (cf. Barsalou, 1983, 1985).

By rejecting the *Uniformity Assumption*, instead, we can easily justify multiple forms of conceptual representation. Henceforth, the fact that some concepts are generally processed and stored in the long-term memory as e.g. conforming to a prototype, while others are dynamically created and elaborated in order to accomplish a goal, does not undermine the explanatory potential of concepts as scientific tools *per se*[15]. Moreover, if

[15] It is worth noting that one of the arguments for conceptual eliminativism (Machery, 2009, 2015; see Prinz, 2010 for a critical reply) resides in the fact that over the history each scientific theory proposed that one single model (e.g., prototypes, exemplars etc.) ought to be considered the default and only form of "concept". According to Machery's view, given the broad body of evidence that some conceptual representations are stored as e.g., prototypes while others as mini-theories, the ontological character of concepts is undermined: in fact, the different models of concepts enumerated all have various functional status, and therefore it is impossible to categorize them under the same label. Machery thus argue for the

we take this pluralistic stance to be correct, the role of conceptual flexibility can be smoothly spelled out: in fact, the kind of structure a conceptual representation would rely upon would depend on the task being performed as well as on the context in which the concept is employed (note that this is also in accordance with a situated idea of cognitive processes)[16].

The reader might wonder how to effectively apply those speculations in the study of concepts, and at a more fine-grained level what are the benefits of a pluralistic theory of conceptual representation for abstract conceptual knowledge. The answer is–in line with MRV recent developments–to carefully investigate grounding sources of each class of concepts, both pertaining to more concrete domains and to more abstract ones. In this vein, a possible strategy is to look at different concepts without positing an a-priori epistemic lens. The impressive amount of literature produced over the years on abstract concepts needs not to be discarded: if we fully endorse a pluralistic perspective on conceptual representation, we can accept that (a) different classes of abstract concepts are acquired and grounded differently, and (b) the same concept can be processed and elaborated in different ways depending on the task for which it is required and the situation it is embedded in.

For instance, let us step back to the introductive examples of this Chapter, namely the concepts of *lust*, *pride* and *avarice*. Considered in a pluralistic perspective, it seems perfectly reasonable to claim that they might have a metaphorical grounding (as the symbolic representations of the sins as animals testify), and that this metaphorical

elimination of the theoretical construct of "concept", because in his perspective we cannot gain relevant scientific knowledge from it.

[16] A pluralistic approach to scientific phenomena does not entail the erase of genuine competition among different theories (Dale, Dietrich, & Chemero, 2009): rather, it suggests the possibility of theoretical integrations spanning across different contexts and disciplines.

grounding could be an important brick of the conceptual representation of the meaning of the terms. Indeed, referring concrete aspects such as renowned animal attitudes to abstract concepts such as *lust*, *pride*, and *avarice* might be crucial during the first steps of acquisition of the concepts, working as a concrete vehicle for an abstract topic (cf. Lakoff & Johnson 1980). Clearly, once acquired those concepts would undergo a process of semantic and conceptual implementation, that will enrich the conceptual knowledge with other important aspects. For example, one can learn that capital sins–as wonders of the world and Rome's hills–come in lists of seven items; thus, once memorized the entire list, linguistic information may become another grounding source for the concepts (see e.g. *Symbol Interdependency Hypothesis*, Louwerse, 2008; 2011 or distributional approaches inspired by LSA). A further dimension to take into account might be emotional valence: after learning how to correctly apply the linguistic label to the concept by collecting different internal states and external observation, for instance, one can additionally add layers to her own knowledge of the concept *pride*. Therefore, we can recognize the instantiations of *pride* besides encyclopedic knowledge and metaphorical thinking by reasoning on our internal states triggered by e.g. the fulfillment of an assignment. Depending on the situation, hence, those different forms of grounding can be reactivated and re-enacted. In sum, by bridging together a pluralistic perspective and Multiple Representation Views on abstract concepts, it appears clearly how abstract concepts too are embodied, enacted, extended, and embedded to different extents.

En route to puzzle out the conundrum posited by abstract concepts, studying few of them in detail and individuating differences and similarities in their underlying mechanisms might furnish us with a much clear understanding of this "hard nut to crack" (Barsalou, 2016; Borghi et al., 2018; Barsalou, Dutriaux & Scheepers, 2018). Towards this end, in the remaining of this Chapter I will examine a specific class of abstract concepts, namely social concepts. I will offer a review, with no pretense to be exhaustive, of behavioral, neurocognitive and philosophical findings supporting the claim that multiple mechanisms subtend the representation of social concepts. Therefore, building on the ideas stemmed from the discussion of MRVs and their approaches to the problem of abstract concepts, I will lay the groundwork for the last Chapter of this dissertation, focused on a specific social concept, viz. the concept of *gender*.

2.9.1. Unfolding abstract concepts: social concepts and the role of metacognition

> The bias against abstract concepts starts with the definition itself, in that they are defined negatively by what they lack rather than by what they contain. They are essentially ‘everything that is not concrete’. This is a bit like dividing buildings into ‘dwellings’ and ‘non-dwellings’. This can be useful especially if we are mainly interested in dwellings, but shortchanges the diversity of non-dwellings that vary from hospitals to museums to shopping centers. The most important feature of a movie theater is not that people do not live there. (Desai, Reilly and van Dam, 2018, p. 2)

The quotation from Desai, Reilly and van Dam (2018, p. 2) excellently illustrates the ratio behind the new interest in unraveling the complexity of abstract concepts. *De facto*, a more flexible organization of the semantic system (viz. an organization that is not centered around the dichotomy abstract-concrete) has been recently proposed and tested by some scholars (cf. among others Binder et al., 2016; Borghi, Barca, Binkofski, & Tummolini, 2018b; Harpaintner, Trumpp, & Kiefer, 2018; Troche, Crutch, & Reilly, 2017, 2014). With the aim of investigating the meaning of abstract and concrete words in a multidimensional perspective, for instance, Troche, Crutch and Reilly (2014) asked a sample of 365 participants (English native speakers) to rate a set of 400 words, half of which were abstract and half concrete, on a number of dimensions. The list of dimensions they included in the study was relevant for testing their hypotheses, namely that meaning is spanned across a multidimensional space including both concrete and abstract aspects; thus, dimensions included were for instance polarity (in relation to positive or negative feelings elicited by the word), relation to action, mental activity or social interaction. After submitting the results of the rating to Factor Reduction, the authors identified three main factors, roughly corresponding to perceptual salience, affective association and magnitude. They subsequently plotted the results of the ratings into clusters (Hierarchical Cluster Analysis; HCA), and the area of highest overlap between abstract and concrete terms resulted to be evident for words at the high end of the 'affective/association-social cognition' dimension. By way of explanation, concrete words that had a high load on the factor identified as 'affective-social', were closer in the semantic space pictured by the solution of the HCA to those abstract words that didn't load relevantly on that dimension (e.g., two words such as father–considered as concrete–and love–considered as abstract–were topographically placed aside).

A similar pattern of results is reported in a recent study by Harpaintner, Trumpp and Kiefer (2018). The authors provided participants a large dataset of abstract words and requested them to generate properties for the items. Through descriptive and cluster analyses, they demonstrated that abstract concepts can be distinguished on the basis of their specific semantic featural composition: some abstract concepts are indeed more characterized by a high proportion of sensorimotor associations, some by verbal associations, while others by a larger proportion of internal and emotional features.

Interestingly, the cluster in which the internal and emotional features were predominant, was also the cluster that included the highest number of ‘social’ features.

Evidence supporting the idea that sociality and emotion are determining aspects of abstract conceptual knowledge is refined by neuroimaging and neuropsychological studies. Metanalyses focused on the neuroanatomical substrates of abstract concepts’ representation (e.g., Wang, Conder, Blitzer, & Shinkareva, 2010) for instance showed that in a sample of 19 studies two regions were found to be consistently activated by abstract content, namely the left anterior temporal lobe (ATL) and the inferior frontal gyrus (IFG). However, the scientific literature regarding the function of ATL is not uncontroversial; some have proposed that its role is that of a representational and transmodal hub (Lambon Ralph, Jefferies, Patterson, & Rogers, 2017; Patterson, Nestor, & Rogers, 2007) connected to spokes localized across the cortex, integrating semantic information regardless of its content. Another line of research identified the more anterior regions of the ATL as central in the processing conceptual information related to people recognition and especially linked to emotional and situational contents, while others insisted on its role in sentence processing (cf. Mellem, Jasmin, Peng, & Martin, 2016).

At a closer look, recent studies reveal that the role of ATL is tightly associated with abstract knowledge, and concomitantly linked to social and emotional cognition, integrating some of the most prominent perspectives like the ones described above. In an MRI study, for example, Mellem and colleagues (2016) showed that the activation of specific areas of the ATL (aSTG/STS) was strongly modulated by constituent size (i.e. number of words per phrase presented) but not by the condition of non-words. More crucially, they were selectively activated when sentences with social-emotional content were presented (i.e. sentences describing interactions between agents containing strong emotionally valenced words). Rice and colleagues (2018) also described a consistent activation of ATL for processing people faces, and additionally they reported how a region in the aSTG responded selectively to socially relevant abstract words but not so socially relevant concrete words. Overall, recent research is evidencing how specific abstract semantic knowledge related to social concepts holds a tight relation with neural regions related to both social and emotional cognition and linguistic processing. These findings are in line with perspectives emphasizing different grounding mechanisms for specific sub-classes of abstract concepts (e.g. the WAT theory), among which sociality and language appear as essential.

Social concepts: a grounded perspective. Considered in a pluralistic framework that rests on the body of evidence just described, theories stressing the importance of language and linguistic information (LASS; WAT), theories centered on the role of emotions (AEA) and theories stressing the relation with sensorimotor activity (Glenberg, 2015, see the role of action in ACE, Glenberg & Kaschak, 2002; Glenberg et al., 2008) can be compatibly employed to disentangle the abstract conceptual domain. However, those proposals seem to provide only a partial explanation. For some abstract concepts, in fact, a further and yet unexplored grounding source might be pivotal, namely metacognitive processes (Borghi, Barca, Binkofski, & Tummolini, 2018b; Shea, 2018). Among those concepts, I will specifically consider the case of social concepts. The variety of experimental results concerning social abstract concepts indicates that dimensions such as affectivity, internal states and normative, social and contextual considerations might be jointly taken into account when investigating this kind of concepts (see also Roversi, Borghi, & Tummolini, 2013). What could possibly be the common grounding, the "glue" holding these kinds of experiences together? Arguably, specific classes of abstract concepts (e.g. “social abstract concepts”) can be more linked to linguistic and social experience with respect to others. Why should this kind of information be so relevant for social concepts with respect to, for instance, numerical concepts?

A possible explanation is proposed by Shea (2018) by introducing the notion of metacognitive deference. The author argues that many concepts are constructed through a collective process of deciding how to use them. In Shea’s view, language may serve as a grounding source in at least two ways: in an “internal” way, as a developmental tool for acquiring and differentiate concepts (see also Borghi et al., 2018; Barca et al., 2017), and in an “external” way, as a mean to socially connect our knowledge of a concept with a much wider body of knowledge. Starting from the process of explicitly deferring to experts when insecure about the correct use of a word, e.g. about the difference between two tree species, Shea extends the discussion by arguing that sometimes deference can be implicit. In this case, the users can just be disposed to trust others about how to use a concept and they can be prone to accept the established range of appliance of that concept. This is particularly true for some social categories, for which we may rely almost completely on deference from experts.

Consider the following example. Martha is attending her first sociology class. The teacher is giving compelling explanations on the necessity of distinguishing the notions of race and ethnicity. Before that moment, Martha never felt the need to reflect on this distinction, but once at home she recognizes that most of the arguments provided by the teacher were in fact impressive. Therefore, from that moment on, she decides to apply consistently the notions of race and ethnicity. In this case, the linguistic experience provided from the explanation of the teacher, along with the “social” experience of becoming part of a shared knowledge, constitutes the primary source of grounding of the concepts. Perhaps, when in doubt whether to apply the notion of race or that of ethnicity, Martha will recall and re-enact the teacher's speech, thus making it her primary grounding source for the two concepts.

When a category is socially determined, the users' dispositions to classify things partly determine which phenomena fall into that category. This creates a mechanism of grounding that acknowledges the role of public language and public knowledge as a basis for our conceptual structure. What is the part played by metacognitive processes in this frame? Shea argues that deference in defining and using a concept, together with the explicit or implicit evaluation of its applicability are metacognitive processes, and that they can be considered as resources needed to ground particular abstract concepts. In this vein, Borghi et al. (2018) introduced the notion of *social metacognition* to account for abstract concepts. Drawing on the distinction between explicit and implicit deference (Shea, 2018), they argued that language and sociality play a pivotal role in the processing and acquisition of abstract concepts, because we might need to engage a process of assessment of our conceptual inadequacy and then to rely on others to fix reference.

The role of social metacognition is thus to integrate different experiences (e.g. the internal acknowledgment of a conceptual gap with a new operational definition in the example of Martha), at an individual level, through language. Since language can also be intended as a social product and a social practice, it can hardly be separated by speakers; therefore, social metacognition operates also at a collective level, for example raising discussions among students attending Martha's class that will confront each other on the newly acquired definitions, thus negotiating their meanings. Through language, in fact, we assign a new status to some phenomena, where the function of that status cannot be inferred solely by virtue of the physical characteristics of the phenomenon (Searle, 1995).

Institutional facts are especially representative of this process, in that as Searle pointed out, their creation can sometimes be simply stated by declaring it to be imposed. In his words (Searle, 1995):

> Symbols do not create cats and dogs and evening stars; they create only the possibility of referring to cats, dogs and evening stars in a publicly accessible way. But symbolization creates the very ontological categories of money, property, points scored in games and political offices, as well as the categories of words, and speech acts. (p.77)

Henceforth, by creating the possibility to publicly refer to some phenomena, we simultaneously create the ontological category into which those phenomena can be included, negotiating its boundaries and refining the ambit of the concepts that pertain to that category (cf. Shea, 2018). Social concepts, as characterized in this discussion, constitute a specific class of abstract concepts. They are entrenched in social and linguistic practices, but they also encompass internal and experiential aspects.

2.10. Halfway Conclusions. Malo Accepto Stultus Sapit

The aim of this Chapter was to present some relevant problems in the study of abstract concepts. Indeed, abstract concepts have been traditionally taken as the prove that theories based on an embodied and grounded perspective on cognition are doomed to fail. Given the importance of bodily and sensory processes implied in the conception of cognition of EG theories, this is not particularly surprising. In fact, one of the reasons why some scholars were skeptical in completely endorsing an EG perspective on conceptual knowledge is that those accounts seemed to be particularly suited for the explaining of concepts whose referents are manipulable and perceivable objects. In a simulation-based account of conceptual knowledge such as the one proposed by EG theories of cognition, it is easy to see how this type of concepts, i.e. ‘concrete concepts’ re-enacts sensorimotor states related to the experiences with its referents (see Chapter 1, par. 1.6.3). Abstract concepts such as *mysticism*, on the other hand, do not have single and bounded referents triggering simulations. Therefore, it has been objected that EGC theories cannot explain abstract concepts for the very same fact that abstract concepts are not tied to multimodal patterns of activation. Nonetheless, researchers embracing EG cognition stances advanced interesting hypotheses to account for abstract conceptual knowledge over the years, as testified by the brief review of literature of the first paragraphs of this Chapter. Some contended that our abstract conceptual knowledge is entrenched with linguistic expressions that shape our concepts (Lakoff & Johnson, 1980), others evidenced the relation between abstract concepts and action-oriented processes (Glenberg & Kaschack, 2002), while others claimed that abstract concepts are ‘built’ through the help of emotional concepts (Kousta et al, 2009; 2011; Vigliocco et al., 2014). The second part of the review is devoted to the inspection of those theories that characterized language as a central source for the acquisition and processing of abstract concepts. They can be roughly divided into two main groups: on the one hand, theories maintaining that language is a sort of shortcut for deeper (and sensorimotor) conceptual representations (cf. Louwerse, 2008; 2011; Louwerse & Jeuniaux, 2010; Barsalou et al., 2008; Simmons et al., 2008; Dove, 2011; 2014; 2016), and on the other hand a theory that stresses the intrinsically social and embodied nature of language (Borghi & Binkofski, 2014; Borghi et al., 2018a, b).

If we look critically at the recent discussion concerning abstract concepts, we can see the emergence of some interesting theoretical proposals. First of all, the traditional distinction between abstract and concrete concepts might turn out to be an artificial oversimplification of the conceptual domain, if taken as the only distinctive parameter in the study of conceptual knowledge. Indeed, some of the researches cited in this Chapter (e.g., Hampton, 1989; Roversi et al., 2013; Harpaintner et al., 2018; Barsalou et al., 2018) showed how sometimes the distinction between abstract and concrete concepts is not so sharp, because properties that are traditionally considered as concrete sometimes contribute to the conceptual representation of abstract concepts and *vice versa*. Hence, recent proposals are endeavoring to refine this traditional dichotomy by taking into account other aspects of concepts (cf. Borghi et al., 2018; Barsalou et al., 2018) that might be more informative. A first operational distinction that can be made at a general level is the one between the notion of *abstraction*–i.e. the process through which we abstract general features of experience at the basis of categorization processes, which regards both abstract and concrete concepts–and *abstractness*–that specifically refers to the detachment from physical reality of the referents of the concepts being examined. Therefore, *money* for instance has a high level of abstraction, because it is placed somehow at the high end of the hierarchy composed by all possible kinds of currencies (e.g., euros, dollars, yen) and it has also a symbolic value, but it has a low level of abstractness because its referent can be a concrete object. In this way, we can distinguish those concepts that were previously considered as abstract in terms of their detachment from the experiential reality through the lens of abstractness. Therefore, a concept like *mysticism* would have a higher level of abstractness than a concept like *number*, because even though in an indirect way we could refer the concept of number to some concrete referent (e.g., 911 is “the number you call for emergencies”). For the sake of the study of abstract concepts, a first definitional criterion might thus be to focus on the dimension of abstractness, keeping in mind that sometimes this is interwoven with the dimension of abstraction. The other important issue that Multiple Representation Views (MRVs) contributed to explicit is that the category of abstract concepts is comprised of a multitude of different sub-domains. Hence, studying abstract concepts as a cohesive and unitary category would mean to overlook at important differences within the category itself. Following this consideration, some scholars proposed that a further distinctive criterion, internal to the category of abstract concepts, might be concurrently employed in their description, namely their *grounding source*. This is pivotal for an embodied and grounded account of abstract concepts on two distinct and interacting levels: on a diachronic and on a synchronic level. Indeed, as evidenced in par. 2.7.1, converging evidence showed that the specific modality of acquisition of concepts impacts their subsequent representation and elaboration. This was evident for example in research focused on numerical knowledge, that revealed how the habit of finger-counting seems to be implicated in the representation of numbers. Importantly, the dimension of abstractness and the grounding source are strictly related: as noted by Borghi et al. (2018), concepts that have higher levels of abstractness are mainly acquired through e.g. linguistic explanations (or metacognitive deference, see par. 2.9.1), due to the fact that it is more difficult to ground them into some perceptual experience. Abstract concepts that have lower levels of abstractness instead can be grounded to a greater extent in our sensorimotor system, as the example of numbers demonstrated.

Another line of criticism concerning abstract concepts derives from the general reluctance to accept the possibility of pluralism as epistemic path. Some influential proposals (cf. Dove 2009; Weiskopf, 2009) suggested that, in order to provide successful theories of conceptual representation, we might dismiss the general avoidance for multiple explanations. In fact, once recognized that different concepts might be represented differently in our conceptual system, depending on the task being performed and on their grounding source, our knowledge of the functioning of the conceptual system can be enhanced. In this perspective, some concepts might be primarily represented in terms of linguistic associations with other similar concepts, while others may be strongly couched in sensori-motor systems. The epistemic turn implied in the endorsing of a pluralistic perspective has already been applied to concrete concepts, that were found to be grounded in different modalities; the next step is henceforth to apply it to abstract concepts.

In a nutshell, in this Chapter I argued for a more complex distinction of abstract conceptual knowledge, which is not based on the classical dichotomy abstract vs. concrete (Brysbaert, Warriner, & Kuperman, 2014; Paivio, 1986). On the contrary, abstract concepts can be characterized in an EG perspective through a more fine-grained classification, based on their level of abstractness and on their grounding sources, keeping in mind that the latter might be multifarious and differently employed and re-enacted depending on the situations.

In line with these considerations, in the next Chapter I will introduce a possible key of interpretation in the study of abstract knowledge. Based on theoretical speculations coming from different disciplines, I will claim that to move forward in the understanding of ACWs, they need to be *queered*. The introduction of the notion of *queer* will offer a theoretical frame affording a reflection on abstract concepts critically outdoing classical dichotomies, with the aim of answering to the quest of specificity stemmed from recent debates. To demonstrate how the theoretical tool offered by the notion of *queer* might be useful, I will discuss how a concept that could be considered as a social abstract concept, namely the concept of *gender*, when inspected carefully encompasses both abstract and concrete aspects. Hence, through the analysis of some of the grounding sources of gender, I will contend that not only the category of abstract concepts is a *queer* category, but also that the concept of gender in itself can be better accounted for if considered as a *queer* concept.

CHAPTER 3

GENDER IS AN ABSTRACT CONCEPT

3.1. What Would You Say to an Alien?

On March 2, 1972, a spacecraft named Pioneer 10 was launched from Cape Canaveral, Florida. The space exploration project for which Pioneer 10 was designed and launched was conducted by the NASA Ames Research Center, and would have become famous for being the first mission to be completed to the planet Jupiter. But this is not the only reason why the spacecraft Pioneer 10–and the subsequent Pioneer 11–became world-wide famous. The spacecraft would have in fact had the possibility to encounter extraterrestrial forms of life during its trip, therefore, someone thought that it would have been a good idea to send to our intergalactic neighbors a message. What would you communicate about our world to an alien? With the aim of solving this conundrum, Carl Sagan, Linda Salzman Sagan, and Frank Drake spent three weeks conceiving and designing special aluminium plaques to be placed on the Pioneer 10 spacecraft. Those plaques should have contained important information concerning the human kind, allowing extraterrestrial forms of life to get a sense of how we live and how we are 'built'. Figure 5 depicts is the outcome of the work.

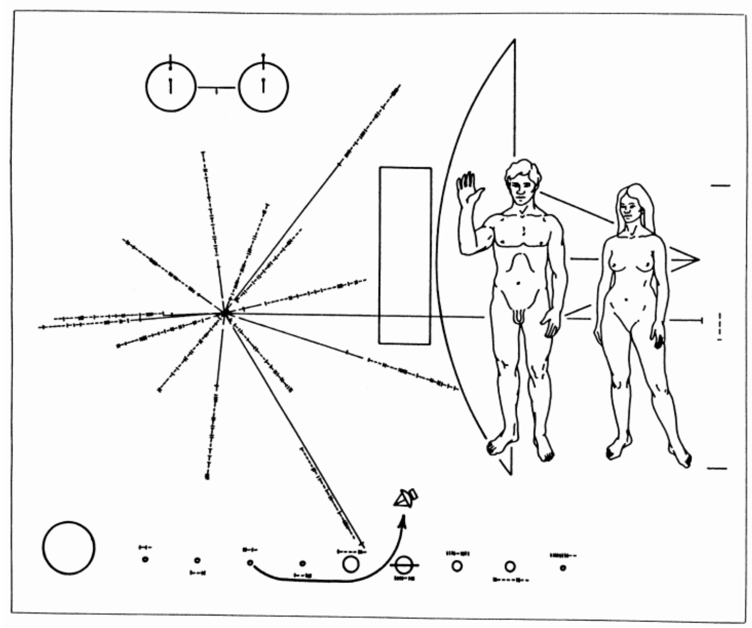

Figure 5. The Pioneer 10 plaque (Vakoch, 1998, p. 314).

How would we present ourselves to the aliens? We would certainly represent the spacecraft wandering through the space and give a sketch of our solar system, but most importantly we would communicate that the human kind is divided into two big categories. We are males and females[1].

Despite all the criticisms raised by the plaque (cf. Wade, 1977), one thing this anecdote made extremely clear is that gender is a salient feature of humanity–so salient that it is the first information we would convey to aliens about our species. It is, so to speak, one way of classifying and dividing entities in the world, and its range of appliance is not limited to human beings: we ascribe a gender to inanimate entities like objects and also (in gendered languages) to abstract notions like philosophy (e.g., in Italian the word *filosofia* is feminine). We employ the categories of gender constantly in our everyday life, sometimes even without really paying attention to the distinctions we are making for

[1] I am thankful to AG Arfini for introducing me to the story of these 'gendered' plaques.

instance by the means of language. But what are we really talking about when talking about gender? Are we referring to some physical and biological set-up allowing us to divide human beings into two categories? Are we talking about social roles to be fulfilled? And what about linguistic structures affording gendered conceptual representation of objects? In sum, how is our conceptual knowledge of gender constructed? What are the grounding sources of the concept of gender, and how those impact our conceptual representation?

To these, and other questions I will try to provide partial answers in this Chapter. Drawing on the characterization of abstract social concepts proposed in Chapter 2, I will analyze the groundings of the concept of gender from multiple perspectives, encompassing psychological, biological and philosophical literature. With this respect, a preliminary methodological and theoretical remark is warranted. The present dissertation is centered on concepts and conceptual representations. Hence, I will examine how the concept of gender has been employed, articulated and analyzed in the scientific debate across several disciplines, tangentially related to cognitive science. Specific consequences of the understanding of gender-related concepts include the development of gender stereotypes (Ellemers, 2018), gender socialization (Epstein & Ward, 2011), legal and organizational practices (Risman, 2004), and cognitive bias or supposed psychological gender differences (for a review see Hyde, 2014; Hyde, Bigler, Joel, Tate, & van Anders, 2019). Although these elements contribute to the reinforcement and the re-conceptualization of concepts akin or knit together with the concept of gender, they will not be treated in this discussion. The specific literature concerning the aforementioned topics will only be discussed when relevant for the purpose of shedding light on the conceptualization of gender.

3.1.1. Some terminological distinctions–or not? Before moving to the core points of this Chapter, we need to precisely identify what is the object of its inquiry: gender. For the contemporary reader, the distinction between *sex*–the biological make-up that distinguishes males from females–and *gender*–the social distinctions constructed upon it–might seem obvious, and even not worth mentioning. But things were different up to the late 60s. Indeed, until that time, English-speaking countries employed the word *gender* solely to refer to grammatical differences conveyed by masculine and feminine forms of language (such as *lo* and *la* in Italian) (Nicholson, 1994). The re-definition of the term *gender* followed two separate but parallel routes, that at the beginning of the seventies led to its articulation in terms of the social constructed norms based on biological factors that distinguish men from women.

On the one hand, the work of sexologists Money and Ehrhardt (1972) contributed to spread the idea that sex and gender are different categories. Money and his colleagues were working with children that had ambiguous sexual markers (e.g. testes and vagina, two X chromosomes and a scrotum and so on), and started to develop a layered model of sex and gender, where the two categories followed a developmental path from birth to adulthood. Importantly, Money and Ehrhardt defined *sex* as a biological and physical determined attribute, and *gender* as the psychological conviction of being a male or a female (what we would call, with some caveats, gender identity), and the expression of this conviction. Specifically, they claimed that at birth a newborn is identified by people surrounding her as a male or a female through the external observation of her genital anatomy (genital dimorphism). Afterwards, this precise classification as either a male or a female triggers a social response that initiates the gender socialization of the baby (e.g. pink clothes for females, truck and guns toys for males). Therefore the *gender fortification*, that is the process through which the baby learns what is in accordance with her sex, begins—eventually resulting in the constitution of the adult gender identity.

Concurrently, in the early 70s, feminist debates focused on the need to distinguish sex from gender, for very different reasons than the ones moving Money and his colleagues at the John Hopkins. The central motivation for feminists to keep sex separate from gender was to oppose biological determinism. Biological determinism, or the view that biological factors determine one's own destiny, was in fact the motor for women's discrimination over time. To illustrate, Geddes and Thomson's (1889)[2] theory of social, psychological and behavioral traits distinguishing men from women was based on the different metabolic states that the two categories supposedly held. Women were considered to conserve energy, and therefore they were deemed as passive and unable to develop interests for politics. Men, on the other hand, were considered 'katabolic', and in the need to spend their energy; thus they were supposed to be energetic, passionate and consequently apt for social and political activism. The biological and metabolic underpinnings of gender differences between men and women were understood not only in terms of behavioral differences, but they constituted also the basis for the exclusion of women from political life. Specifically, given that women were by nature unable to maintain an interest for political facts, they were denied the right to vote. Henceforth, with the aim of distinguishing between given and immutable biological properties and psychological or behavioral traits, feminists separated *sex* from *gender*. In a seminal work, Rubin (1975) defined sex as the biological and fixed datum, and gender as the oppressive outcomes of social costumes that define how men and women should behave. She coined the expression 'sex/gender system', which in

[2] Retrieved from https://plato.stanford.edu/entries/feminism-gender/.

her point of view illustrates “a set of arrangements by which the biological raw material of human sex and procreation is shaped by human, social intervention” (Rubin, 1975, p. 165). The reconceptualization of the term *gender* aimed at highlighting the social nature of those behavioral and psychological traits that were prior judged to be immutable because biologically given, and that were used to justify women’s oppression. If gender was the social transposition of biological differences, it could have been in principle mutable. Political action was therefore invocated for ending women’s subordination and organizing a genderless (but not sexless) world. The basic assumption is that gender, intended as masculinity and femininity, is socially imposed on our sexed bodies: we are all born males and females, but what makes us women and men are the socially and culturally defined norms of masculinity and femininity. In Rubin’s words (1975):

> But we are not only oppressed *as* women, we are oppressed by having to *be* women, or men as the case may be. I personally feel that the feminist movement must dream of even more than the elimination of the oppression of women. It must dream of the elimination of obligatory sexualities and sex roles. The dream I find most compelling is the one of an androgynous and genderless (though not sexless) society, in which one’s own sexual anatomy is irrelevant to who one is, what one does, and with whom one makes love. (p. 204)

Although certainly promising when framed in the cultural and social context in which it appeared, the distinction of sex and gender is not so sharp as it seemed in the first place. From a theoretical point of view, the sex/gender dichotomy represents the old nature/nurture dichotomy; in this sense, feminist theorists arguing for a separation of sex from gender were overlooking some important issues, one above all the fact that we are actually living and sexed bodies, and that this property determines our interaction with the cultural and social world. We are, in fact, embodied agents and our cognitive skills are profoundly influenced by the very same constitution of our bodies. Sexual attributes, in this sense, make no exception in shaping our cognition, if other because they are part of our bodily presentation that leads us in our interaction with the environment (see the discussion of EGC theories in Chapter 1).

More to the point, what if the opposition between natural facts and socially constructed facts turned out to be artificial? After all, scientific theories are placed into existence by scientists through the observation of natural phenomena, but ultimately scientists are human beings on their own, and for that very reason they are *interpreters*. As a matter of facts, a large body of evidence questioned the supposed naturalness of the sexual dimorphism. Some influential works on the biological development of sexual markers (Fausto-Sterling, 1993, 2000, 2012), showed that typically masculine or feminine genitalia are just the two extremes of a variegated spectrum of possible combinations when it comes to chromosomal, gonadal, hormonal and genital sex. The history of treatment of intersexual persons, subjected to 'corrective' surgical and hormonal modifications in order to conform to either one or the other sex (see Chapter 2 in Fausto-Sterling, 2000) compellingly demonstrates that even our idea of 'difference between sexes' is somehow socially constructed and perpetrated through the means of culture (e.g. by defining what is normal and what is not from a medical perspective). Sex, therefore, and specifically the so called 'sexual dimorphism' is not the *natural* underpinning of gender differences. Rather, it's the *naturalized* biological basis for socially constructed differences. This is not to deny the materiality of our bodies: as Fausto-Sterling (2000) pointed out, there are indeed hormones, genes, prostates, uteri and other physical attributes that we can employ to recognize males and females, and importantly any variation if these aspects impacts one's own experience of gender and sexuality. The point is that, we cannot completely disentangle the natural body from the socialized body. This view was elegantly expressed in Butler's seminal book *Gender Trouble* (Butler, 1990):

> Are the ostensibly natural facts of sex discursively produced by various scientific discourses in the service of other political and social interests? If the immutable character of sex is contested, perhaps this construct called "sex" is as culturally constructed as gender; indeed, perhaps it was always gender, with the consequence that *the distinction between sex and gender turns out to be no distinction at all*. (p. 9, italics mine).

As this brief discussion portrayed, terminological distinctions in this area are quite complex to fix, and still controversial. An honest sketch of what the terms gender and sex mean, if they mean something at all, and of what are the differences between them, should therefore take into account the fact that socio-cultural and biological factors are strictly intertwined. Recent lines of research are nowadays gradually abandoning the neat dichotomy opposing sex to gender and nature to culture (e.g. Hyde et al., 2019; Joel & Fausto-Sterling, 2016; van Anders, 2015). In keeping with this idea, in the course of this Chapter, I will try to keep the two notions, where needed, separate; as Fausto-Sterling (2012) pointed out, gender can be referred to social structures that differentiate men from women (and other gender identities) or to gender presentation of an individual, embedded in a specific culture. Sex, on the other hand, can be ascribed to the biological and physical conformation of one's own body (male, female, not designated, other). Each of us engages in the environment through a gender presentation that can be traced back to her individual and physical sex, but is culturally interpreted by the society using specific gender categorizations of the culture she lives in. "Gender, then, is definitely in the eye of the beholder. Sex *and* gender presentation are in the body *and* mind of the presenter" (Fausto-

Sterling, 2012, p. 7). In this perspective, I am not arguing for the elimination of the distinction between sex and gender. Rather, as it was the case for the abstract/concrete dichotomy, I think–in line with influential proposals such as the ones described above–that a critical examination of this distinction might lead us to a more thorough characterization of what *matters* (and when, and if it matters) when it comes to gender. van Anders (2015), for instance, proposed the notion of “sex/gender” rather than only *sex* or *gender*. She described “sex/gender” as an umbrella term that encloses gender, intended as socialization, and sex, intended as biology and evolution. The ratio behind this re-conceptualization of the two terms lies in some innovative findings–along with the influence of philosophers like Butler–that shed a new light on the working of testosterone. To give a hint, consider the following: testosterone is typically considered to be the “masculine” hormone, and being a hormone it is part of the ‘realm of nature’ that in this discussion would be translated into ‘sex’. Nonetheless, testosterone was found to be socially modulated, for example by incrementing sexual thoughts, or by increasing activities of nurturance (van Anders, Goldey, & Kuo, 2011; see also Hyde et al., 2019). Hence, van Anders speculates, “is testosterone “sex” because it’s biological, or is it “gender” because social forces affect it?” (van Anders, 2015, p. 1181). It is evident that with the advancement of scientific technology some of the old categories on which our knowledge system was previously based might be refined. Sex and gender are among those. To sum up, the main points we gained from these considerations are: (a) sex and gender cannot be always and completely disentangled, although (b) in specific situations and for specific purposes we can draw a line between the two terms, if keeping in mind that we are acting as interpreters and that natural variation and cultural practices are always behind the door. Henceforth, I will try to use the terms sex, gender, and gender/sex in this Chapter consistently with the discussion above.

3.2. Moving Beyond Dichotomies

In the previous Chapter, I focused on embodied and grounded (EG) accounts of abstract conceptual knowledge. Among seminal proposals presented in the course of the discussion, I chose to give special attention to Multiple Representation Views (MRVs), and specifically to new developments of the WAT (Words As social Tools) theory. The motivation for this choice resides in the fact that, to the best of my knowledge, the WAT proposal put forward some important tenets to consider in the study of abstract concepts. First of all, Borghi and colleagues (Borghi & Binkofski, 2014; Borghi et al., 2018) provided some useful analytical tools, such as the distinction between *abstraction* and *abstractness* (see Chapter 2). By the means of this double construct, we are able to give a more precise depiction of what an abstract concept is, and not just what an abstract concept is not (i.e. an abstract concept is everything that is not a concrete concept). Second, in line with recent trends in the EG panorama, according to the WAT abstract concepts can have multiple and multifarious sources of grounding, ranging from sensorimotor engagement to linguistic and social practices. This consideration enables us to understand not only the contribution of the modality of acquisition of concepts, but at the same time their consequent representation and usage. In this sense, as discussed in Chapter 2 (see par. 2.9) we can reach a precise portrait of abstract concepts, including both a diachronic and a synchronic point of view. From a theoretical perspective, I suggested that a good strategy to frame these aspects could be to adopt a pluralistic epistemology, that would allow researchers in this area to benefit from findings coming from e.g. philosophy, cognitive psychology, neuroscience etc. carefully weighing their contribution. To adopt a pluralistic stance in this context is to acknowledge that (a) different concepts are acquired and represented differently; for instance, some concepts–being they abstract or concrete–might be primarily grounded in our sensorimotor systems, while other might be more related to linguistic information. Moreover, (b) the same concept may have different sources of grounding, and can therefore be represented differently depending on the situation (as studies on conceptual flexibility widely demonstrated). Think for example of a concept like *dress*. I can have a general representation of a dress, something similar to what could be called 'a prototype'. From an EG point of view, when thinking of a dress, perceptual states connected with the referent of the word such as the sensation of pleasantness of wearing a silk dress might be re-enacted (Barsalou, 2008a) via simulations. I probably have an 'encyclopedic' knowledge of which dresses are appropriate for e.g. a cocktail party, or for clubbing, and also for instance of what are the properties that define a wedding dress. Ultimately, I might hold special feelings of emotional attachment for the dress my mother gave me when I was a little girl. All these different forms of grounding contribute varyingly to my conceptual representation of a dress, so that depending from the situation for which the concept is employed one might prevail on the other, without undermining the meaningfulness of the other aspects. This last point relates to a further idea that MRVs are advising for, namely to reconsider the binary opposition of abstract and concrete concepts. Just like the concept of dress (which is considered as a concrete concept) entails both 'concrete' aspects such as perceptual-based experience and 'abstract' aspects such as emotional involvement and encyclopedic knowledge, so abstract concepts are composed of a multitude of components.

In a binary opposition, each term of the dichotomy defines the boundaries of the other via a process of negation. In the case of the dichotomy concrete/abstract, the positive pole is constituted by the 'concrete' part. Therefore, if concrete concepts have a perceptually salient and manipulable referent, abstract concepts are those concepts whose referent *is not* perceptually salient and manipulable. If concrete concepts are said to activate neural areas related to actions their referents afford, then abstract concept are not supposed to activate sensorimotor areas. In a binary opposition, there is no space for variability. Something either is or is not. As we have seen in the previous Chapter, abstract concepts proved themselves to escape the boundaries of the binary opposition in which they were previously framed. In the same vein, in the preceding paragraph we witnessed the undoing of another binary opposition i.e. sex/gender. The brief discussion on sex and gender exposed how the boundaries of the dichotomy are blurred, and sometimes it is not clear where nature ends and culture starts. And after all, is this distinction really useful? At this point, the reader might wonder where all this discussion is going. After dismantling all these dichotomies, what is left for the researcher to investigate? And also, is this a characterization in which once more the only thing that is set is just what things are not? With the purpose of answering those questions, I believe that research on conceptual knowledge might benefit from a critical shift of perspective, like the one entailed in the questioning of well-established categories put forward by Queer Theory and Studies (see e.g., Sullivan, 2003; Halperin, 1995).

3.2.1. Queering abstract concepts. The term “queer” was firstly introduced in the academic debate by Teresa de Lauretis in a conference held at the University of California, Santa Cruz, in the February of 1990[3]. De Lauretis suggested the label “Queer Theory”, in

[3] Butler (1993b) reminds us that the term ‘queer’ was originally a derogatory term, used to designate people who didn’t conform to the norms of heterosexuality. In her perspective, the term has operated actively by producing the collective identity that it intended to shame. In the same way in which performative speech acts (Austin, 1962; Searle, 1989) constitute a reality relying on a specific history and culture, so the term

the context of sexualities studies, suggesting the possibility to account for homosexuality not only with respect to heterosexuality. In addition, she overtly criticized the well-established formula “lesbian and gay” traditionally used in studies of sexuality. She pointed out that, if used uncritically, this formula could lead to flatten the differences couched in gay and lesbians’ experiences on the basis of a common ground of oppression. In her words (de Lauretis, 1991):

> The project of the conference was based on the speculative premise that homosexuality is no longer to be seen simply as marginal with regard to a dominant, stable form of sexuality (heterosexuality) against which it would be defined *either by opposition or by homology*. […] Instead, male and female homosexualities-in their current sexual-political articulations of gay and lesbian sexualities, in North America- may be reconceptualized as social and cultural forms in their own right, albeit emergent ones and thus still fuzzily defined, undercoded, or discursively dependent on more established forms. Thus, rather than marking the limits of the social space by designating a place at the edge of culture, gay sexuality in its specific female and male cultural (or subcultural) forms acts as an agency of social processes *whose mode of functioning is both interactive and yet resistant, both participatory and yet distinct, claiming at once equality and difference*, demanding political representation while insisting on its material and historical specificity. (p. iii, italics mine)

From that moment on, although not without criticisms, the label “queer” was adopted to describe a perspective in the study of social phenomena which encompasses different and critical approaches. One of the hallmarks of queer studies was the critical analysis and exploration of the very construction of the binarism homosexual/heterosexual as regulatory producer of identities and cultural discourses. By deconstructing traditional

---

‘queer’ has come to signify and represent political subjects of opposition to the established sexual norms. But Butler (1993b, p. 21) warrants “That it can become such a discursive site whose uses are not fully constrained in advance ought to be safeguarded not only for the purposes of continuing to democratize queer politics, but also to expose, affirm, and rework the specific historicity of the term.”.

identities, queer studies demonstrated how those identities are complex socio-cultural products, in which various discourses are embedded. More specifically, queer studies contributed to demonstrate how gender differences could not account by their own for all the possible differences that the binary cultural discourse produces. The multiplicity of differences, reiterated by the mean of power relations that suppress and norm identities, embraces other marginalized identities that are less frequently visible. For this reason, a queer perspective aimed at critically analyze and dismantling a binary construction of reality, in order to avail for all those identities that exist *between* and *within* binary categories.

The label *queer*, therefore, fosters and emphasizes a transversal discourse that traditional binary cultural systems neglect, suggesting a more fluid way of thinking about identity and sexuality. Crucially, the term *queer* implies the acknowledgment of the incompleteness of definitions, and opens the way to new directions:

> If the term “queer” is to be a site of collective contestation, the point of departure for a set of historical reflections and futural imaginings, it will have to remain that which is, in the present, never fully owned, but always and only redeployed, twisted, queered from a prior usage and in the direction of urgent and expanding political purposes, and perhaps also yielded in favor of terms that do that political work more effectively. (Butler, 1993b, p. 19)

This perspective can be useful not only in the approach of gender and sexuality concepts, but it can also be a powerful analytical tool for tackling the topic of abstract concepts in a grounded approach. As a matter of fact, in cognitive science, nothing is as queer as abstract concepts. They proved to resist any attempt to be framed in a unitary category, showing differences at a fine-grained level that nonetheless resulted to be crucial of their constitution. In the very same manner, the concept of gender can be considered as a queer concept in a double sense. First, it is queer because it can be considered a social abstract concept. Therefore, following the characterization introduced in Chapter 2 of abstract concepts, it might benefit of multiple grounding mechanisms—escaping the traditional dichotomy opposing linguistic and sensorimotor or perceptual groundings (Paivio, 1986; Brysbaert, 2014). Second, it is queer because it is irreducible neither to one end of the dichotomy (i.e. the biological/concrete/natural one), nor to the other (i.e. the social/abstract/cultural one). The concept of gender, as emerged from the discussion above, has undergone a multitude of substantial changes; in this sense, we can say that is a concept constantly being redefined by social actors. And yet, some perceptual and physical characteristics can be still traced back to one's own gender/sex, and those features are likely to lead people's cognitive activities (e.g. when recognizing a face). My suggestion is that in order to account for abstract concepts, it could be useful to adopt a critical shift of perspective, such as the one implied in queer studies. As a matter of facts, recent developments in the field of conceptual knowledge seemed to already have adopted a queer perspective on concepts, partly rejecting oppositional binarisms. In this Chapter, my intent is to show how combining scientific advancements in the study of abstract concepts with critical positions such as the ones derived from queer studies might contribute to a partial redefinition of the concept of gender. Specifically, the concept of gender would result to be a literary example of how taking into account different factors we might gain a more specific knowledge of our 'abstract' conceptual system. Thus, my portrait of gender will result in the description of a concept that could be considered as an abstract one, if keeping in mind the account of abstract concepts developed in the previous Chapter. To this extent, I will endeavor in the following of this Chapter to define and analyze some of the possible grounding sources of the concept of gender, in a grounded and pluralistic perspective—and through a queer epistemological lens.

3.3. Queer Concepts: Investigating the Grounding Sources of Gender

In keeping with the idea that our cognition, and our conceptual system, is entrenched in the physical and cultural environment, and that it is influenced by our specific corporeal asset (Barsalou, 2008a), the following pages will unfold an analysis of the concept of gender along three main axes which are crucial in EGC accounts of conceptual knowledge. The concept of gender will be examined in relation to its embodied, grounded and situated aspects. As Pezzulo and colleagues already pointed out (2011), the notions of embodiment, groundedness and situatedness are often treated together and interchangeably. While certainly the three are interrelated and connected, for speculative purposes a more refined distinction can be drawn among them. Embodied aspects, as depicted by Pezzulo et al. (2011) emerge as the "consequences of the filtering properties of our sensory and motor systems", therefore are specifically bodily-dependent. Grounded aspects can be seen as somehow "superordinate" with respect to embodied influences, in that they appeal to the consequences of being part of a determined physical environment (e.g. our cognitive world is somehow constrained by the fact that our physical world is governed by gravity laws). Despite this clear description of groundedness, however, this concept is frequently adopted to describe approaches to cognition that sees it as a complex set of interrelated things, among which simulations, bodily and emotional states and situated actions (Pezzulo et al., 2011). Ultimately, the label situatedness generally refers to the fact that our cognitive processes and our concepts are highly context-dependent (see Chapters 1 and 2). They can evolve and change with experience, practice, habits and can take different forms according to contextual (linguistic and physical) constraints.

Henceforth, this tripartition is not intended as dogmatic or fixed, as clearly it is hard to disentangle whether a process is primarily embodied, grounded or situated—and probably it would make little, or no sense at all. In fact, as already discussed in the previous Chapters of this dissertation, more than 20 years of research in the field of EG theories of cognition compellingly demonstrated that all those aspects are intertwined, constantly interacting and contaminating each other. The tripartite model of analysis I am applying is thus only intended to serve expository purposes while at the same time exposing the complexity of both our conceptual system and of the concept of gender considered as an abstract concept in a comprehensive EG approach.

3.4. Embodied Forms of Grounding

Sex perceptions, discriminations and categorizations are highly valued social skills. Indeed, perceiving others' sex has been defined a form of 'compulsory judgment' (Stangor, Lynch, Duan, & Glas, 1992), in that it occurs with quite remarkable precision and very quickly (Ito & Urland, 2003), and it has been hypothesized to serve adaptive functions (see the discussion on male-biased categorization in Johnson, Iida, & Tassinary, 2012). Obviously, just like a newborn is immediately categorized as a boy or a girl based on her/his external genitalia (see par. 3.1.1), the easiest way of inferring a person's sex would be to look at her genitalia. As a matter of facts, in a seminal work Kessler and McKenna (1978) demonstrated that, among various gendered features (e.g. long hair vs. short hair, flat chest vs. breasts, penis vs. vulva) what drove the categorization of their participants when required to decide whether the picture they were presented with was a man or a woman were, in fact, their genitalia—and in particular the presence of a penis. The authors concluded that ‘gender’ attribution is genital attribution, and specifically penis attribution (Kessler and McKenna, 1978, p. 153). Forty years after the intuitions of Kessler and McKenna, Wenzlaff, Briken and Dekker (2018), designed an experiment aimed at confirming this idea. The authors measured eye fixations of participants presented with 32 black and white pictures of persons. Crucially, the stimuli used vary with regard of the combination of gendered cues: the drawings depicted persons with gender neutral face that could have exclusively male associated features (short hair, narrow hips, flat chest, body hair and penis), exclusively female like features (long hair, wide hips, breasts, no body hair and vulva), or a combination of either feminine secondary sexual markers and a penis or vice versa. Participants were required to decide whether the figure was more likely to be male or female. Their results partly confirmed Kessler and McKenna’s hypothesis: most of the gender attributions were made in keeping with the genitals being depicted. Importantly, when asked to categorize whether a figure presenting breasts, long hair, wide hips and a penis was a male or a female (incongruent condition) participants tended to judge the figure as male, while this pattern was softened in the reverse incongruent condition. As for eye-tracking results, the authors reported that the areas that resulted to be central for gender attribution were head, chest and genitals.

Hence, in order to categorize a person as either male or female we rely on our perceptual system scanning the external appearance of the person, and apparently genital discrimination constitutes the core of judgment. Typically, however, genitalia are covered by clothes, so that we must appeal to some other relevant features in order to decide; therefore, being the ‘primary’ sexual dimorphic characteristics concealed, the perceiver focuses her attention to the 'secondary' sexual dimorphic features. The sense of vision is clearly the most commonly used to discriminate peoples' sex–although auditory (Bachorowski & Owren, 1999) and olfactory (Penn et al., 2007) cues are quite precise as well–and the literature debating what are the most salient features that enable sex recognition is flourishing. For instance, facial traits conveying gendered features have been extensively studied, and empirical evidence converges in reporting a high level of accuracy in sex judgement based on facial cues such as eyebrows and face outlines (Yamaguchi, Hirukawa, & Kanazawa, 1995) even in the absence of specific sexual cues (Wild et al., 2000). On the other hand, the role of specific perceptual bodily features in attributing sex/gender is nowadays well-established. Lippa (1983), for example reported that participants tended to rely primarily on the width of the waist when attributing gender than on the breadth of shoulders. Measures related to waist are among the most commonly used parameters allowing sex discrimination: in particular, a measure called waist-to-hip ratio (WHR, see Singh, 1993) was found to be a salient predictor of gender attribution. Henceforth, the morphology of human body brings important information regarding one's own sex/gender, that the perceiver uses to navigate the social space. In a set of studies, Johnson and Tassinary (2005) took a leap forward in the unraveling of which features are determinant in sex/gender judgements. They speculated that while for the attribution of sex morphology would be predominantly employed (as suggested by studies investigating the role of WHR), in assigning 'gender'–which they intended as being masculine or feminine–patterns of motion would be more crucial. They presented participants with animated human beings walking, that varied in WHR (i.e. hourglass shape vs. tubular shape) and in motion pattern (i.e. extreme shoulder swagger vs. extreme hips sway). Every other observable sexual characteristic was removed from pictures. The authors recorded eye movements of participants that were subsequently requested to judge whether the picture represented a male, a female and whether it was masculine or feminine. Results showed that overall, in sex judgements morphology was the key factor, while gender judgments were equally influenced by the morphology and the motion of the targets. In accordance with previous findings, waist and hips held the majority of dwell time (40%) and fixations (9.9).

Henceforth, both visual-perceptual cues and knowledge of typical masculine-feminine behaviors (e.g., the way women and man walk) are key factors in determining one's own sex/gender. Notably, these perceptual hints are employed almost without effort, driving our categorization accurately. But where is this knowledge processed and represented? And more importantly, is sex/gender attribution just a matter of perceptual discriminability or does it entail other higher-cognitive skills? And above all, are the two processes distinct?

3.4.1. Brain representation of sex/gender. Sex/gender, as characterized in the previous paragraph, is a perceptual feature of tantamount importance, whose saliency is conveyed by specific visual patterns. Early findings coming from neuroimaging studies failed to identify a specific region of interest in the perception and discrimination of gendered faces. For instance, Kaul, Rees and Ishai (2011) mapped face-responsive brain regions of the broad system of face network (FG, IOG, STS, AMG, INS, IFG and OFG) while asking participants to rate the attractiveness of male and female faces. Using multivariate pattern analysis, they found that signals from FG, IOG, STS, INS, IFG and OFG held significant information allowing to decode the gender of the stimuli. The authors reported that no increase in mean levels of brain activity of specific areas was evident for gender recognition. Therefore, they concluded that information about gendered faces is not localized in a single region, rather it is represented in several face-responsive regions. Converging evidence showing how multiple face-recognition brain areas are involved in the categorization of gender evidenced how fusiform face area (FFA) and the lateral fusiform gyrus (FG) generally encode information of sexually dimorphic faces (Freeman, Rule, Adams, & Ambady, 2010). Fusiform face area is generally understood as the locus of face identity representations, among which sex, race[4], and age are automatically coded (Kanwisher & Yovel, 2006). In the effort to disambiguate whether race and gender could be localized in different regions of FFA, Contreras, Banaji and Mitchell (2013) scanned participants' brain activity using fMRI, while participants were requested to categorize sex and race of depicted persons (males, females, Black and White). Multivariate pattern analysis showed that multivoxel patterns in FFA (but not other face-selective brain regions) distinguished faces by sex and race. Specifically, a distinct pattern of activation was observed between male and female faces and Black and White faces. The authors pointed out that the differences they found in multivoxel patterns related to sex and race were small but statistically reliable. Contreras and colleagues discuss their findings claiming that social categories representations such as sex and race might be part of face identity representations, i.e. intertwined with the recognition of a face, which are thought to take place in FFA. In their words "FFA could be the neuroanatomical locus in which social categories that are relevant to face identity (i.e. age, race, and sex) are integrated to form holistic representations of individual faces".

[4] The term 'race' is here used to conform to the literature cited. Although the term 'ethnicity' would be more appropriate, I will keep this presentation consistent with the terms employed by the authors.

Importantly, FFA (i.e. fusiform gyrus) is part of a more extended brain area, namely the Anterior Temporal Lobe (ATL). ATL includes temporal pole and anterior portions of the fusiform, inferior, middle, superior and parahippocampal gyrus. Superior aspects of the ATL are also adjacent to insula (INS) and inferior frontal gyrus (IFG). A unique characterization of the ATL in terms of its functionality is still debated, in that ATL results to be “a transitional region where many different cortical regions met” (Olson, McCoy, Klobusicky, & Ross, 2013, p. 123), and therefore it is likely engaged in different functions. Some scholars, however, pointed out that ATL activity might be related to various aspects of social cognition, as a number of neuroimaging studies testifies (for reviews see Olson, Plotzker, & Ezzyat, 2007; Simmons & Martin, 2009). Among those aspects, some are particularly relevant for this discussion. For instance, fMRI studies indicated that a ventral region of ATL resulted to be decisive for memory of persons (reviewed in Olson et al., 2013): in fact, lesions to ATL were found to frequently cause “associative prosopagnosia” that differently from “apperceptive prosopagnosia” in which the patient is unable to recognize a person on the basis of perceptual cues, impairs the patient’s capacity to associate information about who is the person in question (e.g. her name, the relation that they hold, biographical information). Dorsal and polar regions of ATL were also related to higher forms of social cognition, such as the ability to infer others’ mental states, or Theory of Mind- related skills (Olson et al., 2013, 2007; Simmons & Martin, 2009). Overall, the contribution of ATL regions is discussed in three main lines of research: face recognition, semantic processing and social cognition (see Chapter 2, par. 2.9.1). As for its contribution to semantic processing, it is no surprise–given the aforementioned body of evidence–that ATL is of primary interest when it comes to social concepts. The debate concerning the alleged ‘supra-modality’ of ATL was already introduced in the previous Chapter (see par.

2.9.1), together with some of the most recent findings indicating ATL as the neuroanatomical locus of social concepts.

Further evidence supporting the view that regions comprised in the ATL are crucial in abstract social concepts comes from another line of studies. Zahn and colleagues (2007) for instance, compared the neural activation elicited by couples of social (e.g. ‘honor’ and ‘brave’) and non-social (‘nutritious’ and ‘useful’) concepts, using fMRI techniques while participants performed a meaning relatedness task. Their results show that social concepts consistently activated a superior region of the temporal lobe. Importantly, the authors framed their results in the debate on the activations of temporal pole regions connected with the simple processing of abstract words: they pointed out that since their analyses were carefully adjusted in terms of imageability (that is generally correlated with concreteness), the different patterns of activations they found between social concepts and animal function concepts (the control stimuli) cannot be ascribed to a difference in abstractness. Moreover, subsequent regression analyses showed that the degree of activation in the superior anterior temporal region was increased as a function of the extent to which concepts described social behavior (see also Zahn et al., 2009). These results were partly replicated in a study by Ross and Olson (2010), in which overlapping regions of ATL were found to be active both in the similarity judgment task previously performed by Zahn and colleagues and in a ‘social task’. Specifically, the social task they chose consisted in deciding whether geometrical shapes suggesting social relations and agency portrayed in moving scenes were ‘friends’ or not. The overlap of brain activated areas between the social task and the lexical task was evident in the left but not in the right of ATL. The authors argued that the social attribution in scenes like the ones used in their task (basically animations) elicits the activation of general semantic network in the ATLs, thus social semantic representations might be triggered not only by lexical stimuli but also by pictorial cartoons given that they often involve interactions between people and anthropomorphic agents. They concluded that ATL areas are activated because these kinds of tasks require the retrieval of semantic information specific to social situations. This view reconciles perspectives ascribing the activation of ATL to semantic processing (Lambon-Ralph and Patterson, 2008; Patterson et al., 2007, Rogers et al., 2004) and those referring primarily to social tasks (Zahn et al., 2007; 2009)[5].

Further insights indicating a strict relation between ATL and social semantic knowledge come from the few studies investigating stereotypes (cf. Olson et al., 2013). Given the pivotal role ATLs regions exhibited in social processing, Gallate and colleagues (2011) hypothesized that the inhibition of the activity in those areas could result in a decrease of stereotyped behaviors. Using transcranical stimulations (TMS) on ATL regions the authors designed an adapted version of IAT (Implicit Association Task) in which traditional good-bad and black-white pairs of words were replaced by “terrorist” and “law-abider” and “Arabic” and “Non-Arabic” couples. Their results show that both left and right ATL transcranical stimulations significantly reduced IAT scores, indicating lower prejudicial attitudes. Neuroimaging studies corroborated these findings, suggesting that ATLs might contain conceptual associations that lead to overgeneralizations and stereotypes of social groups. Contreras, Banaji and Mitchell (2012), for instance, performed an fMRI study with the aim of disambiguating between knowledge regarding social and non-social categories. They asked participants to perform a categorical knowledge task in which pairs of nouns were to be associated with relevant features. Crucially, the stimuli

[5] For an account of different contributions of left ATL and right ATL to representation of social and non-social concepts see Pobric, Lambon-Ralph & Zahn (2015).

included social groups forming stereotypical categories (e.g. man-woman) and objects (e.g. guitar-violin), and the properties were balanced following the same ratio (e.g. ‘watches romantic movies’ or ‘has strings’). The authors reported activation for objects in typical semantic-related areas (inferior frontal gyrus and inferotemporal cortex), while activation in these areas didn’t differ from the baseline when participants were presented with social categories. Instead, areas of the anterior temporal cortex like the ones described before were found to be selectively activated.

Recently, Freeman and Johnson (2016) proposed a *dynamic interactive model* (DI) accounting for social perception. In contrast with previous understandings of social categorizations, according to which social perception is the result of perceptual features associations that in turn prompt category’s formation, the authors argued that multiple information sources are integrated in social perception. Specifically, they claimed that social perception and categorization arise from the dynamic interaction of both visual processing of facial features and high-order social cognitive processes such as stereotypes, attitudes, and goals. In their perspective, high-order social skills inform the system with additional feedback, constraining and contributing to the formation of category activation and featural representation. The authors conceived categorical activation (e.g. male) and featural representation (e.g. larger jaw) as the result of not only lower-level visual processing, but also of already activated stereotypes (e.g. aggressive) in a “top-down fashion”. In their model Freeman and Johnson evidenced the relative contribution of precise neural areas to the process of social perception, including the fusiform gyrus (FG), orbitofrontal cortex (OFC) and anterior temporal lobe (ATL). The authors suggested that the network sustains quick and flexible integration of bottom-up perceptual cues and higher-order social cognitive processes. In their words: “Not only are visual perceptions of other people malleable to higher-order social cognition, but the dynamics of these perceptions, in turn, may uniquely impact higher-order processes and bear downstream effects on social evaluation and behavior."

Sex/gender categorization, therefore, emerges from the interplay of basic perceptual skills and more 'abstract' forms of knowledge. The evidence canvassed so far on the role of ATLs in sex/gender categorization supports an embodied and grounded view of gender as a complex abstract social concept (see discussion in Borghi et al., 2018): in fact, sex/gender discrimination seems to rely not only on physical salient features, but it is constructed and represented through the integration of relevant social information. Those two aspects interact and are coupled, resulting in the articulation of the category of sex/gender.

3.5. Grounded Forms of Grounding

3.5.1. Faces beyond dichotomies

> Adults don't ask. Adults are afraid to ask, "What *are* you?" so we ask "What do you *do*?" …in hopes of getting a clue to someone's identity—gender identity seems to be an unspeakable thing in our culture, just as names are considered unspeakable in some other cultures. […] When it comes to sex and gender, we're supposed to observe discreetly and draw our own conclusions. (Bornstein, 1994, p. 10)

Bornstein's quotation from the pivotal book *Gender Outlaw* (1994) is embedded in the context of several considerations on transgender people's appearances, and specifically on lay people's reactions to their appearances. The fact is, as Bornstein portrayed, that in our cultural world, you either are perceptually a boy, or a girl. Every other configuration renders the sex/gender categorization–that as emerged from the previous paragraphs is a key feature in face recognition–problematic, at least. Hence, adults try to find other ways to understand what "category" a transgender person belongs to. But, as Bornstein pointed out "Children still ask" (Bornstein, 1994, p.11). Indeed, children learn at very early developmental stages to distinguish genders in their environment. Around 3–4 months, infants are able to discriminate male from female voices, and by the second half of the first year of life they develop what psychologist call "intermodal" associative skills, allowing them to associate e.g. female voices with female faces. Finally, before the age of one, they can associate pictures of males with culturally stereotyped items such as hammers (Levy & Haaf, 1994), and as they enter the second year of age they show refined associative skills related to gender categories. Specifically, children become progressively aware of culturally specific stereotypes, so that they generally look longer to pictures showing a man putting lipstick or a woman hammering (Poulin-Dubois, Serbin, Eichstedt, Sen, & Beissel, 2002; Serbin, Poulin-Dubois, Colburne, Sen, & Eichstedt, 2001; Serbin, Poulin-Dubois, & Eichstedt, 2002). Therefore, gender representations seem to follow a developmental path starting from the processing of visual, tactile and auditory information and progressively adding layers of knowledge through the observation of frequent patterns of social activities, resulting in a sophisticated gender-knowledge (see Chapter 5 in Fausto-Sterling, 2012, for a recent discussion see 2019).

Despite the ease children show in gender categorization, the gendered world is not composed of only two neat categories. Rather, our environment is filled of diversity, a biological and social "rainbow" (Roughgarden, 2004) spreading its colors from the animal world to the human society. As already discussed in the course of this Chapter, sexes/genders come in variety. Transgender spectrum individuals, for instance, often experience being misgendered, and this misclassification leads to negative sensations including negative affect, less perceived authenticity, less identity strength and coherence, and more transgender felt stigma (McLemore, 2015). The reader might wonder, therefore, what is at the basis of the evaluation and recognition of non-stereotypical gendered faces. When traditional perceptual and physical aspects such as the ones describes in the previous sections fail, what accounts for gender categorization?

With the aim of identifying cultural stereotypes connected with transgender individuals' appearance, Gazzola and Morrison (2014) designed a study that included both qualitative and quantitative analyses. They first asked participants in three focus groups how did they perceived society to view transgender men and women, and subsequently which stereotype traits they personally endorse regarding transgender men and women. They analyzed the results of their focus groups using thematic analysis, and they reported the emergence of eight main themes. Among those themes, some are particularly interesting: participants tended to assign primary importance to the sex transgender individuals were born with, rather than their gender identity, and this tendency is reflected in the judgments they gave regarding physical appearance. To illustrate, transgender women were believed to display physical attributes in accordance with their birth sex (e.g. large shoulders, large hands). The most important trait for the purposes of this discussion, is related to the perceived "abnormality" of transgender appearance. Gazzola and Morrison reported that participants often referred to transgender women and men as "odd, different and gross" (Gazzola and Morrison, p. 81). In sum, participants believed that transgender people looked different from non-transgender people. As suggested by recent developments in the field of social perception (Freeman and Johnson, 2016), expectations and previous stereotypical knowledge regarding specific social groups are likely to shape both perception and categorization of people in a two-way interaction from perceptual cues to higher forms of cognitive skills.

In a set of studies, Huart, Corneille and Becquart (2005) provided evidence in support of the idea that prior knowledge impacts subsequent categorization and memory for gender-ambiguous faces. In one of their studies, participants were told they would be presented with a picture of either “Jean” (i.e. a French masculine name) or “Marie” (i.e. a French feminine name). They were therefore shown pictures of a visually androgynous face and afterwards asked to categorize the face as either male or female, and to sort the original face from a series of pictures. In addition to the target (original) picture, among those pictures two were feminized faces and two were masculinized faces. The authors reported that participants categorized the pictures as either male or female faces accordingly with the label (Jean/Marie): 13 out of 15 pictures labelled as Jean were categorized as male, and the same proportion was evident for the female condition. Crucially, memory for target items was also affected by the gendered linguistic label provided by the experimenters: the same extremely gender ambiguous face appeared to be misrecollected depending on the gender information previously attached to it. In fact, 24 of 30 participants in the study failed to recollect the face from the set of pictures, showing a tendency towards more feminized faces when the label previously presented were feminine and vice versa. Wittlin and colleagues (2018) confirmed this pattern in a set of studies exploring how expectations and memory for a given face vary as a function of whether the face is said to belong to a transgender or a non-transgender individual. Their results showed that participants tended to remember an androgynous face as physically feminine if they were told that was a cisgender woman face, and the reverse pattern was true when they were told the face belonged to a cisgender man. Conversely, participants who were told the face belonged to a transgender woman or man, in the recognition task were less likely that participant who were told the face belonged to a cisgender woman or man to assign the gender congruent version of the face. In addition, participants in the ‘transgender condition’ remembered as more androgynous the face they attended to with respect to participants in the ‘cisgender’ condition, even though the picture depicted the same individual. To summarize, Wittlin and colleagues demonstrated that overall people expect transgender individuals to look less gender congruent than cis-gender individuals.

Social psychologists have largely studied traits related to the evaluations of both feminine and masculine faces, highlighting the role of dimensions like trustworthiness and dominance as well as attractiveness in the perceived positivity or negativity of a face. For instance, Stern and Rule (2018) demonstrated that people tended to rate more negatively transgender people faces when they had androgynous traits, compared to when they had typically masculine or feminine facial features. Furthermore, Sutherland and colleagues (2015) showed that female faces with counter-stereotypical facial traits (e.g. masculine and “dominant” perceived females) were rated more negatively and descripted in less positive terms than both the stereotypical feminine faces and the counter-stereotypical masculine faces, from both females and males. Intriguingly, though, one of the strongest predictors of prejudicial attitudes towards transgender individuals resulted to be respondents’ own gender identity. Gerhardstein and Anderson (2010) found that men had significantly more negative evaluations for transgender people’s facial appearance than women when measured on a set of dimensions such as attractiveness, Osgood’s (Osgood, Suci, & Tannenbaum, 1957; Osgood, May, & Miron, 1975) evaluative dimension and supposed mental health.

This brief discussion evidenced how, when supposed sexually dimorphic characteristics are left aside, such as in the case of some transgender individuals' facial appearance, other factors contribute to the sex/gender categorization and representation. Among those, expectations, stereotypes and symbolic or metaphoric thinking (e.g. dimensions such as potency, trustworthiness and attractiveness) connected to the gender binary system appear to be relevant cues (Oh, Dotsch, Porter, & Todorov, 2019; Sutherland, Oldmeadow, & Young, 2016).

3.5.2. Metaphorical thinking and symbolic associations. In her inspiring book *The Lenses of Gender* (Bem, 1993), feminist psychologist Bem identified three lenses through which it is possible to observe how biology, culture, and what she called 'the individual psyche' all interact to perpetrate the oppression of women and sexual minorities. Those lenses are androcentrism, biological essentialism, and gender polarization. *Gender polarization* is intended as the belief that the perceived differences between men and women stand as organizing principles of societal life and culture. Bem claimed that gender polarization operates in two ways: first, it defines mutually exclusive scripts for being male and female; second, it defines any person or behavior that deviates from the script as–at least–problematic (cf. Bem, 1993, p. 81). The effect of these two interconnected processes is to construct and naturalize a 'gender-polarizing' link between the sex of an individual and the characteristic features of her psyche and sexuality. As she clearly pointed out, the history of psychology and psychiatry has been dominated by the convictions that masculinity and femininity are two extremes and opposite ends of a single dimension.

To contrast this dominant view, Bem started to investigate in the early 70s the concept of androgyny, developing an instrument aimed at measuring masculine and feminine traits independently. The famous Bem Sex Role Inventory (BSRI, Bem, 1974) was designed to reflect psychological traits that American individuals considered to be salient and socially acceptable for women and men. The Inventory is composed of 60 attributes, among which 20 were considered as typically masculine, 20 as typically feminine, and 20 were equally attributed to women and men. The items were selected from an initial large pool of attributes on the basis of the score they got from an independent sample of participants, who were asked to rate on a 7-points scale whether an attribute was "desirable" or not both for a man and for a woman in the American society. The BSRI therefore asks how well each attribute of the list describes one's own personality; scores of masculinity and femininity are calculated independently on the basis of participants' responses, and an androgyny score is calculated as well. Bem imagined this instrument as descriptive of one's own "sex-typing"[6] i.e. the degree to which a person self-definition and behavior are intertwined with stereotyped definitions and gender appropriateness in her culture. I found it useful to introduce some of the most relevant aspects of Bem's work in this context because, even though possibly quite dated (for a recent discussion on the contemporary applicability of BSRI see Donnelly & Twenge, 2017), some of the attributes in the BSRI are rather interesting, and turned out to be recurrent conceptual features in the representations of masculinity and femininity.

[6] The notions of "sex-typing" and of "androgyny"–that were introduced in this seminal work–received several critics over the time. In later works, Bem shifted the attention to what she came to call "Gender Schema Theory", from which the notion of "gender-schematic" emerged (Bem, 1981, 1983). Gender schematicity is understood as the imposition of gender-based classification in the social reality. It is the underlying mechanism of "the sorting of persons, attributes, behaviors and other things on the base of polar definitions of masculinity and femininity that prevail in the culture" (Bem, 1993, p. 125). Importantly, in Bem's perspective, gender-schematicity is both the process and the result of gendered classifications that take place from the infancy and consolidate through adulthood.

Although Bem clearly stated that the masculinity and femininity scales were conceived as independent measures, they present relevant similarities with a famous psychological tool, developed in the 50s by Osgood and colleagues (Osgood et al., 1975, 1957), the Semantic Differential Scales (SD). Osgood (Osgood, 1952) traced back the origins of the SD method in research on synesthesia, a phenomenon occurring to certain individuals in which some sensations belonging to one modality "attach" to certain sensations pertaining to other modalities, and appear regularly whenever a stimulus of the latter occurs (one of the most famous examples concerns the attribution of colors to specific musical tones). With the aim of identifying recurrent semantic features in conceptual space, Osgood and colleagues grouped a total of 50 scales to be used in the judgement of 20 concepts rated by 100 students, and subsequently submitted them to Factor Analysis. They singled out three main dimensions that accounted for the most of variance[7]. These dimensions were "evaluation" (e.g., good-bad), "potency" (e.g. hard-soft), and "activity" (e.g. active-passive). Importantly, the scales that compose the dimensions are bipolar and dichotomous. These three dimensions have been interpreted as corresponding to fundamental dimensions in the adjustment of the individual to the objects in her environment, so that for instance the *evaluation* dimension measures an individual's tendency to approach or avoid a stimulus, the *activity* dimension is a measure of the necessity to make movements to interact with the stimulus (the dimension encompasses scales such as fast-slow; active-passive; excitable-calm; rash-cautious), whether the *potency* dimension is supposed to measure the amount of adjustment made to the stimulus (it includes scales like hard-soft; masculine-feminine; severe-lenient; strong-weak;

[7] The complete system of SD is composed of eight main dimensions (Osgood, Suci, & Tannenbaum, 1957): *evaluation, potency, activity, stability, tautness, novelty, receptivity* and *aggressiveness*.

tenacious-yielding). If we take a closer look at the attributes in the BSRI, it is evident how a consistent number of descriptors of masculinity and femininity adhere to the SD. Among those, some are particularly salient. In the masculine side we find adjectives like aggressive, assertive, dominant, forceful, strong personality, willing to take risks, and of course masculine. On the other hand, in the feminine side adjectives listed include tender, gullible, gentle, flatterable, shy, yielding and feminine (Bem, 1974, p. 156). The resemblance with some of the poles of SD scales is evident, and what is even more striking is that some of the dimensions discussed above resulted to be also significant predictors of sex/gender categorization in face recognition (see previous paragraph).

Hence, the conceptual articulation of masculinity and femininity seems to rely, besides other things, on some sort of "metaphorical" knowledge enclosed in some relevant semantic dimensions. Are those dimensions universal? As a matter of facts, Osgood and colleagues provided cross-cultural evidence suggesting that some of the dimensions are equally important in different cultures, and elicit the same conceptual associations among cultures (see Osgood et al., 1975, and the discussion on anthropological findings suggesting a universal association between up-bright-good and down-dark-bad in Osgood, 1952). More importantly for the purposes of this discussion, the *potency* dimension has been found to correlate with masculinity and femininity evaluations in a number of psycholinguistic studies investigating the conceptual underpinnings of grammatical gender across cultures (e.g. Ervin, 1962; Konishi, 1993; Zubin & Köpke, 1981, 1984). Overall, those studies demonstrated that masculine names were rated as more 'forceful' while feminine names as 'weak' (for an in-depth discussion, see par. 3.6.1).

Gendered categorizations are also carried out by implicit associations with objects– as shown by the developmental literature–and colors. Besides the canonical cultural association blue-male and pink-female (Paoletti, 1987), some scholars have hypothesized that a much broader dimension might be crucial in gendered-colors associations, viz. the bright-dark bipolar scale. In fact, several cultural traditions seem to rely on the implicit association between gender and brightness: white, for instance is the color of virginity (in some Western societies brides wear a white dress), while black is usually culturally associated with authority and seriousness, which in turn are often associated with men (cf. Semin & Palma, 2014). Moreover, the visual opposition between bright and dark has been found to map metaphorical thinking about good and evil (Meier, Robinson, & Clore, 2004). It is possible, therefore, that visual patterns constitute the sensory scaffold for reasoning about more abstract categories, in keeping with the Conceptual Metaphor tradition (Lakoff & Johnson, 1980). Recently, however Semin and colleagues (e.g. Semin & Palma, 2014; Semin, Palma, Acartürk, & Dziuba, 2018) suggested how the cognitive representation of gender might be grounded in the sexual dimorphism of skin color, and as a second step it would be culturally reinforced and encoded in the brightness dimension. Inspired by anthropological and biological evidence showing that overall females have lighter skin than males, the authors proposed that this encoded difference might implicitly drive performances on a variety of tasks. Indeed, across different experimental and cross-cultural studies, the dimension of brightness (light-dark) resulted to be associated with masculinity and femininity. For example, in a classification task, masculine names were processed faster when they were presented in dark colors with respect to light colors, while feminine names showed the reverse pattern (Semin & Palma, 2014). In a recent paper (Sebastián-Enesco & Semin, 2019), the authors extended their findings concerning the grounding of gender in the brightness dimension to a sample of non-industrialized participants (the Wichí community, Salta, Argentina) and compared them with a Spanish sample of participants.

Interestingly, their samples in both communities included both adults and children. In two experiments, they used a newly developed task, in which children and adults were requested to choose for a female (or male) target person between two identical objects that differed only for their degree of brightness. Crucially, they manipulated brightness on the green scale, rather than on the typical white-black scale. The results showed that the children from the two cultural communities were more likely to choose a lighter colored object for the female target and a darker version of the same object for the male target. In both communities of interest, the pattern held constant irrespectively of the age of participants—with the only exception of male Wichí participants.

These findings suggest that, at least to some extent, the grounding of gender includes a perceptual component constituted by colors associations such as the ones described before. Clearly though, color associations are subjected to cultural practices that are able to reinforce or weaken them. It is possible that these established unconscious associations affect our way of categorizing in terms of gender in shallow tasks, while deeper elaboration might recruit other sources of grounding.

3.5.3. Internal and experiential forms of grounding. Gender has always been deemed a pervasive psychological construct. Traditionally, psychological research addressed the topic of gender in the context of a binary system, opposing men to women while only recently is this bigenderist[8] assumption starting to be challenged. Specifically,

[8] In a bigenderist perspective, there are only two genders that map onto two sexes—male and female. Importantly, this strict categorization influences the perception of gender displays that exceeds this binary, such as transgender individuals and or cross-dressers, which are regarded as 'outsiders'. Moreover, historically the two genders were considered to have different weights and importance, resulting in the oppression of the category of women. Some scholars coming from different research areas are nowadays challenging the bigenderist assumption, rejecting both its biological constitution and its social implications. Gilbert (2009), for instance, at the end of an essay dedicated to the examination of bigenderism and its social

a gender binary system entails that "there are two discrete categories into which all individuals can be sorted […] and one's category membership is biologically determined, apparent at birth, stable over time, salient and meaningful to the self, and a host of psychological variables"(Hyde et al., 2019, p. 1). To date, based on the bigenderist assumption, scientists attempted to uncover traits and attitudes distinctive for the two categories. Instrumental tools like scales measuring the degree of gender congruence and "sex-typing" of adults and children (Bem, 1981; Slaby & Frey, 1975) were used as direct measure of gender experiences. Some influent proposals highlighted the complexity of gender experiences and subsequent attainment to gender roles, discussing in particular the intertwinement between socially learned features and biological factors in the constitution of gender identity and stereotyped traits (Spence & Buckner, 2000). The notion according to which a monolithic and bipolar concept of masculinity-femininity could be inferred from the attainment of individuals to directly observable sets of gender-differentiating attributes (such as the traditionally used BSRI items) was criticized by Spence and Buckner (2000), who claimed that "gender-related characteristics and beliefs have diverse etiological roots, that vary widely from one individual to another within each gender" (p. 60). They suggested that, beside one's own sense of gender identity, other factors play a causal role in the development of gender stereotyped behaviors, such as personal temperaments and attitudes,

---

and behavioral entailments proposed a radical model, viz. 'Non-genderism'. According to 'Non-Genderism' there would not be a binary distinction based on the supposedly dimorphic sexual characteristics of people, and no societal valuation rendering masculine more valuable than feminine (cf. p. 107). Clearly, behavioral patterns such as being nurturing, aggressive and so on would still exist; but the difference with a bigenderist conception is that those behaviors would only be considered for what they are, namely behaviors. No further association with any specific gender would be inferred from them. In Gilbert's perspective, (but see also Bem, 1993; Risman, 2004), such a non-gendered world would be the basis for eliminating sexism and androcentrism from our social structures.

social models provided by parents and other social actors, and the value system that an individual is exposed to.

A growing line of research is instead currently facing gender related issues questioning the traditional binary system from neuroscientific, behavioral, biological and physiological perspectives (e.g., Fausto-Sterling, 1993; Joel & Fausto-Sterling, 2016; Jordan-Young & Rumiati, 2012; Olson, Key, & Eaton, 2015; Roughgarden, 2004; van Anders et al., 2011). The recent interest for gender-nonconforming individuals in psychological sciences is also attested by the APA publication (2015) of recommended guidelines for psychological practice with transgender and gender-nonconforming individuals, alongside with critical reviews on the topic (Matsuno & Budge, 2017; Mueller, De Cuypere, & T'Sjoen, 2017) Overall, researchers are becoming gradually aware of the predominance of a gender-binary perspective in the scientific literature. Even though the interest for gender non-conforming experiences is not completely new–the existence through history and across diverse cultures of individuals whose gender identities are not confined into the gender binary system is in fact well documented (e.g., Devor, 1997; Herdt, 1993)–in the western culture, studies on non-conforming gender identities were generally focused on clinical populations and mainly aimed at assessing gender dysphoria (e.g., Coolidge, Thede, & Young, 2002; Deogracias et al., 2007). With this respect, there have been important changes in the fifth edition of the DSM (American Psychiatric Association, 2013), that updated its section on 'Gender Identity Disorder' changing the label into 'Gender Dysphoria'. In doing so, people who experience a feeling of discomfort in being socially identified with the gender 'corresponding' to their natal sex, are no more considered to suffer from a mental disorder[9].

The notion of *gender non-conforming*, or *genderqueer*, has only recently appeared in the measurements of some researchers. Terms such as genderqueer, or non-binary gender, and gender non-conforming are umbrella terms introduced to account for those people who feel traditional labels do not fit with their identities[10] (Richards et al., 2016). As pointed out by Richards and colleagues, non-binary or genderqueer identities might appear a recent and under-represented phenomenon, but it is possible that people who would have previously identified themselves as transsexuals (i.e. moving across the gender binary but still in the binary framework) would have nowadays identified themselves as genderqueer, if that label existed. The authors outlined that individuals reporting a discomfort with their gender (usually linked with their sex) have been historically treated as having some forms of gender identity disorder, regardless of the specific aspects this inference might have carried. Thus, people who do not identified with the gender 'related' to their birth sex, people who felt they were both genders or neither of them could have been conflated into the same label. Moreover, studies investigating the incidence of gender dysphoric feelings in population traditionally looked to individuals who seek for sex reassignment surgery (SRS) or hormone treatments to affirm their experienced gender, and this could have lead to an underestimation of the percentage of individuals experiencing some forms of gender distressing who do not seek, for various reasons, for this kind of treatments. In a study from 2014, for instance, Kuyper and Wijsen (Kuyper & Wijsen,

---

[9] For further insights see https://www.psychiatry.org/patients-families/gender-dysphoria/what-is-gender-dysphoria.

[10] For a critique to the notion of 'queer' as an umbrella term see e.g., Anzaldúa (1991).

2014) examined the presence of ambivalent and/or incongruent gender identities or gender dysphoric feelings among a large sample of Dutch participants. Through the assessment of several aspects related to gender distress, the authors provided evidence that gender dysphoric conditions are composed of a set of dimensions, which are not always reducible to the incidence of participants undergoing SRS or hormonal treatments. In fact, only 1.1% of natal men and 0.8 % of natal women included in their sample reported an incongruent gender identity, while 4.6% of natal men and 3.2% of natal women reported an ambivalent gender identity.

Nowadays, there is an increasing awareness of different gender experiences, and the legal and bureaucratic system is generally evolving to afford several options (e.g. third or neutral gender recognition on documents in some countries). The intent of introducing these notions is therefore aimed at exploring the conceptualization of people's gender identity, avoiding the pathologisation of those individuals whose gender identity doesn't match with the sex assigned them at birth, or that simply are not satisfied with a bigenderist description of their gender and/or sexual identity (Ansara & Hegarty, 2014). For example, Galupo and colleagues (2017) asked to a sample of 197 individuals who self-identified as either gender variant or a-gender to describe their gender identities, focusing on their own "lived experience" rather than on traditional labels. The aim of the study was to investigate through descriptions used by non-binary individuals which features they considered as central for their gender identity. Their findings showed that thematic features in the self-descriptions of participants' gender identities were cues like "fluidity" and "mixture or rejection" of the traditional gender binary system. Moreover, some participants explicitly expressed the need for terms moving "beyond", rather than "between" the two gender poles of woman and man in their descriptions (for a discussion on labels describing the sexual orientation of transgender individuals see Galupo, Henise, & Mercer, 2016). Similarly, Kuper, Nussbam & Mustanski (2012) investigated current and past gender identities, sexual orientations and surgery and hormonal statuses of individuals who identify with a gender identity other than the gender associated with their birth sex ("Anyone who does not identify strictly as their 'male' or 'female' birth sex is encouraged to participate, whether you identify as transgender, genderqueer, intersex, or you enjoy deconstructing gender through drag and so on" p. 246). Specifically, the authors were interested in the analysis of all the possible gender identities generally included in the umbrella-term of transgender. Interestingly, *genderqueer* was found to be the most frequently reported gender identity (55.1% of participants), along with changes of gender identity over time. Hence, although the label *genderqueer* is still largely absent from the academic literature, these studies express the need of contemplating more gender categories with respect to just women and men.

Interestingly, non-conforming gender experiences were also found to be an important aspect of "normative"[11] individuals' perception of their gender identity. Joel and colleagues (2014), compared the scores of a new tool, the Multi-GIQ questionnaire which accounted for dimensions like gender identity, gender dysphoria and gender performativity among people who identified themselves as men, women and queer. Their findings evidenced that non-conforming gender experiences are not limited to non-conforming gender identities. In fact, among men and women enrolled in the study, over 35% reported to feel to some extent as the "opposite" gender, as both genders, or as neither. Although

---

[11] With the term "normative" in this literature are usually indicated those people who feel their assigned birth sex is aligned with their perceived or expressed gender identity. Thus, an example of a normative identity in this scenario would be a natal female identifying herself with the label woman.

those feelings were especially prevalent in queer individuals with respect to men and women, there were no significant differences between the three groups. Crucially, the Multi-GIQ questionnaire is designed as to allow an independent measurement of perceiving oneself as a man and as a woman: therefore, it is able to reflect participants' ambivalence towards a masculine and feminine gender identity. In addition, the authors conceived the questionnaire in compliance with the idea that affirmed gender identity is not a unitary construct, and is not necessarily stable over time. Lately, those findings were replicated and implemented through the examination of a self-identified cis-gender sample of participants, that showed how the presence of "queer" feelings is widely spread even among those individuals who are expected to conform to the gender binary system. In fact, 38% of participants reported to feel sometimes as both a man and a woman, 35% as neither; 38% further expressed a wish of being the "opposite" gender and 35% a desire to have the body of the "other" sex (Jacobson & Joel, 2018). The authors successively compared the cis-gender sample with both a transgender and a gender-variant sample of participants (Jacobson & Joel, 2019). Overall, their results suggest that cis-gender, transgender and gender diverse individuals endorse a wide range of gender experiences. The results were interpreted by the authors as stressing the multidimensionality and fluidity of the conceptualization of gender, that emerged as a complex construct rather than binary and dichotomous. Differently from traditional gender identity measurements, the scale also included the dimension of *performativity*. Gender performativity is conceived as the effect of a regulatory regime of gender differences, in which genders are differentiated and organized in hierarchy. Through performative acts, a gendered identity is not only communicated, but is also created and presented in social contexts (cf. Butler, 1988).

Considered in this perspective, gender identity's conceptualization seems to resent of factors which are strictly related with one's own personal experience. Internal feelings and sensations, together with emotions might represent a grounding mechanism for thinking and reasoning about gender at a deeper level. These internal and embodied factors are also likely to be relevant for the re-enactment of one's own gender expression, affording different gendered performances. Crucially, conceiving gender as a complex construct, not exhausted by the dichotomy male/female (or sex/gender as representative of the dichotomy nature/culture) may allow to uncover potential grounding mechanisms beyond the ones traditionally investigated. In this sense, it could be important to *queer* the concept of gender also in psychological measurements, by acknowledging both the existence of different experiences and its result on conceptualization.

3.6. Situated Forms of Grounding

3.6.1. Language and gender. In the previous paragraphs I focused on how sex/gender, expressed through physical, perceptual and internally experienced characteristics, informs our cognitive world dividing it into distinct categories. Nevertheless, gender is also a grammatical feature, that together with number, person and case separates nouns into classes. Indeed, almost half of the languages in the world possess a grammatical gender. Whether a language encodes gender in relation to biological sex, or to some other criteria on the other hand, is a highly variable. As a matter of facts, the word *gender* derives from the Greek γένος, that indicates 'kind', rather than 'sex'. A frequently cited example of this variability is the classification system of Dyirbal (Australia), described in several works by Dixon (Dixon, 1972, 1982) and reinterpreted by Lakoff

(Lakoff, 1987). The Dyirbal language is described as a semantic system with four genders, that classifies entities on the base of rules denoting important properties:

Gender	Criterion	Examples
I (*bayi*)	animateness; (human) masculinity	men; kangaroos, possums; bats, most snakes, fishes and insects; some birds; moon; storms, rainbow; boomerangs, some spears
II (*balan*)	(human) femininity; water; fire; fighting	women; bandicoots, dog; platypus, echidna; some snakes and fishes; most birds; firefly, scorpion, crickets, hairy mary grub; anything connected with fire or water; sun and stars; shields, some spears; some trees
III (*balam*)	non-flesh food	honey; all edible fruit and vegetables and plants that bear them
IV (*bala*)	residue	parts of the body; meat; bees; wind; yamsticks, some spears; most trees and vines; grass, mud, stones; noises and language

Figure 6. Gender assignment in Dyirbal (retrieved from Kilarski, 2013, p. 214).

Two pivotal rules, according to Dixon, account for gender assignment in Dyirbal. On the one hand, entities are included in a specific gender in order to evidence a salient property (typically harmfulness), so that dangerous fishes and plants are included in gender II instead of I and IV; on the other hand, myths and beliefs seem to shape the constitution of gender assignments. For instance, birds are considered to be the spirits of dead women, thus they are assigned to gender II rather than to gender I. Lakoff (1987) interpreted this system of gender assignment in terms of radial structures, centered on a prototype that share relevant properties with the other constituent entities of the category. In this perspective, the supposed arbitrariness of Dyirbal gender assignment system is rather explained by appealing to some salient cognitive characteristics (e.g. harmfulness, myths)[12] (see also Kilarski, 2013).

[12] The Dyirbal 'gender' classification confirms the idea advanced to explain some of the findings coming from Osgood's SD discussed in the previous paragraph: in fact, it seems that the categorization suggested by the Dyirbal system rests on general guidelines of interaction with objects, such as harmfulness. Through the

Besides world-wide famous examples, the extent to which gender differences are coded and expressed in one language or another fascinated linguists and psychologists for a long time, revealing its global pervasiveness. To illustrate, in a seminal work investigating how more than 200 languages express gender categories, Corbett (1991) reported that "the number of genders is not limited to three: four is common and twenty is possible" (Corbett, 1991, p. 5). Thus, across languages in the world gender classes vary consistently, and the extent to which these classificatory schemes exert an influence in the conceptualizations of different populations animated the scientific debate for a long time.

The potentiality of tools already cited, like the Semantic Differential Scales (Osgood et al., 1957/1975) of revealing covert properties correlated with masculinity and femininity, for example, captivated the interest of linguists and psychologist extensively. Ervin (1962), for instance, conducted an experiment with Italian-English bilinguals, asking them to rate a set of non-sense words that differed in their suffixes –either Italian masculine –*o* or Italian feminine –*a*- on two of the scales from the Osgood Semantic Differential scale which have been previously reported to correlate with *men* and *women* concepts, namely the potency scale (strong-weak, big-little) and the evaluative scale (bad-good and pretty-ugly). Results showed a tendency to ascribe different connotations to masculine or feminine words according to differences in the connotations of men and women concepts. In line with these results, studies from Zubin & Köpcke (1981; 1984) and Konishi (1993) showed the same pattern with German speakers, suggesting that grammatical markers may carry some kind of semantic meaning, leading to specific types of conceptualizations. More recently, scholars developed a wide range of behavioral tasks with the aim of verifying if

means of linguistic features, therefore, Dyirbal speakers were able to discriminate entities in the world in an adaptive way.

gender assignment is completely arbitrary or if it reflects some essential properties of objects, and when does gender assignment affect cognition. For example, Boroditsky & Schmidt (2000) had English participants classify in terms of masculinity and femininity a set of objects and animal nouns, and compared these classifications with the grammatical gender of the items in both Spanish and German. In this case, there was an agreement between English, Spanish and German classifications for animals but not for objects, suggesting that animals' classifications as either masculine or feminine could rely on some animals' property stereotypically masculine or feminine. In the same study, the authors tested German and Spanish participants in English, and made them learn either masculine or feminine names for objects. The task consisted in learning names and remember the pairings. Results showed that participants remembered better object-name pairs when the gender of the proper name assigned to the object was consistent with the grammatical gender of the object in their native language. This suggest that people's intuitions and conceptualization of objects include gender as a feature, even if it is irrelevant such in the case of objects, and that this is modulated by language. An interesting insight comes from a later work (Phillips & Boroditsky, 2003) in which Spanish and German participants were asked to repeat random letters in the middle of a picture similarity task between objects and humans. Results showed no effect of subvocalization: participants rated person-object pairs as more similar when the grammatical gender of the object name in their native language was consistent with the biological gender of the person. Conversely, in a study by Cubelli and colleagues (2011), the effect of gender congruity disappeared in a category membership task implemented by an articulatory suppression task. This suggests that the effect of grammatical gender on categorization is indirect, and occurs because the process of object categorization requires the access to lexical representations.

The constraints of grammatical gender on categorization and conceptualization have been investigated also by Vigliocco and colleagues (2005). With a series of experiments including similarity judgment tasks with triplets of words and pictures, and through the analysis of semantic substitutions errors the authors showed that language-specific effects of grammatical gender might be constrained to languages with a two-gender system (i.e. Italian but not German). Additionally, they might occur in tasks requiring linguistic or verbal information processing (similarity judgment task on words and not on pictures), and they can be limited to a certain semantic category (animals and not objects). In the same vein, Sera and colleagues (2002) asked English, Spanish, French and German speaking children and adults to assign male and female voices to inanimate objects. They found that the assignment of French and Spanish speakers varied predictably with the variation in gender assignment in the two languages, while the German grammatical gender system didn't affect classifications of German speakers to the same extent the Spanish and French system did. Effects of grammatical gender on entities' categorization have therefore proved themselves to be a prominent feature of our conceptual system. Languages assign genders to inanimate entities according to arbitrary criteria, as testified by the cross-linguistic differences described by linguists. But is this assignment completely arbitrary or is it somehow motivated by cultural patterns, as in the case of Dyirbal gender system? And are speakers aware of the possible underlying cultural patterns that constitute the grounding of the gender assignment rules? Bassetti (2014) investigated the impact of second language learning (German) on the grammatical gender arbitrariness awareness. She tested a sample of young adults composed of Italian monolinguals, early bilinguals and instructed second language bilinguals. Participants were asked to evaluate the gender assignment of 25 nouns of entities (animals, abstract concepts, natural kinds and artifacts) and answered open and closed questions on grammatical gender. Specifically, they were asked to rate on a 7-point scale the acceptability of the opposite Italian-German gender assignment of gendered nouns, and then to motivate their choice. Results showed that monolinguals considered gender as semantically motivated, while second language learners mostly explained grammatical gender in terms of culture. A qualitative analysis of the motivations provided by participants revealed an interesting pattern of results. In fact, the most relevant motivation for grammatical gender assignment resulted to be (i) association with traditional feminine vs. masculine properties (beauty vs. ugliness/ strong vs. weak) and (ii) associations with culture (e.g. myths and children tales). Grammatical gender was considered to be more semantically motivated for animals than for artifacts, but abstract concepts and natural kinds were related to the semantically motivation too.

Grammatical concepts like gender are thus conceptually salient, activated automatically and unconsciously, and profoundly affect "how we understand everyday life" (Lakoff, 1987, p. 335). In this perspective, languages that possess a gendered system drive the speaker's attention to some features, habituating individuals to categorize the world in certain specific ways (e.g. by dividing it into two categories corresponding to males and females). One might therefore wonder, in line with neo-Whorfian speculations, whether those linguistic differences affect thought not only in shallow tasks, but possibly at a deeper level. Some political psychologists recently started to interrogate the role that language exerts on the production of gender stereotypes. Tavits and Pérez (2019), for instance, hypothesized that speaking a genderless language, such as Estonian, would promote a greater perceived equality between men and women with respect to a gendered language like Russian. To test this hypothesis, the authors administered to a large sample of Russian-Estonian bilinguals a questionnaire measuring social and political attitudes towards gender parity. In the first study, they randomly assigned a Russian or Estonian questionnaire to a sample of 1200 bilinguals, while in the last study they extended their design to a cross-national sample of participants (divided into gendered and non-gendered languages speakers). Overall, the authors reported that speaking a genderless language "boosts mass support for efforts to combat gender inequality, implying that structural nuances between tongues explain some of the persistence in gender disparities" (p. 21).

To sum up, the robustness of grammatical gender effects on conceptualization suggests that at least to some extent, gender conceptualizations can be grounded in linguistic practices, and that the other way round linguistic practices can shape the way in which we perceive gender differences. Possibly, grammatical distinctive traits of a specific language, interfere with conceptual representations related to gender at a shallow level of reasoning. Arguably, if required to delve into the concept of gender in relation with their identity, people might elaborate on other features as relevant (see previous paragraph).

3.6.2. A role for metacognition and deference. "One is not born, but rather becomes, a woman" (de Beauvoir, 1989, p. 267) is the world-wide famous claim that inspired generations of feminist scholars to rethink of the social conditions allowing the perpetration of sexual-based inequalities. As already noted, in fact, the distinction between the concept of sex as something natural and given, and that of gender as the result of social interactions is relatively new. Feminists have insisted for a long time on the notion of gender as a social structure, or as the "socially imposed division of the sexes" (Rubin, 1975, p. 179), with the aim of unmasking the mechanisms responsible for women's oppression through history and time. Some have proposed to consider gender as an analytical category, such as economy and race, a lens through which it is possible to interpret human history.

Scott's (1986) definition of gender, for instance, is composed of two parts: in her formulation, gender is the constitutive element of social relations and the primary signifier of power relationships. Being based on the *perceived* sexual differences, gender as central element of social relations involves mainly four interconnected elements, which nonetheless need to be addressed separately in order to prospect a clear interpretative picture of how gender works. In Scott's model of analysis, first culturally available symbols that evoke gender-related representations need to be investigated (e.g. remember metaphorical mapping of light and dark colors into sex/gender concepts). Second, science, religion, and education contribute to create normative concepts in order to interpret the cultural symbols[13], typically expressed into binary and exclusionary categories (male-female; masculine-feminine). Those normative concepts are generally taken as fixed, while Scott urges us to consider that the positions emerging from these statements (e.g. what is defined as masculinity) are but one of the possible positions–in fact they are the result of the refusal or repression of alternative possibilities. As a third step, one must account for social institutions and organizations (e.g. politics) that construe and reinforce the idea that those normative representations are immutable and timeless. Last, a comprehensive analysis of gender must include a suitable theory of the formation of gendered subjective identities. As an historian, though, Scott is primarily interested in the study of gender as the

[13] Note that the role of allegorical images and practices has already been discussed in this dissertation, embedded in the discussion of how abstract concepts are often represented through more concrete entities (Chapter 2). The relation is all but fortuitous: in order to explain and portray complex aspects of abstract concepts such as those related to capital sins, the human kind has adapted to "ground" them into more concrete instantiations, in order to vehiculate their difficult and complex meaning in a way that is more "understandable", because more concrete. The same is true for the concept of gender, and its consequent social categorizations. Due to the fact that some social treatments based on gender are not justifiable only through biological differences (for example the fact that women were supposed to be unsuitable for politics life, one of the reasons being that they were considered irrational), myths and images are employed to reinforce and establish normative categorizations (think for example of Eve's incapability to resist temptation, and the impact the myth had on the conceptualization of women overall). I am thankful to M. Santarelli for discussing with me this topic.

pivotal means by and through which power is articulated. She therefore provides example of how gender categories, as expressed by the binary distinction built upon sexual differences, have informed the politics of social institution as well as personal behaviors. In her words "Gender, then, provides a way to decode meaning and to understand the complex connections among various forms of human interaction" (p. 1070).

A multidimensional analysis of gender is also warranted by Risman (2004), when she claims that gender cannot be understood in isolation from other social structures such as race and economy. In her perspective, gender appears as a structure at various level of society, ranging from the individual, to the interactional and the institutional level. According to Risman, overlooking one of the aforementioned aspects of gender–intended as a structure in the same sociological sense of politics and economy–would impoverish the analysis of gender. That is to say, some previous influential perspectives on gender focused specifically on the individual or cognitive aspect of gender (e.g., Bem, 1981), while others evidenced how gender can be considered an institution embedded in social processes of everyday life and social organizations (e.g., Lorber, 1994). Risman's definition of gender as a social structure instead is centered on the interconnection among different analytical planes. To this extent, she defines a social structure as something that shapes individuals, but is simultaneously shaped by individuals. This is a focal point in the understanding of gender as a social structure, in that it acknowledges the fact that social forces influence individual life, but most importantly that those social forces are not "mysterious forces" (Risman, 2004, p. 432): they are constituted by human actions.

In short, according to these perspectives, gendered identities and the differences they carry can be intended as the result of cultural practices and expectations. Gender can be conceived as a social structure in the same way as economy was longwindedly considered a foundational social structure. Furthermore, in light of these characterizations, the concept of gender unravels its complexity. In this context, the link of gender with its supposed concrete referent is loosened, in favor of a more complex understanding of the idea that not only biological forces contribute to the construction of gendered identities. In this regard, it is important to appeal to two central notions in the debate concerning gender concepts, namely those of *performativity* and *normativity*. Butler (1988, 1990, 1993a) compellingly questioned the idea according to which gender is the cultural meaning of sex. Her critique goes back to the genealogy of the idea that sex is the given and factual datum of gender, showing how, instead, sex-based categorizations are in themselves discursive products. Specifically, she argued (Butler, 1993a):

> The category of "sex" is, from the start, normative; it is what Foucault has called a "regulatory ideal." In this sense, then, "sex" not only functions as a norm, but is part of a regulatory practice that produces the bodies it governs, that is, whose regulatory force is made clear as a kind of productive power, the power to produce—demarcate, circulate, differentiate—the bodies it controls. Thus, "sex" is a regulatory ideal whose materialization is compelled, and this materialization takes place (or fails to take place) through certain highly regulated practices. In other words, "sex" is an ideal construct which is forcibly materialized through time. (p.1)

In her perspective a body becomes a gendered body through the repetition of a series of acts, that are constantly being renewed and consolidated through time. In this sense, gender is conceived as *performative*: it doesn’t express any pre-given core essence, but rather it is the result of the collective agreement on normalized acts. The notion of performativity has two other central facets, in Butler’s work. First, gender is performative for it creates what it names (Austin, 1962; Searle, 1989) and therefore it is “real” only when enacted[14]. Furthermore, gender is never an 'individual' act, but it is social in that it is discursively created, interpreted and intelligible. In the same way as the script existed prior to the play and survives the enactment, so gender is constituted by a series of norms sedimented through history that will be interpreted individually, and that will survive their contingent embodiment. The notions of performativity and normativity become strictly intertwined in Butler's depiction of gender (Butler, 1993a), when she asserts that performativity must be understood as the reiterative power of discourse to create the phenomena that it intends to regulate and constrain, rather than as the act through which the subject brings into being what is being named. It is therefore evident that the discourse she is referring to is the hegemonic discourse of heterosexuality, the "heterosexual matrix" (Butler, 1995) through which gender identity is stabilized and created, and that dictates the norms and the accomplishments one must fulfill in order to emerge as a gendered self. Going back to the deconstruction of the distinction between sex and gender, distinction that was so important in the first feminist critiques, Butler argues (Butler, 1990):

> If the immutable character of sex is contested, perhaps this construct called "sex" is as *culturally constructed* as gender indeed, perhaps it was always already gender, with the consequence that the distinction between sex and gender turns out to be no distinction at all. (p. 9, italics mine)

Whether we are to embrace Butler's skepticism to distinguish sex from gender, or we are anchored to the traditional distinction between a natural and a cultural pole of the concept gender/sex, it is evident that society and culture (and discourses, and language, and

[14] This notion is in contrast with the view that there is a "true" or "real" gender identity, that needs to be expressed. Being a performative act, gender is real only when it is enacted, and importantly it is performed. Butler (1988) claimed, for instance, that there is nothing about femaleness to be expressed; on the other hand, there are several things that are being expressed about different experiences of being women. Nonetheless, she warrants caution in the use of this terminology, in that not only labeling someone as a female (or a woman) constructs her/his identity, but it also limits the boundaries of the analyses of her experience.

practices) emerge as constitutive of both alternatives. Specifically, both if we want to acknowledge that gender is the cultural signification of sex, and if we are endorsing the view according to which sex is the naturalization of gender, we are implying that those concepts are socially constructed. But what does it mean for something to be "socially constructed?

Social constructionists claims about reality take many forms, and crucially aim at dismantling essentialism. Since the philosophical literature on social constructionism is extremely conspicuous, and the definition of specific meanings of social constructionism exceed the purposes of this discussion, we can accept the social constructionist claim in its broader form in these terms: something is socially constructed if it is not inevitable, or if it is not determined by the nature of things. This statement often carries the implication that e.g. the concept X (defined as socially constructed) is quite bad as it is, and therefore we would do better without it—or by radically transforming it[15] (Hacking, 1999; Haslanger, 2012). Generally speaking, no one would deny that our concepts are socially constituted: we learn them with the help of our parents, in school, and they are the result of historical and linguistic processes. They also vary from culture to culture and evolve with the advancement of technology. So, what is the point in claiming that a concept is socially constructed? As some scholars acknowledged (Haslanger, 2017), saying that something is socially constructed evidences the ordinary view on our concepts and prompt the analysis of the motivations concurring to the establishment of a specific conceptual framework, as well as its limits. More importantly, some concepts are said to be socially constructed in a

[15] See for instance "ameliorative" projects of conceptual engineering (Haslanger, 2000; Jenkins, 2015).

very specific sense. Haslanger (1995, p. 99) defines *discursive*[16] *construction* as a particular kind of social construction in which *what* or *how* it is partly depends on a sort of looping feedback involving activities such as naming or classifying. In her words “Something is discursively constructed just in case it is the way it is, to some substantial extent, because of what is attributed (and/or self-attributed) to it.” This might seem a very vague statement, but if we consider the famous Hacking’s (1999, p. 11) example of the social construction of the kind “refugee woman” we can see that for someone to be classified a refugee woman, some criteria must be met. Importantly, those criteria are embedded in a “matrix” which is composed by a set of institutions such as advocates, papers, lawyers, court decisions, immigrations procedures etc. that simultaneously create the very category of “refugee woman” and reinforce it (for example through the physical construction of barriers, detention centers, passports). The process through which the social kind of “refugee woman” is created is not an exclusively perceptual process. It is not the same to discriminate a tree from a fish, and to discern who is a refugee woman and who is not. In this sense, some social categories, among which gender, seem to be created by the means of language and symbolic structures. This is one of the central features of institutional facts, as described by Searle (1995); in his account, institutional facts (such as money and marriage) cannot be said to perform their function by virtue of their physical structure. Language is thought to be at the basis of institutional facts, because it is a constitutive part of them. Searle (1995, p. 37) cites the example of ants and bees, who are said to have queens and slaves. Is this an institutional fact or is it just a social behavior? In Searle’s view, that

[16] Note that, in this context the notion of “discourse” is mediated by poststructuralist philosophical speculations. Here, discursive practices are not solely related to linguistic utterances, but specifically refer to historically, socially and institutionally specific structures of statements and categories (Foucault, 1980; Scott, 1988).

would be just a social behavior, intended as a cooperative behavior, in that it lacks the symbolic apparatus that permits the definition of queens and slaves. Language, i.e. the symbolic apparatus allowing for discursively constructed categories, do not bring into existence *de novo* (Haslanger, 2012, p. 123) the entities that it nominates, rather as Haslanger (ibid.) puts it:

> […] something in existence comes to have—partly as a result of having been categorized in a certain way—a set of features that qualify it as a member of a certain kind or sort. My having been categorized as a female at birth (and consistently since then) has been a factor in how I've been viewed and treated; these views and treatments have, in turn, played an important causal role in my becoming gendered a woman. (p.123-124)

Butler (1990) would also agree on the fact that gender is socially and culturally constructed, in the sense that certain cultural configurations of gender (e.g. the assumption that there are two genders, and that they map preexisting distinctions based on biological factors) assume the status of "real" categories through the reinforcement of the hegemonic discourse (e.g. medical and scientific knowledge of sexual configurations, exposure to stereotypical descriptions of masculinity and femininity). This is not to say that gender is not "real" (cf. Butler, 1990; Haslanger, 2017). Rather, gender is socially constructed in two main senses: first, social forces contribute to its formation, and second the conditions for membership in a specific gender group are social rather than biological or perceptual (Haslanger, 1995; Searle, 1995).

This brief excursus through some seminal and challenging perspectives on gender–by no means exhaustive–delineated a further grounding source of the concept of gender, namely a social metacognitive grounding. Indeed, what we consider as gender is composed by a set of socially agreed upon criteria, partly derived from biological factors. This socially (and culturally) mediated way of using and defining concepts is largely compatible with the idea of social metacognition (Borghi et al., 2018; Shea, 2018; see par. 2.9.1 of this dissertation) as the grounding mechanism through which we reflect on our conceptual inadequacy and consequently we decide to rely on others' knowledge to fix the reference of the concept. Importantly, this process might even occur unconsciously, without explicitly deciding to derogate the redefinition of some of our concepts to others. In fact, the social environment we live in is constantly affording re-conceptualizations of some sorts by the means of social and cultural practices. It is likely that we absorb and accumulate knowledge of different instantiations of concepts through the interaction with others, and that via this process our concepts are continuously being refined. This would be especially the case for abstract concepts (as defined in the previous discussions), in that they are applicable to a wider range of situations with respect to concrete ones. Therefore, their representation and consolidation in memory is strictly related to linguistic practices, which contributes to give coherence to different experiences with abstract concepts, but also to the interaction with other social agents.

In the case of gender, the "others" can be experts such as philosophers or theorists, as well as people we encounter in our everyday life, e. g., during demonstrations or political actions. Being a social structure (Risman, 2004), gender shapes individuals, but it is simultaneously shaped by individuals in its conceptual content. The same constraints that society imposes on the category of gender can never be separately conceived from the individuals that constitute the society itself. Social structures never exist beyond actors perpetrating and sustaining them through their actions, or through their words. The concept of gender, as sketched out in the previous discussion, is partly the result of critical examinations of those mechanisms supporting gender differences and essentialist views of gender. Indeed, historically, the concept of gender has undergone substantial changes, also due to the effort of scholars. If nowadays we are quite accustomed to the label *queer* in gender-related discourses, and if we went beyond the traditional dichotomy opposing sex and gender (e.g., van Anders, 2015; Hyde et al., 2019), it is also due to the fact that the concept of gender has been reshaped by cultural and social agents. Henceforth, academic discussions, public discourses, political actions, media representations, poetry and literature are all forms of deference that we may consciously or unconsciously engage to define and redefine a concept like gender. To put it roughly, by the means of metacognitive deference, the meaning of social concepts is re-enacted and possessed in the *collective linguistic body* (Putnam, 1973). As already pointed out by Putnam (1973), specific meanings of everyday concepts can be possessed exclusively by a sub-class of individuals (e.g., experts): at a really fine-grained level, there is no need for me to precisely identify if the ring I am wearing is really gold, or if it is not. This is because I can benefit of the specific knowledge of a goldsmith. Putnam referred to this phenomenon as the *division of linguistic labor*. Through this mechanism, even though I do not possess individually the right competence to discriminate whether something is gold or not, refined aspects of the concept of gold are nonetheless engendered in the linguistic collective body. These considerations parallel the notion of metacognition and deference Shea (2018) purported as fundamental grounding sources for specific sets of abstract concepts, namely social abstract concepts.

Clearly, these forms of grounding are more crucial for gender with respect to other abstract concepts, such as “satisfaction”, which may be more related to internal, emotional, and physical experiences. This complexity might be allegedly constructed and enriched via social interactions and engagement in specific kinds of debates, being that political, institutional or academic. Possibly, at least when the concept is employed in a sort of "thinking for speaking" process (Slobin, 1996), the social metacognitive aspect may serve as a grounding source.

3.7. Conclusions. It Takes Two to Tango

In this Chapter I offered an analysis of the concept of "gender" from a broad cognitive science perspective, hence combining evidence coming from different scientific disciplines such as psychology, neuroscience, psycholinguistics, and philosophy. I specifically focused on the concept of sex/gender as developed and articulated in the course of time, in different scientific domains and its consequences on the public understanding of the concept. I deliberately decided not to discuss the large amount of literature concerning sex/gender differences and similarities, sexual orientation and stereotypes for two main reasons. The first and more naïve one appeals to my specific competences, which do not cover those specific areas. Nonetheless, the interested reader will find a great body of informative and critical works produced in the last years (just to name a few see e.g., Eagly & Wood, 2013; Ellemers, 2018; Hyde, 2014; Hyde et al., 2019; Joel & Fausto-Sterling, 2016; Petersen & Hyde, 2011). The second reason is more of a theoretical kind. Philosophical traditions inquiring the genealogy of the concept of gender (e.g., Butler, 1990; Foucault, 1980) as well as biological evidence (e.g., Fausto-Sterling, 1993; 2012) evidenced how much of the phenomena we generally consider as neat evidence of a distinction between the sexes are mediated and constructed by and through our contingent understanding of the concept of gender. To illustrate, consider the mediatic resonance the debate over the banning of Caster Semenya, the two-time Olympic gold medallist, held in the past months[17]. Semenya, competing in the 800m feminine race refused to reduce her testosterone level as introduced by the IAAF in order to prevent female athletes with differences of sexual development (DSD) to be "advantaged". As this example illustrates, the controversy arises when a binary categorization, such as the one opposing females to males, is strictly applied to a wide range of diverse sexual/biological and social configurations, positing a direct relation between being categorized as a female and hormonal levels. As recent developments in the field of social neuroendocrinology demonstrated (van Anders et al., 2011; van Anders & Watson, 2006, 2007), instead, sex-related hormones production can be socially modulated. Whether athletes are judged to be suitable or not for a given competition, in this case, seems to be more the consequence of whether being female/woman implies one's own attunement with what is considered to be a "normative" feminine body. And yet, history proved those norms to be discursively constructed upon an "ideal" concept of gender. In some relevant sense, whether athletes are judged to be suitable or not for a specific competition, is a matter of how gender is conceptualized. Therefore, in this Chapter I endeavored to unravel what are the most important features the concept of gender is supposed to comprise, and also to offer an understanding of the concept that overcomes the classical nature/nurture dichotomy.

My portrait of *gender* proceeded along three main axes of analysis, that are integral for EGC theories: *embodiment*, *groundedness* and *situatedness*. This structure is thought to metaphorically and theoretically mirror the abstractness continuum described in Borghi & Binkofski (2014) as a way to interpret abstract concepts. The authors proposed that abstract concepts can have different levels of abstractness, mainly depending on their grounding

[17] See for example https://www.theguardian.com/sport/caster-semenya .

sources and their modality of acquisition. In more recent developments of the WAT proposal (e.g., Borghi et al., 2018; 2019) abstract concepts are defined as an heterogeneous category comprised of concepts that vary in their being more or less embodied or grounded (e.g., think of numbers, emotions, moral concepts etc.). In this light, I proposed an account of gender as a special kind of social abstract concept, informed by the recent advancements in the field of conceptual knowledge and representation constituted by Multiple Representation Views (MVRs, see Chapter 2). I have suggested that, attempting to capture the representations of the concept gender requires a critical turn of the epistemic perspective, such as the one implied in the tradition of queer studies and Queer Theory (cf. Sullivan, 2003). As Ahmed (2006, p. 67) reminded us, in fact, the word “queer” comes from the Indo-European word “twist”. The orientational aspect conveyed by the very etymology of the term is precisely what queer studies have strived to outline: the idea that a dominant perspective on sexual (and existential) categories can be challenged by changing the point of view, hence revealing the existence of some individualities that “exceed” the orientation they are directed towards (in this case sexual orientations). Besides epistemic considerations, this suggestion has also consequences on the content of inquiry of this Chapter, namely the conceptual representation of gender. Indeed, a queer perspective affords the analysis of phenomena that falls between and beyond the binary composed by abstract and concrete concepts, by acknowledging the multilayered and composite character of our conceptual system.

Building on these premises and on the literature reviewed up to this point, some general considerations on the concept of *gender* can be made. In line with influential EG perspectives on conceptual system (e.g., Borghi et al., 2018; Barsalou, Dutriaux & Scheepers, 2018), gender can be considered as an abstract concept. It should be noticed that it is entailed in these approaches a radical detachment from the idea that abstract concepts are to be considered as the antonymic counterpart of concrete concepts. In this sense, gender appears as a literary exemplification of how abstract concepts can be grounded in physical, perceptual and biological systems as well as in linguistic, cultural and social practices. In the course of this Chapter, in fact, I presented various ways in which the concept of gender assumes its meaning, ranging from perceptual discriminations conveying gendered traits to academic and politic discussions re-shaping the concept. Crucially, those different planes interact so as to form the complex set of relations that compose the concept of gender. This being said, the discussion aimed at underscore how dichotomies such as abstract/concrete, gender/sex, and nature/nurture have exhausted their explanatory potential. The concept of gender, in fact, has been shown to be couched in multiple grounding systems: among those, some were previously been ascribed as pertaining to the concrete pole of conceptual representations, while others were indicated as distinctive for the abstract pole. Gender can thus be defined as a queer concept in itself, in that it escapes binary distinctions traditionally drawn in the field of conceptual knowledge, and historical debates regarding the predominance of nature over culture—and *vice versa*. It follows, that a fixed and stable definition of gender as an abstract concept is only partial. Instead, according with recent theories of conceptual knowledge it is urgent for the researcher interested in gender-related concepts to firstly identify the context in which she is studying the concept. In fact, in some cases the perceptual underpinnings of gender might be more relevant, while in others cultural and social discourses might be more salient aspects of the conceptualization[18].

[18] Recently, a promising line of research addressing the topic of gender identity is approaching the issue combining different scientific approaches. For instance, Fausto-Sterling (2019) is advising for the application of both psychological dynamical models and speculations coming from embodied and enacted theories of cognition in the understanding of sex/gender identities and sexual orientation.

Although those analytical planes can be kept separate for theoretical and sometimes applicative purposes, it is fundamental to keep in mind that one side of the coin is never given without the other. Separating sex from gender–thus nature from culture and, I would say abstractness from concreteness–is a theoretical artifact, and most importantly has proven to limit the potential of the analysis, when those distinctions prevent the contextualization of the concepts under scrutiny. The aim of this Chapter was therefore to advise for the abandonment of traditional dichotomies, in order to unravel and render explicit aspects of the concept that would otherwise be concealed because placed within or beyond the binarism opposing abstract/concrete, gender/sex, and nature/culture.

Given the impressive body of literature that has been produced over the decades around gender and gender-related concepts, the reader might wonder what difference could possibly make to queer the analytical approach on gender in cognitive science. Eagly and Wood (2014) elegantly discussed the consequences of nature-nurture debates in psychological research, claiming that often researchers focused on one type of cause, or treated them as competing explanations. Moreover, as they noted (p. 340) despite the width of psychological research on gender, it does not always inform public discourse on gender issues. In the same vein, I think that engaging in the investigation on how our concept of gender comes to be structured as it is, starting from a critical perspective on both conceptual representation theories and gender research, could impact not only our methodological practices as cognitive scientists but also our everyday understanding of the world surrounding us.

PART II

EXPERIMENTAL EVIDENCE

Preface to Part II

In the first part of this dissertation I have expounded on theories of conceptual representation, with a special focus on recent developments in the EGC panorama. In particular, I deepened aspects related to one of the most debated topics in theories of EG cognition, namely abstract concepts. I have provided theoretical and empirical arguments in support of the WAT theory, a proposal emerged within the broad research field of Multiple Representation Views (MRVs). Building on the characterization of abstract concepts depicted according to the WAT theory, I have argued that gender is a special kind of abstract concept, whose grounding entails different aspects.

The second part of this dissertation comprises empirical studies aimed at supporting four main tenets arisen from the previous discussion:

(a) The representation and processing of abstract concepts is influenced by the linguistic system—whose embodied counterpart is constituted by the mouth effector—to a major extent than that of concrete concepts;

(b) Abstract concepts encompass grounding sources that can be considered as both ‘concrete’ and ‘abstract’;

(c) The concept of gender can be accounted for by considering it as a social abstract concept. Therefore, its representation would be spanned over a continuum of abstractness in which both embodied/physical properties and situated/cultural features interact;

(d) Being a social abstract concept, the representation of gender could be flexibly modulated by experiences, languages and cultures.

Hence, in Study 1 is addressed the point (a), while Studies 2 and 3 are aimed at investigating points (b-d). For further details on the theoretical stances underlying the assumptions of Study 1 see Chapter 2 of this dissertation, whereas for Study 2 and 3 see Chapter 2 and 3.

CHAPTER 4

STUDY 1

Abstract, Emotional and Concrete Concepts and the activation of mouth-hand effectors[1].

Introduction

According to embodied and grounded theories, concepts are grounded in sensorimotor systems. The majority of evidence supporting these views concerns concepts referring to objects or actions, while evidence on abstract concepts is more scarce. Explaining how abstract concepts such as “freedom” are represented would thus be pivotal for grounded theories. According to some recent proposals, abstract concepts are grounded in both sensorimotor and linguistic experience, thus they activate the mouth motor system more than concrete concepts. Two experiments are reported, aimed at verifying whether abstract, concrete and emotional words activate the mouth and the hand effectors. In both experiments participants performed first a lexical decision, then a recognition task. In Experiment 1 participants responded by pressing a button either with the mouth or with the hand, in Experiment 2 responses were given with the foot, while a button held either in the mouth or in the hand was used to respond to catch-trials.

[1] This paper was published in December 2018 in the peer-reviewed scientific journal *PeerJ*, and can be accessed through this link: DOI 10.7717/peerj.5987.

Experiment 1

Previous results in which participants were required to decide whether a definition matched with a target words revealed that the processing of abstract concepts was facilitated with mouth responses, while the processing of concrete ones with manual responses (Borghi & Zarcone, 2016). In Experiment 1 we used the same response modality and the same response devices adopted by Borghi and Zarcone. We intended to verify whether the facilitation of abstract over concrete concepts in responses with the mouth was also present in a task involving a more superficial processing level, i.e. a lexical decision task, and in a subsequent recognition task. As to emotional words, we were interested in investigating whether they were processed similarly to other abstract words or whether they differed from both concrete and abstract words.

Method

Participants

Forty native Italian speakers in a range of age between 20-30 years (22 females and 18 males; mean age: 20.1; standard deviation of age: 2.12) participated voluntarily. Handedness was assessed using an abridged version of the Edinburgh Inventory (Oldfield, 1971). All participants were Italian native speakers, had normal or corrected-to-normal vision, and were naïve as to the purpose of the experiment. All participants gave written informed consent, and the experimental procedures were approved by the Ethic Committee of the Institute of Cognitive Sciences and Technologies, Italian National Research Council, Rome, Italy (Approval number: 0000441).

Materials

We selected 90 Italian words from the Della Rosa et al. database (Della Rosa et al., 2010), composed by 30 concrete words, 30 abstract and 30 emotional words. The selected words were balanced in Familiarity (mean = 590; *SD*= 148.09). We considered as concrete words, the words that scored high on Concreteness (max. 700, min. 596; mean of Concreteness= 660.42; mean of Abstractness= 138.87), and considered as abstract the words with high Abstractness scores (max. 635, min. 375; mean of Abstractness= 535.24; mean of Concreteness= 213.28). We considered as emotional words those words that had intermediate scores of Abstractness and Concreteness (mean of Concreteness= 400; mean of Abstractness= 372.74) and that according to the experimenters had high emotional valence.

Because the emotional value was not present as a parameter in Della Rosa et al. (2010), in order to verify the emotional valence of words we performed an on-line pre-test in which 25 participants (13 females; mean of age= 30.6; *SD*=14.5) judged the emotional value of each word on a 7-points Likert scale (1 was rated as non-emotional and 7 as completely emotional). Since in the literature it is debated whether emotional words can be considered as a subset of abstract concepts or represent a kind of concepts different from both concrete and abstract concepts (Altarriba et al., 1999; Kousta et al., 2011), the pre-test also aimed to clearly distinguish abstract, concrete and emotional words, avoiding overlaps between abstract and emotional words.

Among the original 90 words we selected 48 words: the 16 more concrete, the 16 more abstract and the 16 rated as more emotional. Characteristics of the three categories of selected words in terms of dimensions and psycholinguistic variables are shown in *Table 1a*.

We performed a T-Student test for independent samples by items and we calculated the Effect size (Cohen's *d*), in order to verify if concrete, abstract and emotional words we chose differed in Concreteness, Abstractness and Emotional value. All the categories (abstract, concrete and emotional words) resulted to differ in Concreteness ($p_s < .001$), Abstractness ($p_s <$ 001) and Emotional value ($p_s < .001$). Emotional words were rated as more emotional than both abstract and concrete words ($p_s < .001$); also abstract words were rated as more emotional than concrete words ($p < .001$).

We also verified whether abstract, concrete and emotional words differed along a series of dimensions that, according to different theories, are considered crucial to distinguish concrete and abstract words, i.e. Imageability (IMG; Paivio, 1986), Age of Acquisition (AoA; Gilhooly, & Logie, 1980), Context Availability (CA; Schwanenflugel et al., 1992) and Modality of Acquisition (MoA; Wauters et al., 2003). We decided to avoid controlling for these variables while selecting abstract and concrete words, because this would result in using a very reduced number of abstract and concrete concepts. More crucially, it would lead us to use concepts that are weird and scarcely familiar. We instead decided to select "good" abstract and concrete words: when compared to concrete words, "good" abstract words are typically less imageable (IMG), they are acquired later (AoA) and mainly through language rather than through perceptual modalities (MoA), and they are less associated to contexts (CA) (see e.g., Borghi et al., 2018b; Villani et al., 2019). The abstract, concrete and emotional words we selected thus differed not only in Concreteness and Abstractness but also in Imageability, Age of Acquisition, Context availability, and Modality of Acquisition.

As to psycholinguistic variables, we took care in balancing words for Familiarity, thus the three categories didn't differ on this dimension (all p_s=.9).

The abstract and emotional words we selected were more frequent than concrete ones (p_s<.005) We chose highly frequent abstract words because we wanted to avoid stimuli that were unfamiliar for participants which could have lead to abstractness driven effects. Emotional and abstract words did not differ (p=.4). Concrete words were also shorter than abstract and emotional words (p_s<.04), while emotional and abstract words did not differ (p=.2). Results of the comparisons between the three categories of selected words in terms of psycholinguistic variables and of all the relevant dimensions are shown in *Table 1b*.

The effect of these variables on the results was determined through Generalized Linear Mixed Models (GLMMs) performed on both experiments (1 and 2) and tasks (Lexical Decision and Recognition) with accuracy and RTs as dependent variables. Together with *Type of Concept* and *Effector* as main factors, we added *Imageability*, *Age of Acquisition*, *Contex Availability*, *Modality of Acquisition*, *Frequency* and *Number of Letters* as covariates (see Results section).

To complete our stimuli we subsequently added 48 pseudowords, created by modifying one letter at the beginning, in the middle or at the end of concrete, abstract and emotional words in the same proportion as the critical words. Then we created 24 words to be used as catch-trials: they were Italian words with a bold letter, at the beginning, in the middle or at the end of the word. Finally, we selected 24 new words, maintaining the proportion between abstract, concrete and emotional words for the recognition task. Words that can directly activate hand or mouth (e.g., tools or food related words) were excluded from the list. Stimuli are shown in *Table 2*.

The experiment consisted of two tasks, a lexical decision task and a recognition task, that were presented in sequence; the lexical decision task always preceded the recognition one. Two separate lists of words were created for the two tasks: for the lexical decision task 24 critical words (8 concrete, 8 abstract, 8 emotional), and 24 pseudo-words. For the recognition task list, 24 critical words (8 concrete, 8 abstract and 8 emotional) and 24 new words were used.

Procedure

Participants were tested individually, and were instructed to respond as quickly and accurately as possible to each trial using a response box connected with a pedal and a button (see *Figure 1a*). They were given the instructions on the computer screen and were trained at the beginning of every task. In no case further instruction from the experimenter was needed; she only needed to specify how to use the button for the mouth responses, and she made sure that participants used their dominant hand for hand's responses. Participants were not aware of the subsequent recognition task; during the instructions they were just informed that they would complete an experiment composed by two phases. Only the participant and the experimenter were present in the room; after the training the experimenter sat outside the lab in order to avoid any kind of interference with the experiment. Testing took place on a Pc (resolution: 1024x768 pixel) running EPrime2 Professional software. Participants sat on a comfortable chair in front of a computer screen, at a distance of about 60 cm.

Words appeared at the center of a computer screen at maximum 6.20° of visual angle. Each trial began with a centred black fixation cross for 500 ms, followed by the presentation of the word. Words remained on the screen for a time of maximum 1.5 second. After 1 second the next trial started (see *Figure 1b*).

Lexical Decision task

The task was divided into two experimental blocks, each preceded by a training block of 12 trials (6 words and 6 pseudo-words). Depending on the block, participants kept the button to press in their dominant hand or in the mouth. The order of the blocks was counterbalanced across participants. A set of 48 words was presented on the computer screen (24 critical words, 24 pseudo-words). Participants were asked to press the button with the hand or with the mouth, depending on the instructions, if they read an Italian word, and to refrain from responding if the word they read was not an Italian one.

Recognition task

The task was divided into two experimental blocks, each preceded by a training block of 6 trials (3 words, 3 new words). Depending on the block, participants were required to keep the button in their dominant hand or in the mouth, between the teeth. A set of 48 words was presented in each block, composed by 24 critical words and 24 new words. The order of the blocks was counterbalanced across participants. Participants were asked to press the button with the hand or with the mouth, depending on the condition, in case they recognized the word on the screen as a word already presented in the previous task, or to refrain from responding if they read a new word.

Results

The data were analyzed with Generalized linear mixed models (GLMM). Generalized linear mixed models (GLMM) incorporate random effects into the linear predictor of a generalized linear model (GLM). They include fixed linear predictor variables, within subject measures and random variances to account for cluster-related correlations in the data. GLMMs consider all the available data points, including those which occasionally failed on some trials. Furthermore, GLMMs can handle non-normal outcome distributions, which is important to account for accuracy, as it is likely to be highly skewed (Hedeker, 2005).

The effect of *Type of Concept* (abstract, concrete and emotional), of the *Effector* (mouth vs. hand) and of their interaction were analyzed on the response times and on the accuracy score (error) with two types of GLMM using *Frequency*, *Number of Letters*, *Imageability*, *Age of Acquisition*, *Context Availability* and *Modality of Acquisition* as covariates. We introduced these covariates to be sure that they did not affect our main results – for example, that the differences we found in processing the kinds of concepts were not due to a linguistic dimension, their different frequency.

In the first type of GLMM model, the response time was assumed to be normally distributed, therefore the Identity link function was used, whereas in the second type of model we adopted a logistic function because the accuracy was considered as having a binomial distribution (presence/absence of error). The two types of models were applied for the Lexical Decision and Recognition tasks of both Experiments 1 and 2.

Table 3 displays the GLMMs results in the different experiments showing the effect of *Type of Concept* (abstract, concrete and emotional) and the *Effector* (mouth vs hand) and their interaction as well as the covariates effect on the response time and accuracy.

Means of response times as a function of *Type of Concept* and *Effector* for both tasks (Lexical Decision and Recognition) and experiments (1 and 2) are displayed in *Table 4*.

Lexical Decision task

All erroneous trials (2,96%) were removed before the analysis of RTs. In the lexical decision task, we found that the factor *Type of Concept* affected the response time [Wald (2) = 11.04; *p*=.004]. Abstract concepts (mean:738.59 *ms*, SE= 10062.11) were responded to slower than emotional ones (mean:697.27 *ms*, SE= 10058.79) and concrete ones (mean: 685.18 *ms*, SE= 10048.57). The analysis also showed an advantage for the hand (mean: 669.44 *ms*, SE= 10056.26) over the mouth effector (mean:744.58 *ms*, SE=10056.70) (Wald (1)= 77.43; *p*<.001).

All these effects are corrected for *Frequency*, *Number of Letters*, *Imageability*, *Age of Acquisition*, *Context Availability* and *Modality of Acquisition*, however only *Frequency* [Wald (1) = 33.84; *p*<.001; B=-.51], *Number of Letters* [Wald (1) = 69.04; *p*<.001; B=18.36] and *Age of Acquisition* [Wald (1) = 9.46; *p*=.002; B=.31] affected the time of response in the lexical decision task. The predicted interaction between the two main factors did not reach the significance.

The factor *Type of Concept* also affected the accuracy of responses [Wald (2)=6.82; *p*=.03]. The mean rate of errors corrected by the covariates were computed from the logistic model for each effect. Mean rates of errors are reported in terms of percentage of errors [abstract=96%, SE=13.51; concrete=99%, SE=4.87; emotional=98%, SE=5.38]. All the effects are corrected for the abovementioned covariates, however only *Frequency* [Wald (1) = 11.06; *p*=.001; B=.01] affected the accuracy of responses. No other main effect or interaction reached the significance.

Recognition task

All erroneous trials (28,30%) were removed before the analysis of RTs. In the analysis of response times, we found an advantage of the hand (mean:726 *ms*, SE=14405.92) over the mouth effector (mean: 777.34 *ms*, SE= 14396.75) [Wald (1)= 22.68; *p*<.001]. All the effects were corrected using *Frequency*, *Number of Letters*, *Imageability*, *Age of Acquisition*, *Context Availability* and *Modality of Acquisition* as covariates, however only *Number of Letters* [Wald (1) = 25.17; *p*<.001; B=13.60] affected the response time in the recognition task. No other main effect or interaction reached the significance.

Nonetheless, a qualitative inspection of the interaction between the two main factors *Type of Concept* and *Effector* revealed that the pattern was in trend with our hypothesis: the advantage of the hand over the mouth responses was namely smallest with abstract words. Emotional words were the most affected by the effector, showing 70 *ms* of advantage of the hand over the mouth responses. They were followed by concrete words that showed a facilitation of 50 *ms* of the hand over the mouth responses, while abstract words showed the smallest advantage with the hand (30 *ms* of difference), as shown in *Table 4 and Figure 2*.

In the analysis on the accuracy, the interaction between the two main factors *Type of Concept* and *Effector* was significant [Wald (2)= 7.16; *p*=.02] (see *Figure 3*). All the effects are corrected for the abovementioned covariates, however only *Number of Letters* [Wald (1)= 4.06; *p*=.04; B=-.05], *Frequency* [Wald (1)=25.20; *p*<.001; B=-.006] and *Modality of Acquisition* [Wald (1)= 6.17; *p*=.01; B=-.003] resulted to affect the accuracy. No other main effect reached the significance.

Discussion

The results show that in the lexical decision task abstract words were processed slower than emotional words and in trend slower than concrete ones, confirming the well-established concreteness effect (Paivio, 1986). In the lexical decision task, *Frequency* and *Number of Letters*, together with *Age of Acquisition* appeared to be important variables, that may have affected the results since in general the selected abstract words were longer and acquired later. As to emotional words, their pattern seems to be similar to the pattern of concrete words: in general, they yielded shorter response times than abstract words, and they seem to be slightly advantaged in the hand condition.

Across the two tasks, responses with the mouth were slower than those with the hand, independently from the concept kind; this effect is not worth discussing since it was likely due to the fact that the button to hold among the teeth was harder to press than the key to press with the hand (see also Borghi and Zarcone, 2016).

As to the activation of the hand and mouth effectors in relation to the different type of concepts, in the lexical decision task we found no significant interaction. A possible explanation is that effectors are differently activated only in tasks that require a deeper processing level. The interaction between *Type of Concept* and *Effector* was instead significant in the recognition task, in the analysis on accuracy, in which the general disadvantage with the mouth effector was less pronounced with abstract words with respect to concrete ones, while emotional words showed an advantage with the mouth effector. It is worth noting that, beside *Frequency* and *Number of Letters*, *Modality of Acquisition* impacted significantly the results on accuracy of the recognition task. This could suggest that, in a task requiring a deeper level of processing the way, in which we acquire words is more relevant than other psycholinguistic variables.

Experiment 2

A potential problem of Experiment 1 was that the device used to respond to critical trials differed in the mouth and the hand conditions; this could explain why RTs were slower with the mouth responses. Experiment 2 was designed to verify whether the findings of Experiment 1 could be replicated also in an experiment in which the mouth and the hand were not the direct response effectors, but were nonetheless occupied during the task. We therefore introduced catch-trials, to which participants had to respond pressing the button either with the hand or with the mouth. Participants were instead invited to respond to critical trials by pressing a pedal with the foot, in order to avoid any potential interference with the hand and mouth effectors. This change had the advantage to allow us to manipulate the effector (hand vs. mouth) and at the same time to collect response times and errors with the same device, i.e. the pedal.

In this experiment we intended to test whether abstract, concrete and emotional concepts were differently activated when the mouth and the hand effectors were occupied. We predicted a facilitation of the mouth responses with abstract concepts.

Method

Participants

Forty native Italian speakers in a range of age between 20-30 years (22 females and 18 males; mean of age: 23.5; standard deviation of age: 2.12) participated voluntarily.

Handedness was assessed using an abridged version of the Edinburgh Inventory (Oldfield, 1971). All participants were Italian native speakers, had normal or corrected-to-normal vision, and were naïve as to the purpose of the experiment. All participants gave written informed consent, and the experimental procedures were approved by the CNR- ISTC ethics committee.

Materials

Materials were the same as Experiment 1, except for 16 catch-trials that were added. Catch-trials were Italian words with a bold letter.

As in Experiment 1, the experiment consisted of two tasks, a lexical decision task and a recognition task, that were presented in sequence; the lexical decision task always preceded the recognition one. Two separate lists of words were created for the two tasks: for the lexical decision task 24 critical words (8 concrete, 8 abstract, 8 emotional), 24 pseudo-words. For the recognition task list, the stimuli consisted of 24 critical words (8 concrete, 8 abstract and 8 emotional) and of 24 new words.

Procedure

The procedure was the same as that of Experiment 1.

Lexical Decision task

The task was divided into two experimental blocks, each preceded by a training block of 16 trials (8 words and 8 catch-trials). A set of 64 words was presented on the computer screen (24 critical words, 24 pseudo- words and 16 catch-trials). The words were arranged in two different lists, one for each block. Depending on the block, participants were required to keep a button in their dominant hand or in the mouth, between the teeth, and to respond to catch-trials by pressing it; they were instead asked to press the pedal to respond to critical stimuli. The order of the blocks was counterbalanced across participants. Participants were asked to press the pedal if they read an Italian word, and to refrain from responding if the word they read was not an Italian one. They were also required to respond to catch-trials by pressing the button with the hand or mouth, depending on the condition. Hence the mouth and the hand were not the direct response effectors, but depending on the condition either the mouth or the hand were occupied during the execution of the task.

Recognition task

The task was divided into two experimental blocks, each preceded by a training block of 8 trials (3 words, 3 new words and 2 catch-trials). A set of 62 words was presented in each block, composed by 24 critical words, 24 new words and 12 catch-trials. The order of the blocks was counterbalanced across participants. Depending on the block, participants were required to keep the button in their dominant hand or in the mouth, between the teeth. As to the critical stimuli, participants were asked to press the pedal in case they recognized that the word on the screen had already been presented in the previous task, or to refrain from responding if the read a new word. When catch-trials were presented, they had to respond by pressing the button with the hand or mouth, depending on the block.

Results

Lexical Decision

All erroneous trials (4,58%) were removed before the analysis of RTs. In the lexical decision task, the factor *Type of Concept* affected the response time [Wald (2) = 15.56; *p*<.001], showing that abstract words (mean: 876.14 *ms*, SE=10707.86) were processed slower than both concrete (mean: 771.67 *ms*, SE=10692.50) and emotional words (mean: 821.95 *ms*, SE=10704.06). All the effects are corrected using *Frequency*, *Number of Letters*, *Imageability*, *Age of Acquisition*, *Context Availability* and *Modality of Acquisition* as covariates, however only *Frequency* [Wald (1) = 10.82; *p*=.001; B=-.33], *Number of Letters* [Wald (1) = 33.68; *p*<.001; B=13.75] and *Imageability* [Wald (1) = 7.37; *p*=.007; B=.31] affected the response time. No other main effect or interaction reached the significance.

In the analysis on accuracy, the hand condition elicited more errors than the mouth condition. The mean rate of errors corrected by the covariates were computed from the logistic model for each effect. Mean rates of errors are reported in terms of percentage of errors (mouth: 95%, SE=11.28; hand: 97%, SE=7.09); (*Effector* [Wald (1)= 4.88; *p*=.02]. All the effects are corrected for the linguistic dimension of the stimulus, however only *Imageability* [Wald (1) = 4.24; *p*=.03; B=-.005] had an impact on the accuracy. No other main effect or interaction reached the significance.

Recognition task

All erroneous trials (26.1%) were removed before the analysis of RTs. In the analyses on response times, no main effect or effects of the covariates reached the significance. However, the interaction between the two main factors *Type of Concept* and *Effector* was significant [Wald (2) = 7.72; p=.02] showing the predicted interaction: abstract words were responded to faster with the mouth than with the hand, while concrete and emotional words were responded faster with the hand than with the mouth (see *Table 4* and *Figure 4*).

In the analysis on accuracy no main effect or interaction reached the significance, nor did the effect of the covariates.

Discussion

Across the two tasks, abstract words were processed slower than both concrete and emotional words. As in Experiment 1, our findings confirm the concreteness effect and at the same time suggest that emotional words cannot be properly assimilated neither to concrete nor to abstract words. In line with the results of Experiment 1, we did not find a significant interaction between *Type of Concept* and *Effector* in the lexical decision task. The effect of the covariates *Frequency*, *Number of Letters* and *Imageability* in the lexical decision task, but not in the recognition task, suggests that these parameters could have affected more incisively a relatively shallow task, especially in the speed of processing. In the recognition task, instead, the interaction reached significance in the analysis of response times. Abstract words yielded faster RTs when processed in the mouth condition, while concrete and emotional words were responded to faster in the hand condition, as predicted by the WAT (Words As social Tools) view.

General discussion

According to some proposals, abstract concepts evoke more linguistic experience than concrete words (Borghi & Binkofski, 2014; Borghi et al., 2018b; Dove, 2011; Gleitman et al., 2005). If the involvement of language activates a motor simulation, this should result in a higher engagement of the mouth effector in the processing of abstract words, compared to that of concrete words. The main aim of this paper was to test the hypothesis that different kinds of concepts, i.e. concrete, abstract and emotional ones, differently engaged the mouth and hand effectors. In the two experiments we reported the mouth and the hand effectors were involved either directly, to provide a response (Experiment 1), or indirectly, keeping them occupied during the response (Experiment 2).

A further aim of this paper was related to the distinction between abstract, concrete and emotional words. Since many authors consider emotional concepts as a subset of abstract concepts while others tend to consider them as independent from both abstract and concrete ones, we intended to verify whether performance with emotional words reflected that with abstract words or not.

Overall, our results confirmed the hypothesis that abstract words involve the activation of the mouth, but the effect was modulated by the task and differed depending on whether the response was provided directly using that effector or not. In the following we will point out the main results, discussing them in light of the advanced hypotheses. We will first illustrate results on the differences in processing the three concept kinds independently of the effector, then we will focus on differences between concepts kinds in relation to the activation of mouth and hand effectors.

Overall processing differences between concept kinds. Overall, abstract concepts were processed generally slower than concrete ones in the lexical decision task (E1 and E2 lexical decision). Our results confirm the well-established concreteness effect (Paivio, 1986; but see exceptions to the effect when controlling stimuli for valence: Kousta et al., 2011; Barca et al., 2002), that shows that abstract words are slower than concrete ones, and extended it showing that in the lexical decision task they are also slower than emotional words (see also Ponari et al., 2017). Interestingly, however, such effect reached significance only in the lexical decision task.

As to emotional words, our results cast doubts on the assimilation of emotional to abstract concepts: across experiments and tasks, the pattern of responses elicited by emotional words differed from that of abstract words and occasionally from that of concrete words too. In the lexical decision task of both experiments emotional words were processed faster than abstract words and did not significantly differ from concrete words. Our results are in line with those of a study by Siakaluk et al. (2016) showing that valenced words were processed faster than other words in lexical decision task. Overall, emotional words differed in processing from both concrete and abstract concepts, confirming the views according to which they represent a third kind of concept (Altarriba et al., 1999; Setti and Caramelli, 2005).

Processing differences between concept kinds in relation to the effectors. The experiments we designed were driven from the hypothesis that abstract concepts would activate more the mouth motor system. Furthermore, we wanted to explore whether the two effectors, mouth and hand, would be differently activated with emotional words. We thus expected to find a *Type of Concept x Effector* interaction.

If we consider lexical decision, in neither experiment the predicted *Type of Concept x Effector* interaction was significant. Results thus seemed to suggest that the lexical decision task did not lead to a differential activation of the hand and mouth effectors depending on the concept kind, likely because of the superficial processing level it implied. This interpretation is supported by the fact that in the lexical decision task typical psycholinguistic variables such as *Frequency* and *Number of Letters* resulted to impact the speed of responses in both Experiments and also the accuracy in Experiment 1.

The results consistently differed if we consider the Recognition task. In Experiment 1 the interaction reached significance in accuracy and was present in trend in RTs, while in Experiment 2 the interaction was significant in RTs. In Experiment 1, the general disadvantage caused by the mouth device was smaller for abstract words with respect to concrete words in both the accuracy and the response times. In Experiment 2, in which the hand and mouth were occupied but responses were provided in the same manner, namely pressing a pedal with the foot, responses to abstract words were faster in the mouth than in the hand condition, while the opposite was true for both concrete and emotional words. These results clearly confirm our hypothesis, indicating that abstract words were facilitated when the mouth was activated, and extend previous results, showing that such a facilitation occurred not only when the mouth was the direct response effector but also when the mouth was occupied with a device.

This confirms the predictions of the WAT proposal, according to which abstract concepts re-enact linguistic and social experience more than concrete concepts, hence determining a higher activation of the mouth. Three possible mechanisms can underline this activation (see for further discussion Borghi & Zarcone, 2016; Borghi et al., 2018b): a. the re-enactment of the acquisition experience, which is mainly linguistic and occurs in a social context; b. the inner speech used to re-explain to us the meaning of abstract concepts; c. the meta-cognitive awareness that our conceptual knowledge is inadequate followed by the motor preparation to ask to others information on words meaning (social-metacognition, Borghi et al., 2018b). The present study does not allow us to determine which of the three mechanisms is responsible of the effects; further research is needed in order to disentangle them.

The pattern of results of emotional concepts was also rather consistent across the two experiments, and clearly different from that of abstract concepts. In the recognition task of both Experiments 1 and 2 emotional words were processed slightly slower in the mouth than in the hand condition, differently from abstract words. Finally, the fact that abstract but not emotional words selectively engage only the mouth effector is in keeping with recent experimental results. Ratings results showed that emotional concepts activate both the mouth and the hand effectors, while mental states concepts activate more selectively the mouth (Ghio et al., 2013), and fMRI results clearly demonstrated that while the face/mouth motor system in the brain is more activated by “pure” abstract concepts as mental state concepts than by emotional ones, which activate hand and face motor cortex to similar degrees (Dreyer and Pulvermüller, 2018). Overall, this finding is in line with views according to which no dichotomy between abstract and concrete concepts exists. Our results rather suggest that emotional concepts cannot be assimilated neither to concrete nor to abstract concepts, (see Barca et al., 2017, and Mazzuca et al., 2017, for further discussion), and are in line with the proposal according to which emotional concepts, being more grounded than other abstract concepts, provide a bootstrapping mechanism to learn them (Ponari et al., 2017).

While we found that abstract concepts processing was facilitated with the mouth, the results are less marked than in a previous study (Borghi and Zarcone, 2016). We ascribe this difference to two factors: first, to the fact that in the previous study participants were provided with a context and not only with single words, and second, to the fact that the task was a deep processing one.

It can be objected that effectors effects have previously been found with lexical decision tasks. However, it is difficult to directly compare our results with those of previous studies with lexical decision, such as those by Pulvermüller et al., 2005 and Neininger & Pulvermüller (2003), because these studies employed as stimuli action words directly related to the effectors (Pulvermüller et al., 2005) and strongly perceptual related words (Neininger & Pulvermüller, 2003).

Even if we did not find the predicted interaction with effectors, our findings are in line with those of previous lexical decision studies with concrete and abstract words. For example, Dreyer et al., (2015) comparing abstract emotional words with tool, food, animal words and effector related words, showed that in the control group abstract-emotional words yielded longer RTs than food and animal related words, while there was no difference in the accuracy. Moreover, in the same study (always in the control group), Dreyer et al. found that hand-related verbs were processed faster than verbs related to face and leg. Our results on lexical decision are in line with the evidence reported, showing a concreteness effect and a general advantage of responses given with the hand.

In sum, the present study adds important information to previous studies on concepts and effectors activation: it suggests that the mouth and hand effectors can be differently activated depending on the task and on the depth level it implies. The different effectors did not influence results in the lexical decision task, but they had an impact on a subsequent recognition task.

Conclusion

Overall, our studies show that, in general, abstract words are more difficult to process than concrete ones, as revealed by the slower RTs, independently from the task. This confirms the concreteness effect, well-established in the literature. Furthermore, the pattern of results obtained with emotional words suggests that they are markedly different from both concrete and abstract concepts.

If we consider the relationship between concepts and effectors, we confirmed the hypothesis proposed by the WAT proposal that abstract concepts had an advantage in the mouth condition. The result was however modulated by the task: the effectors did not have a different effect on concepts in a lexical decision task, but impacted a subsequent recognition task. Overall, our findings highlight that concepts are grounded and activate bodily experiences, but they also point out the exquisitely flexible character of our conceptual representation.

APPENDIX A

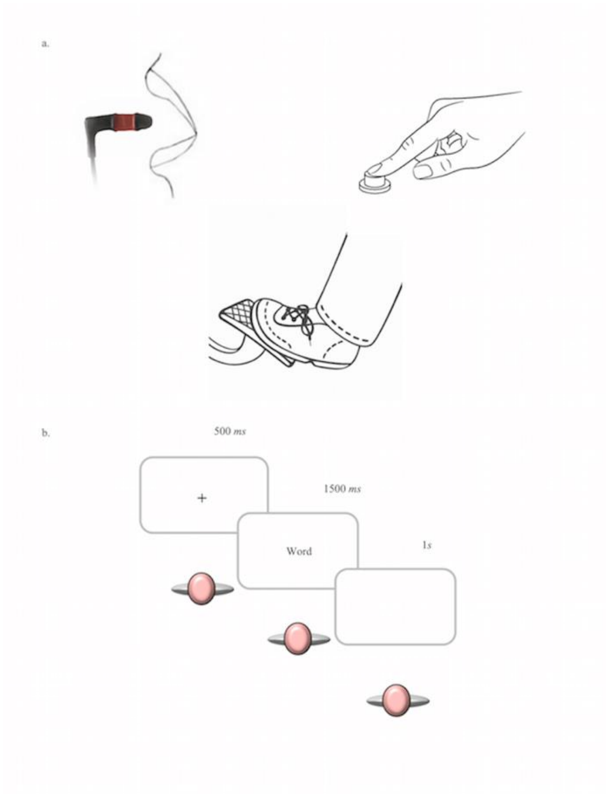

Figure 1. Procedure and devices used to respond to stimuli. (A) Mouth and hand buttons used to respond to stimuli in Experiment 1, and to catch-trial in Experiment 2; pedal used to respond to stimuli in Experiment 2. (B) Procedure: each trial began with a centred black fixation cross for 500 ms, followed by the presentation of the word. Words remained on the screen for a time of maximum 1.5 s. After 1 s the next trial started.

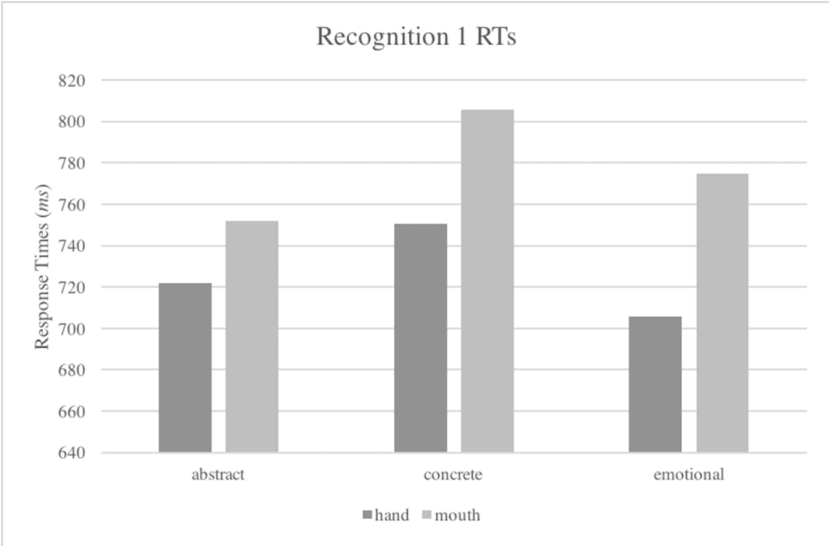

*Figure 2***.** Interaction between Type of Concept and Effector factors in response times of Recognition, Experiment 1.

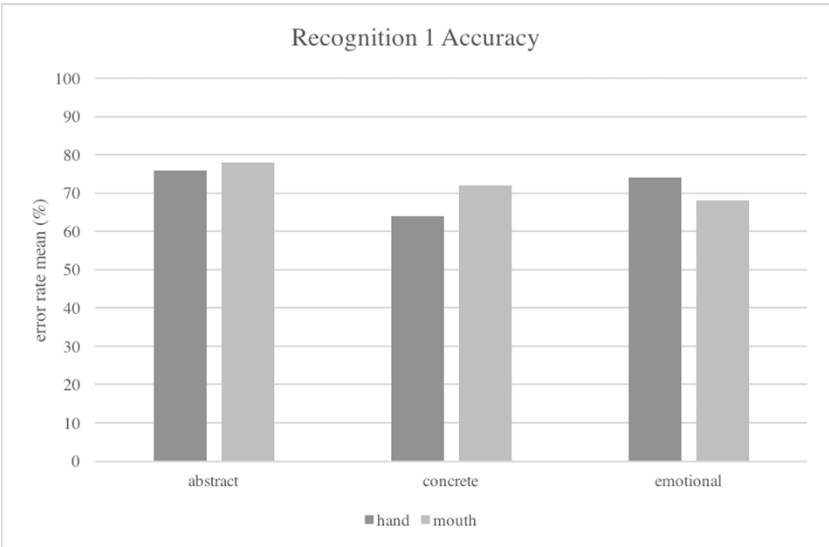

Figure 3. Interaction between Type of Concept and Effector factors in the accuracy of Recognition task, Experiment 1. The mean rate of errors were corrected by covariates included in the logistic model (Frequency, Number of Letters, Imageability, Age of Acquisition, Context Availability and Modality of Acquisition).

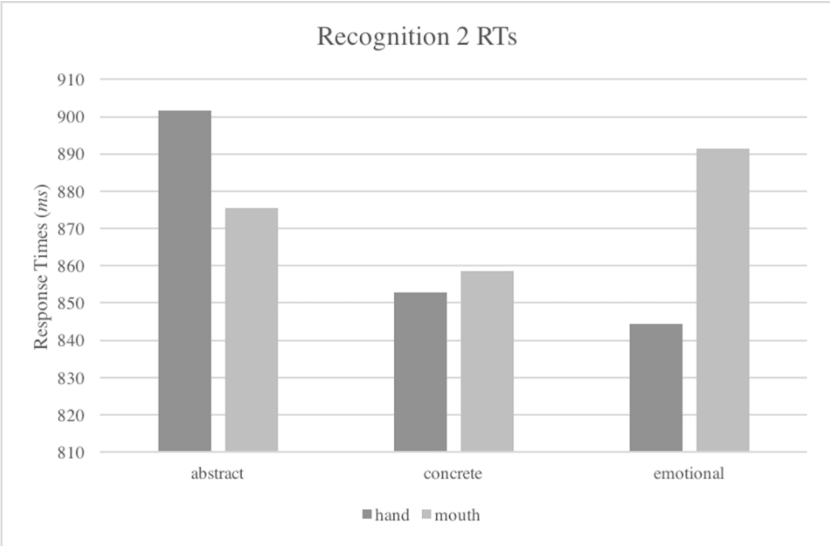

Figure 4. Interaction between Type of Concept and Effector factors in response times of Recognition task, Experiment 2.

Table 1

Characteristics of the three categories of words. A. Characteristics of the three selected categories of words in terms of psycholinguistic dimensions. B. Comparisons between the three selected categories of words in terms of psycholinguistic dimensions.

a.

CATEGORY		Concreteness	Imageability	Familiarity	Age of Acquisition	Context Availability	Abstractness	Modality of Acquisition	Number of Letters	Emotional Value	Frequency
Abstract	Mean	232.28	261.37	441.27	469.27	357.96	530.64	566.43	9.25	2.90	70.25
	N	16	16	16	16	16	16	16	16	16	16
	SD	35.59	70.18	57.45	65.23	59.05	60.75	62.60	2.79	.57	63.28
Concrete	Mean	660.08	653.70	438.80	276.74	600.97	132.47	289.23	6.25	1.63	20.56
	N	16	16	16	16	16	16	16	16	16	16
	SD	30.90	47.99	57.32	81.84	57.96	28.53	91.12	1.65	.18	15.40
Emotional	Mean	321.49	346.32	438.57	395.73	436.12	446.51	483.73	8.13	5.20	82.69
	N	16	16	16	16	16	16	16	16	16	16
	SD	31.54	50.12	75.30	66.83	59.57	34.14	74.25	2.19	.52	61.92
Total	Mean	404.62	420.47	439.55	380.58	465.02	369.87	446.46	7.88	3.24	57.83
	N	48	48	48	48	48	48	48	48	48	48
	SD	188.96	179.21	62.56	106.52	117.45	178.31	139.46	2.54	1.56	57.56

b.

CATEGORY	Concreteness	Imageability	Familiarity	Age of Acquisition	Context Availability	Abstractness	Modality of Acquisition	Number of Letters	Emotional Value	Frequency
Abstract-Concrete	**p<.001**; t(30)= -36.27; SE= 11.79; *d*= 12.82	**p<.001**; t(30) = -18.4; SE= 21.26; *d*= 6.52	p=.9	**p<.001**; t(30)= 7.3, SE= 26.17; *d*= 2.60	**p<.001**; t(30)=-11.7; SE= 20.69; *d*= 4.15	**p<.001**; t(30)= 23.7; SE= 16.76; *d*= 0.92	**p<.001**; t(30)= 10.03; SE= 27.64; *d*= 3.54	**p=.04**; t(30)=3.60; SE= 2.93; *d*= 1.27	**p<.001**; t(30)= 8.507; SE= .149; *d*= 3.068	**p<.001**; t(30)= 3.05; SE= 16.28; *d*= 1.07
Abstract-Emotional	**p<.001**; t(30)= -7.49; SE= 11.92; *d*= 2.65	**p<.001**; t(30) = -3.9; SE= 21.54; *d*= 1.39	p=.9	**p=.004**; t(30)= 3.1; SE= 23.35; *d*= 1.11	**p<.001**; t(30)=-3.7; SE= 20.98; *d*= 1.31	**p<.001**; t(30)= 4.8; SE= 17.40; *d*= 1.70	**p=.002**; t(30)= 3.4; SE= 24.27; *d*= 1.20	p=.2	**p<.001**; t(30) =-11.933; SE=.192; *d*= 4.294	p=.4
Concrete-Emotional	**p<.001**; t(30)= 30.60; SE= 11.06; *d*= 10.82	**p<.001**; t(30)=17.7; SE= 17.35; *d*= 6.26	p=.9	**p<.001**; t(30)= -4.4; SE= 26.45; *d*= 1.59	**p<.001**; t(30)=7.9; SE= 20.79; *d*= 2.80	**p<.001**; t(30)= -28.2; SE= 11.13; *d*= 9.97	**p<.001**; t(30)= -6.6; SE=29.37; *d*= 2.34	**p=.02**; t(30)=-2.32; SE=0.68; *d*= 0.81	**p<.001**; t(30)=-25.980; SE= .137; *d*= 9.391	**p=.005**; t(30)=-3.89; SE= 15.95; *d*= 1.37

Table 2
Selected stimuli from Della Rosa et al. (2010) database.

ITALIAN WORD	ENGLISH WORD	FREQUENCY VALUE	NUMBER OF LETTERS	FREQUENCY MEAN	N. LETTERS MEAN
Affermazione	Affirmation	59	12		
Analogia	Analogy	8	8		
Circostanza	Circumstance	70	11		
Concetto	Concept	118	8		
Fascino	Appeal	149	7		
Funzione	Function	185	8		
Indiscrezione	Indiscretion	16	13		
Inefficienza	Inefficiency	17	12		
Inesperienza	Inexperience	5	12		
Insufficienza	Insufficiency	15	13		
Logica	Logic	107	6		
Merito	Merit	141	6		
Ozio	Idleness	9	4		
Reputazione	Reputation	27	11		
Tendenza	Tendency	161	8		
Unanimità	Unanimity	37	8	*Abstract*=70.3	9.25
Alghe	Seaweed	24	5		
Alveare	Beehive	11	7		
Canoa	Canoe	25	5		
Circo	Circus	43	5		
Cravatta	Tie	38	8		
Elefante	Elephant	36	8		
Falce	Sickle	5	5		
Flotta	Fleet	35	6		
Gallo	Cock	12	5		
Giraffa	Giraffe	1	7		
Minerale	Mineral	9	8		
Oca	Goose	29	3		
Palude	Swamp	12	6		
Telegrafo	Telegraph	3	9		
Torre	Tower	44	5		
Trattore	Tractor	2	8	*Concrete*=20.6	6.25
Abbandono	Abandonment	91	9		
Agitazione	Agitation	25	10		
Agonia	Agony	29	6		
Conflitto	Conflict	140	9		
Disperazione	Desperation	101	12		
Emergenza	Emergency	161	9		
Fallimento	Failure	99	10		
Fremito	Trembling	11	7		
Giuramento	Vow	13	10		
Impulso	Impulse	50	7		
Ira	Anger	45	3		
Orrore	Horror	77	6		
Pericolo	Danger	250	8		
Stupore	Wonder	62	7		
Terrore	Terror	96	7		
Tradimento	Betrayal	73	10	*Emotional*=82.7	8.13

Table 3

GLMMs results of Experiments 1 and 2 of both lexical decision and recognition tasks.

Experiment 1

	Lexical Decision task		Recognition task	
Effects	*RTs*	*Accuracy*	*RTs*	*Accuracy*
Intercept	Wald(1)= 18.94; p<.001	Wald(1)= .35; p=.56	Wald(1)=23.8; p<.001	Wald(1)=15.1; p<.001
Type of Concept	**Wald(2)= 11.04; p=.004**	**Wald(2)=6.82; p=.03**	Wald(1)= .95; p=.62	Wald(1)= 3.73; p=.15
Effector	**Wald (1)= 77.43; p<.001**	Wald(1)= .12; p=.72	**Wald(1)= 22.68; p<.001**	Wald(1)= .54; p=.46
Type of Concept x Effector	Wald(1)= .15; p=.92	Wald(1)= .38; p=.82	Wald(1)= 1.92; p=.38	**Wald(2)= 7.17; p=.03**
Number of Letters	**Wald(1)= 69.04; p<.001**	Wald(1)=3.64; p=.06	**Wald(1)= 25.17; p<.001**	**Wald(1)= 4.07; p=.04**
Frequency	**Wald(1)= 33.84; p<.001**	**Wald(1)= 11.07; p<.001.**	Wald(1)= 2.31; p=.13	**Wald(1)= 25.20; p<.001**
Age of Acquisition	**Wald(1)= 9.47; p=.02**	Wald(1)= 1.38; p=.24.	Wald(1)= 2.77; p=.96	Wald(1)= .69; p=.41
Imageability	Wald(1)= 1.98; p=.16	Wald(1)= .41; p=.52	Wald(1)= .65; p=.42	Wald(1)= 2.78; p=.10
Context Availability	Wald(1)= .60; p=.44	Wald(1)= .76; p=.38	Wald(1)= .92; p=.34	Wald(1)= .55; p=.46
Modality of Acquisition	Wald(1)= .23; p=.63	Wald(1)= 2.37; p=.12	Wald(1)= .102; p=.31	**Wald(1)= 6.18; p=.013**

Experiment 2

	Lexical Decision task		Recognition task	
Effects	*RTs*	*Accuracy*	*RTs*	*Accuracy*
Intercept	Wald(1)= 55.48; p<.001	Wald(1)= 6.04; p=.01	Wald(1)= 53.07; p<.001	Wald(1)= .74; p=.39
Type of Concept	**Wald(2)= 15.57; p<.001**	Wald(1)=2 .69; p=.29	**Wald(1)=5.51; p=.06**	Wald(1)= 3.50; p=.17
Effector	Wald(1)= .69; p=.41	**Wald(1)= 4.88; p=.027**	Wald(1)= .64; p=.42	Wald(1)= 1.04; p=.31
Type of Concept x Effector	**Wald(1)= 77.43; p=.08**	Wald(1)= 1.10; p=.57	**Wald(2)= 7.72; p=.02**	Wald(1)= 2.53; p=.28
Number of Letters	**Wald(1)= 33.68; p<.001**	Wald(1)= .04; p=.84	Wald(1)= .24; p=.62	Wald(1)=1 42; p=.23
Frequency	**Wald(1)= 10.83; p=.001**	**Wald(1)= 3.32; p=.068**	Wald(1)= .41; p=.52	Wald(1)= .88; p=.35
Age of Acquisition	**Wald(1)= 3.12; p=.078**	Wald(1)= .22; p=.63	Wald(1)= 2.12; p=.15	Wald(1)= .24; p=.72
Imageability	**Wald(1)= 7.38; p<.007**	**Wald(1)= 4.24; p<.039**	Wald(1)= 2.93; p=.09	Wald(1)= .78; p=.38
Context Availability	Wald(1)= 1.50; p=.22	Wald(1)= 1.61; p=.20	Wald(1)= .001; p=.97	Wald(1)= .56; p=.45
Modality of Acquisition	Wald(1)= 1.2569; p=.26	Wald(1)= .63; p=.43	Wald(1)= .009; p=.92	Wald(1)= .99; p=.32

Table 4

Means of response times as a function of Type of Concept and Effector for both tasks and experiments.

		RTs of Lexical Decision Task 1,2				*RTs of Recognition Task 1,2*			
		Experiment 1		Experiment 2		Experiment 1		Experiment 2	
Effector	Type of Concepts	*M (RT)*	*SE*	*M (RT)*	*SE*	*M (RT)*	*SE*	*M (RT)*	*SE*
Mouth	Abstract	776.44 *ms*	10062.12	875.74 *ms*	10707.76	751.96 *ms*	14406.93	875.61 *ms*	11412.84
	Concrete	724.52 *ms*	10048.26	766.15 *ms*	10692.60	805.40 *ms*	14383.12	858.48 *ms*	11410.41
	Emotional	732.79 *ms*	10058.45	839.33 *ms*	10704.21	774.65 *ms*	14400.25	891.49 *ms*	11410.57
Hand	Abstract	700.74 *ms*	10062.10	876.55 *ms*	10707.97	721.65 *ms*	14404.91	901.59 *ms*	11415.72
	Concrete	645.83 *ms*	10048.90	777.19 *ms*	10692.41	750.50 *ms*	14384.32	852.80 *ms*	11413.15
	Emotional	661.76 *ms*	10059.14	804.56 *ms*	10703.91	705.84 *ms*	14398.77	844.32 *ms*	11412.07

CHAPTER 5.

STUDY 2&3

Study 2

Gender is a multifaceted concept[1].

Introduction

Categories and concepts are what allow us to coherently make sense of the world: they constitute the “bricks” of thought (Murphy, 2002). Importantly, concepts are said to be flexible representations, re-enacting relevant information about a given category in a specific situation (Kiefer & Barsalou, 2013). A large body of evidence demonstrates that the structure of categories and concepts varies as a function of context, both if considered as the physical context in which people are asked to judge sentences, and when considering the linguistic context (or frame) in which people produce features of concepts (for a review see Yee & Thompson-Schill, 2016). Even in tasks explicitly addressing semantic access, the activation of salient semantic features generally depends on task conditions and is dynamically tied to the context (Lebois, Wilson-Mendenhall & Barsalou, 2015; Borghi & Barsalou, in press). Concepts also show flexibility across individuals and within the same individual over time, and as a function of changing points of view (e.g., Barsalou & Sewell, 1984). The capacity to retrieve different information in different situations for the same concept has been

[1] This paper is currently under review in the journal *Language & Cognition*.

robustly demonstrated both with behavioral tasks (e.g., Barsalou, 1987) and through neuroimaging techniques (Hoenig et al., 2008; Wilson-Mendenhall et al., 2011).

Together with task contexts, linguistic and cultural contexts can also affect categories. As the growing number of studies concerned with the linguistic and cultural relativism testifies, concepts of time (Boroditsky et al., 2011), space (Majid et al., 2004), motion (Papafragou, Hubert & Trueswell, 2008), color (Regier & Kay, 2009) odor (Majid et al., 2018), and moral concepts (Casasanto, 2009) are influenced by the linguistic, cultural, social, and experiential environment, demonstrating how variable concepts can be across groups of people in different environments (see Malt & Majid, 2013). In this paper, we specifically address between-groups conceptual flexibility by the means of a linguistic task.

In fact, in order to reveal insights about conceptual structure, linguistic tasks such as word-associations or feature- and property-generation tasks are among the most commonly employed tools (e.g., McRae et al., 2005). Asking participants to produce properties for a given concept like “truth” (i.e. property-generation task), for example, shed light on some of the relevant features incorporated in the representation of abstract concepts, such as introspective and experiential relations (e.g., Barsalou & Wiemer-Hastings, 2005), and show how abstract concepts are characterized by fewer intrinsic properties and more complex situational relations in their representation (Wiemer-Hastings & Xu, 2005; Barca, Mazzuca & Borghi, 2017). Given the higher contextual dependency of abstract concepts compared to concrete concepts (Borghi & Binkofski, 2014), their representation might be more flexibly tied to the social context and personal experiences.

While traditional theories contend that abstract and concrete concepts engage different semantic systems (e.g., Paivio, 1986; Brysbaert, Warriner & Kuperman, 2014), recent approaches have started to reconsider the classic dichotomy between purely "abstract" and purely "concrete" concepts (Borghi et al., 2018a, 2018b, 2019; Barsalou, Dutriaux & Scheepers, 2018). Specifically, in a situated perspective (e.g., Barsalou, 2008), both concrete and abstract concepts include situational and perceptual information, and support goal-oriented actions. In this light, abstract concepts can be considered as being represented in a multidimensional semantic space with regions that partly overlap with the semantic space of concrete concepts (Troche, Crutch and Reilly, 2014; 2017; Binder et al., 2005; Harpaintner, Trumpp & Kiefer, 2018).

Abstract concepts also show high intra-class variability (Ghio et al., 2013; Borghi et al., 2018b; Desai et al., 2018). For instance, Roversi, Borghi and Tummolini (2013) compared properties listed for "social entities" such as "party" with properties listed for "institutional artifacts" such as "ownership" in a property-generation task and found that although both classes of concepts could broadly be considered "social", each elicited distinct properties: "social entities" elicited a higher proportion of contextual features (e.g., typical situations, entities or events that co-occur with the target concept), while "institutional artifacts" were conceptualized in terms of normative relations. So, some abstract concepts are more linked to linguistic and social experience, while others have a more salient affective and experiential component (Prinz, 2002; 2012). More generally abstract concepts might be considered a heterogeneous class, grounded in multiple systems, including perception, action and sensori-motor components just like concrete concepts, but also language, emotion and sociality (cf. Borghi et al., 2018a; 2019; Desai, Reilly & van Dam, 2018; Mellem, Jasmin, Peng & Martin, 2016). These grounding mechanisms might contribute to the representation of specific abstract concepts to different extents.

1.1. Is Gender an Abstract Concept?

Gender is an interesting concept to think about in this context. It can be considered an embodied social concept in which both concrete (e.g. sexual and biological factors) and abstract components (related to social interpretation) are relevant. In fact, recent research has proposed the hybrid label "gender/sex" pointing to the coupling of biological, physical and perceptual factors with the social and cultural in the constitution of gendered and sexual identities (van Anders, 2015; Fausto-Sterling, 2019). This contrasts with the traditional distinction between sex as the natural datum of biological sex (hormones, genes, genitalia etc.), and gender as the province of social and cultural practices built upon a supposed sexual dimorphism. The sex-gender distinction dates back to feminist works (e.g., Rubin, 1975) and aimed at opposing the biological determinism at the basis of women's discrimination. Separating sex from gender allowed feminists to show that gendered traits (Bem, 1974), and more broadly genders (West & Zimmerman, 1987), are at least in part products of social practices (Haslanger, 1995; Risman, 2004). Nonetheless, scholars such as Butler (1990) have made clear that not only "abstract" notions such as gender roles, but also our sexed bodies (Fausto-Sterling, 1993; 2012) are defined by cultural practices and do not exist outside social meanings (Butler, 1993a).

Within psychology, gender is perhaps one of the most employed constructs. Psychological research has focused on gender/sex differences relying on a binary gender system that opposes men to women. Specifically, a binary gender system presupposes that "there are two discrete categories into which all individuals can be sorted […] and one's category membership is biologically determined, apparent at birth, stable over time, salient and meaningful to the self, and a host of psychological variables" (Hyde et al., 2019, p. 1). On this basis scientists have attempted to unravel traits and attitudes that distinguish the two categories. By the means of instrumental constructs, such as gender-schematicity (Bem, 1981) or gender-consistency, scholars have tried to explain the degree of gender-congruence of individuals from childhood to adulthood.

Another line of research specifically addresses gendered social stereotypes, showing how these implicitly guide people's expectations, judgements and perception of individual men and women (for a review see Ellemers, 2018). For instance, traits such as assertiveness, competence, warmth, and nurturance are valued differently in relation to men and women; overall, women are more frequently associated with family life, whereas men are associated with career advancement (Greenwald & Banaji, 1995). Importantly, implicit stereotypical gendered knowledge is also activated in language processing: the elaboration of linguistic information consistent with stereotypical gender-expectations (e.g., feminine pronouns and "nurse") has a cognitive advantage over grammatical and stereotypical gender mismatch (e.g., masculine pronouns and "nurse"; see e.g., Miersky, Majid & Snijders, 2019; Pesciarelli, Scorolli & Cacciari, 2019)

Other approaches focus instead on the influence of grammatical gender in cognitive processes such as categorization (e.g., Cubelli et al., 2011). Converging evidence suggests that speakers of gendered languages incorporate gender as a salient feature even when this is irrelevant, as in the representation of inanimate entities. For example, Spanish and French adults and children tend to assign feminine and masculine voices to objects according to the grammatical gender of the objects in their native languages (Sera et al., 2002), and Spanish and German speakers remember noun-object pairings better when the noun of the object matches the grammatical gender of the object in their language (Boroditsky & Schmidt, 2000; for a systematic review see Samuel, Cole & Eacott, 2019).

1.2. Challenges to the Binary Gender System.

While the “bigenderist assumption” dominates the scientific literature, an emerging area of research from cognitive science and biology questions the binary nature of gender (e.g. van Anders, Goldey & Kuo, 2011; Olson, Key & Eaton, 2015; Joel & Fausto-Sterling, 2016; Roughgarden, 2004; Jordan-Young & Rumiati, 2012; Joel, 2016). Notably, although most people are likely cisgender (i.e., people who perceive their assigned birth sex as congruent with their expressed and desired gender identity), individuals whose identities are not confined to the binary gender system (e.g., gender non-conforming, genderqueers, gender-diverse or transgender individuals) have been documented through history and across diverse cultures (Herdt, 1993; Devor, 1997). Attention to gender-nonconforming individuals in the psychological sciences is also promoted by the American Psychological Association, which in 2015 issued guidelines for best practices with transgender and gender-nonconforming individuals (APA, 2015)

Only recently have some scholars introduced in their measurements the notion of gender non-conforming or *genderqueer* (i.e. a person rejecting traditional gender categories such as man/woman), and they have begun to investigate gender identity without pathologizing gender-diverse individuals (see Hegarty, Ansara & Barker, 2018 for a recent discussion). For example, Galupo, Pulice-Farrow, and Ramirez (2017) asked a sample of 197 individuals who self-identified as either gender-variant or agender to describe their gender identities with the aim of investigating what non-binary individuals consider as central features of their gender identity. A thematic analysis of responses showed that fluidity, mixture and rejection of traditional bipolar dimensions such as femininity and masculinity were key features.

Experiences of non-binary feelings were also evident among "normative"[2] individuals in a study by Joel, Tarrasch, Berman, Mukamel and Ziv (2014) with Israeli participants. Joel and colleagues explored gender identity using a questionnaire which measured gender identity, gender dysphoria and gender performance (Multi-GIQ questionnaire, Joel et al., 2014; see also Jacobson & Joel, 2018; 2019) among people who identified themselves as men, women, and queer. They found that among self-identified men and women, over 35% of people reported feeling the "opposite" gender, both genders, or neither. This was especially prevalent in queer individuals, although no significant differences emerged between the three groups suggesting that far from being binary, gender is fluid and multidimensional.

To summarize, gender has been investigated from three broad perspectives: (1) relating to the representation of grammatical gender in language and thought, (2) as a characteristic related to the sense of one's own identity, and (3) in relation to social stereotypes. However, it is unclear how lay people conceptualize gender exactly. Is it something related to our physical and biological make-up or better characterized by social practices? For reasons discussed next, our study aimed at examining the concept of gender in Italian speaking participants.

1.3. The Current Study: How do Italian People Conceptualize Gender?

We adopted a common methodology used to investigate conceptual knowledge. We asked a sample of Italian speaking participants to list words they freely associated with the concept of *genere* 'gender'. The main purpose of the study is to offer a depiction of people's conceptual representation of gender, taking into account specific

[2] "Normative" in this literature refers to the situation where people feel their assigned birth sex is aligned with their affirmed gender identity, and that generally conform to heterosexual norms, or that are not plurisexual (i.e. are sexually attracted by only one sex). Note that the term "normative" is in quotation marks, indicating that the term is applied in a strictly statistical sense, and not as a value-judgement (see Joel et al., 2014).

experiences that might contribute to the shaping of the concept. Henceforth, we will first delve into the free-listing results provided by the whole sample of participants, to understand how gender is broadly represented; afterwards we will focus on results from specific sub-groups, to test whether there are some differences in conceptual representations derived from different gender-related experiences.

Our study was conducted in Italy which is an interesting context to explore this question because of the specific linguistic and cultural particulars of this community. In the Italian language, *genere* ('gender'), is a polysemous word covering five areas of meaning. In addition to the social interpretation of sex[3] it also includes: (1) The original Latin notion of "genus" representing what species have in common, e.g., the genus Panthera, within the family Felidae, includes species such as lions and tigers; (2) A notion similar to the English meaning of *kind* or *type*; (3) Aesthetic canon—similar to the English *genre*—applying to literature as well as to cinema, arts, and music; (4) The grammatical category distinguishing nouns into masculine or feminine classes, also used to differentiate individuals based on biological features. This distinction is not confined to animate entities, but also applies to inanimate entities on the basis of linguistic conventions—e.g., in Italian *philosophy* is feminine and *table* is masculine. This binary dichotomy may have ramifications for the general concept of "gender" too. Indeed, it has been hypothesized that speaking a language encoding gender in a binary fashion (e.g., Italian, French) may contribute to reinforce the conceptualization of gender as a binary system, and possibly strengthen sexist conceptual associations (see Gabriel & Gygax, 2016; Gabriel, Gygax & Kuhn, 2018; Pérez & Tavits, 2019).

[3] In Italian the terms sex and gender are frequently used interchangeably. However, there is a growing awareness of the necessity to separate the two terms to account for social phenomena such as gender gaps in salary, gender-based violence, and to bring attention on specific gender non-conforming experiences, mostly due to the efforts of academic and political discourses (LGBTQ and feminist activism).

The concept of gender in Italian is also interesting because of the specific cultural and social context. Italy is a predominantly catholic country, and theological accounts of gender, sexuality and family politics are very prominent[4]. In Italian public debate, the English term *gender* is maintained in its English form as a derogatory term. It describes gender and queer studies as based on an “ideology” that undermines the structure of the traditional family and suggests the possibility of choosing one’s own gender identity and sexual orientation (the so-called *ideology of gender*; see e.g., Garbagnoli, 2014; Bernini, 2016).

In order to investigate how Italian speakers represent the concept of gender, we used a free-listing paradigm. We were primarily interested in uncovering conceptual structure, and not in assessing participants’ explicit attitudes towards gender-related issues. To avoid participants adopting social desirability strategies, we refrained from explicit measures such as questionnaires or scales measuring attitudes towards sexuality or gender-roles. Instead we focused on participants’ own conceptual relations, thus opting for an approach more explicit than, for example, IAT (Greenwald, McGhee & Schwartz, 1998). Free-listing tasks, also termed *semantic fluency procedures*, are thought to make explicit the psychological proximity of concepts and words produced in sequence. The general assumption underlying this kind of task is that when a concept is activated in memory, be it recalled or spoken, it will in turn prime words and concepts which are semantically related or similar to it. This provides an indirect measure of the psychological saliency of concepts (see Crowe & Prescott, 2003).

[4] An illustrative example is provided by some of the statements of Bergoglio on the family, which according to him is composed solely of a union between man and woman. This perspective is shared by the former Family and Disabilities Minister Lorenzo Fontana, who in his first public statement declared that “rainbow families [families headed by gay couples] don’t exist” (https://www.dailymail.co.uk/wires/ap/article-5800563/Italy-Right-wing-leader-says-new-govt-wont-undo-gay-unions.html). Indeed, in Italy same-sex marriages are not legal: civil unions between same sex partners are regulated by a law enacted in 2016 as a special social formation.

We conducted the free-listing task with a diverse pool of Italian participants that were divided into three subgroups according to their gender identity, sexual orientation, and classification according to heteronormative or bigenderist benchmarks.

In line with the idea that abstract concepts are represented as multidimensional constructs (Borghi et al., 2018a; Barsalou et al., 2018), where both embodied and contextual aspects interact, we expected that across all participants we would find evidence of the duality of *genere* 'gender' in Italian, such that participants would list features relating to both the abstract and concrete sense of gender. So we expected early and frequent listing of features of gender as a social construct (e.g., culture, femininity, masculinity), as well as features related to the more concrete meaning (e.g., sex, body, genitalia).

In addition, we hypothesized that gender is at least in part represented differently depending on the sub-group of interest following the proposal that conceptual knowledge is flexibly modulated by different experiences (Casasanto & Lupyan, 2015). We investigated whether participants that differed in their gender identity listed different features of the concept gender. Additionally, we expected "normative" and heteronormative individuals, which typically conform to the gender-binary system (Motschenbacher, 2019), to produce more features focusing on physical, sexual and biological aspects of gender, while "non-normative" and non-heteronormative (i.e. homosexual, plurisexual) participants would generate more features related to their personal experiences and to the social sense of gender.

Method

2.1. Participants

80 native Italian speakers voluntarily took part in the study. Ethical approval was provided by the Ethics Committee of the Institute of Cognitive Sciences and Technologies of the Italian National Research Center (ISTC-CNR Ethical Approval n.0000315). Participants were asked to provide their birth sex, self-identified gender identity, and sexual orientation (details of procedure below). The majority of individuals were highly educated: 67.5% had a Master Degree and 13.7% had a PhD; 17.5% completed High School, while only 1.2% had Lower High School education.

2.2. Procedure

We created an on-line questionnaire divided into three sections that participants filled in a fixed order. In the first section, participants gave basic personal information, such as age and birth sex (male; female; intersex). The second section consisted of the free-listing task. Participants were asked to provide 10 concepts they thought were related to the concept of gender (*Il tuo compito ora è quello di scrivere dieci concetti che ti vengono in mente in relazione al concetto di genere*; 'Your task is now to type ten concepts that come to your mind related to the concept of gender').

Finally, in the third section, participants provided additional information about their self-identified gender identity, sexual orientation and level of education. Gender identity was assessed through forced-choice boxes (woman, man, queer, and transgender), in addition to a blank text box labeled "other" that participants could fill according to their preferences. Keeping birth sex separate from gender identity allowed participants to report their affirmed gender identity, thus avoiding mis-gendering practices (see Ansara & Hegarty, 2014). Indeed, inferring gender identity from biological sex has been criticized by some scholars, in that self-determined gender identity does not always match with the sex assigned at birth. However, we made this distinction explicit only in the third section of the questionnaire, to avoid potential demand effects. Sexual orientation was assessed through the Kinsey Scale (Kinsey et al., 1948), a self-report measure where participants respond on a 7-point scale, ranging from "exclusively heterosexual" to "exclusively homosexual"—hence not considering sexual behavior a strict dichotomy (although for criticism see Galupo, Mitchell & Davis, 2018, Savin-Williams, 2016).

Results

We sought to provide a sketch of how individuals conceptualize gender, in particular in relation to their personal experiences related to gender. As a first step, we report the characteristics of our participants. We then focus on the free-listing data and aggregate results across all participants to illustrate which words were produced more frequently overall. We show how words produced by the full cohort of participants tested are clustered together using a measure which accounts for the psychological saliency of the produced associates (see the following sections for details). This overall analysis is followed by subsidiary analyses zooming in on the free-listing produced by different sub-groups.

3.1. Participant Characteristics

The total sample of participants was 56.2% female (n=45; age M = 29.5; SD=7.7), 43.7% male (n=35; age M = 32.7; SD=10.5), and 0% intersex. Among those individuals, 51.2% identified as women (n=41; age M = 29.5; SD=6.8), 40% identified themselves as men (n=32; age M = 33.3; SD=11.5), 8.7% identified as queer (n=7; age M = 28.1; SD=6.7), and 0% as transgender.

Sexual orientation was also assessed using the Kinsey Scale (Kinsey et al., 1948; for further details, see *Procedure*). Among the total sample, 46.2% (n=36) placed their sexual behavior at the heterosexual extreme of the Kinsey Scale (points 1 and 2), while

47.5% (n=37) considered their sexual behavior as homosexual (points 6 and 7 of the Kinsey Scale). 8.9% of participants fell in the middle of the scale (points 3, 4, 5) or defined their sexual orientation as bisexual or asexual (n=7). At a more fine-grained level, 62.5% of participants reported to be attracted only by one sex (points 1 and 7), while 37.5% reported to be attracted to more than one sex to different extents (points 2, 3, 4, 5, 6).

In order to explore how these differences relate to the concept of *genere* 'gender', participants were first divided into two groups according to their affirmed gender identity (woman and man). Individuals who identified as queer were excluded from the analysis by gender identity because of the small sample size; however, their responses were collated in the subsequent analyses by "normativity", thus partially avoiding the potential marginalization of underrepresented gender and sexual minorities.

Second, participants were divided according to their sexual orientation according to their ratings on the Kinsey Scale. Participants' responses followed a bimodal distribution. Accordingly, participants who scored 1 or 2 in the Kinsey Scale were considered heterosexual, while those who scored 6 or 7 were considered homosexual for the purposes of the analyses by sexual orientation. The remaining participants who rated their sexual orientation on the Kinsey Scale as 3, 4 or 5, or bisexual and asexual were excluded from this analysis, but they were included in the subsequent analyses.

Finally, to distinguish "normative" vs. "non-normative" individuals, we took into account participants' gender identity, sexual orientation, and the correspondence between birth sex and affirmed gender identity. "Normative" individuals (n=43) are therefore cis-gender monosexual individuals (either exclusively heterosexual or exclusively homosexual; see e.g. Galupo, Lomash & Mitchell, 2017; Jacobson & Joel, 2019); “non-normative” individuals (*n*=37) are gender-diverse individuals, individuals falling under the umbrella term of transgender, and/or cis-gender individuals who did not define their sexual preferences in strictly monosexual terms. We decided to include exclusively-homosexual cis-gender individuals in the category of “normative” individuals in line with Motschenbacher, (2019), that suggests that “when certain (originally non-normative) sexualities are increasingly enacted as locally valid norms, they are likely to become part of what is perceived as “normal” on the social macro-level.” / “[..] sexualities that have evolved as macro-social discourses tend to be associated with powerful identity discourses (such as heterosexual, gay or lesbian identities; see Foucault, 1978). Less recognized or non-normative sexualities (such as objcetophilia, see next section) generally form marginalized discourses that rarely surface in language use.”(p. 9). It is worth noting that we relied on the help of LGBTQI+ centers for the recruitment of participants, hence in this specific social setting non-exclusively monosexual individuals can be considered as “less normative” than cis-gender exclusively homosexual individuals (see also Hegarty, Ansara & Barker, 2018).

3.2. Free-listing task

3.3. How is the Concept of “Gender” Represented Across all Participants?

Overall, the total sample of 80 participants produced 300 words. There was great variation in the responses provided by participants suggesting that, as expected, *genere* ‘gender’ is a complex concept incorporating a number of distinct components and different experiences. Participants produced a small number of common associates: out of 300 words, 64% (*n*= 192) were produced only once by an individual. The most frequently listed word (*identity*), was produced by 24 out of a total sample of 80 participants. So there is low overall coherence of this category in this sample. For the overall analysis presented first, we focus on associates produced by at least 5% of all participants.

Words with either a strong physical and perceptual connotation (e.g., *sex, sexuality, male* and *female, body*), or related to social and cultural experiences (e.g., *discrimination, stereotype, fluidity, feminism, binarism, queer, rights* and *role*) were the most frequently produced. Experiential and personal features appeared too (e.g., *education, identity, discrimination, identification*), as well as linguistic associations connected to the term *genere* in Italian (e.g., *music, literature, grammar, type*). See below for further details.

3.3.1. Measure of psychological proximity. To analyze the free-listing data in more depth, we used a measure developed by Crowe and Prescott (2003). According to this measure, similarity between pairs of items in a free-listing task can be calculated by considering both the distance of two items produced in a single list (from an individual participant), and the distance of the same two items produced across lists (across participants). The measure is given by two component measures, namely α and β_w, one based on within-list proximity (α), and the other on across-list item co-occurrence (β_w). These two metrics are combined to form the overall inter-item similarity metric ($\alpha\beta_w$). Matrices of inter-item dissimilarity were computed initially for all the participants, and then for all the groups of interest (for further details see Crowe & Prescott, 2003). Once the most frequently produced words were identified, both for the total sample of participants and for the sub-groups of interest, associate words were subjected to cluster analyses based on inter-item dissimilarity matrices described above. The data were analyzed using R (version 3.6.0, R-Core Team, 2019) and RStudio (version 1.2.1335; RStudio Team, 2018). Hopkins' statistic test has been performed using the package "factoextra" (Kassambara & Mundt, 2017). Clustering indexes have been calculated with the "NbClust" package (Charrad, Ghazzali, Boiteau & Niknafs, 2014), and dendrograms were produced using "dendextend" package (Galili, 2015).

3.3.2. Clustering methods and analyses. Before applying specific clustering methods, we assessed whether our data could be clustered using Hopkins' statistic test (Lawson and Jurs, 1990), which measures the probability that a given data set is generated by a uniform data distribution. Results show our data do not support strong clustering but approach a good tendency (H= 0.47). Hierarchical cluster analysis was performed based on the dissimilarity matrix using Ward's method, based on a sum-of-squares criterion (Murtagh & Legendre, 2014) which minimizes within group dispersion (see also Harpaintner et al., 2018). In order to determine the number of clusters and assess cluster validity, we relied on indexes that are most frequently used in the literature. We thus computed Silhouette Index, C-Index, McClain Index and Dunn Index. Two of the aforementioned indices provided a six-cluster solution (SI= 0.3; CI= 0.3), while the remaining two suggested a two-cluster solution (McClain= 0.3; Dunn=0.06). We opted for the six-cluster solution (Figure 1), which better illustrates the fine-grained structure of 'gender'. The outcome is represented in the dendrogram as visual proximity of words; namely, words that appear clustered together are words that were most frequently produced in succession.

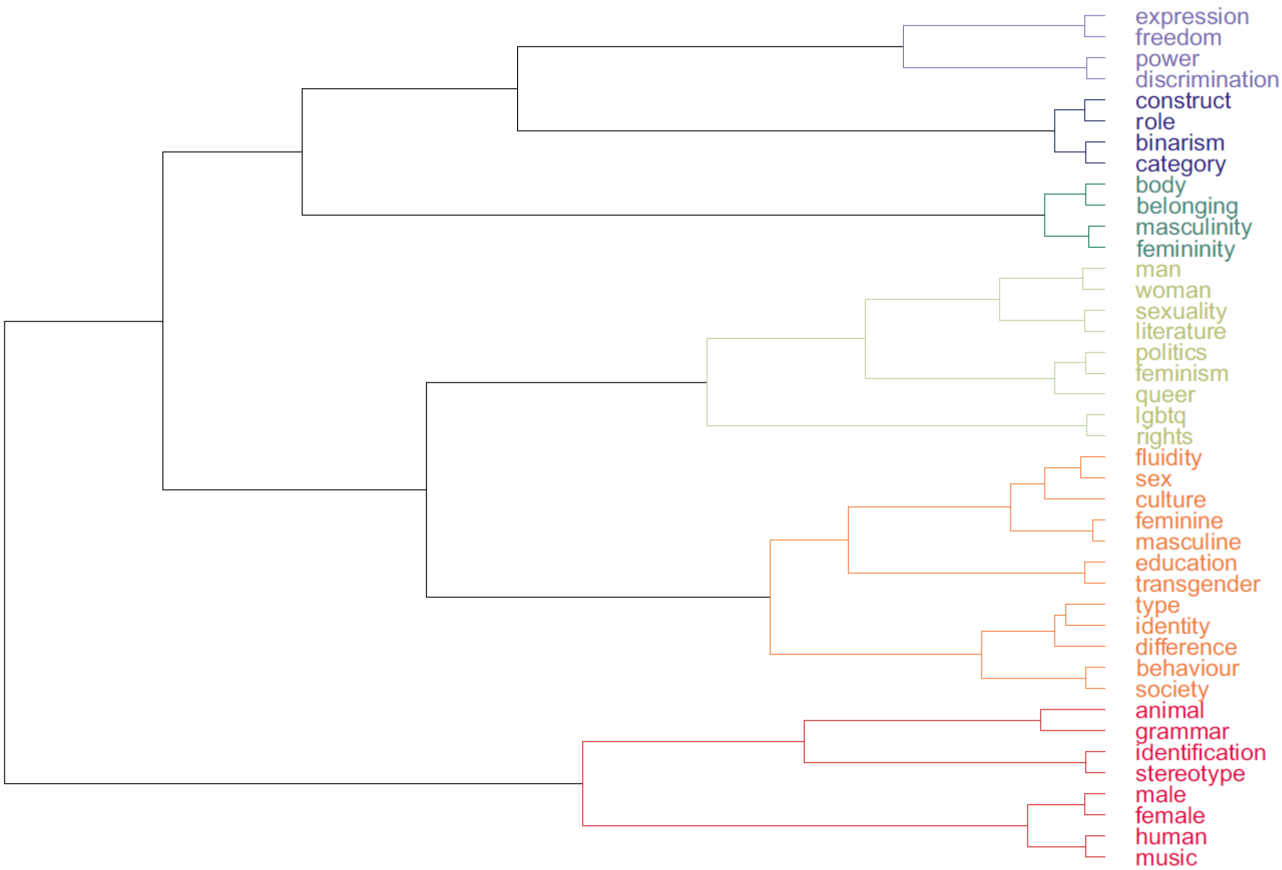

Figure 1. Dendrogram representing the six-clusters solution for words produced by at least 5% of participants.

From top to bottom of Figure 1, we find in cluster 1 (violet) and cluster 2 (blue) features consistent with the conceptualization of gender as a social construct. These two clusters represent the most "abstract" part of the dendrogram, and point to the idea of gender as a social construction (Butler, 1990), entrenched in the social structure (*power*, *discrimination*; Foucault, 1978).

Cluster 2 specifically includes concepts generally used in philosophical and political discourses on gender, and it reveals the most "abstract" component of the term derived from a shared knowledge and mediated by cultural and social factors (see Shea, 2018).

In cluster 3 (green) features related to the physical, perceptual, and interoceptive characteristics of gender are present. Words in this set refer to the physical display of gender attitudes (*masculinity* and *femininity*), clustered together with *sex*; *body* and *belonging* are linked together. Compared to the first two clusters, this cluster can be considered as the most traditionally "concrete" one in the sense that it relies more on perceptual and physical properties.

In cluster 4 (yellow) gender is a specifically cultural and social discourse. This is suggested by the presence of *sexuality, politics, feminism* and *queer* (e.g., Foucault, 1978, Motschenbacher, 2019; Butler, 1993b), and by the strong associations of the words *rights* and *lgbtq*.

Cluster 5 (orange) is the most heterogeneous cluster. Here, terms relating and challenging the normative facet of gender (*transgender*, *fluidity*) appear as closely linked to socially and culturally connotated terms (*culture*, *education*, *difference*, *society*, and *behaviour*) and to identifying terms (*feminine*, *masculine* and *identity*). This is likely to reflect the relation that exists in people's minds between education and the development of a gendered identity (for a review see e.g., Fausto-Sterling, 2012), and it is in line with the notion of *socialization* (e.g., Witt, 1997), according to which parents and peers play a fundamental role in the development of gender-stereotyped self-concepts in children, by reproducing and projecting culturally derived behaviors and norms

In cluster 6 (red) a different meaning of the Italian word *genere* appears. We find words referring to the meaning of 'genre' (*music*), as well as 'kind', 'species' (*animal*, *human*) and *grammar*. In addition, this cluster includes the two Italian grammatical genders *male* and *female*, likely linguistic associations given that they are clustered closely together with the words *human* and *music*.

Overall, our results suggest the concept of gender cannot be considered either a purely abstract or a purely concrete concept. Rather, it encompasses aspects traditionally considered to be both abstract and concrete. Linguistic associations (e.g., Paivio, 1986) such as *literature* and *animal*, experiential and situational features like *identification* and *behaviour* (e.g., Barsalou & Wiemer-Hastings, 2005), social and contextual features like *binarism* and *queer* (Roversi et al., 2013), culturally mediated aspects like *politics* and *feminism* (Shea, 2018), and bodily or biological properties (e.g., *body*, *male* and *female*) appear. This result is in line with recent perspectives on abstract conceptual knowledge (e.g., Barsalou et al., 2018; Borghi et al., 2018a) and with contemporary debates reconsidering the distinction between the concepts of sex and gender (e.g., van Anders, 2015).

3.4. Does the Concept of "Gender" Vary Across Sub-Groups?

In the analysis presented so far, we do not distinguish people by gender identity, sexual orientation, or according to gender and sexual norms. However, these aspects are likely to influence the conceptualization of gender. To assess this, participants were divided into three subgroups according to their gender identity (woman, man), sexual orientation (heterosexual, homosexual), and "normativity" ("normative", "non-normative") (see section *3.1. Participant Characteristics*). For each of these sub-groups, we examined how people conceptualized *genere* 'gender'. Target words that entered the cluster analysis were items produced by at least by 10% of participants in each sub-group. Given the extreme variability of responses elicited by the concept *gender* (see par. 3.3), in the sub-groups analyses we raised the threshold for inclusion from 5% to 10%, as keeping it consistent with the Overall analysis would have led to include in the analysis also items produced by only one participant in the sub-samples.

3.4.1. The concept of gender as a function of gender identity. Overall, there was no significant difference, in the total number of items listed by women (M=8.9; SD=2.7) and men (M= 7.8; SD=2.8) , $t(71) = -1.61$, $p > .05$, although women showed higher agreement in the terms they mentioned, with 29 words overcoming the critical threshold, compared to 12 words in the men group. The most frequently produced words by women (Panel A) were *identity* (39% of the sample) and *sex* (27% of the sample). For men (Panel B) *masculine* was the most frequently produced word (22% of the sample), followed by *identity* (19%). Figure 2 shows the dendrograms resulting from Hierarchical Cluster Analysis (HCA) for each group.

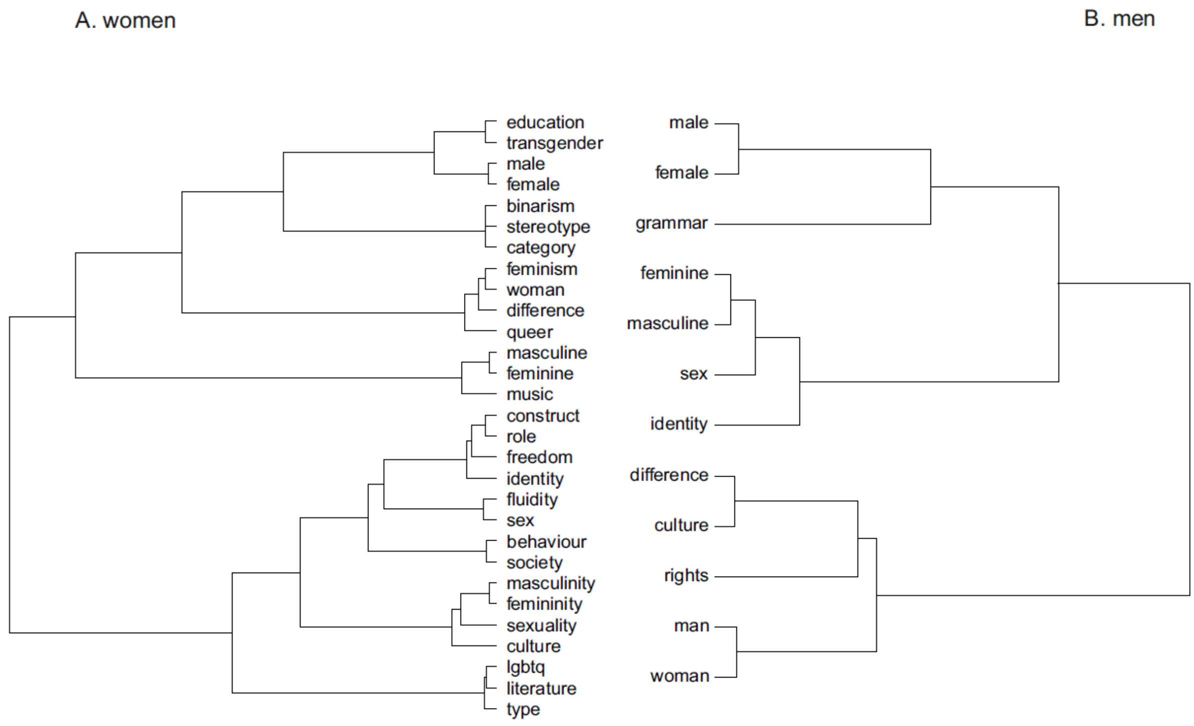

Figure 2. Dendrograms of words produced by at least 10% of (A) women and (B) men.

Even though some words overlapped between the two groups (*n*=9), the cluster analyses showed interesting differences between men and women. For instance, *identity*—one of the most frequently produced term by both groups—was mentioned by men together with *feminine*, *masculine* and *sex*, suggesting a relation between perceptual and physical properties and gender identities. For women, however, *identity* appeared as tightly related to social terms (*construct*, *role*, *freedom*) and subsequently connected with *fluidity*, *sex*, *behaviour* and *society*, suggesting a non-deterministic perspective on gender identity.

It is also noteworthy that although traditional bigender terms were mentioned by both groups, they are differently positioned in the dendrograms. On the one hand, *male* and *female* are represented in a small biological cluster, in the women's dendrogram, which in turn is connected to words that seem to challenge a traditional dimorphic conception of gender (*education*, *transgender*). In the men's dendrogram, however, the clustering of *male* and *female* appears as a linguistic association to the grammatical category of gender, as indicated by the link between the two terms and the word *grammar*. *Masculine* and *feminine* are part of a small linguistic cluster for women (indicated by the presence of the word *music*); for men they are part of a cluster marking the identity-laden value of gender, possibly delimited by sexual differences (*sex*). *Woman* co-occurred with *man* in the men's responses, while in the women's dendrogram the word *woman* was coupled with *feminism* along with *difference* and *queer*, whereas *man* does not appear. *Difference* and *culture* are both part of a socio-cultural cluster in both groups. While women generally associated *culture* with *sexuality* in a cluster including *masculinity* and *femininity*, men often mentioned them together with *rights* and subsequently *man* and *woman*.

In sum, there are notable differences between the two groups. Although the conceptualization of gender by men included social and cultural features (e.g., *rights* was mentioned by men, but not women), terms explicitly challenging a binary and heteropatriarchal system were not highly salient: most words referred to the perceptual, biological and physical sphere; for women, social, cultural and experiential features played a more central role. Women mentioned words with social and political value (e.g., *queer*, *feminism*, *construct*, *stereotype*, *fluidity* and *binarism*) consistent perhaps with their social experience of being historically considered a subaltern identity. This relates to the notion of "androcentrism", that implies "the privileging of male experience and the "otherizing" of female experience' such that males and male experience are treated as a neutral standard or norm ... and females and female experience are treated as a sex-specific deviation from that allegedly universal standard." (Bem, 1993; p. 41; for a recent review see Bailey, LaFrance & Dovidio, 2019)

3.4.2. The concept of gender as a function of sexual orientation. There was no significant difference in the total number of items listed by heterosexual participants (M= 8.6; SD=2.8) and homosexual participants (M= 8.3; SD=2.8), $t(71) = .517$, $p > .05$, although heterosexual participants showed higher agreement in the terms they mentioned, with 22 words overcoming the critical threshold, compared to 12 words in the homosexual group. *Sex* was the most frequently produced word by the heterosexual group (Panel C) (30% of the sample), followed by *culture* (19%). The homosexual group (Panel D) produced *identity* (40%) and *masculine* (30%) the most frequently. Figure 3 shows the dendrograms resulting from HCA performed on target concepts for each group.

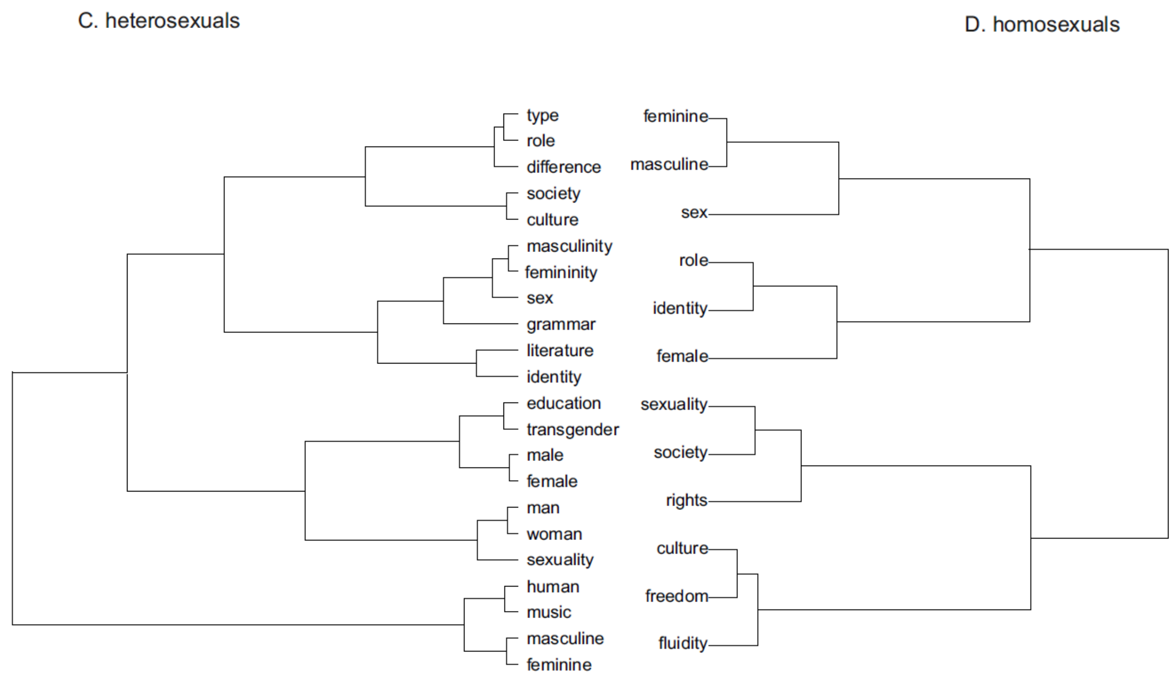

Figure 3. Dendrograms of words produced by at least 10% of (C) heterosexuals and (D) homosexuals.

Even though some words overlapped between the two groups (*n*=9), the cluster analyses showed interesting differences. *Sexuality* forms a separate cluster in both groups, but in the heterosexual group is paired with gendered and identifying terms (*man* and *woman*), while in the homosexual group it forms a separate and distinct cluster together with *rights* and *society*; *culture* is instead in a separate cluster connecting *fluidity* and *freedom*. *Masculine* and *feminine* form a separate small cluster in both groups but they are associated with linguistic features such as *human* and *music* by the heterosexual group, and *sex* by the homosexual group. *Sex* was instead frequently produced together with *masculinity* and *femininity* by the heterosexual group, indicating a connection between biological sex and physical appearance.

The clusters in the heterosexual group's dendrogram shows a high prevalence of linguistic associations, along with an attention to the bipolar structure of the term gender (with the addition of *transgender*). This suggests that one crucial dimension for this group is the biological one that includes the female/male distinction, and the social roles that this distinction carries. The most abstract cluster in this group can be considered a socio-cultural cluster, centered on *culture* and *society,* and encompassing *difference* and *role.* In contrast, for the homosexual group the two most abstract clusters specifically address the political and social value of the term gender: we find here terms such as *rights*, *fluidity* and *freedom*. Interestingly, these are important instances for the LGBTQI community. The fact that they were mainly mentioned by this sub-group suggests that personal experiences and different contexts might shape our conceptual system.

3.4.3. The concept of gender as a function of "normativity". There was no significant difference in the total number of items listed by "normative" participants (M= 8.7; SD= 2.4) and "non-normative" participants (M= 8.7; SD=3.1), $t(78) = .966$, $p > .05$. The first two most frequently listed words by the "normative" (Panel E) group were *identity* (30%), and *sex* (26%). In the "non-normative" group (Panel F), the most frequently produced words were *identity* (30%) and *culture* (24%). Figure 4 shows the dendrograms resulting from HCA performed on target words for each group.

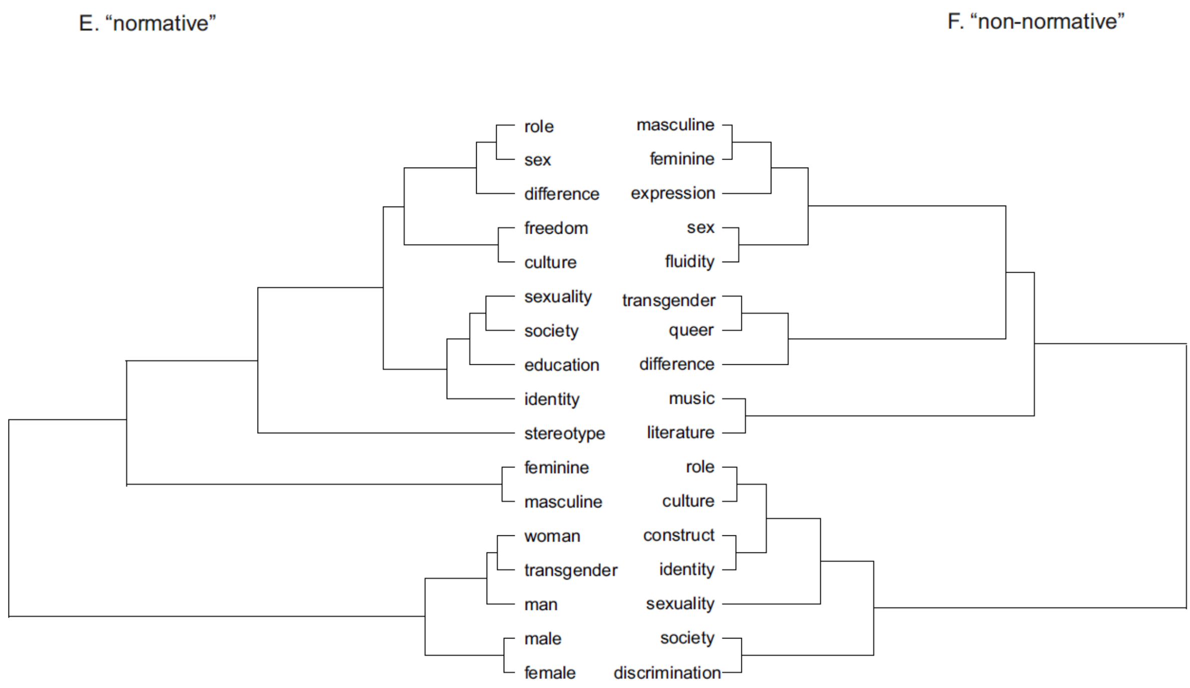

Figure 4. Dendrograms of words produced by at least 10% of (E) "normative" and (F) "non-normative".

Even though some words overlapped between the two groups (*n*=10), the cluster analyses showed interesting differences. *Masculine* and *feminine* formed a separate cluster in the "normative" group, suggesting that the two terms represent the crucial axes along which the concept of gender is organized; in the "non-normative" group they were instead grouped together with the word *expression* and subsequently *sex* and *fluidity*, in a cluster evoking the idea of traditional gendered roles as social and cultural constructions, and laying forward the idea of femininity and masculinity as performative acts (Butler, 1990). *Society* was mentioned mainly with the word, *sexuality* and *education*, and then connected to the word *identity* in the "normative" group, in a cluster that can be labeled as socio-cultural. In the "non-normative" group, *society* is also included in a heterogeneous cluster that represents the concept of gender as a social construct. Specifically, the term *society* is frequently mentioned together with *discrimination*. *Sex* was produced in association with *role* and *difference* in the "normative" group, while it is paired with the word *fluidity* in the "non-normative" group.

The words listed by both groups reveal differences in the conceptual representation of gender. The "normative" group frequently mentioned words referring to gender as a bipolar dimension (e.g., *male/female*, *woman/man*). In the "non-normative" group, the experiential and personal domain together with social and cultural aspects emerges more sharply (e.g., *discrimination, expression*, *construct, fluidity*, and *queer*). At the broadest level, two main clusters emerge in the "normative" group: one explicitly referring to a binary perspective on gender which can be considered a more "concrete" cluster, with the addition of the word *transgender*. The second cluster is a more abstract cluster including words such as *sexuality, education*, *society, stereotype* and *culture*. On the other hand, in the "non-normative" group the concrete grounding relies mainly on the experiential corporeity of gender (*masculinity* and *femininity* connected to *expression*), but it is connected with *sex* and *fluidity*. Overall, the "normative" group emphasized a bigenderist perspective of gender, while the "non-normative" group referred to contextually-dependent and social phenomena challenging traditional bigenderist assumptions.

General Discussion

Our results demonstrate that the concept of gender is multilayered. According to participants' responses, biological, perceptual and social aspects converge in the conceptual representation of *genere*. When people are asked to produce free associations of the term, both abstract (i.e., social, cultural, and linguistic) and concrete (i.e., physical, biological, and sexual) associations are elicited. Moreover, our findings indicate that the concept of gender is flexible: depending on the characteristics of the individuals, some features of the concept appear more salient than others.

The results do not align well with the traditional view that assumes abstract and concrete concepts are represented distinctly (e.g., Paivio, 1986, Brysbaert et al., 2014), but are more compatible with the idea of a fuzzy boundary between abstract and concrete concepts (e.g., Barsalou et al., 2018). The concept of gender is particularly illustrative of this haziness. Specifically, experiential, bodily, biological and perceptual features (e.g., *male*, *female*, *body*, *sex*) are combined with social, cultural introspective and linguistic features (e.g., *queer*, *binarism*, *construct*, *feminism*, *rights*, *fluidity*, *discrimination*). In this light, the boundaries of the concept gender seem to be also delineated by "social metacognition" (Shea, 2018; Borghi et al., 2018c), incorporating terms conveyed by specific cultural and social contexts such as academic discussions and public debates.

Our findings also shed light on the debate concerning the distinction between sex and gender. Specifically, our results support the claim that sex and gender are intrinsically entrenched in social context. People's conceptual knowledge of gender seems to incorporate sexual and biological factors implicated in the distinction between genders (e.g., *sex*, *female*, *male*, *body*), as well as aspects related to the performativity of gender (e.g., *femininity*, *masculinity*, *role*, *difference*, *expression*) which are inevitably embedded in social and cultural norms. As Butler (1993a) has argued the very distinction between sex as the corporeal fact of our existence, and gender as the social conventions shaping traditional femininity and masculinity is questionable, in that the very perception of physical-sexual differences is affected by social conventions. Indeed, the very adequacy of a two-sex system has been questioned as a social construction that does not include the full spectrum of human sexual configurations, better characterized as lying on a continuum (see e.g., Fausto-Sterling, 1993). More recently, van Anders (2015) proposed the notion of gender/sex as “an umbrella term for both gender (socialization) and sex (biology, evolution) […] reflects social locations or identities where gender and sex cannot be easily or at all disentangled.” (p.1181). So gender/sex is a multidimensional, dynamic and complex construct, reflecting how sex and socio-cultural gender are entwined, and therefore making explicit the “being” and the “doing” of gender at the same time.

According to some proposals conceptual knowledge is affected by cultural, linguistic and social factors (e.g. Boroditsky et al., 2011; Majid et al., 2004; Casasanto, 2009), and different populations may categorize things differently depending on the language spoken, and on the experiential and cultural environment they live in (Casasanto & Lupyan, 2015). In this study we investigated a bigendered language, but it would be interesting in the future to assess whether a language with more than two genders (e.g., Dutch) or with no grammatical gender (e.g., English) might convey a less binary idea of the concept gender (Gabriel & Gygax, 2016). In line with the predictions of experiential relativity instead, we hypothesized that individuals conforming to a “normative” conception of gender would produce more words related to a bigenderist conception, while “non-normative” individuals would rely more on socio-cultural aspects of gender and on their personal experiences. A comprehensive categorization of gender experiences combining instrumental constructs such as the Kinsey Scale and tick-boxes with pre-given answers arguably rely on a cis-genderist and normative approach. We attempted to overcome this limitation by allowing participants to produce their own label for each variable (assigned birth sex, affirmed gender identity and sexual orientation), using a blank text box. In spite of this, we are aware that our operationalization of “normative” and “non-normative” individuals is possibly problematic, in that it is not always an explicit assessment of participants’ of themselves, but an experimenter’s inference from participants’ answers. Nonetheless, in line with recent developments in language and sexuality research (e.g. Motschenbacher, 2019), we aimed at representing how normativity plays a pivotal role in the discursive construction of gender and sexuality. To avoid misconceptions and misgendering phenomena, and to fully account for gender in its full complexity, further research could make different choices for categorizing gender and sexuality experiences (e.g., see new instruments such as TMF Scale, Kachel et al., 2016; Multi-GIQ questionnaire, Joel et al., 2014, or Sexual-Romantic and Gender-Inclusive Scales, Galupo et al., 2017b).

Despite these caveats, we found some interesting differences in how people conceptualize gender. “Normative” individuals were more likely to mention dichotomous terms, while “non-normative” individuals mentioned words related to the social dimension of gender, such as *fluidity*, *construct*, and *queer*, along with terms such as *expression* and *discrimination*—pointing at specific personal experiences. Recent findings investigating gender identity among non-binary transgender individuals (Galupo et al., 2017a) showed that one central theme in self-descriptions was the notion of *fluidity*, suggesting that gender identity can fluctuate across time. Our results are in line with these findings, showing that the majority of “non-normative” individuals, in contrast to “normative” individuals, mentioned the term *fluidity* in their associations with the term gender, along with terms such as *construct* and *queer*. In this regard, the inclusion of the term *queer* in the conceptualization of gender of “non-normative” individuals fosters the importance of the social context in the embodiment of specific experiences. Indeed, over history, the term *queer* acquired the power to give visibility and legitimization to a community of individuals not conforming to bigenderist and heteronormative assumptions. In Butler's words (1993b, p. 19) the term *queer* is "a site of collective contestation", hence a term with a high social and political valence but rooted in personal experiences. It is also worth noting that, in line with findings coming from the analysis of the interaction between gestures and speech in transgender individuals (Lederer, 2019) our sample of "non-normative" individuals mentioned bipolar terms such as *feminine* and *masculine*, like our "normative" sample. In one of Lederer's (2019) example, even when one individual verbally identified as a-gender, the gestures accompanying the elucidation of the term a-gender matched with the conceptual metaphor of gender as two bounded regions delimiting the boundaries between males and females. This suggest that the bipartite model of gender is so culturally entrenched that even in individuals questioning, rejecting, or moving across a bigendered schema it is likely to endure.

This experiential relativism emerged also in our data from the other groups of interest. For example, homosexual individuals mentioned the word *rights* near *society* and *sexuality*, while for the heterosexual group the word *rights* was not a salient feature of the concept of gender. This could be because in Italy LGBTQI rights are still a matter of debate, and these kinds of issues are strictly related to gender expressions and/or gender identity. On the other hand, cis-gender heterosexual individuals are usually less likely to see their rights compromised based on their sexual preferences or gender identity/expression.

To conclude, gender is a complex and multifaceted concept, whose intricacy is not exhausted by simplistic dichotomies between biological qualities of the human body and cultural or social aspects of sex expressions. These features interact at different levels and to different extents, depending also on specific experiences so as to form the representation of the concept of gender.

Study 3

Gender is a flexible concept: A comparison of Italian and Dutch

Introduction

Embodied and grounded perspectives of cognition contend that concepts are the re-enactment of sensorimotor, internal, and perceptual experiences connected with their referent in the world (Barsalou, 2008). In order to access conceptual content, scholars conventionally drew on linguistic descriptions provided by tasks such as property listing (Papies, 2013) or free-listing (Van Overschelde, Rawson & Dunlosky, 2004). Thus, a large body of evidence has demonstrated concepts vary as a function of, e.g., contexts and tasks, (Lebois, Wilson-Mendenhall & Barsalou, 2015) frequency of instantiation (Barsalou, 1985), and also point of view (Barsalou & Sewell, 1984). This flexibility, crucially, allows concepts to represent relevant information about the specific category in a specific situation (Kiefer & Barsalou, 2013), and encompasses aspects related to language, context, and culture.

While studies traditionally investigated concepts such as time (Boroditsky, 2001), space (Majid et al., 2004) and colors (Regier & Kay, 2009), the concept of gender has mainly been treated in cognitive science in relation to linguistic structures (Corbett, 1991), and to personality and stereotypical gendered traits (Bem, 1981). Grammatical gender, for example, has been widely scrutinized by both linguists and psychologists, as a means for revealing conceptual structure in different populations (Boroditsky, Schmidt & Phillips, 2003; Cubelli et al., 2011). But what exactly do people think when thinking about *gender*? Examining language diversities and similarities is necessary to understand categorization (Malt & Majid, 2013).

Philosophical debates historically endeavored to define gender as a social category (Risman, 2004; Haslanger, 2017), in order to account for the effects that gender produces on society. Today, the traditional dichotomy that sees sex opposed to gender (Rubin, 1975)—opposing nature to culture—is less tenable (van Anders, 2015; Butler, 1990; Hyde et al., 2019). In this perspective, gender is the result of perceptual, physical, social, and cultural features.

Bearing these considerations in mind, the aim of our study was to examine whether the concept of gender varies as a function of language and society. Specifically, in line with recent grounded and situated approaches to conceptual knowledge (Borghi et al., 2018; Barsalou, Dutriaux & Scheepers, 2018), we investigated the "abstract" dimension of gender. According to these accounts abstract concepts are not, in fact, a unitary entity; they comprise a variety of exemplars with different characteristics (e.g., numbers, moral concepts, aesthetic concepts, odors) that may recruit different sources of grounding. These sources might be abstract or concrete to different extents, such as in the case of gender: we can consider it as a highly concrete concept if related to bodily experience and biological features; but it can also be conceptualized as a complex set of relations between culture, norms, and society.

Therefore, we compared two linguistic and social groups, namely Italian speakers and Dutch speakers. Given that Dutch and Italian societies vary with respect to their social construct of gender, we hypothesized that this may impact individuals' conceptualization of gender. Specifically, while Italian culture still has a rather traditional distinction between men and women, Dutch culture is more progressive, recognizing, for example, the possibility of a third gender on documents, same sex marriages, etc. These differences are likely to affect the way in which different social and linguistic groups represent the concept of gender. If that is the case, we would expect to find distinct conceptual representations outlined by each group.

Overview of Methods

To assess participants' conceptualization of gender, we used a free-listing task. Participants were asked to type 10 words that were related to the concept of gender (*genere* in Italian and *geslacht* in Dutch, see Study 2 for details on the procedure).

Participants

80 Italian native speakers (45 F; *M* age= 31.1; *SD*=9.4) and 52 Dutch native speakers (28 F; *M* age=33.5; *SD*=12.9) were enrolled on-line. Participants were recruited with special effort to include individuals from less socially represented sexual groups. Invitations were sent to several Italian and Dutch groups and organizations that concentrate on LGBTQ issues and posted on the Facebook and Twitter profiles of the researchers. The invitation included an explicit request to forward the invitation to as many people as possible (see, e.g, Jacobson & Joel, 2018 for a similar procedure).

Materials

Participants were presented with an on-line questionnaire, in their native language. In the first section they completed the free-listing task. In the second section they were asked to provide demographic information.

Results

Participants' responses were collated, and words that were produced by at least 10% of participants in each group were included in the analyses. The list of words produced by participants was analyzed by relying on a dissimilarity measure ($\alpha\beta_w$) developed by Crowe and Prescott (2003), accounting both for within and between participants' word co-occurrences. We subsequently performed cluster analyses of the most frequently produced words for each group using R (R-Team Core, 2017).

Relative frequencies of items that were produced by the 10% of participants in each group are shown in *Table 1*.

Table 1

Relative frequencies of items listed by the 10% of participants.

Dutch words	English transl.	Relative freq.	Italian words	English transl.	Relative freq.
man	man	0,19	*identità*	identity	0,07
vrouw	woman	0,19	*sesso*	sex	0,06
gender	gender	0,10	*maschile*	masculine	0,05
identiteit	identity	0,06	*cultura*	culture	0,04
sekse	sex	0,06	*femminile*	feminine	0,04
vagina	vagina	0,05	*ruolo*	role	0,04
voortplanting	reproduction	0,05	*società*	society	0,04
meisje	girl	0,05	*femmina*	female	0,03
transgender	transgender	0,05	*differenza*	difference	0,03
geslachtsdeel	genitals	0,04	*libertà*	freedom	0,03
penis	penis	0,04	*maschio*	male	0,03
jongen	boy	0,04	*sessualità*	sexuality	0,03
geboorte	birth	0,03	*donna*	woman	0,03
seksualiteit	sexuality	0,03	*fluidità*	fluidity	0,03
genderneutraal	genderneutral	0,03			
hormonen	hormones	0,03			
borsten	breasts	0,02			
sex	sex1	0,02			

A qualitative inspection of Table 1 reveals that similar features were listed by both groups (woman, sex, identity and sexuality), but interestingly it also reveals Italian and Dutch participants drew attention to different aspects of the same concept. Dendrograms reported in *Figure 1* and *2* represent the results of the cluster analyses

(Murtagh & Legendre, 2014) performed on the most frequently produced words by the two groups.

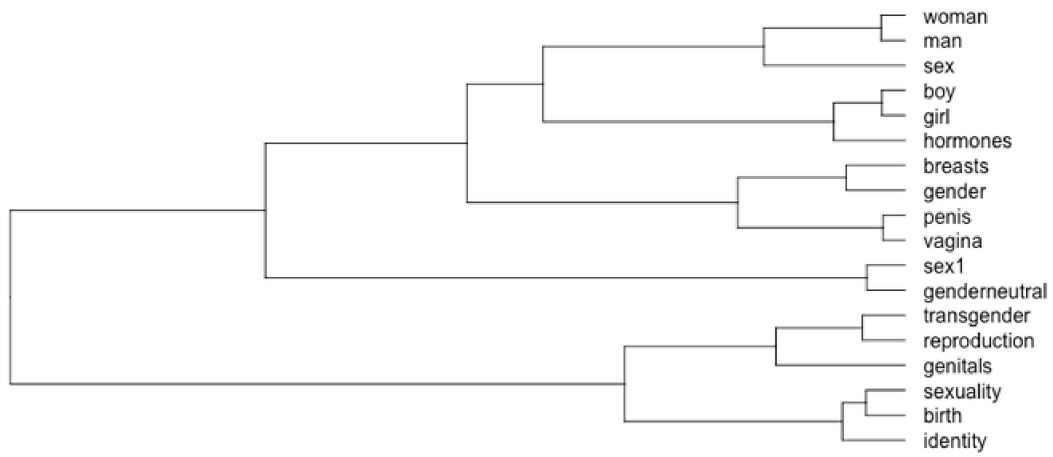

Figure 1. Cluster analysis of inter-item dissimilarity data using items that were listed by at least 10% of Dutch participants.

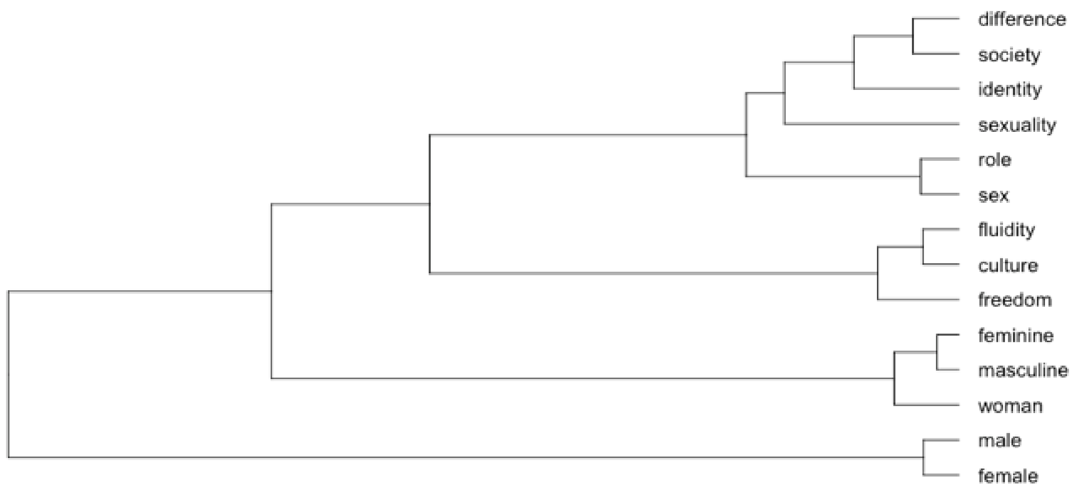

Figure 2. Cluster analysis of inter-item dissimilarity data using items that were listed by at least 10% of Italian participants.

In the dendrograms, words that were frequently produced together in the free-listing task are visually represented as close together, where nearness is depicted by the length of branches connecting words. Thus, in *Figure 1* man and woman are depicted near each other, but both are further away from sexuality, for example.

Critically, the Dutch sample produced more perceptual, biological, and physical features, whereas the Italian sample evidenced features strongly related to cultural and social aspects connected with gender.

In fact, Dutch participants specifically mentioned physical and biological features (hormones, genitalia, secondary sexual characteristics), while Italian participants mainly reported social and cultural features (fluidity, society, culture, freedom, difference). Interestingly, Italian speakers demonstrated a binary opposition, mentioning traditional dichotomous poles such as male/female, masculine/feminine. On the other hand, Dutch speakers also included terms beyond the dichotomy, such as transgender and gender-neutral. To summarize, in general Dutch participants highlighted a more "concrete" dimension of gender, opposed to a more "abstract" depiction by the Italian sample.

Discussion

Overall, our results point to the exquisite flexible character of concepts in at least two respects. First, in line with studies on conceptual flexibility, different linguistic and social groups seem to represent gender in different ways. Dutch participants mainly stressed bodily experiences, along with biological features, connected to gender, whereas Italian participants stressed social factors and reactions to social norms. Two possible interpretations for this difference can be ascribed to the traditional character of Italian social environment. Possibly, words specifically referring to sex or bodily parts represent a taboo in Italy. Another hypothesis is that LGBTQ Italian participants (who are a part of the sample) specifically strive to stress their political stances, by evidencing the social construction of gender. Further studies are needed to disentangle these speculations.

Second, taken together, our results suggest that gender cannot be considered either a purely abstract or a purely concrete concept, thus rejecting the traditional sex/gender dichotomy (Hyde et al., 2019). We showed how gender encompasses both perceptual, concrete and abstract and culturally driven features. This combination of findings, while preliminary, illustrates that gender is a flexible and multilayered concept, whose grounding is related to both linguistic and social practices and to bodily and experiential factors (Borghi et al., 2018).

CONCLUSIONS

This dissertation had two main topics: concepts and dichotomies. The reason inspiring this inquiry is that this couple of theoretical constructs is implicitly intertwined. Let's examine in turn why, starting from the last term of the couple, viz. dichotomies. *Dichotomy* is in the first place a concept–and not surprisingly an "abstract" concept–connecting two terms in a very specific way; in the context of this work, we dealt precisely with dichotomies where *tertium non datur*. Differently from other kinds of dichotomies, in this case there are mainly two alternative conceptions at stake, and the possibility to adopt a third kind of conception is excluded. In this sense, we could better characterize this specific kind of dichotomies as binary or oppositional dichotomies. Now, what is the place occupied by concepts in this frame? The construct of concepts and that of dichotomies were covertly correlated for a long time. In Chapter 1, for instance, we witnessed how theories of conceptual knowledge were broadly conceived as a reaction one to another: concepts are prototypes because they cannot be definitions; they are theory-driven constructs because they cannot be exemplars, or they are grounded in our bodily states because they cannot be physically detached symbols. Clearly, scientific advancement proceeds also in this way, namely by rejecting previous theories on the basis of newly acquired knowledge gained from the evolution of scientific tools. But I think that our *modus operandi* as cognitive scientists is never completely separated by our specific way of thinking, and the fact that much of the scientific literature concerning concepts is developed by oppositions and antinomic relations is all but casual.

The core dichotomous opposition I addressed in this dissertation is the one concerning abstract and concrete concepts. Starting from an embodied and grounded perspective on conceptual knowledge (Chapter 1, par 1.6), I examined theories of cognition that dealt with abstract concepts. I specifically focused on Multiple Representation Views (MRVs, Chapter 2, par 2.9), because they seem to offer an account of conceptual representation escaping traditional dichotomies implied in monolithic theories of concepts. The point of departure of my analysis is therefore constituted by the presentation of some of the most relevant tenets of the WAT theory—considered as a proposal inscribed in the field of MRVs. A key point of the WAT theory is the redefinition of the conditions defining abstract and concrete concepts, not only in terms of their referents but also in terms of their grounding sources. Whereas classical accounts of concepts defined abstract concepts generally as concepts lacking a physical, concrete, and manipulable referent, in the WAT theory there are at least three other dimensions to consider when studying abstract concepts. First of all, we ought to distinguish two axes of analysis: *abstraction* and *abstractness* (Chapter 2, par. 2.1), which are related but independent measures. Second, one of the major achievements of MRVs and their developments is the acknowledgment that abstract concepts, such as concrete ones, might benefit from multiple grounding sources. These sources can be aspects previously classified as pertaining to the 'concrete' side of the dichotomy, like sensorimotor activations (cf. the case of numerical concepts), or they can be more 'abstract' forms of grounding (e.g., linguistic associations). Importantly, in keeping with proponents of MRVs, I argued that the modality of acquisition of concepts plays a pivotal role in the subsequent consolidation in memory of concepts, even though it is not the only factor at stake. In fact, as studies focused on conceptual flexibility compellingly demonstrated (Chapter 1, par. 1.6.4), we can re-enact different aspects of a concepts depending on situations and contextual constraints. Hence, an insightful investigation of abstract concepts revealed that they are dynamical and flexible representations, and suggested a radical rethinking of traditional and dichotomous categories such as abstract and concrete.

In line with these speculations and with the evidence coming from experimental investigations of abstract concepts, I claimed that in order to provide an honest sketch of abstract concepts, we might need to reconsider the entire category by *queering* its ontological status. The theoretical framework purported by queer studies, in fact, allows us to deepen and recognize aspects of phenomena into question within and beyond established dichotomies (Chapter 3, par. 3.2.1).

Against this background, in Chapter 3, I confronted the second dichotomy: the one opposing sex and gender. Drawing on the characterization of abstract concepts provided in Chapter 2, I argued that *gender* can be considered as a social abstract concept. Indeed, if abstract concepts are to be considered as a heterogenous category, couched in multiple cognitive mechanisms, gender can be seen as a social abstract concept spanned over a continuum of abstractness. Thus, I tried to unravel possible grounding sources of the concept of gender (Chapter 3, par. 3.3). The portrait that resulted from this critical analysis highlighted different aspects that concur both to the formation and to the representation of the concept. Interestingly, a multitude of features appeared to contribute to the conceptual knowledge of gender, suggesting a partial reconceptualization as "sex/gender". Indeed, when dealing with the concept of gender, both physical/biological properties and social/cultural factors seem to be implicitly involved (par. 3.1.1): 'concrete' aspects like perceptual discrimination and neural activations (paragraphs 3.4, 3.4.1) interact with more 'abstract' features such as cultural and social contaminations (paragraphs 3.6.1, 3.6.2) so as to shape the concept of sex/gender. In this sense, the binary opposition of sex and gender, just as the one of abstract and concrete concepts, resulted to be an artificial distinction. I tried to show

how, when considered in a pluralistic, grounded, and queer perspective, gender is a queer concept in itself, encompassing aspects historically considered as abstract and concrete. In line with recent developments in the study of gender related concepts (Chapter 3), thus, a better way to study gender-related issues also in psychological and cognitive science might be to abandon the old nature-nurture dichotomy reflected in the distinction between sex as the natural, given datum and gender as its cultural and social signification. As it was the case for abstract concepts, I suggested that once acknowledged the artificial nature of the distinction between the two terms, a possible strategy to move forward in the understanding of gender-related issues might be to contextually reformulate and apply the concept of sex/gender. For instance, discussing specific policies contrasting gender pay gap might still require a distinction based on gender (specifically intended as socialization, but importantly conceived as a non-binary category). On the other hand, physical and biological features specific of the sexed embodiment of an individual can be considered as foundational in terms of health, once we recognize that there are more than two "sexual" assets.

The reader might wonder whether and how such an extensive discussion on abstract concepts, abstraction, and abstractness might apply to "concrete" understandings of the world we live in, our society and ultimately our lives. In the first place, as noted by Hegarty (2007) and many others before, "psychology is a site where power and knowledge are transformed into each other in particularly dense ways in modern worlds" (p. 76). The idea of an objective science, capable of describing natural phenomena has long been a matter of debate among philosophers and sociologists of science (see Wittig, 1985), and the critical examination of metatheoretical assumptions underlying scientific inquiry resulted in the acknowledgment that scientific facts are not separable from values. In this framework, it is evident how concepts and scientific concepts play a crucial role in determining which entities come into existence and are legitimized, and which are not. This is particularly noticeable in the study of gender, and in the constructs that have been put into place in order to explain it. The idea according to which gender is rooted in sexual differences (conceived as distinctions on a two-based axis, i.e., female and male) has simultaneously contributed to the reinforcement of the concept of gender as something exclusively related to biological factors and to the stigmatization, medicalization, and historical persecution of all of those individuals that did not fit into this sharp categorization. Besides historical reflections on e.g., the treatment of intersexed individuals, the attempts to cure homosexuality and transvestitism, and the discussion of sexual desires as linked to one's own feminine or masculine core identity, the idea of a neat categorization of human beings into two gendered classes has deep implications also from a cognitive point of view. A wide body of evidence, in fact, demonstrated that "gender systems are capable of grounding new associations even with very abstract categories (e.g., female= second, right, and odd, whereas male= first, left, and even)" (Hegarty, Ansara & Barker, 2018, p. 62). In this sense, the concept of gender–and specifically the concept of gender as a bipartite model of categorization–is pervasive.

And yet, a bigender system explained by biological constraints and reiterated through the means of social roles is not "the norm" everywhere around the world (see Hegarty, Ansara & Barker, 2018). Even more importantly, if science and scientific advancement is devoted to the improvement of social conditions, the very own existence of individuals claiming and reclaiming a different perspective on gender needs to be fully incorporated in scientific research (see Ansara & Hegarty, 2014). By rethinking the conditions that constitute a concept in a grounded perspective we can therefore account for the fact that sex and gender are but two concepts that must be interpreted within a socially constructed system of meanings.

In conclusion, to give some non-exhaustive and partial answers to the questions hastened in the Introduction, according to the discussion developed in this dissertation: (a) a concept is a flexible, multimodal and dynamic representation couched in multiple embodied and grounded systems; (b) abstract concepts are a complex and multifarious set of concepts, that benefit from several grounding sources, depending on the modality of acquisition and on contextual constraints; importantly, they encompass both sensorimotor/embodied aspects and social and linguistic features, to a different extent according to their specific class; (c) gender–or better sex/gender–is a multilayered abstract concept, whose representation and usage is bounded to situations and experiences.

Whether traditional dichotomies such as abstract and concrete and sex and gender will still be useful in some contexts or not, I suggest to keep in mind that for some purposes they can be misleading, concealing important aspects of the phenomena we are investigating. For this reason, I proposed a queer re-conceptualization of concepts, and specifically of abstract concepts, precisely because they have proven to resist any sharp distinction.

While Queer Theory may now be recognised by many as an academic discipline, it nevertheless continues to struggle against the straitjacketing effects of institutionalisation, to resist closure and remain in the process of ambiguous (un)becoming. Queer Theory does not want to 'straighten up and fly right' to have the kinks ironed out of it: it is a discipline that refuses to be disciplined, a discipline with a difference, with a twist if you like. In saying this, however, I do not mean to endow Queer Theory with some sort of 'Tinkerbell effect'; to claim that no matter how hard you try you'll never manage to catch it because essentially it is *ethereal*, *quixotic*, unknowable. Obviously Queer Theory does function in specific–albeit complex and somewhat ambiguous–ways *in particular contexts*, *and in relation to particular issues*.

(Sullivan, 2003, pp. v-vi, italics mine)

BIBLIOGRAPHY

Ahmed, S. (2006). Queer Phenomenology: Orientations, objects, others. Durham and London: Duke University Press.

Altarriba, J., Bauer, L. M., & Benvenuto, C. (1999). Concreteness, context availability, and imageability ratings and word associations for abstract, concrete, and emotion words. Behavior Research Methods, Instruments, & Computers, 31(4), 578–602. https://doi.org/10.3758/BF03200738

Altarriba, J., Bauer, L.M. (2004). The distinctiveness of emotion concepts: a comparison between emotion, abstract, and concrete words. American Journal of Psychology, 117(3), 389–410. doi: 10.2307/4149007.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Arlington, VA.

American Psychological Association. (2015). Guidelines for psychological practice with transgender and gender nonconforming people. American Psychologist, 70(9), 832–864. https://doi.org/10.1037/a0039906

Anderson, M. L. (2010). Neural reuse: A fundamental organizational principle of the brain. Behavioral and Brain Sciences, 33(4), 245–266. https://doi.org/10.1017/S0140525X10000853

Ansara, Y. G., & Hegarty, P. (2014). Methodologies of misgendering: Recommendations for reducing cisgenderism in psychological research. Feminism & Psychology, 24(2), 259–270. https://doi.org/10.1177/0959353514526217

Anzaldúa, G. (1991). 'To (o) queer the writer: loca, escrita y chicana'. In Warland (Ed.), InVersions: Writings by Dykes, Queers and Lesbians. Vancouver: Press Gang, pp. 249-263.

Armstrong, S. L., Gleitman, L. R., & Gleitman, H. (1983). What some concepts might not be. Cognition, 13(3), 263–308. https://doi.org/10.1016/0010-0277(83)90012-4

Austin, J. L. (1962). *How to Do Things with Words*. Clarendon Press.

Bachorowski, J.-A., & Owren, M. J. (1999). Acoustic correlates of talker sex and individual talker identity are present in a short vowel segment produced in running speech. The Journal of the Acoustical Society of America, 106(2), 1054–1063. https://doi.org/10.1121/1.427115

Bailey, A. H., LaFrance, M., & Dovidio, J. F. (2019). Is man the measure of all things? A social cognitive account of androcentrism. *Personality and Social Psychology Review*, *23*(4), 307-331.

Barca, L., Burani, C., & Arduino, L. S. (2002). Word naming times and psycholinguistic norms for Italian nouns. Behavior Research Methods, Instruments, & Computers, 34(3), 424–434. https://doi.org/10.3758/BF03195471

Barca, L., Mazzuca, C., & Borghi, A. M. (2017a). Pacifier Overuse and Conceptual Relations of Abstract and Emotional Concepts. Frontiers in Psychology, 8. https://doi.org/10.3389/fpsyg.2017.02014

Barca, L., Mazzuca, C., & Borghi, A. (2020). Pacifier overuse interferes with children's abstract word processing. In press: *Journal of Child Language*.

Barclay, J. R., Bransford, J. D., Franks, J. J., McCarrell, N. S., & Nitsch, K. (1974). Comprehension and semantic flexibility. Journal of Verbal Learning and Verbal Behavior, 13(4), 471–481. https://doi.org/10.1016/S0022-5371(74)80024-1

Barsalou, L. W. (1981). Determinants of graded structures in categories. Unpublished doctoral dissertation, Stanford University.

Barsalou, L. W. (1982). Context-independent and context-dependent information in concepts. Memory & Cognition, 10(1), 82-93.

Barsalou, L. W. (1983). Ad hoc categories. Memory & Cognition, 11(3), 211-227.

Barsalou, L.W., & Sewell, D.R. (1984). Constructing representations of categories from different points of view. Emory Cognition Project Technical Report #2, Emory University. Retrieved July 26, 2019, from http://eprints.gla.ac.uk/112570/

Barsalou, L. W. (1985). Ideals, central tendency, and frequency of instantiation as determinants of graded structure in categories. Journal of Experimental Psychology: Learning, Memory, and Cognition, 11(4).

Barsalou, L. W. (1987). The instability of graded structure: Implications for the nature of concepts. Concepts and Conceptual Development: Ecological and Intellectual Factors in Categorization, 10139.

Barsalou, L. W., Yeh, W., Luka, B. J., Olseth, K. L., Mix, K. S., & Wu, L. L. (1993). Concepts and meaning.

Barsalou, L. W. (1999). Perceptions of perceptual symbols. Behavioral and Brain Sciences, 22(4), 637–660. https://doi.org/10.1017/S0140525X99532147

Barsalou, L. (2003). Situated simulation in the human conceptual system. Language and Cognitive Processes, 18(5–6), 513–562. https://doi.org/10.1080/01690960344000026

Barsalou, L. W., Simmons, W. K., Barbey, A. K., & Wilson, C. D. (2003). Grounding conceptual knowledge in modality-specific systems. Trends in Cognitive Sciences, 7(2), 84–91. https://doi.org/10.1016/S1364-6613(02)00029-3

Barsalou, L. W., & Wiemer-Hastings, K. (2005). Situating abstract concepts. In D. Pecher and R. Zwaan (Eds.), Grounding Cognition: The Role of Perception and Action in Memory, Language, and Thought (pp. 129-163). New York: Cambridge University Press.

Barsalou, L. W. (2008a). Grounded Cognition. Annual Review of Psychology, 59(1), 617–645. https://doi.org/10.1146/annurev.psych.59.103006.093639

Barsalou, L. W. (2008b). Grounding symbolic operations in the brain's modal systems. In Embodied grounding: Social, cognitive, affective, and neuroscientific approaches (pp. 9–42). https://doi.org/10.1017/CBO9780511805837.002

Barsalou, L. W, Santos, A., Simmons, W. K., & Wilson, C. D. (2008). Language and simulation in conceptual processing. In M. de Vega, A. M. Glenberg, & A. Graesser (Eds.), Symbols, embodiment, and meaning (pp. 245–283). Oxford, UK: Oxford University Press.

Barsalou, L. W. (2010). Grounded cognition: Past, present, and future. Topics in Cognitive Science, 2(4), 716-724.

Barsalou, L. W. (2016a). On Staying Grounded and Avoiding Quixotic Dead Ends. Psychonomic Bulletin & Review, 23(4), 1122–1142. https://doi.org/10.3758/s13423-016-1028-3

Barsalou, L. W. (2016b). Can Cognition Be reduced to Action? In A. K. Engel, K. J. Friston, & D. Kragic (Eds.), The Pragmatic Turn: Toward Action-Oriented Views in Cognitive Science. Cambridge, MA: The MIT Press.

Barsalou, L. W., Dutriaux, L., & Scheepers, C. (2018). Moving beyond the distinction between concrete and abstract concepts. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1752), 20170144. https://doi.org/10.1098/rstb.2017.0144

Bassetti, B. A. L. (2014). Is grammatical gender considered arbitrary or semantically related? Evidence from young adult monolinguals, second language learning, and early bilinguals. British Journal of Psychology, 105, 273–294.

Bem, S. L. (1974). The measurement of psychological androgyny. Journal of Consulting and Clinical Psychology, 42(2), 155–162.

Bem, S. L. (1981). Gender Schema Theory: A Cognitive Account of Sex Typing. Psychological Review, 88(4), 354–364.

Bem, S. L. (1983). Gender Schema Theory and Its Implications for Child Development: Raising Gender-Aschematic Children in a Gender-Schematic Society. Signs, 8(4), 598–616.

Bem, S. L. (1993). The lenses of gender. Transforming the debate on sexual inequality. New Heaven and London: Yale University Press.

Bergelson, E., & Swingley, D. (2013). The acquisition of abstract words by young infants. Cognition, 127(3), 391–397. https://doi.org/10.1016/j.cognition.2013.02.011

Bernardi, N. F., De Buglio, M., Trimarchi, P. D., Chielli, A., & Bricolo, E. (2013). Mental practice promotes motor anticipation: Evidence from skilled music performance. Frontiers in Human Neuroscience, 7. https://doi.org/10.3389/fnhum.2013.00451

Bernini, L. (2016). La “teoria del gender”, i “negazionisti” e la “fine della differenza sessuale”. AG, About Gender-Rivista internazionale di studi di genere, 5(10).

Binder, J. R., Westbury, C. F., McKiernan, K. A., Possing, E. T., & Medler, D. A. (2005). Distinct brain systems for processing concrete and abstract concepts. Journal of Cognitive Neuroscience, 17(6), 905-917.

Binder, J. R., Desai, R. H., Graves, W. W., & Conant, L. L. (2009). Where Is the Semantic System? A Critical Review and Meta-Analysis of 120 Functional Neuroimaging Studies. Cerebral Cortex, 19(12), 2767–2796. https://doi.org/10.1093/cercor/bhp055

Binder, J. R., Conant, L. L., Humphries, C. J., Fernandino, L., Simons, S. B., Aguilar, M., & Desai, R. H. (2016). Toward a brain-based componential semantic representation. Cognitive Neuropsychology, 33(3–4), 130–174. https://doi.org/10.1080/02643294.2016.1147426

Bolognesi, M., & Steen, G. (2018). Editors’ Introduction: Abstract Concepts: Structure, Processing, and Modeling. Topics in Cognitive Science, 10(3), 490–500. https://doi.org/10.1111/tops.12354

Borges, J. L. (1956). Ficciones (A. Kerrigan, Trans.). New York: Grove Press.

Borghi, A. M., Glenberg, A. M., & Kaschak, M. P. (2004). Putting words in perspective. Memory & Cognition, 32(6), 863–873. https://doi.org/10.3758/BF03196865

Borghi, A. M., & Cimatti, F. (2009). Words as tools and the problem of abstract word meanings. Proceedings of the Annual Meeting of the Cognitive Science Society, 31(31).

Borghi, A. M., Flumini, A., Cimatti, F., Marocco, D., & Scorolli, C. (2011). Manipulating Objects and Telling Words: A Study on Concrete and Abstract Words Acquisition. Frontiers in Psychology, 2. https://doi.org/10.3389/fpsyg.2011.00015

Borghi, A. M. (2011). Simulating the elimination of simulation: The case of language comprehension. Journal of Mental Imagery, 3–4, 27–33.

Borghi, A. M., Caruana, F. (2015). Embodiment Theory. In: James D. Wright (editor-in-chief), International Encyclopedia of the Social & Behavioral Sciences,2nd edition, Vol 7. Oxford: Elsevier. pp. 420-426. ISBN: 978008097086

Borghi, A. M., & Binkofski, F. (2014). Words as Social Tools: An Embodied View on Abstract Concepts. New York, NY, US: Springer Science.

Borghi, A. M., & Zarcone, E. (2016). Grounding Abstractness: Abstract Concepts and the Activation of the Mouth. Frontiers in Psychology, 7. https://doi.org/10.3389/fpsyg.2016.01498

Borghi, A. M., Binkofski, F., Castelfranchi, C., Cimatti, F., Scorolli, C., & Tummolini, L. (2017). The challenge of abstract concepts. Psychological Bulletin, 143(3), 263–292. https://doi.org/10.1037/bul0000089

Borghi, A. M., Barca, L., Binkofski, F., & Tummolini, L. (2018a). Abstract concepts, language and sociality: From acquisition to inner speech. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1752), 20170134. https://doi.org/10.1098/rstb.2017.0134

Borghi, A. M., Barca, L., Binkofski, F., & Tummolini, L. (2018b). Varieties of abstract concepts: Development, use and representation in the brain. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1752), 20170121. https://doi.org/10.1098/rstb.2017.0121

Borghi, A. M., Barca, L., Binkofski, F., Castelfranchi, C., Pezzulo, G., & Tummolini, L. (2018). Words as social tools: Language, sociality and inner grounding in abstract concepts. Physics of Life Reviews. https://doi.org/10.1016/j.plrev.2018.12.001

Borghi, A. M., (in press). Linguistic Relativity and Abstract Concepts. Paradigmi

Borghi, A. M., & Barsalou, L. (in press). Perspectives in the conceptualization of categories. *Psychological Research.*

Bornstein, K. (1994). Gender Outlaw: On Men, Women and the Rest of Us. London: Routledge.

Boroditsky, L., & Schmidt, L. (2000). Sex, Syntax, and Semantics. In L. R. Gleitman & A. K. Joshi (Eds.), Proceedings of the 22nd Annual Meeting of the Cognitive Science Society (pp. 42–47). New York: Psychology Press.

Boroditsky, L. (2001). Does Language Shape Thought?: Mandarin and English Speakers' Conceptions of Time. Cognitive Psychology, 43(1), 1–22. https://doi.org/10.1006/cogp.2001.0748

Boroditsky, L., & Ramscar, M. (2002). The Roles of Body and Mind in Abstract Thought. Psychological Science, 13(2), 185–189.

Boroditsky, L., Schmidt, L., A., & Phillips, W. (2003). Sex, Syntax, and Semantics. In D. Gentner & S. Goldin-Meadow (Eds.), Language in Mind: Advances in the Study of Language and Thought. Cambridge: MIT Press.

Boroditsky, L., Fuhrman, O., & McCormick, K. (2011). Do English and Mandarin speakers think about time differently? Cognition, 118(1), 123–129. https://doi.org/10.1016/j.cognition.2010.09.010

Boroditsky, L. (2018). Language and the Construction of Time through Space. Trends in Neurosciences, 41(10), 651–653. https://doi.org/10.1016/j.tins.2018.08.004

Boulenger, V., Roy, A. C., Paulignan, Y., Deprez, V., Jeannerod, M., & Nazir, T. A. (2006). Cross-talk between Language Processes and Overt Motor Behavior in the First 200 msec of Processing. Journal of Cognitive Neuroscience, 18(10), 1607–1615. https://doi.org/10.1162/jocn.2006.18.10.1607

Bowerman, M., & Choi, S. (2000). Shaping Meanings for Language: Universals and Language Specific in the Acquisition of Spatial Semantic Categories. In M. Bowerman & S. C. Levinson (Eds.), Language Acquisition and Conceptual Development. Cambridge: Cambridge University Press.

Brown, P., & Levinson, S. C. (1993). “Uphill” and “Downhill” in Tzeltal. Journal of Linguistic Anthropology, 3(1), 46–74. https://doi.org/10.1525/jlin.1993.3.1.46

Brysbaert, M., Warriner, A. B., & Kuperman, V. (2014). Concreteness ratings for 40 thousand generally known English word lemmas. Behavior Research Methods, 46(3), 904–911. https://doi.org/10.3758/s13428-013-0403-5

Brysbaert, M. (2018). Numbers and Language: What’s New in the Past 25 Years? In Heterogeneity of Function in Numerical Cognition (pp. 3–26). https://doi.org/10.1016/B978-0-12-811529-9.00001-7

Buccino, G., Colagè, I., Gobbi, N., & Bonaccorso, G. (2016). Grounding meaning in experience: A broad perspective on embodied language. Neuroscience & Biobehavioral Reviews, 69, 69–78. https://doi.org/10.1016/j.neubiorev.2016.07.033

Buccino, G., Sato, M., Cattaneo, L., Rodà, F., & Riggio, L. (2009). Broken affordances, broken objects: A TMS study. Neuropsychologia, 47(14), 3074–3078. https://doi.org/10.1016/j.neuropsychologia.2009.07.003

Butler, J. (1988). Performative Acts and Gender Constitution: An Essay in Phenomenology and Feminist Theory. Theatre Journal, 40(4), 519–531. https://doi.org/10.2307/3207893

Butler, J. (1990). Gender Trouble. Feminism and the Subversion of Identity. New York and London: Routledge.

Butler, J. (1993a). Bodies that matter. On the discursive limits of “sex”. New York and London: Routledge.

Butler, J. (1993b). Critically queer. GLQ: A Journal of Lesbian and Gay Studies, 1(1), 17–32.

Butler, J. (1995). Melancholy gender—Refused identification. Psychoanalytic Dialogues, 5(2), 165–180. https://doi.org/10.1080/10481889509539059

Capitani, E., Laiacona, M., Mahon, B., & Caramazza, A. (2003). What are the facts of semantic category-specific deficits? A critical review of the clinical evidence. Cognitive Neuropsychology, 20(3–6), 213–261. https://doi.org/10.1080/02643290244000266

Cappa, S. F., & Pulvermüller, F. (2012). Cortex, Special Issue: Language and the motor system. Cortex, 48(7), 785-787.

Casasanto, D. (2008). Who's Afraid of the Big Bad Whorf? Crosslinguistic Differences in Temporal Language and Thought. Language Learning, 58(s1), 63–79. https://doi.org/10.1111/j.1467-9922.2008.00462.

Casasanto, D., & Boroditsky, L. (2008). Time in the mind: Using space to think about time. Cognition, 106(2), 579–593. https://doi.org/10.1016/j.cognition.2007.03.004

Casasanto, D. (2009). Embodiment of abstract concepts: good and bad in right-and left-handers. Journal of Experimental Psychology: General, 138(3), 351.

Casasanto, D., & Lupyan, G. (2015). All Concepts Are Ad Hoc Concepts. In E. Margolis & S. Laurence (Eds.), The Conceptual Mind. New Directions in the Study of Concepts (pp. 543–566). Cambridge: MIT Press.

Chao, L. L., & Martin, A. (2000). Representation of Manipulable Man-Made Objects in the Dorsal Stream. NeuroImage, 12, 478–484. https://doi.org/10.1006/nimg.2000.0635

Charrad, M., Ghazzali, N., Boiteau, V., Niknafs, A. (2014). NbClust: An R Package for Determining the Relevant Number of Clusters in a Data Set. Journal of Statistical Software, 61(6), 1-36. URL http://www.jstatsoft.org/v61/i06/.

Chemero, A. (2009). Radical Embodied Cognitive Science. Bradford.

Clapper, J. P. (2019). Graded similarity in free categorization. Cognition, 190, 1–19. https://doi.org/10.1016/j.cognition.2019.04.009

Clark, A. (1998). Magic words: How language augments human computation. Language and thought: Interdisciplinary themes, 162–183.

Clark, A., & Chalmers, D. J. (1998). The extended mind. Analysis, 58(1), 7–19.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. Psychological Review, 82(6), 407–428.

Connell, L., Lynott, D., & Dreyer, F. (2012). A Functional Role for Modality-Specific Perceptual Systems in Conceptual Representations. PLOS ONE, 7(3), e33321. https://doi.org/10.1371/journal.pone.0033321

Connell, L., & Lynott, D. (2014a). Principles of Representation: Why You Can't Represent the Same Concept Twice. Topics in Cognitive Science, 6(3), 390–406. https://doi.org/10.1111/tops.12097

Connell, L., & Lynott, D. (2014b). I see/hear what you mean: Semantic activation in visual word recognition depends on perceptual attention. Journal of Experimental Psychology: General, 143, 527–533.

Connell, L., Lynott, D., & Carney, J. (2017). Interoception: The Forgotten Modality in Perceptual Grounding of Concepts. Proceedings of Cognitive Science Society.

Connell, L., Lynott, D., & Banks, B. (2018). Interoception: The forgotten modality in perceptual grounding of abstract and concrete concepts. Philosophical Transactions of the Royal Society B: Biological Sciences. 373, 20170143. (doi:10.1098/rstb.2017.0143)

Contreras, J. M., Banaji, M. R., & Mitchell, J. P. (2012). Dissociable neural correlates of stereotypes and other forms of semantic knowledge. Social Cognitive and Affective Neuroscience, 7(7), 764–770. https://doi.org/10.1093/scan/nsr053

Contreras, J. M., Banaji, M. R., & Mitchell, J. P. (2013). Multivoxel Patterns in Fusiform Face Area Differentiate Faces by Sex and Race. PLOS ONE, 8(7), e69684. https://doi.org/10.1371/journal.pone.0069684

Coolidge, F. L., Thede, L. L., & Young, S. E. (2002). The Heritability of Gender Identity Disorder in a Child and Adolescent Twin Sample. Behavior Genetics, 32(4), 251–257. https://doi.org/10.1023/A:1019724712983

Corbett, G. G. (1991). Gender. Cambridge: Cambridge University Press.

Crowe, S., & Prescott, T. (2003). Continuity and change in the development of category structure: Insights from the semantic fluency task. International Journal of Behavioral Development, 27(5), 467-479.

Cubelli, R., Paolieri, D., Lotto, L., & Job, R. (2011). The effect of grammatical gender on object categorization. Journal of Experimental Psychology: Learning, Memory, and Cognition, 37(2), 449–460. https://doi.org/10.1037/a0021965

Cuccio, V., & Gallese, V. (2018). A Peircean account of concepts. Grounding abstraction in phylogeny through a comparative neuroscientific perspective. Philosophical Transactions of the Royal Society B: Biological Sciences. 373, 20170128. (doi:10.1098/rstb.2017.0128)

Cuccio, V., & Caruana, F. (2019). Rethinking the abstract/concrete concepts dichotomy: Comment on “Words as social tools: Language, sociality and inner grounding in abstract concepts” by Anna M. Borghi et al. Physics of Life Reviews. https://doi.org/10.1016/j.plrev.2019.04.007

Dale, R., Dietrich, E., & Chemero, A. (2009). Explanatory Pluralism in Cognitive Science. Cognitive Science, 33(5), 739–742. https://doi.org/10.1111/j.1551-6709.2009.01042.x

de Beauvoir, S. (1989). The Second Sex (H. M. Parshley, Trans.). New York: Vintage.

de Lauretis, T. (1991). Queer Theory: Lesbian and Gay Sexualities. Differences: A Journal of Feminist Cultural Studies, 3(2), iii–xviii.

Decety, J., & Grèzes, J. (2006). The power of simulation: Imagining one's own and other's behavior. Brain Research, 1079(1), 4–14. https://doi.org/10.1016/j.brainres.2005.12.115

Della Rosa, P. A., Catricalà, E., Vigliocco, G., & Cappa, S. F. (2010). Beyond the abstract—concrete dichotomy: Mode of acquisition, concreteness, imageability, familiarity, age of acquisition, context availability, and abstractness norms for a set of 417 Italian words. Behavior Research Methods, 42(4), 1042-1048.

Deogracias, J. J., Johnson, L. L., Meyer-Bahlburg, H. F. L., Kessler, S. J., Schober, J. M., & Zucker, K. J. (2007). The Gender Identity/Gender Dysphoria Questionnaire for Adolescents and Adults. The Journal of Sex Research, 44(4), 370–379. https://doi.org/10.1080/00224490701586730

Desai, R. H., Reilly, M., & van Dam, W. (2018). The multifaceted abstract brain. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1752), 20170122. https://doi.org/10.1098/rstb.2017.0122

Devor, A. (1997). FTM: Female-to-Male Transsexuals in Society. Bloomington: Indiana University Press.

di Pellegrino, G., Fadiga, L., Fogassi, L., Gallese, V., & Rizzolatti, G. (1992). Understanding motor events: A neurophysiological study. Experimental Brain Research, 91(1), 176–180. https://doi.org/10.1007/BF00230027

Dijkstra, K., Kaschak, M. P., & Zwaan, R. A. (2007). Body posture facilitates retrieval of autobiographical memories. Cognition, 102(1), 139–149. https://doi.org/10.1016/j.cognition.2005.12.009

Dixon, R. M. W. (1972). The Dyirbal language of North Queensland. Cambridge: Cambridge University Press.

Dixon, R. M. W. (1982). "Noun Classes". Where Have All the Adjectives Gone? And other essays in semantics and syntax. Berlin: Mouton.

Dolscheid, S., Shayan, S., Majid, A., & Casasanto, D. (2013). The Thickness of Musical Pitch: Psychophysical Evidence for Linguistic Relativity. Psychological Science, 24(5), 613–621. https://doi.org/10.1177/0956797612457374

Donnelly, K., & Twenge, J. M. (2017). Masculine and Feminine Traits on the Bem Sex-Role Inventory, 1993–2012: A Cross-Temporal Meta-Analysis. Sex Roles, 76(9–10), 556–565. https://doi.org/10.1007/s11199-016-0625-y

Dove, G. (2009). Beyond perceptual symbols: A call for representational pluralism. Cognition, 110(3), 412–431. https://doi.org/10.1016/j.cognition.2008.11.016

Dove, G. (2011). On the need for Embodied and Dis-Embodied Cognition. Frontiers in Psychology, 1. https://doi.org/10.3389/fpsyg.2010.00242

Dove, G. (2016). Three symbol ungrounding problems: Abstract concepts and the future of embodied cognition. Psychonomic Bulletin & Review, 23(4), 1109-1121.

Dove, G. (2018). Language as a disruptive technology: Abstract concepts, embodiment and the flexible mind. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1752), 20170135. https://doi.org/10.1098/rstb.2017.0135

Dreyer, F. R., Frey, D., Arana, S., Saldern, S. von, Picht, T., Vajkoczy, P., & Pulvermüller, F. (2015). Is the Motor System Necessary for Processing Action and Abstract Emotion Words? Evidence from Focal Brain Lesions. Frontiers in Psychology, 6. https://doi.org/10.3389/fpsyg.2015.01661

Dreyer, F. R., & Pulvermüller, F. (2018). Abstract semantics in the motor system? – An event-related fMRI study on passive reading of semantic word categories carrying abstract emotional and mental meaning. Cortex, 100, 52–70. https://doi.org/10.1016/j.cortex.2017.10.021

Eagly, A. H., & Wood, W. (2013). The Nature–Nurture Debates: 25 Years of Challenges in Understanding the Psychology of Gender. Perspectives on Psychological Science, 8(3), 340–357. https://doi.org/10.1177/1745691613484767

Eco, U. (1997). Kant and the platypus: Essays on language and cognition (A. McEwan, Trans.). London, UK: Vintage.

Ellemers, N. (2018). Gender Stereotypes. Annual Review of Psychology, 69(1), 275–298. https://doi.org/10.1146/annurev-psych-122216-011719

Ellis, R., & Tucker, M. (2000). Micro-affordance: The potentiation of components of action by seen objects. British Journal of Psychology, 91(4), 451–471. https://doi.org/10.1348/000712600161934

Epstein, M., & Ward, L. M. (2011). Exploring Parent-Adolescent Communication About Gender: Results from Adolescent and Emerging Adult Samples. Sex Roles, 65(1), 108–118. https://doi.org/10.1007/s11199-011-9975-7

Ervin, S. M. (1962). The Connotations of Gender. Word, 18(1–3), 249–261. https://doi.org/10.1080/00437956.1962.11659776

Fadiga, L., Fogassi, L., Pavesi, G., & Rizzolatti, G. (1995). Motor facilitation during action observation: A magnetic stimulation study. Journal of Neurophysiology, 73(6), 2608–2611. https://doi.org/10.1152/jn.1995.73.6.2608

Fadiga, L., Craighero, L., Buccino, G., & Rizzolatti, G. (2002). Speech listening specifically modulates the excitability of tongue muscles: A TMS study. European Journal of Neuroscience, 15(2), 399–402. https://doi.org/10.1046/j.0953-816x.2001.01874.x

Fausto-Sterling, A. (1993). The Five Sexes: Why Male and Female Are Not Enough. The Sciences, 33(2), 20–25.

Fausto-Sterling, A. (2000). Sexing the body: Gender politics and the construction of sexuality. New York: Basic Books.

Fausto-Sterling, A. (2012). Sex/Gender. Biology in a Social World. New York: Routledge.

Fausto-Sterling, A. (2019). Gender/Sex, Sexual Orientation, and Identity Are in the Body: How Did They Get There? The Journal of Sex Research, 56(4–5), 529–555.

Fernandino, L., Humphries, C. J., Seidenberg, M. S., Gross, W. L., Conant, L. L., & Binder, J. R. (2015). Predicting brain activation patterns associated with individual lexical concepts based on five sensory-motor attributes. Neuropsychologia, 76, 17–26. https://doi.org/10.1016/j.neuropsychologia.2015.04.009

Fillmore, C. J. (1975, September). An alternative to checklist theories of meaning. In Annual Meeting of the Berkeley Linguistics Society (Vol. 1, pp. 123-131).

Fillmore, C. J. (1982), Towards a Descriptive Framework for Spatial Deixis, in R.J. Jarvella & W. Klein (eds.), Speech, Place, and Action: Studies in Deixis and Related Topics, John Wiley & Sons, Chichester, pp. 31-59.

Fischer, M. H., Castel, A. D., Dodd, M. D., & Pratt, J. (2003). Perceiving numbers causes spatial shifts of attention. Nature Neuroscience, 6(6), 555–556. https://doi.org/10.1038/nn1066

Fisher, A. V., & Sloutsky, V. M. (2005). When Induction Meets Memory: Evidence for Gradual Transition From Similarity-Based to Category-Based Induction. Child Development, 76(3), 583–597. https://doi.org/10.1111/j.1467-8624.2005.00865.

Fischer, M. H., & Brugger, P. (2011). When Digits Help Digits: Spatial–Numerical Associations Point to Finger Counting as Prime Example of Embodied Cognition. Frontiers in Psychology, 2. https://doi.org/10.3389/fpsyg.2011.00260

Fischer, M. H., Kaufmann, L., & Domahs, F. (2012). Finger Counting and Numerical Cognition. Frontiers in Psychology, 3. https://doi.org/10.3389/fpsyg.2012.00108

Fischer, M. H. (2012). A hierarchical view of grounded, embodied, and situated numerical cognition. Cognitive Processing, 13(S1), 161–164. https://doi.org/10.1007/s10339-012-0477-5

Fodor, J. A. (1975). The Language of Thought (Vol. 87). Harvard University Press.

Fodor, J. A. (1981). The present status of the innateness controversy. In J. Fodor (Ed.), RePresentations: Philosophical Essays on the Foundations of Cognitive Science (pp. 257–316). MIT Press.

Fodor, J. A. (1985). Precis of the modularity of mind. Behavioral and Brain Sciences, 8(1), 1–42.

Fodor, J. A. (1998). Concepts: Where Cognitive Science Went Wrong. Oxford University Press.

Foucault, M. (1980). The History of Sexuality (Vol. 1). New York: Vintage.

Freeman, J. B., Rule, N. O., Adams, R. B., & Ambady, N. (2010). The Neural Basis of Categorical Face Perception: Graded Representations of Face Gender in Fusiform and Orbitofrontal Cortices. Cerebral Cortex, 20(6), 1314–1322. https://doi.org/10.1093/cercor/bhp195

Freeman, J. B., & Johnson, K. L. (2016). More Than Meets the Eye: Split-Second Social Perception. Trends in Cognitive Sciences, 20(5), 362–374. https://doi.org/10.1016/j.tics.2016.03.003

Frege, G. (1975). On Sense and Reference. In J. M. E. Moravcsik (Ed.), Logic and philosophy for linguists (pp. 13–32). https://doi.org/10.1515/9783111546216-003

Fuhrman, O., & Boroditsky, L. (2010). Cross-cultural differences in mental representations of time: Evidence from an implicit nonlinguistic task. Cognitive Science, 34(8), 1430-1451.

Gabriel, U., and Gygax, P. (2016). Gender and linguistic sexism. In H. Giles and A. Maas (Eds), *Advances in intergroup Communication*. Bern: Peter Lang Publishers.

Gabriel, U., Gygax, P. M., and Kuhn, E. A. (2018). Neutralising linguistic sexism: promising but cumbersome? *Group Process. Intergroup Relat. 21*, 844–858. doi: 10.1177/1368430218771742

Galili, T. (2015). dendextend: an R package for visualizing, adjusting, and comparing trees of hierarchical clustering. Bioinformatics. <doi:10.1093/bioinformatics/btv428>

Gallate, J., Wong, C., Ellwood, S., Chi, R., & Snyder, A. (2011). Noninvasive brain stimulation reduces prejudice scores on an implicit association test. Neuropsychology, 25(2), 185–192. https://doi.org/10.1037/a0021102

Gallese, V., Fadiga, L., Fogassi, L., & Rizzolatti, G. (1996). Action recognition in the premotor cortex. Brain, 119(2), 593–609. https://doi.org/10.1093/brain/119.2.593

Gallese, V., & Lakoff, G. (2005). The Brain’s concepts: The role of the Sensory-motor system in conceptual knowledge. Cognitive Neuropsychology, 22(3–4), 455–479. https://doi.org/10.1080/02643290442000310

Gallese, V., Eagle, M. N., & Migone, P. (2007). Intentional Attunement: Mirror Neurons and the Neural Underpinnings of Interpersonal Relations. Journal of the American Psychoanalytic Association, 55(1), 131–175. https://doi.org/10.1177/00030651070550010601

Gallese, V. (2008). Mirror neurons and the social nature of language: The neural exploitation hypothesis. Social Neuroscience, 3(3–4), 317–333. https://doi.org/10.1080/17470910701563608

Gallese, V. (2009). Motor abstraction: A neuroscientific account of how action goals and intentions are mapped and understood. Psychological Research PRPF, 73(4), 486–498. https://doi.org/10.1007/s00426-009-0232-4

Galupo, M. P., Davis, K. S., Grynkiewicz, A. L., & Mitchell, R. C. (2014). Conceptualization of sexual orientation identity among sexual minorities: Patterns across sexual and gender identity. Journal of Bisexuality, 14(3-4), 433-456.

Galupo, M. P., Henise, S. B., & Mercer, N. L. (2016). “The labels don’t work very well”: Transgender individuals’ conceptualizations of sexual orientation and sexual identity. International Journal of Transgenderism, 17(2), 93–104. https://doi.org/10.1080/15532739.2016.1189373

Galupo, M. P., Pulice-Farrow, L. K., & Ramirez, J. L. (2017). “Like a constantly flowing river”: Gender identity flexibility among non-binary transgender individuals. In J. D. Sinnott (Ed.), Identity Flexibility During Adulthood: Perspective in Adult Development (pp. 163–177). Cham: Springer.

Galupo, M. P., Lomash, E., & Mitchell, R. C. (2017b). “All of my lovers fit into this scale”: Sexual minority individuals’ responses to two novel measures of sexual orientation. *Journal of Homosexuality*, *64*(2), 145-165.

Galupo, M. P., Mitchell, R. C., & Davis, K. S. (2018). Face validity ratings of sexual orientation scales by sexual minority adults: Effects of sexual orientation and gender identity. *Archives of Sexual Behavior*, 47(4), 1241-1250.

Garbagnoli, S. (2014). ‘L’ideologia del genere’: l’irresistibile ascesa di un’invenzione retorica vaticana contro la denaturalizzazione dell’ordine sessuale. AG, About Gender, 3(6), 250-263.

Gardner, H. (1985). The mind’s new science: A history of the cognitive revolution. New York: Basic Books.

Gazzola, S. B., & Morrison, M. A. (2014). Cultural and Personally Endorsed Stereotypes of Transgender Men and Transgender Women: Notable Correspondence or Disjunction? International Journal of Transgenderism, 15(2), 76–99. https://doi.org/10.1080/15532739.2014.937041

Gelman, S. A., & Markman, E. M. (1986). Categories and induction in young children. Cognition, 23(3), 183–209.

Gelman, S. A., & Markman, E. M. (1987). Young Children’s Inductions from Natural Kinds: The Role of Categories and Appearances. Child Development, 58(6), 1532–1541. https://doi.org/10.2307/1130693

Gelman, S. A., & Wellman, H. M. (1991). Insides and essences: Early understandings of the non-obvious. Cognition, 38(3), 213–244.

Gentner, D., & Goldin-Meadow, S. (2003). Language in Mind: Advances in the Study of Language and Thought. MIT Press.

Gerhardstein, K. R., & Anderson, V. N. (2010). There's More Than Meets the Eye: Facial Appearance and Evaluations of Transsexual People. Sex Roles, 62(5), 361–373. https://doi.org/10.1007/s11199-010-9746-x

Ghio, M., Vaghi, M. M. S., & Tettamanti, M. (2013). Fine-Grained Semantic Categorization across the Abstract and Concrete Domains. PLOS ONE, 8(6), e67090. https://doi.org/10.1371/journal.pone.0067090

Ghio, M., Vaghi, M. M. S., Perani, D., & Tettamanti, M. (2016). Decoding the neural representation of fine-grained conceptual categories. NeuroImage, 132, 93–103. https://doi.org/10.1016/j.neuroimage.2016.02.009

Gibbs, R. W. (2006). Embodiment and Cognitive Science. New York ; Cambridge University Press.

Gibson, J. J. (1979). The Ecological Approach to Visual Perception. Houghton Mifflin.

Gilbert, M. A. (2009). Defeating Bigenderism: Changing Gender Assumptions in the Twenty-first Century. Hypatia, 24(3), 93–112. https://doi.org/10.1111/j.1527-2001.2009.01047.x

Gilhooly, K. J., & Logie, R. H. (1980). Age-of-acquisition, imagery, concreteness, familiarity, and ambiguity measures for 1,944 words. Behavior Research Methods & Instrumentation, 12(4), 395-427.

Gillette, J., Gleitman, H., Gleitman, L., & Lederer, A. (1999). Human simulations of vocabulary learning. Cognition, 73(2), 135–176. https://doi.org/10.1016/S0010-0277(99)00036-0

Gleitman, L. R., Cassidy, K., Nappa, R., Papafragou, A., & Trueswell, J. C. (2005). Hard Words. Language Learning and Development, 1(1), 23–64. https://doi.org/10.1207/s15473341lld0101_4

Glenberg, A. M., & Kaschak, M. P. (2002). Grounding language in action. Psychonomic Bullettin & Review, 9 (3), 558–565.

Glenberg, A. M., Sato, M., Cattaneo, L., Riggio, L., Palumbo, D., & Buccino, G. (2008). Processing abstract language modulates motor system activity. The Quarterly Journal of Experimental Psychology, 61(6), 905–919. https://doi.org/10.1080/17470210701625550

Glenberg, A. M., & Gallese, V. (2012). Action-based language: A theory of language acquisition, comprehension, and production. Cortex, 48(7), 905–922. https://doi.org/10.1016/j.cortex.2011.04.010

Glenberg, A. M., Witt, J. K., & Metcalfe, J. (2013). From the revolution to embodiment: 25 years of cognitive psychology. Perspectives on Psychological Science, 8(5), 573-585.

Glenberg, A. M. (2015). Few believe the world is flat: How embodiment is changing the scientific understanding of cognition. Canadian Journal of Experimental Psychology/Revue Canadienne de Psychologie Expérimentale, 69(2), 165–171. https://doi.org/10.1037/cep0000056

Goddard, C. (2010). Universals and variation. In B. C. Malt & P. M. Wolff (Eds.), Words and the mind: How words capture human experience (pp. 72–93). Oxford University Press, USA.

González, J., Barros-Loscertales, A., Pulvermüller, F., Meseguer, V., Sanjuán, A., Belloch, V., & Ávila, C. (2006). Reading cinnamon activates olfactory brain regions. NeuroImage, 32(2), 906–912. https://doi.org/10.1016/j.neuroimage.2006.03.037

Gopnik, A., & Meltzoff, A. N. (1999). Words, Thoughts, and Theories. Mind, 108(430), 395–398.

Granito, C., Scorolli, C., & Borghi, A. M. (2015). Naming a Lego World. The Role of Language in the Acquisition of Abstract Concepts. PLOS ONE, 10(1), e0114615. https://doi.org/10.1371/journal.pone.0114615

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: the implicit association test. Journal of Personality and Social Psychology, 74(6), 1464.

Greenwald, A. G., & Farnham, S. D. (2000). Using the implicit association test to measure self-esteem and self-concept. Journal of Personality and Social Psychology, 79(6), 1022.

Gumperz, J. J., & Levinson, S. C. (1996). Rethinking Linguistic Relativity. Cambridge University Press.

Hacking, I. (1999). The Social Construction of What? Cambridge, MA: Harvard University Press.

Halperin, D. M. (1995). Saint Foucault: Towards a Gay Hagiography. Oxford University Press. United Kingdom.

Hampton, J. A. (1979). Polymorphous concepts in semantic memory. Journal of Verbal Learning and Verbal Behavior, 18(4), 441–461. https://doi.org/10.1016/S0022-5371(79)90246-9

Hampton, J. A. (1981). An investigation of the nature of abstract concepts. Memory & Cognition, 9(2), 149–156. https://doi.org/10.3758/BF03202329

Hampton, J. A. (1987). Inheritance of attributes in natural concept conjunctions. Memory & Cognition, 15(1), 55–71. https://doi.org/10.3758/BF03197712

Hampton, J. (1993). Prototype models of concept representation. In Cognitive Science Series. Categories and concepts: Theoretical views and inductive data analysis (pp. 67–95). San Diego, CA, US: Academic Press.

Harnad, S. (1990). The symbol grounding problem. Physica D, 42, 335–346.

Harpaintner, M., Trumpp, N. M., & Kiefer, M. (2018). The Semantic Content of Abstract Concepts: A Property Listing Study of 296 Abstract Words. Frontiers in Psychology, 9. https://doi.org/10.3389/fpsyg.2018.01748

Haslanger, S. (1995). Ontology and Social Construction. Philosophical Topics, 23(2), 95–125.

Haslanger, S. (2012). Resisting Reality: Social Construction and Social Critique. Oxford, UK: Oxford University Press.

Haslanger, S. (2017). The Sex/Gender Distinction and the Social Construction of Reality. In A. Garry, S. J. Khader, & A. Stone (Eds.), The Routledge Companion to Feminist Philosophy (1st ed., pp. 157–167). https://doi.org/10.4324/9781315758152-14

Hauk, O., & Pulvermüller, F. (2004). Neurophysiological distinction of action words in the fronto-central cortex. Human Brain Mapping, 21(3), 191–201. https://doi.org/10.1002/hbm.10157

Hauk, O., Johnsrude, I., & Pulvermüller, F. (2004). Somatotopic Representation of Action Words in Human Motor and Premotor Cortex. Neuron, 41(2), 301–307. https://doi.org/10.1016/S0896-6273(03)00838-9

Havas, D. A., Glenberg, A. M., Gutowski, K. A., Lucarelli, M. J., & Davidson, R. J. (2010). Cosmetic Use of Botulinum Toxin-A Affects Processing of Emotional Language. Psychological Science, 21(7), 895–900. https://doi.org/10.1177/0956797610374742

Hedeker, D. (2005). Generalized linear mixed models. In B. S. Everitt D. C. Howell (Eds.), Encyclopedia of statistics in behavioral science (pp. 729–738). Chichester: Wiley. doi:10.1002/0470013192.bsa251

Hegarty P. (2007) Getting dirty - Psychology's history of power. *History of Psychology*, *10*, 75-91.

Hegarty, P., Ansara, Y. G., & Barker, M. J. (2018). Nonbinary gender identities. In N. K. Dess, J. Marecek, & L. C. Bell (Eds.), *Gender, sex, and sexualities: Psychological perspectives*. Oxford: Oxford University Press, pp. 53-76.Herdt, G. (Ed.). (1993). Third sex, third gender: Beyond sexual dimorphism in culture and history. New York, NY: Zone Books.

Herdt, G. H. (1993). Ritualized homosexuality in Melanesia (Vol. 2; G. H. Herdt, Ed.). University of California Press.

Hoenig, K., Sim, E.-J., Bochev, V., Herrnberger, B., & Kiefer, M. (2008). Conceptual Flexibility in the Human Brain: Dynamic Recruitment of Semantic Maps from Visual, Motor, and Motion-related Areas. Journal of Cognitive Neuroscience, 20(10), 1799–1814. https://doi.org/10.1162/jocn.2008.20123

Hofweber, T. (2018). Logic and Ontology. In E. N. Zalta (Ed.), The Stanford Encyclopedia of Philosophy (Summer 2018). Retrieved from https://plato.stanford.edu/archives/sum2018/entries/logic-ontology/

Huart, J., Corneille, O., & Becquart, E. (2005). Face-based categorization, context-based categorization, and distortions in the recollection of gender ambiguous faces. Journal of Experimental Social Psychology, 41(6), 598–608. https://doi.org/10.1016/j.jesp.2004.10.007

Humphreys, G. W., & Forde, E. M. E. (2001). Hierarchies, similarity, and interactivity in object recognition: Category-specific neuropsychological deficits. Behavioral and Brain Science, 57.

Hyde, J. S. (2014). Gender Similarities and Differences. Annual Review of Psychology, 65(1), 373–398. https://doi.org/10.1146/annurev-psych-010213-115057

Hyde, J. S., Bigler, R. S., Joel, D., Tate, C. C., & van Anders, S. M. (2019). The future of sex and gender in psychology: Five challenges to the gender binary. American Psychologist, 74(2), 171–193. https://doi.org/10.1037/amp0000307

Ito, T. A., & Urland, G. R. (2003). Race and gender on the brain: Electrocortical measures of attention to the race and gender of multiply categorizable individuals. Journal of Personality and Social Psychology, 85(4), 616–626. https://doi.org/10.1037/0022-3514.85.4.616

Jacobson, R., & Joel, D. (2018). An Exploration of the Relations Between Self-Reported Gender Identity and Sexual Orientation in an Online Sample of Cisgender Individuals. Archives of Sexual Behavior, 47(8), 2407–2426. https://doi.org/10.1007/s10508-018-1239-y

Jacobson, R., & Joel, D. (2019). Self-Reported Gender Identity and Sexuality in an Online Sample of Cisgender, Transgender, and Gender-Diverse Individuals: An Exploratory Study. The Journal of Sex Research, 56(2), 249–263. https://doi.org/10.1080/00224499.2018.1523998

Joel, D., Tarrasch, R., Berman, Z., Mukamel, M., & Ziv, E. (2014). Queering gender: Studying gender identity in 'normative' individuals. Psychology & Sexuality, 5(4), 291–321. https://doi.org/10.1080/19419899.2013.830640

Joel, D. (2016). Captured in terminology: Sex, sex categories, and sex differences. Feminism & Psychology, 26(3), 335-345.

Joel, D., & Fausto-Sterling, A. (2016). Beyond sex differences: New approaches for thinking about variation in brain structure and function. Philosophical Transactions of the Royal Society B: Biological Sciences, 371(1688), 20150451. https://doi.org/10.1098/rstb.2015.0451

Johnson, K. L., & Tassinary, L. G. (2005). Perceiving Sex Directly and Indirectly: Meaning in Motion and Morphology. Psychological Science, 16(11), 890–897. https://doi.org/10.1111/j.1467-9280.2005.01633.x

Johnson, K. L., Iida, M., & Tassinary, L. G. (2012). Person (mis)perception: Functionally biased sex categorization of bodies. Proceedings of the Royal Society B: Biological Sciences, 279(1749), 4982–4989. https://doi.org/10.1098/rspb.2012.2060

Johnson, M. (1990). The body in the Mind. The Bodily Basis of Meaning, Imagination, and Reason. Chicago: Chicago University Press.

Johnson-Laird, P. N. (1988). The computer and the mind: An introduction to cognitive science. Harvard University Press.

Jones, S. S., & Smith, L. B. (2002). How children know the relevant properties for generalizing object names. Developmental Science, 5(2), 219–232. https://doi.org/10.1111/1467-7687.00224

Jordan-Young, R., & Rumiati, R. I. (2012). Hardwired for Sexism? Approaches to Sex/Gender in Neuroscience. Neuroethics, 5(3), 305–315. https://doi.org/10.1007/s12152-011-9134-4

Kachel, S., Steffens, M. C., & Niedlich, C. (2016). Traditional masculinity and femininity: Validation of a new scale assessing gender roles. Frontiers in Psychology, 7, 956.

Kalénine, S., Shapiro, A. D., Flumini, A., Borghi, A. M., & Buxbaum, L. J. (2014). Visual context modulates potentiation of grasp types during semantic object categorization. Psychonomic Bulletin & Review, 21(3), 645–651. https://doi.org/10.3758/s13423-013-0536-7

Kanwisher, N., & Yovel, G. (2006). The fusiform face area: A cortical region specialized for the perception of faces. Philosophical Transactions of the Royal Society B: Biological Sciences, 361(1476), 2109–2128. https://doi.org/10.1098/rstb.2006.1934

Kaschak, M. P., & Borreggine, K. L. (2008). Temporal dynamics of the action–sentence compatibility effect. The Quarterly Journal of Experimental Psychology, 61(6), 883–895. https://doi.org/10.1080/17470210701623852

Kassambara, A. and Mundt, F. (2016). factoextra: Extract and Visualize the Results of Multivariate Data Analyses, https://CRAN.R-project.org/package=factoextra, r package version 1.0.3.

Kaul, C. P., Rees, G., & Ishai, A. (2011). The Gender of Face Stimuli is Represented in Multiple Regions in the Human Brain. Frontiers in Human Neuroscience, 4. https://doi.org/10.3389/fnhum.2010.00238

Keesman, M., Aarts, H., Ostafin, B. D., Verwei, S., Häfner, M., & Papies, E. K. (2018). Alcohol representations are socially situated: An investigation of beverage representations by using a property generation task. Appetite, 120, 654-665.

Keil, F. C. (1989). Concepts, Kinds, and Cognitive Development. Cambridge, MA: The MIT Press.

Kessler, S. J., & McKenna, W. (1978). Gender: An Ethnomethodological Approach. New York: Wiley.

Kiefer, M., Sim, E.-J., Liebich, S., Hauk, O., & Tanaka, J. (2007). Experience-dependent Plasticity of Conceptual Representations in Human Sensory-Motor Areas. Journal of Cognitive Neuroscience, 19(3), 525–542. https://doi.org/10.1162/jocn.2007.19.3.525

Kiefer, M., & Martens, U. (2010). Attentional sensitization of unconscious cognition: Task sets modulate subsequent masked semantic priming. Journal of Experimental Psychology: General, 139(3), 464–489.

Kiefer, M., & Pulvermüller, F. (2012). Conceptual representations in mind and brain: Theoretical developments, current evidence and future directions. Cortex, 48(7), 805–825. https://doi.org/10.1016/j.cortex.2011.04.006

Kiefer, M., & Barsalou, L.W. (2013). In W. Prinz, Miriam Beisert, & Arvid Herwig (Eds.), Action science: Foundations of an emerging discipline (pp. 381-407). Cambridge, MA: MIT Press.

Kilarski, M. (2013). Nominal Classifications. A History of Its Study from the Classical Period to the Present. John Benjamins Publishing Company.

Kinsey, A. C., Pomeroy, W. B., & Martin, C. E. (1948). Sexual behavior in the human male. Oxford, England: Saunders.

Komatsu, L. K. (1992). Recent views of conceptual structure. Psychological Bulletin, 112(3), 500–526. https://doi.org/10.1037/0033-2909.112.3.500

Konishi, T. (1993). The semantics of grammatical gender: A cross-cultural study. Journal of Psycholinguistic Research, 22(5), 519–534.

Kousta, S.-T., Vinson, D. P., & Vigliocco, G. (2009). Emotion words, regardless of polarity, have a processing advantage over neutral words. Cognition, 112(3), 473–481. https://doi.org/10.1016/j.cognition.2009.06.007

Kousta, S.-T., Vigliocco, G., Vinson, D. P., & Andrews, M. (2011). The Concreteness Effect: Dual Coding Theory and the Context Availability Model.

Kuper, L. E., Nussbaum, R., & Mustanski, B. (2012). Exploring the Diversity of Gender and Sexual Orientation Identities in an Online Sample of Transgender Individuals. The Journal of Sex Research, 49(2–3), 244–254. https://doi.org/10.1080/00224499.2011.596954

Kuyper, L., & Wijsen, C. (2014). Gender Identities and Gender Dysphoria in the Netherlands. Archives of Sexual Behavior, 43(2), 377–385. https://doi.org/10.1007/s10508-013-0140-y

Lakoff, G. (1987). Women, Fire, and Dangerous Things: What Categories reveal about the mind (6th ed.). Chicago: University of Chicago Press.

Lakoff, G., & Johnson, M. (1980). Metaphors We Live By. Chicago: University of Chicago Press.

Lakoff, G., & Nuñez, R. E. (2000). Where mathematics comes from: How embodied mind brings mathematics into being. (Vol. 12).

Lambon Ralph, M. A., Jefferies, E., Patterson, K., & Rogers, T. T. (2017). The neural and computational bases of semantic cognition. Nature Reviews Neuroscience, 18(1), 42–55. https://doi.org/10.1038/nrn.2016.150

Landauer, T. K., & Dumais, S. T. (1997). A solution to Plato's problem: The latent semantic analysis theory of acquisition, induction, and representation of knowledge. Psychological Review, 104(2), 211–240.

Landauer, T. K., Foltz, P. W., & Laham, D. (1998). An introduction to latent semantic analysis. Discourse Processes, 25(2–3), 259–284. https://doi.org/10.1080/01638539809545028

Lawson, R. G., & Jurs, P. C. (1990). New index for clustering tendency and its application to chemical problems. Journal of Chemical Information and Computer Sciences, 30(1), 36-41.

Lebois, L. A. M., Wilson-Mendenhall, C. D., & Barsalou, L. W. (2015). Putting Everything in Context. Cognitive Science, 39(8), 1987–1995. https://doi.org/10.1111/cogs.12295

Lederer, J. (2019). Gesturing the source domain: The role of co-speech gesture in the metaphorical models of gender transition. *Metaphor and the Social World*, *9*(1), 32-58.

Leshinskaya, A., & Caramazza, A. (2016). For a cognitive neuroscience of concepts: Moving beyond the grounding issue. Psychonomic Bulletin & Review, 23(4), 991–1001. https://doi.org/10.3758/s13423-015-0870-z

Levelt, W. J. M. (1989). Speaking. From intention to articulation. Cambridge, MA: The MIT Press.

Levinson, S. C., & Majid, A. (2013). The Island of Time: Yélî Dnye, the Language of Rossel Island. Frontiers in Psychology, 4. https://doi.org/10.3389/fpsyg.2013.00061

Levy, G. D., & Haaf, R. A. (1994). Detection of gender-related categories by 10-month-old infants. Infant Behavior and Development, 17(4), 457–459. https://doi.org/10.1016/0163-6383(94)90037-X

Lewis, J. W. (2006). Cortical Networks Related to Human Use of Tools. The Neuroscientist, 12(3), 211–231. https://doi.org/10.1177/1073858406288327

Lippa, R. (1983). Sex typing and the perception of body outlines. Journal of Personality, 51(4), 667–682. https://doi.org/10.1111/j.1467-6494.1983.tb00873.x

Lorber, J. (1994). Paradoxes of gender. Yale University Press.

Louwerse, M. M. (2008). Embodied relations are encoded in language. Psychonomic Bulletin & Review, 15(4), 838–844. https://doi.org/10.3758/PBR.15.4.838

Louwerse, M. M. (2011). Symbol Interdependency in Symbolic and Embodied Cognition: Topics in Cognitive Science(2010). Topics in Cognitive Science, 3(2), 273–302. https://doi.org/10.1111/j.1756-8765.2010.01106.x

Louwerse, M. M., & Jeuniaux, P. (2010). The linguistic and embodied nature of conceptual processing. Cognition, 114(1), 96–104. https://doi.org/10.1016/j.cognition.2009.09.002

Lynott, D., Connell, L., Brysbaert, M., Brand, J., & Carney, J. (2019). Lancaster Sensorimotor Norms. Preprint.

Machery, E. (2009). Doing without concepts. New York: Oxford University Press.

Machery, E. (2015). By Default: Concepts Are Accessed in a Context-Independent Manner. In E. Margolis & S. Laurence (Eds.), The Conceptual Mind. New Directions in The Study of Concepts. Cambridge, MA: The MIT Press.

Mahon, B. Z., & Caramazza, A. (2008). A critical look at the embodied cognition hypothesis and a new proposal for grounding conceptual content. Journal of Physiology-Paris, 102(1), 59–70. https://doi.org/10.1016/j.jphysparis.2008.03.004

Majid, A. (2002). Frames of Reference and Language Concepts. Trends in Cognitive Sciences, 6, 503–504.

Majid, A., Bowerman, M., Kita, S., Haun, D. B. M., & Levinson, S. C. (2004). Can language restructure cognition? The case for space. Trends in Cognitive Sciences, 8(3), 108–114. https://doi.org/10.1016/j.tics.2004.01.003

Majid, A., Boster, J. S., & Bowerman, M. (2008). The cross-linguistic categorization of everyday events: A study of cutting and breaking. Cognition, 109(2), 235–250. https://doi.org/10.1016/j.cognition.2008.08.009

Majid, A. (2010). Words for Parts of the Body. In B. C. Malt & P. M. Wolff (Eds.), Words and the Mind: How Words Capture Human Experience (pp. 58–69). New York: Oxford University Press.

Majid, A., & Burenhult, N. (2014). Odors are expressible in language, as long as you speak the right language. Cognition, 130(2), 266–270. https://doi.org/10.1016/j.cognition.2013.11.004

Majid, A., Burenhult, N., Stensmyr, M., De Valk, J., & Hansson, B. S. (2018). Olfactory language and abstraction across cultures. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1752), 20170139.

Majid, A., Roberts, S. G., Cilissen, L., Emmorey, K., Nicodemus, B., O'Grady, L., … Levinson, S. C. (2018). Differential coding of perception in the world's languages. Proceedings of the National Academy of Sciences, 115(45), 11369–11376. https://doi.org/10.1073/pnas.1720419115

Makris, S., Hadar, A. A., & Yarrow, K. (2011). Viewing objects and planning actions: On the potentiation of grasping behaviours by visual objects. Brain and Cognition, 77(2), 257–264. https://doi.org/10.1016/j.bandc.2011.08.002

Malt, B. C., Sloman, S. A., Gennari, S., Shi, M., & Wang, Y. (1999). Knowing versus Naming: Similarity and the Linguistic Categorization of Artifacts. Journal of Memory and Language, 40(2), 230–262. https://doi.org/10.1006/jmla.1998.2593

Malt, B., & Wolff, P. M. (2010). Words and the Mind: How words capture human experience. Oxford University Press, USA.

Malt, B. C., & Majid, A. (2013). How thought is mapped into words. Wiley Interdisciplinary Reviews: Cognitive Science, 4(6), 583–597. https://doi.org/10.1002/wcs.1251

Margolis, E., & Laurence, S. (1999). Concepts: Core Readings. Cambridge, MA: MIT Press.

Margolis, E., & Laurence, S. (2015). The Conceptual Mind. New Directions in the Study of Concepts. Cambridge, MA: The MIT Press.

Marques, J. F. (2006). Specialization and semantic organization: Evidence for multiple semantics linked to sensory modalities. Memory & Cognition, 34(1), 60–67. https://doi.org/10.3758/BF03193386

Martin, A., & Chao, L. L. (2001). Semantic memory and the brain: Structure and processes. Current Opinion in Neurobiology, 11(2), 194–201. https://doi.org/10.1016/S0959-4388(00)00196-3

Matheson, H. E., & Barsalou, L. W. (2018). Embodiment and Grounding in Cognitive Neuroscience. In Stevens' Handbook of Experimental Psychology and Cognitive Neuroscience (pp. 1–27). https://doi.org/10.1002/9781119170174.epcn310

Matsuno, E., & Budge, S. L. (2017). Non-binary/Genderqueer Identities: A Critical Review of the Literature. Current Sexual Health Reports, 9(3), 116–120. https://doi.org/10.1007/s11930-017-0111-8

Mauss, M. (1966). The gift: Forms and functions of exchange in archaic societies. London: Cohen & West.

Mazzuca, C., Barca, L., & Borghi, A. M. (2017). The Peculiarity of Emotional Words: A Grounded Approach. Rivista Internazionale Di Filosofia e Psicologia, 8(2), 124–133. https://doi.org/10.4453/rifp.2017.0010

Mazzuca, C., Lugli, L., Benassi, M., Nicoletti, R., & Borghi, A. M. (2018). Abstract, emotional and concrete concepts and the activation of mouth-hand effectors. PeerJ, 6, e5987

Mazzuca, C., & Borghi, A. M. (2019). Abstract concepts and the activation of mouth-hand effectors. In M. Bolognesi & G. Steen (Eds.), Perspectives on abstract concepts: From cognitive processing to semantic representations. Amsterdam: Benjamins Publishing Company.

McCloskey, M. E., & Glucksberg, S. (1978). Natural categories: Well defined or fuzzy sets? Memory & Cognition, 6(4), 462–472. https://doi.org/10.3758/BF03197480

McCloskey, M. E., & Glucksberg, S. (1979). Decision processes in verifying category membership statements: Implications for models of semantic memory. Cognitive Psychology, 11(1), 1–37. https://doi.org/10.1016/0010-0285(79)90002-1

McLemore, K. A. (2015). Experiences with Misgendering: Identity Misclassification of Transgender Spectrum Individuals. Self and Identity, 14(1), 51–74. https://doi.org/10.1080/15298868.2014.950691

McRae, K., Cree, G. S., Seidenberg, M. S., & McNorgan, C. (2005). Semantic feature production norms for a large set of living and nonliving things. Behavior Research Methods, 37(4), 547-559.

Medin, D. L., & Schaffer, M. M. (1978). Context theory of classification learning. Psychological Review, 85(3), 207–238. https://doi.org/10.1037/0033-295X.85.3.207

Meier, B. P., Robinson, M. D., & Clore, G. L. (2004). Why Good Guys Wear White: Automatic Inferences About Stimulus Valence Based on Brightness. Psychological Science, 15(2), 82–87. https://doi.org/10.1111/j.0963-7214.2004.01502002.x

Meier, B. P., Hauser, D. J., Robinson, M. D., Friesen, C. K., & Schjeldahl, K. (2007). What's "up" with God? Vertical space as a representation of the divine. Journal of Personality and Social Psychology, 93(5), 699–710. https://doi.org/10.1037/0022-3514.93.5.699

Mellem, M. S., Jasmin, K. M., Peng, C., & Martin, A. (2016). Sentence processing in anterior superior temporal cortex shows a social-emotional bias. Neuropsychologia, 89, 217–224. https://doi.org/10.1016/j.neuropsychologia.2016.06.019

Merleau-Ponty, M. (1962). Phenomenology of Perception. Routledge.

Mervis, C. B., Catlin, J., & Rosch, E. H. (1976). Relationships among goodness-of-example, category norms, and word frequency. Bulletin of the Psychonomic Society, 7(3), 283–284.

Meteyard, L., Cuadrado, S. R., Bahrami, B., & Vigliocco, G. (2012). Coming of age: A review of embodiment and the neuroscience of semantics. Cortex, 48(7), 788–804. https://doi.org/10.1016/j.cortex.2010.11.002

Misersky, J., Majid, A., & Snijders, T. M. (2019) Grammatical Gender in German Influences How Role-Nouns Are Interpreted: Evidence from ERPs. *Discourse Processes*, 56(8), 643-654, DOI: 10.1080/0163853X.2018.1541382

Money, J., & Ehrhardt, A. A. (1972). Man and Woman, Boy and Girl. Baltimore, MD: Johns Hopkins University Press.

Morsella, E., & Miozzo, M. (2002). Evidence for a cascade model of lexical access in speech production. Journal of Experimental Psychology: Learning, Memory, and Cognition, 28(3), 555–563. https://doi.org/10.1037/0278-7393.28.3.555

Moseley, R., Carota, F., Hauk, O., Mohr, B., & Pulvermüller, F. (2012). A Role for the Motor System in Binding Abstract Emotional Meaning. Cerebral Cortex, 22(7), 1634–1647. https://doi.org/10.1093/cercor/bhr238

Motschenbacher, H. (2019). Language and sexual normativity. In: R. Barrett & K. Hall (Eds.), *Oxford Handbook of Language and Sexuality*. Oxford: Oxford University Press, in press.

Mueller, S. C., De Cuypere, G., & T'Sjoen, G. (2017). Transgender Research in the 21st Century: A Selective Critical Review From a Neurocognitive Perspective. American Journal of Psychiatry, 174(12), 1155–1162. https://doi.org/10.1176/appi.ajp.2017.17060626

Murphy, G. L., & Medin, D. L. (1985). The Role of Theories in Conceptual Coherence. Psychological Review, 92(3), 28.

Murphy, G. L. (2002). The big book of concepts. Cambridge, MA: The MIT Press.

Murphy, G. L. (2016). Is there an exemplar theory of concepts? Psychonomic Bulletin & Review, 23(4), 1035–1042. https://doi.org/10.3758/s13423-015-0834-3

Murtagh, F. and Legendre, P. (2014). Ward's hierarchical agglomerative clustering method: which algorithms implement Ward's criterion? Journal of Classification, 31, 274–295. doi: 10.1007/s00357-014-9161-z.

Nagel, T. (1974). What Is It Like to Be a Bat? The Philosophical Review, 83(4), 435–450. https://doi.org/10.2307/2183914

Navarrete, E., & Costa, A. (2005). Phonological activation of ignored pictures: Further evidence for a cascade model of lexical access. Journal of Memory and Language, 53(3), 359–377. https://doi.org/10.1016/j.jml.2005.05.001

Neininger, B. & Pulvermüller, F. (2003). Word-category specific deficits after lesions in the right emisphere. Neuropsychologia, 41(1), 53-70.

Newcombe, P. I., Campbell, C., Siakaluk, P. D., & Pexman, P. M. (2012). Effects of emotional and sensorimotor knowledge in semantic processing of concrete and abstract nouns. Frontiers in Human Neuroscience, 6.

Newell, A., & Simon, H. A. (1972). Human problem solving (Vol. 104). Englewood Cliffs, NJ: Prentice-Hall.

Newell, A., & Simon, H. A. (1981). Computer science as empirical inquiry: Symbols and search. Communications of the Association for Computing Machinery, 19, 113–126.

Newell, A. (1980). Physical symbol systems. Cognitive Science, 4(2), 135–183.

Nicholson, L. (1994). Interpreting Gender. Signs, 20(1), 79–105.

Nosofsky, R. M. (1984). Choice, similarity, and the context theory of classification. Journal of Experimental Psychology: Learning, Memory, and Cognition, 10(1), 104–114. https://doi.org/10.1037/0278-7393.10.1.104

Núñez, R. E., & Sweetser, E. (2006). With the Future Behind Them: Convergent Evidence From Aymara Language and Gesture in the Crosslinguistic Comparison of Spatial Construals of Time. Cognitive Science, 30(3), 401–450. https://doi.org/10.1207/s15516709cog0000_62

O'Regan, J. K., & Noë, A. (2001). A sensorimotor account of vision and visual consciousness. Behavioral and Brain Sciences, 24(5), 939–973. https://doi.org/10.1017/S0140525X01000115

Oh, D., Dotsch, R., Porter, J., & Todorov, A. (2019). Gender biases in impressions from faces: Empirical studies and computational models. Journal of Experimental Psychology: General.. https://doi.org/10.1037/xge0000638

Oldfield, R. C. (1971). The assessment and analysis of handedness: the Edinburgh inventory. Neuropsychologia, 9(1), 97-113.

Olson, I. R., Plotzker, A., & Ezzyat, Y. (2007). The Enigmatic temporal pole: A review of findings on social and emotional processing. Brain, 130(7), 1718–1731. https://doi.org/10.1093/brain/awm052

Olson, I. R., McCoy, D., Klobusicky, E., & Ross, L. A. (2013). Social cognition and the anterior temporal lobes: A review and theoretical framework. Social Cognitive and Affective Neuroscience, 8(2), 123–133. https://doi.org/10.1093/scan/nss119

Olson, K. R., Key, A. C., & Eaton, N. R. (2015). Gender Cognition in Transgender Children. Psychological Science, 26(4), 467–474. https://doi.org/10.1177/0956797614568156

Orwell, G. (1949). Nineteen eighty-four. A novel. London: Secker & Warburg.

Osgood, C. E. (1952). The Nature and Measurement of Meaning. Psychological Bulletin, 49(3), 197–237.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). The measurment of meaning. Urbana IL: University of Illinois Press.

Osgood, C. E., May, W. H., & Miron, M. S. (1975). Cross-cultural universals in affective meaning. Urbana IL: University of Illinois Press.

Paivio, A. (1986). Mental Representations: A dual coding approach. New York: Oxford University Press.

Paivio, A. (1991). Dual coding theory: Retrospect and current status. Canadian Journal of Psychology/Revue Canadienne de Psychologie, 45(3), 255–287. https://doi.org/10.1037/h0084295

Paoletti, J. B. (1987). Clothing and Gender in America: Children's Fashions, 1890-1920. Signs: Journal of Women in Culture and Society, 13(1), 136–143. https://doi.org/10.1086/494390

Papafragou, A., Hulbert, J., & Trueswell, J. (2008). Does language guide event perception? Evidence from eye movements. Cognition, 108(1), 155-84.

Papies, E. K. (2013). Tempting food words activate eating simulations. Frontiers in Psychology, 4. https://doi.org/10.3389/fpsyg.2013.00838

Patterson, K., Nestor, P. J., & Rogers, T. T. (2007). Where do you know what you know? The representation of semantic knowledge in the human brain. Nature Reviews Neuroscience, 8(12), 976–987. https://doi.org/10.1038/nrn2277

Pecher, D., Zeelenberg, R., & Barsalou, L. W. (2003). Verifying Different-Modality Properties for Concepts Produces Switching Costs. Psychological Science, 14(2), 119–124.

Pecher, D., Zeelenberg, R., & Barsalou, L. W. (2004). Sensorimotor simulations underlie conceptual representations: Modality-specific effects of prior activation. Psychonomic Bulletin & Review, 11(1), 164–167. https://doi.org/10.3758/BF03206477

Pederson, E., Danziger, E., Wilkins, D., Levinson, S., Kita, S., & Senft, G. (1998). Semantic typology and spatial conceptualization. Language, 74(3), 557–589. https://doi.org/10.1353/lan.1998.0074

Penn, D. J., Oberzaucher, E., Grammer, K., Fischer, G., Soini, H. A., Wiesler, D., Brereton, R. G. (2007). Individual and gender fingerprints in human body odour. Journal of The Royal Society Interface, 4(13), 331–340. https://doi.org/10.1098/rsif.2006.0182

Pesciarelli, F., Scorolli, C., & Cacciari, C. (2019). Neural correlates of the implicit processing of grammatical and stereotypical gender violations: a masked and unmasked priming study. *Biological Psychology*, *146*.

Petersen, J. L., & Hyde, J. S. (2011). Gender Differences in Sexual Attitudes and Behaviors: A Review of Meta-Analytic Results and Large Datasets. The Journal of Sex Research, 48(2–3), 149–165. https://doi.org/10.1080/00224499.2011.551851

Pezzulo, G., Barsalou, L. W., Cangelosi, A., Fischer, M. H., Spivey, M., & McRae, K. (2011). The Mechanics of Embodiment: A Dialog on Embodiment and Computational Modeling. Frontiers in Psychology, 2. https://doi.org/10.3389/fpsyg.2011.00005

Phillips, W., & Boroditsky, L. (2003). Can quirks of grammar affect the way you think? Grammatical gender and object concepts. Proceedings of the Annual Meeting of the Cognitive Science Society, 25.

Pinker, S. (1994). The Language Instinct: How the Mind Creates Language. New York: Harper.

Pobric, G., Lambon Ralph, M. A., & Zahn, R. (2015). Hemispheric Specialization within the Superior Anterior Temporal Cortex for Social and Nonsocial Concepts. Journal of Cognitive Neuroscience, 28(3), 351–360. https://doi.org/10.1162/jocn_a_00902

Ponari, M., Norbury, C., & Vigliocco, G. (2018). Acquisition of abstract concepts is influenced by emotional valence. (21). Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1111/desc.12549

Poulin-Dubois, D., Serbin, L. A., Eichstedt, J. A., Sen, M. G., & Beissel, C. F. (2002). Men Don’t Put on Make-up: Toddlers’ Knowledge of the Gender Stereotyping of Household Activities. Social Development, 11(2), 166–181. https://doi.org/10.1111/1467-9507.00193

Prinz, J. (2002). Furnishing the Mind. Cambridge, MA: The MIT Press.

Prinz, J. (2010). Can Concept Empiricism Forestall Eliminativism? Mind & Language, 25(5), 612–621. https://doi.org/10.1111/j.1468-0017.2010.01404.x

Prinz, J. (2012). Beyond Human Nature: How Culture and Experience Shape Our Lives. London: Penguin Group.

Pullum, G. K. (1991). The Great Eskimo Vocabulary Hoax and Other Irreverent Essays on the Study of Study of Language. Chicago: University of Chicago Press.

Pulvermüller, F. (2005). Brain mechanisms linking language and action. Nature Reviews Neuroscience, 6(7), 576–582. https://doi.org/10.1038/nrn1706

Pulvermüller, F., Hauk, O., Nikulin, V. V., & Ilmoniemi, R. J. (2005). Functional links between motor and language systems. European Journal of Neuroscience, 21(3), 793–797. https://doi.org/10.1111/j.1460-9568.2005.03900.

Pulvermüller, F. (2018). Neurobiological Mechanisms for Semantic Feature Extraction and Conceptual Flexibility. Topics in Cognitive Science, 10(3), 590–620. https://doi.org/10.1111/tops.12367

Putnam, H. (1973). Meaning and reference. Journal of Philosophy, 70(19), 699–711.

Pylyshyn, Z. (1985). Computation and Cognition. Cambridge, MA: The MIT Press.

Pylyshyn, Z. W. (1973). What the mind's eye tells the mind's brain: A critique of mental imagery. Psychological Bulletin, 80(1), 1–24. https://doi.org/10.1037/h0034650

Pylyshyn, Z. W. (1980). Computation and cognition: Issues in the foundation of cognitive science. Behavioral and Brain Sciences, 3(1), 111–132.

R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Recchia, G., & Jones, M. N. (2012). The semantic richness of abstract concepts. Frontiers in Human Neuroscience, 6.

Regier, T., & Kay, P. (2009). Language, thought, and color: Whorf was half right. Trends in Cognitive Sciences, 13(10), 439-446.

Reines, M. F., & Prinz, J. (2009). Reviving Whorf: The Return of Linguistic Relativity. Philosophy Compass, 4(6), 1022–1032. https://doi.org/10.1111/j.1747-9991.2009.00260.x

Rey, G. (1983). Concepts and stereotypes. Cognition, 15(1–3), 237–262.

Rice, G. E., Hoffman, P., Binney, R. J., & Lambon Ralph, M. A. (2018). Concrete versus abstract forms of social concept: An fMRI comparison of knowledge about people versus social terms. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1752), 20170136. https://doi.org/10.1098/rstb.2017.0136

Richards, C., Bouman, W. P., Seal, L., Barker, M. J., Nieder, T. O., & T'Sjoen, G. (2016). Non-binary or genderqueer genders. International Review of Psychiatry, 28(1), 95–102. https://doi.org/10.3109/09540261.2015.1106446

Rips, L. J. (1989). Similarity, typicality, and categorization. In S. Vosniadu & A. Ortony (Eds.), Similarity, analogy, and thought (pp. 21–59). Cambridge, UK: Cambridge University Press.

Rips, L. J. (1995). The Current Status of Research on Concept Combination. Mind & Language, 10(1–2), 72–104. https://doi.org/10.1111/j.1468-0017.1995.tb00006.x

Risman, B. J. (2004). Gender As a Social Structure: Theory Wrestling with Activism. Gender & Society, 18(4), 429–450. https://doi.org/10.1177/0891243204265349

Rizzolatti, G., Fadiga, L., Gallese, V., & Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. Cognitive Brain Research, 3(2), 131–141. https://doi.org/10.1016/0926-6410(95)00038-0

Rizzolatti, G., & Fadiga, L. (1998). Grasping objects and grasping action meanings: The dual role of monkey rostroventral premotor cortex (area F5). 91–94. Wiley.

Rizzolatti, G., Fogassi, L., & Gallese, V. (2000). Cortical mechanisms subserving object grasping and action recognition: A new view on the cortical motor functions. The New Cognitive Neurosciences, 2, 539–552.

Rizzolatti, G., & Craighero, L. (2004). The Mirror-Neuron System. Annual Review of Neuroscience, 27(1), 169–192. https://doi.org/10.1146/annurev.neuro.27.070203.144230

Roberson, D., Davidoff, J., Davies, I. R., & Shapiro, L. R. (2005). Color categories: Evidence for the cultural relativity hypothesis. Cognitive psychology, 50(4), 378-411.

Rosch, E. H. (1973). Natural categories. Cognitive Psychology, 4(3), 328–350. https://doi.org/10.1016/0010-0285(73)90017-0

Rosch, E. H. (1975). Cognitive representations of semantic categories. Journal of Experimental Psychology: General, 104(3), 192–233.

Rosch, E. H., & Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. Cognitive Psychology, 7(4), 573–605. https://doi.org/10.1016/0010-0285(75)90024-9

Rosch, E., Simpson, C., & Miller, R. S. (1976). Structural bases of typicality effects. Journal of Experimental Psychology: Human Perception and Performance, 2(4), 491–502. https://doi.org/10.1037/0096-1523.2.4.491

Ross, L. A., & Olson, I. R. (2010). Social Cognition and the Anterior Temporal Lobes. NeuroImage, 49(4), 3452. https://doi.org/10.1016/j.neuroimage.2009.11.012

Roughgarden, J. (2004). Evolution's Rainbow. Diversity, Gender and Sexuality in Nature and People. Berkeley: University of California Press.

Roversi, C., Borghi, A. M., & Tummolini, L. (2013). A Marriage is an Artefact and not a Walk that We Take Together: An Experimental Study on the Categorization of Artefacts. Review of Philosophy and Psychology, 4(3), 527–542. https://doi.org/10.1007/s13164-013-0150-7

RStudio Team (2018). RStudio: Integrated Development for R. RStudio, Inc., Boston, MA URL http://www.rstudio.com/.

Rubin, G. S. (1975). The Traffic in Women: Notes on the "Political Economy" of Sex. In R. Reiter (Ed.), Toward an Anthropology of Women. New York: Monthly Review Press.

Sakreida, K., Scorolli, C., Menz, M. M., Heim, S., Borghi, A. M., & Binkofski, F. (2013). Are abstract action words embodied? An fMRI investigation at the interface between language and motor cognition. Frontiers in Human Neuroscience, 7. https://doi.org/10.3389/fnhum.2013.00125

Samuel, S., Cole, G., & Eacott, M. J. (2019). Grammatical gender and linguistic relativity: A systematic review. *Psychonomic Bulletin & Review*. https://doi.org/10.3758/s13423-019-01652-3

San Roque, L., Kendrick, K. H., Norcliffe, E., Brown, P., Defina, R., Dingemanse, M., … Majid, A. (2014). Vision verbs dominate in conversation across cultures, but the ranking of non-visual verbs varies. Cognitive Linguistics, 26(1), 31–60. https://doi.org/10.1515/cog-2014-0089

Sapir, E. (1929). The Status of Linguistics as a Science. Language, 5(4), 207–214. https://doi.org/10.2307/409588

Savin-Williams, R. C. (2016). Sexual orientation: Categories or continuum? Commentary on Bailey et al.(2016). *Psychological Science in the Public Interest*, *17*(2), 37-44.

Schwanenflugel, P. J., Harnishfeger, K. K., & Stowe, R. W. (1988). Context availability and lexical decisions for abstract and concrete words. Journal of Memory and Language, 27(5), 499–520. https://doi.org/10.1016/0749-596X(88)90022-8

Schwanenflugel, P. J., Akin, C., & Luh, W.-M. (1992). Context availability and the recall of abstract and concrete words. Memory & Cognition, 20(1), 96–104. https://doi.org/10.3758/BF03208259

Scorolli, C., & Borghi, A. M. (2007). Sentence comprehension and action: Effector specific modulation of the motor system. Brain Research, 1130, 119–124. https://doi.org/10.1016/j.brainres.2006.10.033

Scorolli, C. (2014). Embodiment and language. In Routledge Handbooks in Philosophy. The Routledge handbook of embodied cognition (pp. 127–138). New York, NY, US: Routledge/Taylor & Francis Group.

Scott, J. W. (1986). Gender: A Useful Category of Historical Analysis. The American Historical Review, 91(5), 1053–1075. https://doi.org/10.4324/9780203966105-16

Scott, J. W. (1988). Deconstructing Equality-Versus-Difference: Or, the Uses of Post-structuralist Theory for Feminism. Feminist Studies; College Park, Md., 14(1).

Searle, J. R. (1980). Minds, brains, and programs. Behavioral and Brain Sciences, 3(3), 417–457.

Searle, J. R. (1989). How performatives work. Linguistics and Philosophy, 12(5), 535–558. https://doi.org/10.1007/BF00627773

Searle, J. (1995). The Construction of Social Reality. New York: The Free Press.

Sebastián-Enesco, C., & Semin, G. R. (2019). The brightness dimension as a marker of gender across cultures and age. Psychological Research. https://doi.org/10.1007/s00426-019-01213-2

Selmi, G. (2015). Chi ha paura della libertà? La così detta ideologia del gender sui banchi di scuola. AG About Gender, Rivista internazionale di studi di genere, 4(7).

Semin, G. R., & Palma, T. A. (2014). Why the bride wears white: Grounding gender with brightness. Journal of Consumer Psychology, 24(2), 217–225. https://doi.org/10.1016/j.jcps.2013.09.003

Semin, G. R., Palma, T., Acartürk, C., & Dziuba, A. (2018). Gender is not simply a matter of black and white, or is it? Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1752), 20170126. https://doi.org/10.1098/rstb.2017.0126

Sera, M. D., Elieff, C., Forbes, J., Burch, M. C., Rodríguez, W., & Dubois, D. P. (2002). When language affects cognition and when it does not: An analysis of grammatical gender and classification. Journal of Experimental Psychology: General, 131(3), 377–397. https://doi.org/10.1037//0096-3445.131.3.377

Serbin, L. A., Poulin-Dubois, D., Colburne, K. A., Sen, M. G., & Eichstedt, J. A. (2001). Gender stereotyping in infancy: Visual preferences for and knowledge of gender-stereotyped toys in the second year. International Journal of Behavioral Development, 25(1), 7–15. https://doi.org/10.1080/01650250042000078

Serbin, L. A., Poulin-Dubois, D., & Eichstedt, J. A. (2002). Infants' Responses to Gender-Inconsistent Events. Infancy, 3(4), 531–542. https://doi.org/10.1207/S15327078IN0304_07

Setti, A., & Caramelli, N. (2005). Different Domains in Abstract Concepts. XXVII Annual Conference of Cognitive Science Society, 7.

Shallice, T., & Cooper, R. P. (2013). Is there a semantic system for abstract words? Frontiers in Human Neuroscience, 7. https://doi.org/10.3389/fnhum.2013.00175

Shapiro, L. (2011). Embodied Cognition. Routledge.

Shea, N. (2018). Metacognition and abstract concepts. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1752), 20170133. https://doi.org/10.1098/rstb.2017.0133

Short, T. L. (2007). Peirce's Theory of Signs. Cambridge, MA: Cambridge University Press

Siakaluk, P. D., Newcombe, P. I., Duffels, B., Li, E., Sidhu, D. M., Yap, M. J., & Pexman, P. M. (2016). Effects of Emotional Experience in Lexical Decision. Frontiers in Psychology, 7, 1157.

Simmons, W. K., Martin, A., & Barsalou, L. W. (2005). Pictures of Appetizing Foods Activate Gustatory Cortices for Taste and Reward. Cerebral Cortex, 15(10), 1602–1608. https://doi.org/10.1093/cercor/bhi038

Simmons, W. K., Hamann, S. B., Harenski, C. L., Hu, X. P., & Barsalou, L. W. (2008). FMRI evidence for word association and situated simulation in conceptual processing. Journal of Physiology-Paris, 102(1), 106–119. https://doi.org/10.1016/j.jphysparis.2008.03.014

Simmons, W. K., & Martin, A. (2009). The anterior temporal lobes and the functional architecture of semantic memory. Journal of the International Neuropsychological Society : JINS, 15(5), 645–649. https://doi.org/10.1017/S1355617709990348

Singh, D. (1993). Adaptive significance of female physical attractiveness: Role of waist-to-hip ratio. Journal of Personality and Social Psychology, 65(2), 293–307.

Slaby, R. G., & Frey, K. S. (1975). Development of Gender Constancy and Selective Attention to Same-Sex Models. Child Development, 46(4), 849–856. https://doi.org/10.2307/1128389

Slobin, D. I. (1996). From "thought and language" to "thinking for speaking". In J. J. Gumperz & S. C. Levinson (Eds.), Rethinking Linguistic Relativity (pp. 70–96). Cambridge: Cambridge University Press.

Sloutsky, V. M. (2003). The role of similarity in the development of categorization. Trends in Cognitive Sciences, 7(6), 246–251. https://doi.org/10.1016/S1364-6613(03)00109-8

Smith, E. E., Shoben, E. J., & Rips, L. J. (1974). Structure and process in semantic memory: A featural model for semantic decisions. Psychological Review, 81(3), 214–241.

Smith, E. E., & Medin, D. L. (1981). Categories and concepts. Cambridge, MA: Harvard University Press.

Smith, E. E. (1989). Three Distinctions about Concepts and Categorization. Mind & Language, 4(1–2), 57–61. https://doi.org/10.1111/j.1468-0017.1989.tb00241.

Smolensky, P. (1988). On the proper treatment of connectionism. Behavioral and Brain Sciences, 11(1), 1-23.

Solomon, K. O., & Barsalou, L. W. (2001). Representing Properties Locally. Cognitive Psychology, 43(2), 129–169. https://doi.org/10.1006/cogp.2001.0754

Solomon, K. O., & Barsalou, L. W. (2004). Perceptual simulation in property verification. Memory & Cognition, 32(2), 244–259. https://doi.org/10.3758/BF03196856

Speed, L. J., & Majid, A. (2019). Grounding language in the neglected senses of touch, taste, and smell. Cognitive Neuropsychology, 1–30. https://doi.org/10.1080/02643294.2019.1623188

Spence, J. T., & Buckner, C. (1995). Masculinity and femininity: Defining the undefinable. Gender, power, and communication in human relationships, 105-138.

Spence, J. T., & Buckner, C. E. (2000). Instrumental and expressive traits, trait stereotypes, and sexist attitueds. What do they signify? Psychology of Women Quarterly, 24(1), 44–62. https://doi.org/10.1111/j.1471-6402.2000.tb01021.x

Stanfield, R. A., & Zwaan, R. A. (2001). The Effect of Implied Orientation Derived from Verbal Context on Picture Recognition. Psychological Science, 12(2), 153–156. https://doi.org/10.1111/1467-9280.00326

Stangor, C., Lynch, L., Duan, C., & Glas, B. (1992). Categorization of individuals on the basis of multiple social features. Journal of Personality and Social Psychology, 62(2), 207.

Stern, C., & Rule, N. O. (2018). Physical Androgyny and Categorization Difficulty Shape Political Conservatives' Attitudes Toward Transgender People. Social Psychological and Personality Science, 9(1), 24–31. https://doi.org/10.1177/1948550617703172

Sullivan, N. (2003). A Critical Introduction to Queer Theory. New York: New York University Press.

Sutherland, C. A. M., Young, A. W., Mootz, C. A., & Oldmeadow, J. A. (2015). Face gender and stereotypicality influence facial trait evaluation: Counter-stereotypical female faces are negatively evaluated. British Journal of Psychology, 106(2), 186–208. https://doi.org/10.1111/bjop.12085

Sutherland, C. A. M., Oldmeadow, J. A., & Young, A. W. (2016). Integrating social and facial models of person perception: Converging and diverging dimensions. Cognition, 157, 257–267. https://doi.org/10.1016/j.cognition.2016.09.006

Tavits, M., & Pérez, E. O. (2019). Language influences mass opinion toward gender and LGBT equality. Proceedings of the National Academy of Sciences, 116(34), 16781–16786. https://doi.org/10.1073/pnas.1908156116

Taylor, L. J., & Zwaan, R. A. (2009). Action in cognition: The case of language. Language and Cognition, 1(1), 45–58. https://doi.org/10.1515/LANGCOG.2009.003

Team, R. C. (2017). R: A language and environment for statistical com-puting. R Foundation for Statistical Computing, Vienna, Austria. URL https://www. R-project. org.

Tettamanti, M., Buccino, G., Saccuman, M. C., Gallese, V., Danna, M., Scifo, P., Perani, D. (2005). Listening to Action-related Sentences Activates Fronto-parietal Motor Circuits. Journal of Cognitive Neuroscience, 17(2), 273–281. https://doi.org/10.1162/0898929053124965

Thill, S., & Twomey, K. E. (2016). What's on the inside counts: A grounded account of concept acquisition and development. Frontiers in Psychology, 7.

Tomasino, B., & Rumiati, R. I. (2013). Introducing the special topic “The when and why of sensorimotor processes in conceptual knowledge and abstract concepts”. Frontiers in Human Neuroscience, 7.

Topolinski, S., & Strack, F. (2009). Motormouth: mere exposure depends on stimulus-specific motor simulations. Journal of Experimental Psychology: Learning, Memory, and Cognition, 35(2), 423.

Topolinski, S., Maschmann, I. T., Pecher, D., & Winkielman, P. (2014). Oral approach–avoidance: Affective consequences of muscular articulation dynamics. Journal of Personality and Social Psychology, 106(6), 885.

Troche, J., Crutch, S., & Reilly, J. (2014). Clustering, hierarchical organization, and the topography of abstract and concrete nouns. Frontiers in Psychology, 5. https://doi.org/10.3389/fpsyg.2014.00360

Troche, J., Crutch, S. J., & Reilly, J. (2017). Defining a Conceptual Topography of Word Concreteness: Clustering Properties of Emotion, Sensation, and Magnitude among 750 English Words. Frontiers in Psychology, 8. https://doi.org/10.3389/fpsyg.2017.01787

Tschentscher, N., Hauk, O., Fischer, M. H., & Pulvermüller, F. (2012). You can count on the motor cortex: Finger counting habits modulate motor cortex activation evoked by numbers. NeuroImage, 59(4), 3139–3148. https://doi.org/10.1016/j.neuroimage.2011.11.037

Tucker, M., & Ellis, R. (1998). On the relations between seen objects and components of potential actions. Journal of Experimental Psychology: Human Perception and Performance, 24(3), 830–846. https://doi.org/10.1037/0096-1523.24.3.830

Tucker, M., & Ellis, R. (2001). The potentiation of grasp types during visual object categorization. Visual Cognition, 8(6), 769–800. https://doi.org/10.1080/13506280042000144

Tucker, M., & Ellis, R. (2004). Action priming by briefly presented objects. Acta Psychologica, 116(2), 185–203. https://doi.org/10.1016/j.actpsy.2004.01.004

Tversky, A. (1977). Features of similarity. Psychological Review, 84(4), 327–352.

Umiltà, M. A., Escola, L., Intskirveli, I., Grammont, F., Rochat, M., Caruana, F., Rizzolatti, G. (2008). When pliers become fingers in the monkey motor system. Proceedings of the National Academy of Sciences, 105(6), 2209–2213. https://doi.org/10.1073/pnas.0705985105

Vakoch, D. A. (1998). Signs of Life beyond Earth: A Semiotic Analysis of Interstellar Messages. Leonardo, 31(4), 313–319. https://doi.org/10.2307/1576671

van Anders, S. M., & Watson, N. V. (2006). Social neuroendocrinology. Human Nature, 17(2), 212–237. https://doi.org/10.1007/s12110-006-1018-7 van Anders, S. M., & Watson, N. V. (2007). Effects of ability- and chance-determined competition outcome on testosterone. Physiology & Behavior, 90(4), 634–642. https://doi.org/10.1016/j.physbeh.2006.11.017

van Anders, S. M., Goldey, K. L., & Kuo, P. X. (2011). The Steroid/Peptide Theory of Social Bonds: Integrating testosterone and peptide responses for classifying social behavioral contexts. Psychoneuroendocrinology, 36(9), 1265–1275. https://doi.org/10.1016/j.psyneuen.2011.06.001

van Anders, S. M. (2015). Beyond Sexual Orientation: Integrating Gender/Sex and Diverse Sexualities via Sexual Configurations Theory. Archives of Sexual Behavior, 44(5), 1177–1213. https://doi.org/10.1007/s10508-015-0490-8

Van Dantzig, S., Pecher, D., Zeelenberg, R., & Barsalou, L. W. (2008). Perceptual Processing Affects Conceptual Processing. Cognitive Science, 32, 579–590.

Varela, F., Thompson, E., & Rosch, E. (1991). The Embodied Mind: Cognitive Science and Human Experience. MIT Press.

Vermeulen, N., Niedenthal, P. M., & Luminet, O. (2007). Switching Between Sensory and Affective Systems Incurs Processing Costs. Cognitive Science, 31(1), 183–192. https://doi.org/10.1080/03640210709336990

Vigliocco, G., Vinson, D. P., Paganelli, F., & Dworzynski, K. (2005). Grammatical Gender Effects on Cognition: Implications for Language Learning and Language Use. Journal of Experimental Psychology: General, 134(4), 501–520. https://doi.org/10.1037/0096-3445.134.4.501

Vigliocco, G., Meteyard, L., Andrews, M., & Kousta, S.-T. (2009). Toward a theory of semantic representation. Language and Cognition, 1(2), 219–247. https://doi.org/10.1515/LANGCOG.2009.011

Villani, C., Lugli, L., Liuzza, M. T., & Borghi, A. M. (2019). Varieties of abstract concepts and their multiple dimensions. Language and Cognition, 11(3), 403–430. https://doi.org/10.1017/langcog.2019.23

Wade, N. (1977). NASA Bans Sex from Outer Space. Science, 197(4309), 1163–1165.

Wallentin, M. (2009). Putative sex differences in verbal abilities and language cortex: A critical review. Brain and Language, 108(3), 175-183.

Wang, J., Conder, J. A., Blitzer, D. N., & Shinkareva, S. V. (2010). Neural representation of abstract and concrete concepts: A meta-analysis of neuroimaging studies. Human Brain Mapping, 31(10), 1459–1468. https://doi.org/10.1002/hbm.20950

Wang, X., Wu, W., Ling, Z., Xu, Y., Fang, Y., Wang, X., ... & Bi, Y. (2017). Organizational Principles of Abstract Words in the Human Brain. Cerebral Cortex, 1-14.

Wauters, L. N., Tellings, A. E. J. M., Bon, W. H. J. V., & Haaften, A. W. V. (2003). Mode of acquisition of word meanings: The viability of a theoretical construct. Applied Psycholinguistics, 24(3), 385–406. https://doi.org/10.1017/S0142716403000201

Weiskopf, D. A. (2009). The plurality of concepts. Synthese, 169(1), 145. https://doi.org/10.1007/s11229-008-9340-8

Weiss, E. M., Siedentopf, C., Hofer, A., Deisenhammer, E. A., Hoptman, M. J., Kremser, C., & Delazer, M. (2003). Brain activation pattern during a verbal fluency test in healthy male and female volunteers: a functional magnetic resonance imaging study. Neuroscience Letters, 352(3), 191-194.

Wenzlaff, F., Briken, P., & Dekker, A. (2018). If there's a penis, it's most likely a man: Investigating the social construction of gender using eye tracking. PLOS ONE, 13(3), e0193616. https://doi.org/10.1371/journal.pone.0193616

Whorf, B. L. (1956). Language, thought, and reality: Selected writings of Benjamin Lee Whorf. (J. B. Carroll, Ed.). Oxford, England: Technology Press of MIT.

Wiemer-Hastings, K., & Xu, X. (2005). Content Differences for Abstract and Concrete Concepts. Cognitive Science, 29(5), 719–736. https://doi.org/10.1207/s15516709cog0000_33

Wild, H. A., Barrett, S. E., Spence, M. J., O'Toole, A. J., Cheng, Y. D., & Brooke, J. (2000). Recognition and Sex Categorization of Adults' and Children's Faces: Examining Performance in the Absence of Sex-Stereotyped Cues. Journal of Experimental Child Psychology, 77(4), 269–291. https://doi.org/10.1006/jecp.1999.2554

Wilson, M. (2002). Six views of embodied cognition. Psychonomic Bulletin & Review, 9(4), 625–636. https://doi.org/10.3758/BF03196322

Wilson-Mendenhall, C. D., Barrett, L. F., Simmons, W. K., & Barsalou, L. W. (2011). Grounding emotion in situated conceptualization. Neuropsychologia, 49(5), 1105-1127.

Wilson-Mendenhall, C. D., Simmons, W. K., Martin, A., & Barsalou, L. W. (2013). Contextual Processing of Abstract Concepts Reveals Neural Representations of Nonlinguistic Semantic Content. Journal of Cognitive Neuroscience, 25(6), 920–935. https://doi.org/10.1162/jocn_a_00361

Witt, J. K., Proffitt, D. R., & Epstein, W. (2005). Tool Use Affects Perceived Distance, But Only When You Intend to Use It. Journal of Experimental Psychology: Human Perception and Performance, 31(5), 880–888. https://doi.org/10.1037/0096-1523.31.5.880

Witt, S. D. (1997). Parental influence on children's socialization to gender roles. Adolescence, 32(126), 253-260.

Wittgenstein, L. (1953). Philosophical Investigations (Vol. 17). Wiley-Blackwell.

Wittig, M. A. (1985). Metatheoretical dilemmas in the psychology of gender. *American Psychologist*, *40* (7), 800-811.

Wittlin, N. M., Dovidio, J. F., LaFrance, M., & Burke, S. E. (2018). About face: Memory for transgender versus cisgender targets' facial appearance. Journal of Experimental Social Psychology, 78, 77–92. https://doi.org/10.1016/j.jesp.2018.04.009

Wood, G., & Fischer, M. (2008). Numbers, space, and action – From finger counting to the mental number line and beyond. Cortex, 44(4), 353–358. https://doi.org/10.1016/j.cortex.2008.01.002

Wu, L., & Barsalou, L. W. (2009). Perceptual simulation in conceptual combination: Evidence from property generation. Acta Psychologica, 132(2), 173–189. https://doi.org/10.1016/j.actpsy.2009.02.002

Yamaguchi, M. K., Hirukawa, T., & Kanazawa, S. (1995). Judgment of Gender through Facial Parts. Perception, 24(5), 563–575. https://doi.org/10.1068/p240563

Yee, E., & Thompson-Schill, S. L. (2016). Putting concepts into context. Psychonomic Bulletin & Review, 23(4), 1015–1027. https://doi.org/10.3758/s13423-015-0948-7

Zahn, R., Moll, J., Krueger, F., Huey, E. D., Garrido, G., & Grafman, J. (2007). Social concepts are represented in the superior anterior temporal cortex. Proceedings of the National Academy of Sciences of the United States of America, 104(15), 6430–6435. https://doi.org/10.1073/pnas.0607061104

Zahn, R., Moll, J., Paiva, M., Garrido, G., Krueger, F., Huey, E. D., & Grafman, J. (2009). The Neural Basis of Human Social Values: Evidence from Functional MRI. Cerebral Cortex, 19(2), 276–283. https://doi.org/10.1093/cercor/bhn080

Zubin, D. A., & Köpke, K. (1981). Gender: A less than arbitrary grammatical category. Papers from the Regional Meetings, 17, 439–449. Chicago Linguistic Society.

Zubin, D. A., & Köpke, K. (1984). Gender and folk taxonomy: The indexical relation between grammatical and lexical categorization. In C. Craig (Ed.), Categorization and noun classification. Philadelphia: Benjamins.