Studi Linguistici Pisani

IRENE DE FELICE

Language and Affordances

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Collana diretta da Giovanna Marotta

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A Damiano ed Emanuele

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Introduction

The concept of affordance was first fully elaborated within the field of ecological psychology by James Gibson in the late 1970s. Affordances are defined as *possibilities for action* that the environment offers to living beings. The basic idea of this theory is that, when we perceive the world surrounding us, and the objects in it, what we are actually doing is perceiving potential actions. For instance, when we look at a cup with a handle, full of tea, we automatically perceive at one and the same time the possibility to grasp the object by its handle and to drink its content.

With the theory of affordances, Gibson highlights the close connection that exists between perception and action, and his empiricist approach has been of great influence in several fields of study (Chong and Proctor 2020). In more recent years, a growing body of literature in the cognitive neurosciences has provided strong empirical evidence that the sensory and the motor systems are closely interconnected and interact with each other in a complex way. In particular, a fundamental and fascinating contribution comes from the behavioural and neurophysiological research conducted on the manipulation and grasping of objects, which demonstrates that the same cortical areas are activated both when an agent grasps and manipulates an object, and when the agent simply observes the object, even without any intention to act (Chao and Martin 2000; Grèzes and Decety 2002; Grèzes, Armony et al. 2003, among others). Such findings point to the concrete existence, at least in the specific field of grasping, of affordances, understood as neural representations of possible actions automatically triggered by the perception of visually presented objects (Tucker and Ellis 1998). In other words, when we observe a cup with a handle, our brain automatically constructs a mental simulation of the actions necessary to grasp it, and recruits the same neurons that would be active during the real act of grasping the cup. But there is more. Experiments also show that sensory-motor responses to visual stimuli presentation are modulated by the properties of the perceived objects: for instance, the category to which the object belongs (whether it is an animal, a tool, a natural object, etc.), its location, orientation, consistency, shape, and size. So, to take up the example just given, if the cup is at some distance from us, or if its handle is broken, the activation of the motor system after object perception is much weaker than when the cup is close to us and its handle intact.

This evidence led me, as a linguist, to pose the fundamental question that inspired this work: does language reflect affordances? More specifically: is

linguistic production sensitive to, and affected by, the same variables that modulate sensory-motor responses to object stimuli?

Such questions prompted me to enter a hitherto unexplored area of research – and the aim of this book is to help probe this area. I will tackle these very broad and intriguing issues within the specific domain of grasping, to allow an easier comparison with the existing works on this topic. In order to explore the relation between language and affordances, I collected and analysed at different levels a speech corpus of grasp descriptions (that is, linguistic descriptions of how the action of grasping a particular object could be performed). My primary purpose was to investigate whether the way in which people linguistically describe the act of grasping a visually presented object is modulated by the same factors that shape brain activity within the domain of grasping, that is, in relation to the affordance of 'graspability'. Part of the results of this analysis are further investigated in a second experiment, which explores the extent to which affordances play a role in the lexico-semantic representations of action-related words denoting graspable objects.

This book is structured as follows.

In Chapter 1, I outline the theoretical framework and aim of this research. Through a review of a selected literature, I trace a brief history of the concept of affordance since its first emergence within the field of ecological psychology right up to its later developments in other research domains, namely neurophysiology, neurolinguistics and psycholinguistics. The huge number of studies that in the last 40 years have grown up around the notion of affordance, together with the diversity of the methodological and theoretical approaches that distinguish them, open a window on the complex relation between perception, action, cognition and language.

In Chapter 2, I illustrate an action description task purposely designed to investigate the linguistic reflexes of the affordance of graspability. In this experiment, informants are shown pictures representing graspable and/or manipulable entities of different kinds and are asked to describe how they would grasp them. In the two following chapters, I go through an analysis of the linguistic descriptions of grasps and investigate whether the differences between the object stimuli adopted in the experiment (in terms of category, orientation, consistency, shape, and size) correspond to any difference in the linguistic production of the informants. In particular, in Chapter 3, I consider the distribution of explicit references to the effector of the grasp (such as the mention of the hand), which reflects a focus of attention on the agent involved in the action, and the target of the grasp (such as an object's handle), which instead reflects a focus on the perceived object, namely one of its constituent parts. A more in-depth analysis of the linguistic data is presented in Chapter 4; here I extract from the interviews

the lexemes used by informants to refer to the effector or the target of the grasp and I classify them according to a set of semantic classes. The results of these two complementary analyses are discussed in light of the behavioural and neurophysiological findings presented in Chapter 1.

Chapter 5 describes the methodology and the results of a further investigation, a property generation task that regards only a selection of the stimuli adopted in the previous experiment and that has been conducted to complement the results of the analysis presented in Chapters 3 and 4. While in the grasp description task stimuli consist of images of objects visually presented to informants (e.g., the picture of a jug), in this property generation task they consist of the written form of the words denoting the same objects (e.g., the word *brocca*, 'jug'). Informants are asked to list a series of features they consider relevant when describing what these linguistic items mean. The primary purpose of this second experiment was to determine whether the prominence given to specific object parts (such as handles) only emerges in response to their visual presentation during the grasp description task, or whether it is an important part of object conceptual representation *per se*. This question is addressed by establishing a comparison between the explicit mentions of object parts (meronyms) produced in the grasp description task to indicate the target of the grasp (such as *manico*, 'handle') and those produced in the property generation task.

Lastly, Chapter 6 provides a general overview of the main results of this research.

Chapter 1
Affordances

In this chapter, I will review some of the relevant literature, discuss the theoretical framework that lies behind this study and outline the purpose of the book. I will first provide a brief history of the concept of affordances, from its first emergence within ecological psychology to its later developments in other research fields (Sections 1.1–1.2). The second part of the chapter will focus on affordances relative to object manipulation and grasping: this will serve as a basis for the following chapters of the book, centred on these kinds of events. I will discuss the arguments proposed by many recent contributions from neurophysiological, neuropsychological and behavioural research for defining affordances as *motor representations* elicited by visually presented objects (Section 1.3). Neurolinguistic studies have shown that linguistic material can elicit motor representations in a similar manner (Section 1.4); nevertheless, affordances still remain a largely unknown field in linguistics, although some approaches to lexical semantics show interesting points of contact with the Gibsonian theory (Section 1.5). Against this theoretical background, the last part of the chapter will then set forth the research questions and aims of the book (Section 1.6).

1.1. James Gibson and ecological psychology

The American psychologist James Jerome Gibson (1904–1979) first introduced the concept of affordances in 1966 in his book *The Senses Considered as Perceptual Systems*, but only in his most famous work, *The Ecological Approach to Visual Perception* (1979), did he fully elaborate the idea (see also Gibson 1977). The author, in a well-known passage, writes:

> The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to afford is found in the dictionary, the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment. (Gibson 1979: 127)

As Gibson claims, he was the first to introduce the term *affordance*, referring to the possibilities for action that an environment offers living beings. For instance, if an agent is faced with a flat surface that comes up to about his knees, he is offered the chance to sit down. But knee height for a child is not the same as knee height for an adult (Gibson 1979: 128). It is evident, then, that the

possibilities for action afforded by objects also depend on the agent who perceives them: "Affordances are properties of things taken with reference to the observer" (Gibson 1979: 143).

Gibson introduced the concept of affordance within the framework of ecological psychology, whose main assumption is that the behaviour of living beings is anchored in the environment in which they find themselves and that it is not possible to leave aside this 'external' information, i.e., the setting in which every event takes place, from the study of behaviours. Perception obviously plays a central role in this theory. It is through the perceptual abilities of animals, as well as through the existence of perceptible features in the environment, that animals may establish a relation with the world around them and may detect affordances. This animal-environment system may be called a niche: "In ecology, a niche is a setting of environmental features that are suitable for an animal, into which it fits metaphorically" (Gibson 1979: 129).

An ecological theory of perception thus assumes that perception is directly grounded in the environment and directed at every kind of available information it contains. In this sense, external information provided by the environment, and thus direct perception, is more relevant than any other kind of indirect perception or internal sensation (as Mace 1977 puts it: "Ask not what's inside your head, but what your head's inside of"). From Gibson's point of view, direct perception is not a passive process of visual perception of objects *per se*, nor does it require high-level processes such as reasoning about object properties: "In the realm of manipulation, for example, a person seeing an object would not necessarily only perceive colours, shapes and so on, but first and foremost also directly perceive the object's 'graspability', 'liftability' and so on" (Thill et al. 2013: 492).

It is now possible to understand why Gibson uses the term 'affordance' in a very broad sense, referring to almost every kind of possibility for action agents may find in the world (later others will redefine the limits of the concept): affordances comprise *every possibility for action* that living beings are able to seize in the environment, detecting any kind of directly perceivable external information. For example, humans may also identify affordances in other humans: "What other persons afford, comprises the whole realm of social significance for human beings. We pay the closest attention to the optical and acoustic information that specifies what the other person is, invites, threatens, and does" (Gibson 1979: 128).

1.1.1. An inherently relational concept

Since it was first defined, the concept of affordance has been presented as an inherently relational one.

> An affordance is neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer. (Gibson 1979: 129)

It is clear that, in Gibson's theory, affordances are different and unique for each agent, since they are not simply related only to visually perceivable properties of objects ("an affordance cannot be measured as we measure in physics", Gibson 1979: 128). Rather, they reside in the possible ways in which living beings can *interact* with objects, in the most literal sense of the verb ('to act between', i.e., 'reciprocally').

A number of psychological studies explored this issue and demonstrated that judgements about the ability to perform particular actions depend on both the physical characteristics of agents and the perceivable characteristics of objects. For instance, Warren (1984) assumes that humans and animals, in order to visually control their actions, must be capable of perceiving the relationship between the environmental properties and the properties of their own action system (note that the properties he refers to may rely on geometric variables, e.g., size, dimension, as well as kinetic variables, e.g., mass, force, friction, elasticity, work). In his experiments (see Warren 1984), he asked two groups of people, one composed of tall and the other of short people, to judge if the stairs they were seeing in a photograph were climbable, and also to express a 'confiance' judgement. Answers show that as properties vary (namely the dimensions of the riser, the leg length), judgements change as well. In particular, the author identifies "critical points", after which people start to consider the stair unclimbable (e.g., when riser height increases and reaches a height that cannot afford bipedal climbing), as well as "optimal points", that is, "stable, preferred regions of minimum energy expenditure, or 'best fit' affordances" (Warren 1984: 686).

What is interesting is that in this study he demonstrates that the best fit is always reached at a constant point, according to a body-scaled metric. The analysis of data from the two groups, as was expected, gave different results about the exact determination of critical and optimal points: tall people considered climbable stairs that were deemed unclimbable by short people. Notably, optimal/critical points turned out to be closely tied to the proportion between agents' leg length and riser height: as summarised by Masoudi et al. (2019: 1356), "the most efficient stairway in terms of oxygen consumption is one that has stairs that are about 25% of a person's leg length. […] Stairs less than 25% of one's leg length, and those larger than 25% but smaller than 88%, still afford climbing, but not in the optimal manner". Therefore, the category boundaries that emerge from Warren's study are constant over changes in scale (short/tall

agents, different heights of the riser), thus demonstrating that perception is anchored in the biomechanics of activity.

The study proposed by Warren, which is based on the principle of intrinsic measurement (or body-scaled metric) and the dynamics of critical/optimal points, demonstrates that "perception for the control of action reflects the underlying dynamics of the animal-environment system" (Warren 1984: 683). In addition to this study, many other works were conducted on other affordances, such as passing or squeezing through openings or doorways (Warren and Whang 1987; Fath and Fajen 2011; Higuchi et al. 2011; Petrucci et al. 2016; Franchak 2017), sitting on seats (Mark 1987; Mark et al. 1990; Stoffregen et al. 2005), crossing gaps (Mark et al. 1999; see also Chemero et al. 2003), which show that a strong relationship exists between, on the one hand, the possibilities for a given agent to perceive affordances (by detecting multiple sources of information that support affordance perception), and on the other, the physical characteristics of the agent, together with the characteristics of the environment in which the event takes place.

1.1.2. Where are affordances?

Closely linked to the relativity of the concept is the question about *where* affordances are. According to Gibson, affordances may be conceived of as "properties of things *taken with reference to an observer* but not properties of the *experiences of the observer*" (Gibson 1979: 137, original emphasis). This implies, firstly, that affordances do exist independently of the existence of a perceiver and are true properties of entities. They "are not created in the act of perception" (Michaels 2003: 136). However, to be called affordances, object properties must be such as to allow the interaction with the properties of a specific perceiver, so that an activity can be carried out:

> An affordance, as I said, points two ways, to the environment and to the observer. So does the information to specify an affordance. But this does not in the least imply separate realms of consciousness and matter, a psychophysical dualism. It says only that the information to specify the utilities of the environment is accompanied by information to specify the observer himself, his body, legs, hands, and mouth. This is only to reemphasize that exteroception is accompanied by proprioception – that to perceive the world is to coperceive oneself. (Gibson 1979: 141)

This point may sound a bit confusing and, to a reader, affordances may look like "impossible, ghostly entities" (Chemero 2009: 136), not entirely a property of a living being, not entirely a property of the environment, but situated somewhere in between these two entities, and at the same time connecting them. It is true that in many post-Gibsonian works, affordances are fundamentally seen as *environmental* properties. However, the central idea of a close connection between

the agent/perceiver and the environment is not lost, because these properties, to be true affordances, must be complemented by agents' "effectivities" (Turvey et al. 1981; Shaw et al. 1982; Turvey 1992), "abilities" (Greeno 1994), or "aptitudes" (Snow 1992). Even if different authors adopt different names to distinguish between the two 'poles' to which an affordance points, their complementarity is still a strong point. Turvey (1992) exemplifies the complementarity between affordances and effectivities through an analogy, that of the solubility of salt in water: thanks to their material properties, salt has the dispositional property to dissolve in water, and water has the dispositional property to dissolve salt.[1] These two dispositions complement each other, and only in this complementarity lies the possibility of the solution of salt in water.[2]

1.1.3. Affordances as distinctive features of objects

Another important issue related to this point is that affordances are often regarded as *invariant* properties of objects that can distinguish and characterise them. In this respect, they in some way resemble other object properties, such as colour, shape, size, etc.; but according to Gibson, affordance-related properties are even more salient than any other type of perceivable feature:

> Orthodox psychology asserts that we perceive these objects insofar as we discriminate their properties or qualities […] I now suggest that what we perceive when we look at objects are their affordances, not their qualities. […] The affordance of an object is what the infant begins by noticing. The meaning is observed before the substance and surface, the colour and form, are seen as such. An affordance is an invariant combination of variables. (Gibson 1979: 134)

This is because the act of perception, according to Gibson (1979: 135), is governed by the principle of economy. Humans need not perceive all the properties of an object to recognise it and distinguish it from other things (perhaps it would be impossible to do so). They only notice the minimum number of distinctive features of objects. This topic has been further investigated by James Gibson's wife, Eleanor Gibson, who in the following years explored the concept of affordances within the field of developmental psychology. Studying the exploratory activity of children, she suggested that affordances play a crucial role

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[1] On the idea of 'affordances as dispositions' and its problems, see Wilson (2018).

[2] In more recent years, Chemero (2001, 2003, 2009) has tried to solve the difficulty in a different way. He understands affordances not as the relationship between two distinct entities (i.e., the properties of the environment and the properties of the agent), but as "features of whole situations", provided that "animals are, of course, usually crucial parts of these whole situations, so perceiving something about the whole situation cannot always be just perceiving something about the environment, divorced from the animal" (Chemero 2003: 185).

in their development, since perceptual learning passes through the discovery of these distinctive features and invariant properties of objects (Gibson 2000; Gibson and Pick 2000).

1.1.4. The role of visual perception

In the passage from James Gibson quoted in the last section, there is another interesting point (emphasis added): "what we perceive *when we look* at objects are their affordances, not their qualities". A central point of the whole theory of affordances, not only as it appears in Gibson's works but also in much of its later development, is that perception is almost always understood with reference to *visual* perception. As pointed out by Marotta (2013: 14), this is one of the weakest points in Gibson's theory of perception. For instance, Gibson considers sufficiently good light conditions necessary in order to perceive affordances: "The central question for the theory of affordances is not whether they exist and are real but whether information is available in ambient light for perceiving them" (Gibson 1979: 140). However, he himself refers to affordances also as *every* possibility for action that the environment offers living beings. As already noted, from his point of view even humans afford behaviour to other humans. But Gibson did not examine these points in depth, so that the concept of affordance itself seems to have been developed entirely within the framework of a new theory for perception, which since the title of his famous 1979 book (*The Ecological Approach to Visual Perception*) refers only to the domain of sight.

It is unquestionable that visual perception is the first, most immediate and most informative way in which living beings discover the world and detect the possibilities for action it offers them, but there is something more. When we interact with objects, the other senses are usually activated at the same time, namely taste, smell, touch, and hearing, and not only sight. Indeed, MacWhinney (1999: 218) conceives affordances in a very broad sense, as "sensations that we experience when we interact with individual objects". However, in most theories, affordances are better to be regarded as "preconditions for action" (Greeno 1994: 340) and closely related to action, not only to sensations; it is also true, though, that many different possibilities for action may be afforded by a single object, and not all of them are necessarily elicited by visual perception.

1.2. Affordances in other research fields

1.2.1. Design and technology

After the first studies in the field of psychology, the original definition of affordances, as outlined by Gibson, was partly changed and adapted to other fields.

For instance, in the field of design, the idea that objects provide direct information as to how they are supposed to be used has been exploited to plan and design easily usable artifacts that suggest relevant actions in an immediate way. As Donald Norman puts it, "affordances are of little use if they are not visible to the users. Hence, the art of the designer is to ensure that the desired, relevant actions are readily perceivable" (Norman 1988: 123). Therefore, while for Gibson the affordance is the action possibility itself, for Norman the affordance is the action possibility *and* the way this possibility is conveyed or made visible to a perceiver (McGrenere and Ho 2000: 181). In other words, Norman uses the term affordances to refer to *perceived affordances*, as he calls them.

The primary role given to the act of perception also emerges from the definition that Norman gives for affordances in his best-known work, *The Psychology of Everyday Things*: "The term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (Norman 1988: 9).

It is evident that Norman's idea of affordances is not built around the general possibilities for acting but specifically around the possibilities for acting *on objects* ("just how the thing could possibly be used"). Artifacts in general, and tools in particular, are special kinds of objects created with the purpose of being used, and thus they often have a particular design that incorporates explicit suggestions about their possible handling and utilisation. The intended use of man-made objects is so important that it is also frequently reflected in their names. In Navajo, a chair is *bikáá'dah'asdáhíor*, i.e., 'on-it-one-sits' (MacWhinney 1999: 219), and a towel is *bee 'ádít'oodí*, 'one-wipes-oneself-with-it' (Steedman 2009: 186). In this regard we may also think of some familiar words usually cited as examples for transparent compounds, such as *corkscrew*, or *dishwasher*.[3] While Norman restricts his research and focuses only on actions related to the usability of objects, Gibson maintains a wider scope, considering that humans also afford behaviours to other humans and animals to other animals, even asserting that dangerous

[3] These are evident cases of 'descriptive lexicalization' (*deskriptive Benennung* in Seiler 1975), since the *designatum* is associated with the word by means of a description, and not by being attributed a label (as in the case of 'labelling lexicalization', or *etikettierende Benennung* in Seiler 1975; for this distinction, see Ježek 2016: 10).

situations afford risks to living beings. In this sense, Gibson's idea of affordances recalls a passage in Koffka (1935: 7, quoted in Gibson 1979: 138): "To primitive man each thing says what it is and what he ought to do with it: a fruit says, 'Eat me'; water says, 'Drink me'; thunder says, 'Fear me', and woman says, 'Love me'".

This brings us to highlight another major difference between Norman's and Gibson's approaches: for Gibson, affordances are *all* the possibilities for action latent in the environment, whereas for Norman, (perceived) affordances are *only* those object properties that may support an activity that are *likely* to be perceived by an agent, according to his beliefs, goals and past experiences (remember the "perceived *and* actual properties of the thing" cited from Norman 1988: 9; emphasis added). Thus, for an agent to perceive an affordance, it is not sufficient that s/he has the physical ability to do this. In a sense, this reformulation (actually a restriction) of the concept stresses even more the idea of complementarity already present in Gibson's work, but also implies a radical difference between the two authors. Norman believes that "affordances result from the mental interpretation of things, based on our past knowledge and experience applied to our perception of the things about us" (Norman 1988: 219). It is clear that this assertion contrasts sharply with the idea that affordances exist independently of perceivers and do not arise as a consequence of mental operations. While for Gibson an agent only needs physical abilities (or effectivities) to perceive affordances, for Norman s/he also needs a mental and perceptual ability, together with specific 'cultural' knowledge. The ability to perceive affordances, in this sense, depends also on subjective factors, which act as constraints and limit opportunities for action.

If Norman stresses the importance of the act of perception in detecting affordances, Gaver (1991) goes a step further, separating affordances, understood as possible ways of interacting with objects, and perceptual information about them (Figure 1.1). By doing this, he reclaims the Gibsonian idea that affordances do not necessarily need to be perceived in order to exist.

Perceptual Information		Affordance: No	Affordance: Yes
	Yes	*False Affordance*	*Perceptible Affordance*
	No	*Correct Rejection*	*Hidden Affordance*

Figure 1.1. Gaver's classification of affordances; affordances are separated from the perceptual information that specifies them (adapted from Gaver 1991: 80).

As shown in Figure 1.1, the author makes an important distinction and divides affordances into three categories. Affordances are *perceptible*, if the perceptual information provided by a given object (that is, its design) matches the intended use of the object. They are *false* if an object's design suggests an action that is not the intended one. They are *hidden* if no perceptual information is provided by the object about its possible use. Finally, people will usually not think of a given action if there is no affordance for it nor any perceptual information suggesting it (*correct rejection*). The first two cases cover Norman's concept of perceived affordances (McGrenere and Ho 2000: 183).

1.2.2. Robotics and AI

In recent years, the notion of affordance has also been applied to robotics and artificial intelligence. The idea that an artificial (just as a living) agent can extract information relevant to action directly from the world surrounding it, minimising the need for complex internal representations, has led researchers to programme agents that are more flexible and better able to adapt their behaviour to real world conditions, that is, *embodied* agents, able to operate in a complex and unstable environment (Horton et al. 2012: 70).

A number of works describe how affordances may be used at different levels of robot control, ranging from perceptual learning to planning (see, for instance, Rome et al. 2008). They generally share a view of affordances as internal relations between external objects and the agent's own actions. For example, Şahin et al. (2007; cf. also Ugur et al. 2009) define affordances as relations that pertain to the robot-environment interaction, and represent them as triples of (1) the agent's behaviour, (2) the object perceived, and (3) the resulting change of state after the agent's behaviour has been applied. Accordingly, affordances are seen as interactions in which an action (behaviour) performed on an entity produces a given effect. "For instance, the lift-ability affordance is represented as a relation between the (properties of an) object, the behavioural capabilities of the robot and the effects produced by the lift behavior" (Ugur et al. 2009: 178). This formalisation enables artificial agents to record the effects of their actions on perceived objects, that is, to 'learn' affordances (Çakmak 2007), and to predict a desired effect (from a known behaviour applied to a known entity). This also allows agents to develop planning abilities.

Results obtained in robotics are a good example of how a multifaceted concept like that elaborated by Gibson can be applied also to other research fields and can help achieve better results.

1.3. Action, perception and affordances: evidence from behavioural and neurophysiological studies

All the different approaches to the theory of affordances share a common idea (which is probably one of the strongest points of the original theory as worked out by Gibson): that a close connection exists between action and perception. As we know from daily experience, our actual possibilities for acting are greatly dependent on, and constrained by, our ability to perceive. If we were not able to perceive the properties of the environment and the objects that surround us, we could not satisfy most of our needs, nor achieve most of our goals. In other words, we could not adapt the world to our own necessities.

However, the close interrelation between action and perception goes far beyond this obvious intuition. In the last few decades, a large number of studies have demonstrated, using neurophysiological techniques, that the motor and perception systems are not isolated. Rather, they closely interact with one another in different and complex ways, and they constitute the ground in which many of our cognitive abilities are rooted. In this sense, cognition can be said to be *embodied* (as further discussed in Section 1.4). In particular, the close connection that exists between an agent's ability to perceive an object's properties and possibilities for action has been revealed by the discovery of canonical neuron circuits.

Mirror and canonical neurons were first found in macaque monkeys in the ventral premotor area F5, but later studies provided evidence for the existence of equivalent circuits also in the human brain (Fadiga and Craighero 2003). Both types of neurons have motor properties: they fire when the agent executes a specific action on objects, such as manipulation or grasping. However, mirror neurons and canonical neurons produce different visual responses. Mirror neurons also discharge when agents observe and recognise the same action performed by other agents, or when they hear the related sound; therefore, they are usually understood to play an important role in the recognition of others' actions and intentions (see, among many others, Di Pellegrino et al. 1992; Rizzolatti et al. 1996; Rizzolatti and Arbib 1998; Rizzolatti and Craighero 2004; Rizzolatti and Sinigaglia 2006).

On the other hand, canonical neurons, which were first found in the F5 area of the macaque brain (as mirror neurons), fire during goal-directed actions as well as when the monkey simply looks at an object related to action (Rizzolatti et al. 1988; Jeannerod et al. 1995; Murata et al. 1997; Raos et al. 2006). To verify their existence in the human brain, Grafton et al. (1997) used positron emission tomography (PET) and found that the observation of manipulable objects activates the motor system, in particular the left premotor cortex (cf. also Grèzes and Decety 2002). Canonical neurons in the human brain were studied also using

neuroimaging techniques. For example, the analysis carried out by Grèzes, Armony et al. (2003) reveals, thanks to the use of fMRI (functional magnetic resonance imaging), the activation of the parietal and premotor areas when subjects passively observe objects, as well as when they execute movements directed at objects. These regions seem to correspond to the circuit in the macaque brain where canonical neurons were discovered[4] (Grèzes, Armony et al. 2003: 933; see also Chao and Martin 2000; other studies will be cited below).

These works demonstrate that perceiving some properties of manipulable objects activates a sort of *action simulation* in brain circuits. Considering the recruitment of the motor system during object observation, and particularly of the same areas activated during actual object manipulation, in large part of the cognitive and neuroscientific literature the concept of affordance has been extended beyond the Gibsonian interpretation to refer to "the *brain representations of affordances*", that is, of "possible sensorimotor interactions with objects" (Thill et al. 2013: 492, original emphasis).

In a seminal study, Tucker and Ellis (1998) explicitly define affordances, traditionally viewed as possibilities for action, as "motor patterns":

> We use the term *affordance* to refer to the motor patterns whose representation visual objects and their properties give rise to, both during explicit goal-directed acts […] as well as, we argue, before explicit intentions have been formed. Although this is a representational account of affordances, and therefore very different from the use of the term in the ecological sense, it nonetheless has its basis in a similar emphasis of the intimate link between perception and action. (Tucker and Ellis 1998: 833)

The authors call their approach representational, since they assume that a mental representation of a visual object also includes encoding of the actions relevant to that object, so that a relationship between the world and object representations is established (Ellis and Tucker 2000: 452).

If in Gibson's studies (as also in many subsequent works) affordances appear to be anchored in the dispositional properties of both the environment and of agents, from a representational perspective they appear as "dispositional properties of a viewer's nervous system" (Ellis and Tucker 2000: 466). As pointed out by De Wit et al. (2017: 623), it is clear that in this view, as "within several influential neuroscientific accounts, affordances are representational concepts that are decidedly placed inside the brain (and waiting to be activated)".

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[4] In the same study, an equivalent for mirror neurons circuits was also found, in the concomitant activation of some regions (dorsal premotor cortex, the intraparietal sulcus, the right parietal operculum and the superior temporal sulcus) when subjects observed grasping actions and when they had to imitate them (Grèzes, Armony et al. 2003: 933).

Ellis and Tucker (2000) also introduced a different term, *micro-affordances*, to refer to the specific motor patterns elicited by object perception:

> The facilitated actions observed in our experiments are of specific components of grasping. Moreover they involve facilitation of particular values of the components concerned. It is not grasping in general that is facilitated, but a specific grasp appropriate to the viewed object. It is a particular shape of the hand and a particular orientation of the wrist, which are afforded. We term these effects, for obvious reasons, micro-affordances. (Ellis and Tucker 2000: 467)

This gives us a clear idea of the difference, not only on a terminological level, from the Gibsonian tradition. Here, 'higher level' affordances, understood as actions associated with an object's function, are clearly distinguished from 'low-level' affordances, which refer to the minimal number of motor patterns potentiated by objects, such as the specific components of grasping elicited by an object with particular features (see also Tucker and Ellis 2001).

This view of affordances, intended as referring not to the action possibilities of the environment, but instead to the "neural representation of motor patterns for actions that are afforded to the observer" (De Wit et al. 2017: 623; for a similar account see also Gentilucci 2002; Barbieri et al. 2007), takes into account both the perceiver's motor capacities (also because brain motor patterns are dependent on agents' actual ability to act, as will be shown in next sections) and the visual information available (an object's properties, such as size, shape, location, etc.).

In light of recent discoveries, psychologists and cognitivists reshaped the concept of affordances by taking into account significant findings in the neurosciences and extending it far beyond the Gibsonian interpretation; but neuroscientific works, in turn, often explicitly refer to affordances and to psychological research. In particular, object manipulation and grasping is nowadays the field in which the overlapping of different theories and methods related to affordances is most evident. On this specific topic, many efforts from different disciplines (also neurolinguistics: cf., in particular, Sections 1.4.1 and 1.4.2) converge. The variety that characterises the huge amount of research activity conducted into the specific action of grasping objects clearly reflects the need for a multidisciplinary approach to analysing the complex relationship between action and perception.

The remaining part of this chapter will focus on some phenomena coming out of behavioural and neurophysiological research that in my view have a major impact on the theory of affordances. In particular, I will present some of the factors that have been proved to have a role in modulating brain activity, affecting the motor representations objects elicit and thus being responsible for recruiting motor responses in a selective way. These are related to specific object

properties, such as size and shape (Section 1.3.1), the category to which the object belongs (Section 1.3.2), its constituent parts and its orientation (Section 1.3.3), its location with respect to the observer (Section 1.3.4) and the level of familiarity that the observer has with the object (Section 1.3.5). Additionally, we will also make a distinction between 'stable' affordances, i.e., related to invariant properties of objects, and 'variable' affordances, i.e., related to temporary object characteristics (Section 1.3.6).

1.3.1. Object size and shape

The type of grip afforded by an object, according to its shape and size, is one of the factors that have been proved to have an influence on motor responses. Usually, in behavioural research, affordances relating to a particular object feature are studied by verifying whether this feature has an impact on a task to which that feature is not relevant. For instance, in Tucker and Ellis (2001), participants were asked to perform an easy categorisation task, that is, to choose whether an observed object was an artifact or a natural object. They had to express their judgement by performing a unimanual precision or power grasp on a manipulandum. The grasp they had to perform, therefore, only depended on the kind of stimulus presented. However, it might be congruent or incongruent with the size of the object stimulus, because authors used both small stimuli (e.g., a screw, a grape), which afford a precision grip, and large stimuli (e.g., a hammer, a cucumber), which afford a power grip. Measurements of reaction times indicate that, even when object dimension was not a factor participants had to pay attention to in order to carry out the task, responses were significantly affected by the level of compatibility between the type of grasp required by the task and the type of grasp afforded by the visually presented object. When participants looked at a large object, power grip responses were significantly faster than precision responses; conversely, when they looked at a small object, precision responses were faster than power responses.

Similarly, in 2002, Gentilucci demonstrated with a behavioural study that some object-intrinsic properties, such as volume (in particular the size of an object's graspable part) and shape, affect grasp kinematics, even when these components are irrelevant to the task. In particular, the participants that took part in his experiment (Gentilucci 2002: 1150–1151) had to grasp two bells of different volumes (the larger one was approximately 7 cm, whereas the smaller one was approximately 3 cm) in different ways, even though the handle, that is, the part where subjects were explicitly requested to grasp the object, was identical, i.e., had the same physical features. Although people were asked to grasp the handle, the volume of the two objects influenced the grasp kinematics: the hand, when the target-object was the large bell, was partly pre-shaped as if the entire object,

and not only its handle, was to be grasped. These results support the hypothesis that a single motor representation, which encodes *all affordances* enabled by the object, is involved in grasp kinematic implementation. In this experiment, kinematics proved to be influenced by a task-irrelevant characteristic such as the volume of the bells, even if subjects knew perfectly well that they had to grasp only their handle (other details from Gentilucci's experiments will be given in Section 1.3.5). These data point to the fact that shape and size affect motor representation of objects (i.e., affordances) that are responsible for hand shaping and grasp kinematics during the execution of a grasp (see also Girardi et al. 2010).

Other interesting results about the effect of an object's shape and volume come from brain imaging studies. Grèzes, Tucker et al. (2003) conducted a complex behavioural and fMRI experiment in which participants were asked to execute a power or a precision grip response on a manipulandum, according to the type of object they were presented, either natural or man-made (the experiment was partly similar to the one illustrated above conducted by Tucker and Ellis 2001). The study sought to find a compatibility effect between the type of grip afforded by the object, which was a task-irrelevant feature, and the type of grip required as a response by the classification task. The type of grip afforded by stimuli objects, in the experiment, was exclusively related to their size: the authors used large objects to afford a power grip, and small objects to afford a precision grip. As in Tucker and Ellis (2001), responses were faster in congruent cases, i.e., when the type of grip afforded coincided with the grip that participants had to perform: a power grip response to a large object, or a precision grip response to a small object. In addition, brain imaging techniques also revealed that the degree of motor activation (registered in the parietal, dorsal premotor and inferior frontal cortex) during the execution of a given hand grip depended on the congruence between the hand grip afforded by the object and the grip required by the task. During incongruent tasks, a strong competition between the action required (e.g., a precision grip for the categorisation of artifacts) and the action afforded by the stimulus object (e.g., a power grip for a large artifact, such as a hammer) was generated, and this competition was responsible for both the slower reaction times in motor responses[5] and the greater activation of the sensory-motor system. This study, together with those previously described, provides evidence for the fact that different object sizes may automatically generate different types of motor responses, and that object affordances (in this case, the possibility for an object to be grasped in a particular way) are evoked

[5] The authors are not able to say whether the difference in reaction times is due to a facilitation effect occurring in congruent trials, an interference effect occurring in incongruent trials, or both (Grèzes, Tucker et al. 2003: 2738).

even when they are irrelevant to the task and no reaching and grasping movement towards the object is actually required.

1.3.2. Object category

Many studies have demonstrated that the activation of the sensory-motor region is affected not only by the size and shape of a stimulus but also by its category: the activation of the motor-related regions seem to occur, in particular, during the visual presentation of artifacts, especially tools.

Chao and Martin (2000) examined, using fMRI, the neural responses in frontal and parietal cortices associated with viewing pictures of different categories of objects and silently repeating their names. In their study, they asked 10 subjects to look carefully at black-and-white photographs of tools, animals, faces and houses (1728 stimuli: 432 different photographs per category) and, in a second experiment, to silently name pictures of tools and animals (360 stimuli: six exemplars of 30 animals and 30 tools). The results of the fMRI analysis showed that viewing (and naming) pictures of tools selectively activated the left ventral premotor cortex, the region for which previous PET studies of imagined right-hand movements have also reported activity (e.g., Decety et al. 1994) and which the authors consider as the human homologue of the canonical F5 area in monkeys (Chao and Martin 2000: 482). Tools also selectively activated the left posterior parietal cortex, an area that previous studies have shown to be active during object grasping (Binkofski et al. 1999). These results, together with further evidence (e.g., Chao et al. 1999; Creem-Regehr and Lee 2005), suggest that "compared with other object categories, such as animals, houses, or faces, tool stimuli elicit extra-temporal activation in frontal and parietal regions that have been associated with motor processes" (Kourtis et al. 2018: 1221).

The fact that artifacts (in particular, tools) and natural objects have a different representation within the motor system has been further investigated, more recently, by Visani et al. (2022), who conducted a combined behavioural and MEG (magnetoencephalography) study to compare the modulation of motor responses and cortical rhythms during the processing of natural objects and tools (the stimuli were either verbally or pictorially presented: see Visani et al. 2022 for details). Results emerging from the two experiments showed that natural objects and tools affected in a different manner both behavioural and MEG results (regardless of the mode of presentation). As the authors explain, "observed graspable tools […] do not modulate the activity of the motor system in the same manner as natural objects do".

However, studies have shown that there are significant differences in the activation of the sensory-motor system even between different types of artifacts:

for instance, artifacts that possess *affording parts* have been found to elicit affordances more than others, as will be discussed in the next section.

1.3.3. Artifacts' affording parts and their orientation

Hereafter, I will use the expression *affording part* to refer to the part of an object that is typically involved in actions (in particular, for the purposes of this book, the act of grasping), and that is often specifically designed for it (at least in case of artifacts).

Many studies have demonstrated that the presence of an object's affording part (e.g., a handle) is able to elicit affordances. When we observe, for instance, the handle of a cup, our sensory-motor system automatically evokes a motor representation of the actions typically performed on that specific affording part. That is, in this case, a precision grip. This sensory-motor activation can be understood as a sort of preparation for action. As such, it may also affect subsequent actions, as shown by Rounis et al. (2018), who demonstrated that the presence of a handle on a cup has a significant effect on the grasping movements towards it. In their experiment, the authors used kinematic measures to quantify the grip aperture while participants executed a grasp on a cup. Participants were explicitly told to grasp the cup at its rim in order to move it. Crucially, the cup may have no handle, or a handle pointing towards or away from the grasping hand. Grip apertures recorded for the two cups with the handle turned out to be significantly smaller compared to the grip aperture for the cup with no handle (independent of handle orientation), even if the cups were of the same size at their grasping point. Such findings reveal an effect of the presence of a handle during the execution of a grasp. When presented with a cup with a handle, the action that participants performed to grasp the cup by its body incorporated the representation of a different action, that of a smaller grip directed towards its handle. Surprisingly, this happened also when the handle pointed away from the grasping hand, meaning that it would have required an uncomfortable posture.

However, other behavioural studies, mostly based on compatibility paradigms, provide clear evidence for the effect of the orientation of the object part on affordance activation. The presence of an affording part may potentiate the execution of hand motor acts; but this effect is stronger when the orientation of the affording part is spatially aligned with the responding hand (what is called a compatibility effect). For instance, Tucker and Ellis (1998: 834–838) show that, in their experiments, the leftward or rightward orientation of familiar objects (such as a teapot, a frying pan, a jug, a kettle) had a significant effect on the speed (measured as reaction time) with which a response was executed by participants with the left or the right hand. In the experiments, the horizontal orientation of the object was irrelevant to the task required: participants just had to decide

whether the household item they were seeing in a picture was upright or upside-down, and respond accordingly with a key press performed with their left or their right hand. Push-button responses were faster and more accurate when they corresponded to the orientation of the object. For instance, the presentation of objects with a leftward-oriented handle improved the performance for left-hand responses. This effect demonstrates that not only is the simple visual presentation of an object with a handle able to activate a mental simulation of the action of grasping the handle, but also that this simulation improves specific movement performance. It is worth noting that when participants were asked, subsequently, to execute responses by using not two hands but only two adjacent fingers of their right hand, no compatibility effect occurred, demonstrating that "it is the affordance for grasping *by a particular hand* that gives rise to the binary left-right distinction" (Tucker and Ellis 1998: 838, emphasis added), not the object orientation itself.

Similar results, indicating that the orientation of an object's affording part may automatically trigger components of specific actions, in particular grasping, even without any intention to act, also emerged from other compatibility studies, such as Riddoch et al. (1998), Ellis and Tucker (2000), Tucker and Ellis (2001), Phillips and Ward (2002). What all these studies have in common is the fact that they use stimuli that have an obvious action connotation (they are all concrete, familiar and meaningful objects) and are asymmetrical (with the result that visually salient areas might bias attention), such as cups with handles. In order to avoid confusion with attentional factors and to investigate whether orientation can be considered a "pure physical affordance", i.e., "an affordance that is solely revealed by the physical structure or arrangement of the object" (Symes et al. 2007: 239), Symes et al. (2007) studied the orientation-dependent compatibility effect by adopting a series of elongated, geometrical stimuli shown on a display. Such stimuli could be oriented $\pm$ 45° from the perpendicular (i.e., with a left-down or right-down orientation) and consisted of an abstract 2D rectangle, a 3D cylinder presented only in the frontal plane, and a 3D cylinder also rotated in the depth plane (in order to appear to be pointing out in space towards a particular hand of the viewer). Orientation was again a task-irrelevant property, since participants had to press a right or left button according to whether the stimulus pattern was straight or wobbly, respectively. If the pattern was neutral, they had to wait until it changed into a wobbly or straight pattern. Reaction times from motor responses in congruent (i.e., when the responding hand corresponds to the orientation of the object) or incongruent trials were recorded. From the results obtained in five different experiments conducted on these stimuli, the authors conclude that the more realistic, three-dimensional and graspable an object appears to be, the more potent its "pure physical affordance" is. The 3D cylinder

presented only in the frontal plane produced a small orientation-dependent spatial compatibility effect, whereas the abstract 2D rectangle that had the same orientation did not. For the 3D cylinder rotated in depth, pointing out in space towards a particular hand of the viewer, larger and more robust compatibility effects were produced (Symes et al. 2007: 251–252).

These findings from behavioural studies may be compared with the brain imaging analysis conducted by Buccino et al. (2009). The authors investigated, using single pulse TMS (transcranial magnetic stimulation), the activation of parieto-premotor circuits while subjects observed photographs of familiar objects with handles (six common containers, such as a mug or a coffee maker). The handle of these object stimuli could be rightward- or leftward-oriented; crucially, it could also be either broken or intact. In their study, the largest motor-evoked potential area was recorded from hand muscles when participants looked at images of rightward-oriented objects that had intact handles. When the handle was leftward-oriented, or when it was rightward-oriented but broken, motor activation was much less evident. Significantly, the participants were all right-handed. In this regard, it must be stressed that besides the effect caused by the orientation of an object (in particular, of its affording parts) there is also evidence that handedness affects how object stimuli are processed and manipulated (Thomas et al. 2019: 2). For instance, in Linkenauger et al. (2009), handedness turned out to affect how participants estimated the distance between them and tools with handle orientations that made them either easy or difficult to grasp with their dominant and non-dominant hands (see also Apel et al. 2012; Main and Carey 2014).

1.3.4. Spatial constraints

The findings reported so far demonstrate the recruitment of the motor system during the observation of graspable objects. But it is evident that actual manipulation of objects may be carried out only if objects are close enough to agents so that they are able to reach them. Thus affordances, in the sense of possibilities for action, must depend not only on the intrinsic relation between object features and agents' abilities, but also on the real possibility for the agents to act on the objects and thus, above all, to reach them with their hands.

It is known that the way we perceive the space surrounding us is highly dependent on subjective or contextual factors. For instance, the judgement of the distance from an object varies according to the abilities of the agent: the distance is judged to be shorter when the agent is able to (and has the intention to) reach and grasp the object with a tool (Witt et al. 2005), or when handle orientation makes the object easier to pick up (Linkenauger et al. 2009). Thus, perception of a fixed distance between an agent and an object is modulated by the dispositions

of both the object (its orientation) and the subject (his or her capabilities and intentions).

Interestingly, some researchers modulated the distance between an object and an agent, in order to investigate the possible existence of spatial constraints on affordances. For instance, Costantini et al. (2010), adopting a spatial alignment effect paradigm, conducted a study in which participants had to replicate, either with their right or left hand, a reach and grasp movement as soon as they saw a task-irrelevant go-signal on a display – in this case a mug on a table. The handle of the mug could have a congruent or incongruent orientation with respect to the action required, and the object could appear in a space that was reachable (30 cm) or unreachable (150 cm) by the agent. Thus, as the stimulus appeared, two different motor patterns were recruited: the representation of the grasping movement to execute, and that of the grip afforded by the object. The analysis of the grasping onset time showed a compatibility effect (that is, faster responses) only when the object fell within the reachable space.

Other experiments confirm with neural evidence what is noticed at a behavioural level. Cardellicchio et al. (2011) investigated exactly whether motor representations depend not only on the visual presentation of the affording feature of an object, but also on its reachability, i.e., on the distance of the affording object from the observer. In their TMS experiments, subjects observed a 3D room with, again, a mug on a table, or a big box, either located in the reachable space, or outside the reachable space; their left primary motor cortex was stimulated, and motor-evoked potentials (MEPs) were recorded for the right hand (right first dorsal interosseous and opponens pollicis). MEPs were higher in amplitude when the mug was presented in the subjects' peripersonal space, and not in the extrapersonal space. Significantly, the same effect was not observed for the large box, which had no affording parts and did not afford a one-handed grasp. It is worth noting that no significant difference in measurements was registered in relation to the different (left/right) orientation of the handle of the mug, so results for these two conditions were merged. This contrasts with results in Buccino et al. (2009), where a significant difference was found between the MEPs registered in the right intact handle condition compared to those registered in the left intact handle condition. The authors (Cardellicchio et al. 2011: 1371) explain this by pointing out that the experiment conducted by Buccino et al. (2009) clearly focused on the orientation of the handle and that this could have attracted the attention of participants to this specific structural element.

These studies reveal that the processing of an object's affording properties is spatially constrained, i.e., it depends on the spatial relation between the object's physical features and the individual's motor abilities (Costantini and Sinigaglia 2012: 440). However, further studies provide additional insights on this question.

In Costantini et al. (2011) and Cardellicchio et al. (2013), much of the experimental setting and procedure already described was reused (the mug on a table in the peripersonal or extrapersonal space), but an avatar was introduced in the scene. Interestingly, the spatial alignment effect, as well as the highest motor-evoked potentials from the subject's hand muscles, were observed both when the mug was reachable for the participants and when it was unreachable for them but reachable for the avatar. In this condition, the affordance relation is mediated by the peripersonal space of another individual. According to the authors, this effect is due to the existence of a mirror mechanism[6] that maps the peripersonal space of others onto the observer's own peripersonal space, as well as others' action potentialities onto the observer's own motor abilities.

1.3.5. Beyond the object: familiarity

As Buccino et al. (2009: 3077) point out, familiarity with objects and with the actions they are typically involved in is an important factor that influences motor representations (as well as semantic knowledge retrieval: see Chrysikou et al. 2017). This has also been emphasised, from a slightly different perspective, by Gentilucci (2002), who argues that, from a motor point of view, familiar objects can be represented by the types of interaction we habitually have with them. In his behavioural study (already mentioned in Section 1.3.1) the author conducted eight experiments in which participants had to reach and grasp various objects, different in terms of weight, volume, shape, intrinsic height and centre of mass. The analysis indicates that familiarity affected the grasp kinematics, because the volume effect was stronger when subjects had to grasp familiar objects (e.g., an apple, a strawberry, a bell) than unfamiliar ones (geometrical solids of different shapes).

1.3.6. Stable and variable affordances

The possible properties of an object mentioned so far, namely its spatial location with respect to an agent, the familiarity that an agent has with it, its size and shape, or the presence of an affording part, are all characteristics that are able to modulate the sensory-motor system, as the neurophysiological and behavioural studies reviewed so far have demonstrated; however, they are not equivalent to each other. We may take as an example a very common stimulus, such as a cup. If a perceived cup has a handle, it will activate stronger motor

[6] As already stated in Section 1.3, mirror neurons fire when an agent executes specific actions on objects, such as manipulation or grasping, as well as when the agent observes (or hears) the same action being performed by another agent; for this reason, they are usually thought to play a role in the recognition of others' actions and intentions (Rizzolatti and Craighero 2004).

simulation in the brain than a cup without a handle or a cup with a broken handle (as demonstrated, for instance, by Buccino et al. 2009; cf. Section 1.3.3); the presence of what we have called an affording part is a physical and invariant property of the object. Then, we also know that, if this cup with a handle is presented to a right-handed subject, it will again activate stronger motor simulation if it is rightward-oriented rather than leftward-oriented; but this characteristic, of being a rightward-oriented object, is less 'stable'. It is not an object's intrinsic characteristic. Rather, it depends on the situational context and emerges in relation to the agent: therefore, orientation is a property of the object only in relation to a perceiver.

To account for these differences in object properties, Borghi and Riggio (2009, 2015) distinguished *stable affordances*, which are usually linked to invariant features or properties of objects and incorporated into an object's representation, from *variable affordances*, which are related to temporary characteristics of the object and are specific to a given situation. When a temporary property, such as orientation, is firmly associated with the typical actions we perform on the object (right-handed people usually take cups by their handle, if it is rightward-oriented), the property is said to be a *canonical affordance*.

1.4. Affordances and embodied language

I share with many of the authors cited so far the idea that affordances are deeply grounded in the perception-action system and that, extending the concept beyond the Gibsonian interpretation, they can be understood as the neural representation of motor patterns automatically triggered by the perception of objects (cf. Section 1.3; further evidence will be provided in this section), a view that stems fundamentally from an *embodied* approach to the concept of affordances.

Theories of embodied cognition share the idea that human cognition is largely shaped by embodied experience; that is to say, that fundamental cognitive functions, such as those supporting thought and language, are deeply influenced by our bodily nature and by our concrete experience of the world around us (Gibbs 2005). Since for us experiencing the world means above all perceiving it with our sensory system through different modalities, and then also interacting concretely with it (moving in the surrounding space, acting on objects, and so on), cognitive structures develop from perception and action (Pecher and Zwaan 2005). Therefore, "We must not assume cognition to be purely internal, symbolic, computational, and disembodied, but seek out the gross and detailed ways that language and thought are inextricably shaped by embodied action" (Gibbs 2005: 9). In this regard, of particular relevance is the research on *conceptual metaphors* (since

the seminal works of Lakoff and Johnson 1980, 1999), which has highlighted that people for the most part rely on their 'concrete' bodily experience, and more in general on "concrete, simple, familiar, physical and well-delineated experiences" to make sense of, and speak of, "relatively abstract, complex, unfamiliar, subjective or poorly delineated" concepts (Semino 2008: 6).

An increasingly large body of recent works in cognitive linguistics (e.g., Barsalou 1999; Gallese and Lakoff 2005, among others) demonstrates that at least to some extent also linguistic structures are embodied (Gibbs 2003) and that a strong interrelation exists between perception, action and language. Following this account, linguistic concepts consist of the mental simulation of the experiences to which words and sentences refer, and linguistic material is thus processed (at least in part) using the same brain mechanisms that underlie perception, action and other types of human-world interactions (this topic will be covered more specifically in Sections 1.4.1–1.4.2 and Section 5.1; see also the discussion in Fischer and Zwaan 2008).

It is already clear from these opening remarks that this approach contrasts with symbolist theories, according to which words and sentences are deemed to be abstract, amodal and arbitrary mental symbols (e.g., Fodor 1975; Pylyshyn 1984; Mahon and Caramazza 2008; Chatterjee 2010); in this view, comprehension fundamentally consists of a translation process from an external symbolic language (words) into an internal symbolic language (mental symbols) (De Vega 2015). As Louwerse (2011: 275) asserts, in many cases "Symbolic cognitive models are theories of human cognition that take the form of working computer programs" and computational algorithms can be used to extract meaning from language. One of the best-known models within the symbolist framework, for instance, is that of *Latent Semantic Analysis* (LSA), discussed extensively in Landauer and Dumais (1997; see also Landauer et al. 2007). LSA is a statistical theory of knowledge representation in which word meaning does not need to have embodied grounding, since it is considered as based on word co-occurrence: the fundamental assumption is that words occupy positions in a semantic space and that their meaning is thus defined by the relation of each word to all the others. Words that share a similar meaning occur in similar linguistic contexts (therefore, large corpora can be used to compute semantic similarities between words; De Vega et al. 2008).

However, it must be emphasised that even though the symbolist and embodied accounts have long been considered to be two different or even contrasting approaches (see, e.g., De Vega et al. 2008, eds.), they are not necessarily mutually exclusive. For example, Paivio's (1971) *Dual Coding Theory* assumes that concrete words are processed by both the symbolic and the sensory-motor system, while abstract words are processed by the symbolic system only (this hypothesis

contrasts with that put forward by other researchers, who consider that both abstract and concrete language could be grounded in perception and action; e.g., Barsalou and Wiemer-Hastings 2005; Harpaintner et al. 2020). In more recent years, Louwerse (2007, 2008) has suggested that the two accounts may even be mutually reinforcing, and that linguistic comprehension is *both* symbolic *and* embodied. In line with his theory, the *Symbol Interdependency Hypothesis*, the author argues that "language comprehension can be symbolic through interdependencies of amodal linguistic symbols, but it can also be embodied through the references these symbols make to perceptual representations" (Louwerse 2011: 279).[7] In this view, the embodied component of meaning is, in fact, encoded in language.

In the next two sections (1.4.1–1.4.2), I will describe some studies conducted in cognitive linguistics and neurolinguistics that support an embodied view of language and help us better understand affordances, since they provide clear and compelling evidence that linguistic material (in particular nouns, verbs and sentences that relate to action) can elicit affordances and activate motor representations, just as visually perceived objects can (cf. Section 1.3).

1.4.1. Action-related verbs and sentences

The fact that language processing activates motor simulations, at least in the case of language relating to action, appears evident from a growing body of both behavioural and neuroscientific research conducted in the last twenty years on sentences or verbs related to actions (cf., among others, Barsalou 1999; Pulvermüller 2001, 2002, 2005; Gallese and Lakoff 2005; Pulvermüller et al. 2005; Tettamanti et al. 2008; Jirak et al. 2010; Buccino et al. 2016). The main finding of these works is that reading or listening to action-related verbs or sentences activates the same motor and premotor brain areas that are activated when subjects perform the actions denoted by the verbs or sentences considered; we may refer to this phenomenon as to meaning-action matching (De Vega 2012).

Clear and direct evidence for meaning-action matching is provided by Hauk et al. (2004). In their study, participants passively read action-related verbs denoting mouth, hand or leg movements (e.g., to *lick*, *pick* or *kick*); in a different task, they also performed actions involving the same body parts (moving the tongue, index fingers and feet). Using fMRI, the authors found that reading these action verbs, pertaining to different semantic subcategories, activates the motor

[7] There is also empirical evidence showing that the processes linked to symbolic cognition occur early during linguistic comprehension, in a phase of underspecified or 'shallow' processing, whereas the processes linked to embodied cognition occur later, in a phase of specified or 'deep' language processing (Louwerse 2011: 279; Louwerse and Jeuniaux 2008, 2010).

cortex in a somatotopic way; in other words, it activates specific regions of the cortex responsible for the motor control of different areas of the body. Language-related cortical activity overlaps with the diverse activation patterns observed in premotor and motor cortex during actual movements of the body parts to which the specific words refer (Hauk et al. 2004: 301).

The involvement of the sensory-motor system in language processing is also proved indirectly, at a behavioural level, by the facilitation or interference effects on motor responses caused by the comprehension of action-related words or sentences (the action-sentence compatibility effect). For instance, the processing of actional sentences (i.e., sentences that describe actions) may facilitate subsequent actions that require performing movements congruent with the type of action described by the sentence. Thus, a movement of the hand towards (or away from) the subject's body will be performed faster after understanding sentences describing movements directed towards (or away from) the subject, such as *Courtney handed you the notebook* vs. *You handed Courtney the notebook* (Glenberg and Kaschak 2002; see also Borghi et al. 2004; Zwaan and Taylor 2006; Scorolli and Borghi 2007).

Despite this evidence, as we said, meaning-action matching may also cause interference rather than facilitation effects. Buccino et al. (2005) used transcranial magnetic stimulation and a behavioural paradigm to assess whether listening to action-related sentences modulates the activity of the motor system. The authors found that, after hearing foot-related sentences, subjects' motor responses were faster when performed by hands than when performed by feet (and the amplitude of motor-evoked potentials recorded from subjects' foot muscles decreased). Conversely, after hand-related sentences, their foot responses were faster (and the amplitude of motor-evoked potentials recorded from their hand was reduced). This interference effect, which causes slower motor responses, reflects a neural competition due to the fact that the same effector (the hand or the foot) is involved in both the motor response and the meaning of the sentence.[8]

Considering these findings as a whole, Buccino et al. (2016: 72) assume that "the modulation of the motor system during language processing changes over time, going from an early interference, operating between 100 and 200 ms after stimulus onset, to a subsequent facilitation, operating later than 200 ms after stimulus presentation" (on this view, cf. also Garcia and Ibanez 2016).

Despite growing evidence that there is an activation of cortical motor areas during the comprehension of action-related verbs and sentences, the type of

[8] Interestingly, similar facilitation or interference effects also emerged for emotion-related sentences, the processing of which interacts with the muscles for facial expressions (Havas et al. 2007, 2010).

relation that links the two phenomena still remains the object of debate: the question is whether they are just co-occurring and experiential simulation is a sort of by-product of language processing (cf. Strozyk et al. 2019), or the recruitment of the motor-system really contributes information that is critical in order to comprehend language (on this, see also the discussion in Mahon and Caramazza 2008; De Vega 2012). There are at least two reasons that may support the latter hypothesis. The first is the precocity of motor representations. As Pulvermüller et al. (2009: 87) put it, neurophysiological studies "confirm near-simultaneous early brain correlates of phonological, lexical and semantic information immanent to a spoken word within the first ~150 ms [milliseconds] after the auditory input allows for word identification". According to Buccino and Mezzadri (2013), a very early and likely automatic recruitment of the motor system during language processing (150–170 ms after the stimulus, as many of the studies cited so far record) provides compelling evidence for the necessary and crucial role of the motor system in language comprehension, as appears from interference effects. On the other hand, other kinds of phenomena that occur later, such as facilitation effects, could just be due to an interaction between the motor system and the language, but not as a necessary part of language processing (cf. also Buccino et al. 2016).

The second piece of evidence comes from studies conducted on patients with Parkinson's disease: people with damage in the motor area also have selective difficulties not only in performing actions but also, crucially, in understanding verbs relating to action and concrete nouns indicating graspable objects (Boulenger et al. 2008; Ibanez et al. 2013; Buccino et al. 2018). Furthermore, a study conducted on healthy subjects interestingly shows that a reversible disruption of the premotor cortex induced by repetitive TMS, which causes a sort of virtual lesion, interferes with the comprehension of sentences describing manual actions (Tremblay et al. 2012). These results confirm that cortical motor regions are critical to word understanding, and that processing lexico-semantic information about action words necessarily depends on the integrity of the motor system (Boulenger et al. 2008: 743).

As many researchers suppose, the partial overlapping of the motor patterns activated during the comprehension of action-related verbs and sentences and those activated during action execution may be due to an involvement of the mirror neuron system in the processing of action-related language (for a review, see Kemmerer 2006; cf. also Buccino and Mezzadri 2013). The mirror neuron system is organised in a somatotopic fashion[9] (Buccino et al. 2001; Wheaton et

[9] As already stated above, somatotopy is the point-for-point correspondence of a specific part of the body to a distinct location in the central nervous system.

al. 2004), and likewise somatotopically differentiated are the motor simulations triggered by linguistic stimuli: that is, stimuli activate specific regions of the cortex responsible for the motor control of different areas of the body. Clear evidence for the involvement of the mirror neuron system in the processing of action-related language is provided, for instance, by Aziz-Zadeh et al. (2006), who found that the same brain areas are activated both when subjects read sentences relating to actions and when subjects observe those actions being performed by other agents.

1.4.2. Action-related nouns

If the circuit of mirror neurons is probably involved in the comprehension of action-related sentences and verbs, it is also possible that canonical neurons[10] underlie the comprehension of action-related nouns. Indeed, the visual perception of graspable objects activates the same neural patterns as those activated during their actual manipulation (Section 1.3). Is a similar recruitment of the motor region also observed when the stimulus is a word denoting an object, and not an image or an object? Neurophysiological studies demonstrate that nouns and verbs activate different neural circuits (cf. *infra*; for a review, see Vigliocco et al. 2011) and that the same is true also for some subcategories within the class of nouns. These findings clearly suggest that linguistic representations, as well as the concepts associated with them, give rise to neural patterns that are heterogeneously distributed and integrated in different cortical areas.[11]

We know, for instance, that brain regions that become active during the processing of concrete nouns are not the same as those activated by abstract nouns (see Kiehl et al. 1999; Martín-Loeches et al. 2001); furthermore, conceptual knowledge about concrete nouns belonging to different categories, such as animals, fruits and vegetables, tools, appears to be distributed across different neuroanatomical areas (e.g., Martin et al. 1996; Grabowski et al. 1998; Chao et al. 1999; Caramazza and Mahon 2003). In particular, as already mentioned in Section 1.3.2, the action of naming tools involves the cortical areas where canonical neurons were found in monkeys and humans, the same areas that are also activated by object manipulation (Chao and Martin 2000).

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[10] We should recall (cf. Section 1.3) that both mirror and canonical neurons have motor properties, that is to say, they fire when an agent executes a specific action on objects, such as manipulation or grasping, but they have different visual responses. Mirror neurons also discharge when the agent observes the same action being performed by another agent, whereas canonical neurons also fire when the agent simply looks at an object related to action (cf. Chao and Martin 2000; Grèzes and Decety 2002; Grèzes, Tucker et al. 2003).

[11] A similar phenomenon, for example, regards the representations of faces and objects of various categories in the ventral temporal cortex, which are widely distributed and overlapping (Haxby et al. 2001).

Most of the works cited thus far in this section are based on tasks in which subjects were required to name pictures of objects; they received a visual stimulus and had to actively produce a linguistic response, namely, to retrieve the correct word for each stimulus. However, some studies indicate that nouns denoting tools or artifacts selectively activate the motor system even without an image of the object (as already shown for action-related verbs). For instance, Cattaneo et al. (2010) conducted an interesting behavioural and neurophysiological study that points out the recruitment of the ventral premotor cortex (the probable homologue of the macaque F5 area where canonical neurons are found) in the processing of tool-related words. Subjects were primed by reading either the word *Tool* or *Animal* (or a sequence of symbols, in the control condition) written on a screen, after which a common word denoting an example of one of these categories appeared. Single-pulse TMS was applied at each target onset over either the left ventral premotor cortex (which previous studies have revealed to be associated with the processing of graspable tools or objects) or the left dorsal premotor cortex (used as a control TMS site). Participants were asked to decide as quickly as possible whether the stimulus-word shown after the prime denoted a tool or an animal, and to answer by pressing one or other of the buttons with their left hand.

As expected, from a behavioural point of view, a facilitation effect of the prime over response reaction times was found: subjects responded faster to the target words when they were congruent with the primed category than when the target words were incongruent with it. Furthermore, results show that when the target word denoted a tool, TMS applied over the ventral premotor cortex interacted with the prime effect, facilitating reaction times when the prime was *Animal* (because TMS increased the cortical excitability of the ventral premotor cortex responsible for the comprehension of tool words), but having no effect when the prime was *Tool* (the primed neuronal representation was less susceptible to the facilitatory effect of the stimulation). No effects were observed when the target word denoted an animal or when TMS was applied over the dorsal premotor cortex. Taken together, these results clearly indicate that the left premotor ventral cortex (the probable homologue of the F5 area in macaques where canonical neurons are found) contains a representation of the tool category, but not of the animal category, and is involved in the analysis and comprehension of words denoting graspable artifacts.

The activation of the motor system during the processing of nouns denoting graspable artifacts is also demonstrated by Gough et al. (2012). The authors applied TMS to the primary motor cortex representation of the first dorsal interosseous muscle of the right hand after the subjects read noun words, in order to study the differences in terms of motor representations between nouns denoting

artifacts or natural kinds. Motor evoked potentials were larger for names denoting graspable artifacts (tools) than those evoked by nouns referring to natural objects.

Thus, the modulation of cortical motor regions during noun word presentation is comparable to the activity observed during the visual perception of the corresponding objects or their images. In line with this assumption, Shinkareva et al. (2011) show that words and pictures may give rise to common neural representations. In particular, graspable artifacts stand out for the motor simulations they evoke when used as linguistic or visual stimuli.

Behavioural studies conducted on linguistic material support these findings and, from a more general point of view, indicate an involvement of the motor system in the semantic processing of nouns. Ahlberg et al. (2013), in their study, used noun stimuli that either contained the lexeme *hand* or *foot* (*football*, *handbag*, etc.), or indicated objects usually manipulated by the hands or the feet (*cup*, *shoe*, etc.). Participants had to respond by pressing either a button with their hand, or a pedal with their foot, depending on the print colour of the presented word. As expected, participants' responses were faster when the effector (i.e., the body part that was to perform the action, in this case a hand or a foot) with which participants had to press the button or pedal and the effector evoked by the presented noun matched rather than when they mismatched.

However, the recruitment of the motor system during linguistic processing of nouns may also emerge from interference effects (cf. Section 1.4.1). For instance, Glover et al. (2004) conducted a kinematic study in which participants had to read the names of objects of different sizes that afford a power or a precision grip (e.g., *pea*, *grape*, *pencil* vs. *apple*, *orange*, *baseball*) and then, after an acoustic signal (1 second after stimulus presentation), to grasp a wooden block. The authors found that the type of grip afforded by the object denoted by the noun interfered with the grasping movement directed at the block. For example, reading a word representing a large object led to a larger grip aperture than reading a word representing a small object. Affordances evoked by a word are able to influence the planning of grasp kinematics: this finding is quite similar to the results obtained with visual and concrete stimuli (cf. Section 1.3.1, in particular about the experiments carried out by Gentilucci 2002; see also Bub et al. 2008, in which both depicted objects and visual words are used as stimuli). Another significant interference effect was found by Marino et al. (2013), who carried out a go/no-go experiment on Italian nouns referring to hand-related objects (e.g., *forbici*, 'scissors'; *spazzola*, 'brush'; *forchetta*, 'fork'), foot-related objects (e.g., *pedale*, 'pedal'; *pattini*, 'skates'; *scalinata*, 'staircase') and abstract entities (e.g., *superbia*, 'pride'; *gelosia*, 'jealousy'). Participants read nouns on a computer screen and were required to give a motor response as quickly as possible by pressing a key with

the left or the right hand if the noun denoted a concrete object. The go-signal might appear early (150 ms) or late (1150 ms). One of the most interesting results was that responses were significantly slower when participants had to respond with the right hand to hand-related nouns only for the early go-signal. According to the authors, this result indicates that the interference effect is due to the early involvement of the motor cortex of the left hemisphere in the representation of artifacts activated by words (cf. Buccino et al. 2005, for a similar effect).

Research conducted on linguistic material thus reveals that motor simulations are largely engaged in the comprehension and processing of action-related verbs, nouns and sentences. Accessing semantic information about manipulable objects automatically activates affordances, in other words, motor information regarding micro-interactions with their referents (on this topic, cf. Borghi 2005, 2007; for a different opinion, see Mahon and Caramazza 2008). Therefore, affordances are thoroughly grounded in both the motor and the sensory systems, and understanding individual words reactivates our normal, personal encounters with objects.

1.5. Affordances and lexical semantics

It is clear from the evidence of the studies discussed in Section 1.4 that the comprehension and processing of words belonging to certain categories, at least those that denote action-related objects, involve an automatic motor simulation of the very activities that are typically done with objects. If the actions most frequently performed with artifacts are so closely and intimately connected with them that even the presentation of a word activates a mental simulation, it should be assumed that information related to such actions should be included in the lexical representation of words, as an integral and fundamental part of it.

However, the possibility of including information about the affordances of objects in the lexical representations of the words that denote them has thus far been little explored. Studies in theoretical linguistics, and particularly in semantics, rarely mention theories of affordances, which are still mostly investigated in the (albeit vast) field of psychology and cognitive science. This may be due to the fact that, as is easily understood from the (non-exhaustive) review of the literature presented in this chapter, we still lack a single, unified theory of affordances. Different authors building on Gibson's studies have reworked the notion and approached research on affordances from different points of view, with different methods and aims. In my opinion, however, this is also a major strength of this field of research, which lends itself to being investigated in a multidisciplinary manner (cf. Section 6.4).

There is also a more general issue that should be taken into account in trying to explain why the theory of affordances has received little attention among linguists. Especially among semanticists, but also among psycholinguists, there is some debate about how rich or thin lexico-semantic representations are (Hogeweg and Vicente 2020: 866). For instance, there is no consensus on whether the lexical meaning of a word such as *cup* contains only abstract information or also more detailed information as to what a cup is, what it is made of, what it is used for, and so on. Some authors assume that lexical meanings mostly contain scant, abstract information (e.g., Levin and Rappaport Hovav 2011). Many scholars, however, especially within cognitive linguistics, assume that lexical meanings are rich in conceptual information, and include part of our world knowledge.

In some of the theories that follow the latter kind of approach, such as Jackendoff's (1992) *Conceptual Semantics* and Pustejovsky's (1995) *Generative Lexicon*, it is possible to find some points of contact with the theory of affordances. This is true, in particular, for the *qualia theory*, first fully elaborated by James Pustejovsky within the theory of the Generative Lexicon (Pustejovsky 1995, 1998), based on the idea that "a core set of word senses, typically with greater internal structure than is assumed in previous theories, is used to generate a larger set of word senses when individual lexical items are combined with others in phrases and clauses" (Pustejovsky 1995: 2). Among the multiple levels that represent the lexical information in the Generative Lexicon approach (which also comprise argument structure, event structure, and inheritance structure), in the qualia structure four essential aspects of a word's meaning related to the *defining attributes of an object* are represented. Specifically, the qualia structure comprises four levels that specify (i) "the relation between an object and its constituent parts" (*constitutive quale*, or *C*), (ii) "that which distinguishes it within a larger domain" (*formal quale*, or *F*), (iii) "its purpose and function" (*telic quale*, or *T*), and (iv) the "factors involved in its origin or 'bringing it about'" (*agentive quale*, or *A*) (Pustejovsky 1995: 76). For instance, the qualia structure of the noun *sandwich* can be formally represented as follows: [F = physical A = make T = eat C = bread,…] (Pustejovsky 2010: 693).

The four qualia relations therefore provide information about particular properties and activities associated with the objects. However, they do not only represent our knowledge of words: qualia are "the major building blocks for constructing word and phrasal meaning in a language compositionally" (Pustejovsky 2010: 693), so they also suggest how to correctly interpret a word in a given context. For instance, a verb such as *to use* is largely underspecified (it is a 'light' verb, according to the terminology adopted in Di Sciullo and Rosen 1990: 110). In *John used the new knife on the turkey*, any explicit reference to the

activity of cutting may be omitted because we know that knives are tools *used to cut*, since *cutting* is the telic quale of *knife* (Pustejovsky 1995: 87). In the idea of a 'generative' lexicon, this implicit sense of *cutting* is activated by the telic quale of *knife*. The telic quale relation therefore implies that there is a 'hidden' event in the lexical representation of nouns[12] denoting objects made for a particular purpose. When this event is not expressed linguistically, it can be recovered via the complement of the verb.

Another example is provided by the verb *to enjoy*, which can be interpreted correctly only thanks to the telic quale of its direct object. Consider for instance the following sentences (taken from Pustejovsky 1995: 88):

a. *Mary enjoyed the movie last night.*
b. *John quite enjoys his morning coffee.*
c. *Bill enjoyed Steven King's last book.*

The telic quale of *movie*, *coffee* and *book* projects onto the verb the activities of *watching*, *drinking* and *reading* respectively, which may remain unexpressed linguistically. This is just one example of how interpretation is constructed online and dynamically, thanks to compositional rules in the grammar that make reference to values such as qualia structure.

The qualia theory, which has been extended and explored in more detail in the theory of *habitats* (Pustejovsky 2012, 2013), has evident connections with the idea of affordances developed by Gibson, especially with the key idea of affordances as possibilities for action. In particular, telic qualia closely resemble 'higher-level' affordances, understood as actions most typically associated with an object's function. These, however, need to be clearly distinguished from 'low-level' affordances, which are the motor patterns automatically triggered by the perception of objects, as maintained in Section 1.3. Another major difference between 'telic affordances' and 'low-level affordances' lies in the fact that the former are goal-directed, purpose-driven and intentional activities, whereas the latter arise unintentionally and are independent of the agent's will (cf. Pustejovsky and Krishnaswamy 2016). Therefore, telic qualia cannot be regarded as a formal representation of affordances at the lexico-semantic level, if we accept the definition of affordances assumed in this book (as motor simulations activated by object perception: cf. Sections 1.3, 1.4).

[12] We are referring here primarily to the nominal category, but it should be noted that every lexical category expresses a qualia structure, and that not all lexical items necessarily carry a value for each qualia role (thus also a telic quale).

1.6. Research questions and aims of the book

In this first chapter, I have reviewed a body of literature that provides behavioural, neurophysiological and neuropsychological evidence that the motor system is activated not only by the visual perception of manipulable objects but also by the nouns denoting them. The theory of affordances finds fertile soil in these contributions. Motor simulations activated by object perception can be understood as affordances (or micro-affordances), in that they function as true "preconditions for action" (Greeno 1994: 340), as demonstrated by the effects of interference or facilitation often registered in behavioural studies. Motor simulations, emerging as a sort of memory of past experience, not only allow us to *understand* a stimulus, but they also *prepare* actions. There is an evident connection with Gibson's idea of affordances: when we see a graspable object in our peripersonal space, our neural system is immediately primed to grasp it, giving rise to motor patterns as images of possible actions in a fast, automatic and somatotopic fashion. It is in this mechanism of mental imagery and simulation that possibilities for action are rooted.

The fact that nouns that refer to graspable artifacts are able to modulate the motor system in a similar way, together with other pieces of evidence obtained from many studies on the neural correlates of language processing, indicates not only that nouns, just like objects, may automatically trigger affordances, but also that language, at least in part, is embodied; in other words, many of our linguistic structures are deeply grounded in our sensory-motor system. Nevertheless, little attention has been paid to affordances in linguistics (at least, outside neurolinguistics). In particular, research on affordances has so far had little impact on theories developed in the field of lexical semantics.

Nowadays, one of the major contributions to the discovery of the close connection between cognition, perception and action, as well as of the embodiment of language, has been provided by research on grasping. Most of the works cited in this chapter highlight that artifacts and tools, when used as visual stimuli, are particularly effective in activating motor simulations of grasping and manipulation, and that some of the specific features of objects (those that we have termed affording properties) can directly modulate the activation of the sensory-motor system, especially in those areas that are activated during the actual manipulation and grasping of objects; among these are the presence of an affording part and the object's spatial position or orientation vis-à-vis the observer.

The study presented in this book seeks to explore and verify the hypothesis that *language production* might reflect affordances, that is, that it might be sensitive to the same variables that prove to modulate the activation of affordances (for instance, causing a stronger or weaker recruitment of the sensory-motor system, or faster or slower physical reactions during experiments).

Chapter 2
The linguistic reflexes of affordances: an experimental study

This chapter describes an experiment conducted to investigate the linguistic reflexes of the affordance of graspability. Crucially, experimental data are obtained from linguistic descriptions of grasps. This is, to our knowledge, a hitherto unattempted task that may open up a new way to investigate affordances, a topic rarely mentioned in linguistic studies.

This chapter is structured as follows. Section 2.1 discusses some preliminary theoretical and methodological issues. Sections 2.2 and 2.3 describe the material and procedure of the experiment. Section 2.4 presents the methods used to transcribe oral interviews. The analysis of the transcripts and its results will be discussed in the following chapters (in particular, Chapters 3 and 4).

As a preliminary note, I shall specify that, hereafter, the expression *affording properties* will refer to those specific physical features (whether variable or stable) of objects, such as size, shape, constituent parts and location, that are able to trigger and modulate specific motor responses; in particular, the *affording part* will be the part of an object typically involved in (and often specifically designed for) grasping, which is most likely to affect such brain activity.

2.1. Experiment design: theoretical and methodological issues

The overall purpose of the experiment was set forth in the previous section, but each constituent part of the experiment also had to take into account, and rely on, theoretical bases. Furthermore, this test needed to be as congruent as possible with the previously described studies, in order to be able to compare results and provide further evidence for what has already been demonstrated in other research fields. Thus, many key concepts introduced and discussed in Chapter 1 needed to find an exact counterpart in the framework of this experiment, that is to say, they had to correspond to a component that reflected them at a behavioural or linguistic level, as will be clarified in what follows. These theoretical assumptions and their experimental transposition will be now examined in turn.

2.1.1. The role of visual perception

The importance of visual perception in detecting affordances has been stressed in many studies, starting from Gibson's (cf. Section 1.1.4), and in line

with widely-held theoretical assumptions almost all experiments presented in the previous chapter use visual stimuli, in particular pictures of objects (e.g., Tucker and Ellis 1998, 2001; Symes et al. 2007; Buccino et al. 2009). Therefore, the best way to detect the affordance of graspability was to design a task in which objects were visually presented to participants; in this regard, photographs or images have already proved to be a highly suitable stimulus. However, the purpose of this research was to analyse linguistic behaviour relating to affordances, so the test was built around visual inputs, but led to a linguistic output. In particular, the experiment was designed as follows: a series of images were presented to participants, and they were asked to carry out an action description task.

2.1.2. Affordances as an inherently relational concept

Since Gibson, affordances have been considered an inherently relational concept that regards both living beings and the environment in which they act (cf. Section 1.1.1). This is a basic assumption that needed to be taken into account in designing the test: this experiment was expected to provide information about how people interact (in the etymological sense of the word, 'to act between') with objects during the action of grasping. For this reason, when giving descriptions of grasps, participants were supposed to describe both how an object can be grasped according to its physical properties and how they would most probably take hold of it according to their personal dispositions and abilities.

Since the visual-linguistic test did not require the volunteers to perform any concrete action, it was the instruction they were given that needed to stress this point, so that the close connection between agents and objects could emerge. Responses were expected to reflect the assumption of complementarity posited thus far. For this reason, the adverb *how* was the keyword of the task: volunteers were asked to *describe how they would grasp* a series of objects. Leaving aside any other specification, the word *how* was supposed to activate simultaneously both proprioception, i.e., the perception of oneself and the awareness of one's abilities, and exteroception, i.e., the perception of an object's salient properties. The linkage between the two types of perception perfectly fits in with the concept of affordances outlined above. The adverb *how* points in two directions, leaving informants free to focus their attention, in their linguistic representation of the event, more on the agent, or on the object of the grasp, or to 'shift' their attention from one element to another as different stimuli were presented. Answers that focus more on the role of the agent of the grasp were expected to be those in which body parts are explicitly mentioned ("with my right hand" and the like), whereas when attention on the object increases or predominates, I expected the object, or specific object parts, to be named explicitly ("by the handle", and the like).

2.1.3. Affordances, familiarity with objects and past experience

The way humans interact with objects is very much influenced by their experience and their familiarity with them. Familiarity has been demonstrated to affect the activation of the sensory-motor system during object presentation (Section 1.3.5). For this reason, most of the cited studies on affordances adopt common everyday objects as stimuli, such as a frying pan, a knife, a mug (e.g., Riddoch et al. 1998; Ellis and Tucker 2000; Tucker and Ellis 1998, 2001; Phillips and Ward 2002; Buccino et al. 2009), while only a few use geometrical shapes (Gentilucci 2002; Symes et al. 2007).

Since using familiar objects in experiments enhances the possibility to observe affordance effects (Pavese and Buxbaum 2002: 562), highly meaningful, concrete and familiar objects were used as stimuli. I selected them from a list taken from speech corpora: in this way, only objects that are frequently referred to in speech were included in this study (cf. Section 2.2).

2.1.4. Categories of object stimuli

Ideally, the sample of objects chosen as stimuli needed to be representative of many kinds of graspable objects; therefore, even if the studies presented in Chapter 1 were mostly conducted on artifacts and natural kinds, variation both in terms of object category (artifacts, natural kinds, humans) and in terms of object size (big or small) was guaranteed in this experiment.

There is another characteristic of objects that needed to be taken into account: the presence of affording parts. Affording parts play an important role during the visual processing and recognition of objects: for instance, we have shown that the perception of a cup with a broken handle causes a decrease in motor evoked potentials recorded from hand muscles compared to those elicited by a cup with an intact handle (Buccino et al. 2009). For this reason, artifacts were divided into two classes: objects with a part that is particularly suited for grasping (e.g., a tea-cup with a handle), and objects without any part that urges grasping over others (e.g., a tennis ball).

Moreover, since many studies have demonstrated that objects with affording parts elicit different motor representations as the orientation of the affording part varies, in this experiment, too, some objects were presented in different orientations: they could be rightward- or leftward-oriented, upright or upside-down.

2.2. Visual stimuli

2.2.1. Nouns denoting graspable objects in the ImagAct corpus

The list of objects used as visual stimuli was extracted from the corpus developed within the ImagAct project.[13]

ImagAct is a multilingual ontology[14] that focuses exclusively on the domain of action verbs (Moneglia et al. 2012, 2013; Panunzi et al. 2014; a detailed and complete description of the resource is provided by Gagliardi 2014). It is organised around short videos or 3D animations, constituting the nodes of the ontology, that represent particular *action types* (e.g., a man taking a glass from a table, or a man taking water from a tap using a bottle), set in a pragmatically neutral context. Action types are kinds of events that are conceptually different from each other and distinguished not only by the verb (or the class of verbs) that denotes them, but most importantly by the ways in which the participants in the events act and move.[15]

Each action type in ImagAct corresponds to a video and each video is in turn associated with a list of Arabic, Chinese, Danish, English, French, German, Greek, Hindi, Italian, Japanese, Polish, Portuguese, Serbian, Spanish, Swedish and Urdu verbs that can be used to describe that particular event.[16] Obviously, one verb usually points to more than one scene; in other words, it may be used to denote different types of events.

What is of particular interest for the present study is the corpus that lies behind this ontology. Since the first major task of the ImagAct project was to

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[13] Information about the project and the ImagAct resource can be retrieved at the URL: http://www.imagact.it.

[14] In computational linguistics, ontologies can be defined as "semantic data structures that provide an explicit modelling for a portion of the real world" (Navigli 2022: 537).

[15] For instance, we may consider the verb *to take* in the following examples: (1) *John takes a present from a stranger*; (2) *John takes Mary the book*; (3) *John takes the pot by the handle*; (4) *John takes Mary to the station*. All these sentences contain the verb *to take*, but they denote completely different types of action. In (1), the verb *to take* means 'to receive, to accept', but in (2) it means 'to bring', in (3) simply 'to grasp' and in (4) 'to accompany'. Such different action types correspond to events in which agents move and act in different ways, and therefore the sets of locally equivalent verbs that in each case may substitute *to take* are different: *John receives a present from a stranger* is acceptable, but *John receives Mary the book* is not; *John brings Mary the book* would rephrase *John takes Mary the book*, but *John brings the pot by the handle* is not equivalent to *John takes the pot by the handle*, etc.

[16] For each video there is also a 'best example', namely a short sentence that exemplifies the use of a verb in all the languages available. Moreover, ImagAct has been linked to (Ital)WordNet (for which, see Fellbaum 1998) through an automatic mapping established between ImagAct's videos and (Ital)WordNet's synsets (see Bartolini et al. 2014 for a description of the procedure adopted; the results of evaluating the quality of the mapping were published in De Felice et al. 2014).

develop an 'ontology of action' from Italian and English data (which was later extended to other languages), two corpora that focused specifically on high-frequency English and Italian action verbs were first created. Action verbs provide the main semantic contribution in sentences and are also the most frequent items in speech (Moneglia and Panunzi 2007); therefore, English and Italian ImagAct corpora have been derived from different parts of pre-existing spoken corpora. For English, ImagAct exploited a random sampling of the BNC-Spoken corpus (of around 2 million words). The Italian part of the corpus consists in a collection (of around 1.6 million words) of spontaneous speech corpora available for research, in particular the entire LABLITA Corpus of Adult Spontaneous Spoken Italian (Cresti and Moneglia 2005), the entire LIP corpus (De Mauro et al. 1993) and part of the CLIPS corpus[17] (Albano Leoni 2003).

From these collections of texts, the ImagAct corpus was derived in parallel for English and Italian in different steps (Moneglia and Panunzi 2011; Frontini et al. 2012; Moneglia et al. 2012). First, all occurrences of high-frequency action verbs (more than 1100 Italian or English lemmas) were extracted from spoken corpora with their linguistic context. Then, through a web interface, each context extracted was standardised by expert annotators and reduced to a very simple sentence (present indicative, 3rd-person singular, active voice, definite and singular subject, definite object, etc.). In doing this, each piece of information irrelevant to the action itself was disregarded, in order to create, for each lemma, a list of instances that show which kinds of events people are usually referring to when they use these verbs in a real conversation (e.g., a sentence like *then I finally took the red book that was on the table* would have been standardised as *John takes the book*). When there was an implicit (usually anaphoric) reference to an agent or an object, annotators found the correct anchor in the original corpus and made it explicit (e.g., a sentence like *they finally caught them* would have been standardised, after reading the entire original text, as *the policeman catches the thieves*).

Annotators then assigned a 'primary' or 'marked' value to all standardised sentences: 'primary' sentences occur when an action verb refers to a concrete physical action, as in *John gave Mary the umbrella*, *John runs to the station*; in 'marked' sentences, verbs are used in abstract, metaphorical or idiomatic expressions, as in *John gives me a good idea*, *John gives up smoking*, *time is running too fast*, etc. After these preliminary operations, only primary uses of action verbs were considered in building the ImagAct resource (see Frontini et al. 2012; Moneglia et al. 2012; Moneglia et al. 2013; Panunzi et al. 2014).

[17] Only the sub-corpora obtained from radio and television programmes and some of the dialogues were considered, because they were the most useful for the purposes of the ImagAct project. For details about the composition of the ImagAct corpus, see Gagliardi (2014: 58 ff.) and Moneglia (2014).

2.2.2. Object stimuli

The choice of the object stimuli used in the present study was based on information taken from the Italian part of the ImagAct corpus, which specifically focuses on action verbs as they are used in real conversations and familiar situations. Furthermore, since anaphora is avoided and explicit reference to objects is always restored, this corpus provides direct evidence about the objects typically involved in actional events as they are referred to in speech.

In order to compile a list of graspable objects, the verbs pertaining to the semantic field of grasping were manually identified and selected from among the almost 600 Italian verbs present in the ImagAct database: *acchiappare*, *accogliere*, *afferrare*, *cogliere*, *pigliare*, *prendere*, *raccattare* ('to catch', 'to take in', 'to grasp', 'to pick', 'to grab', 'to take', 'to pick up'). Then, all the primary instances of these verbs (tot. 1309) were collected, all direct object lemmas were extracted and sorted according to frequency.[18]

The stimuli chosen for the experiment were selected from this list of nouns denoting familiar graspable objects, according to different criteria. First, object stimuli had to be representative of different categories: thus, nouns denoting artifacts (with or without affording parts), natural kinds, substances and aggregates, and humans, were chosen (note that substances, aggregates and humans were never used as stimuli in any of the studies cited in the previous chapter).

Size is another relevant parameter; therefore, nouns referring to both large and small objects were selected (in the specific field of grasping, we can consider as 'large' a size that exceeds the maximum span of a hand). During the selection of the stimuli for the experiment, objects denoted by nouns with the highest frequency in the ImagAct corpus were preferred.

Table 2.1 shows the stimuli adopted in the experiment. All these stimuli correspond to nouns belonging to the list of graspable objects extracted from the ImagAct corpus (which are shown in Table 2.1 between round brackets), except for the mandarin, which was added as an example of a small fruit, and the pumpkin seeds, which occupy an intermediate position between two different categories (see Section 2.3.2). For the reasons discussed in Section 2.1.4, some stimuli

[18] In De Felice (2014b), the direct object lemmas of all primary and marked occurrences of these seven verbs (tot. 2802 sentences) were used in an experiment of word sense disambiguation. All lemmas were annotated with information relating to affordances as well as with semantic data. Results of automatic classification experiments demonstrated that affordance-based knowledge proves useful in disambiguating different senses of verbs (concrete vs. metaphorical uses). For a complete description of the experiment and its results, see De Felice (2014b), a rewritten and expanded version of De Felice (2013).

belonging to the artifact category were chosen to be presented in different orientations (rightward- or leftward-oriented, upright or upside-down).

Class of stimuli	Object stimuli
artifacts – with affording parts	chair (*sedia*); coffee cup (U) (*tazzina da caffè*); handbag (*borsa*); hairdryer (L/R) (*phon*); jug (L/R) (*brocca*); ladle (L/R) (*mestolo*); microphone (L/R) (*microfono*); dummy (L/R) (*ciuccio*); rubber boat (*gommone*); backpack (*zaino*); sword (L/R) (*spada*); tea-cup (L/R/; UL/UR) (*tazza*); trolley case (*valigia*); umbrella (*ombrello*).
artifacts – without affording parts	box (*scatola*); glass (*bicchiere*); lighter (*accendino*); pencil (*matita*); plate (*piatto*); football (*pallone*); tennis ball (*pallina*); vase (*vaso*).
natural kinds	apple (*mela*); banana (*banana*); mandarin; stone (*sasso*).
substances and aggregates	flour (*farina*); pumpkin seeds; sand (*sabbia*); water (*acqua*).
humans	baby (*bambino*); man (*Marco*, *Luca*, *Giulio*); woman (*Cristina*).

Table 2.1. Stimuli chosen for the action description task (R: right orientation; L: left orientation; U: upside-down).

2.3. Procedure

2.3.1. The participants and the experimental setting

Thirty participants entered the study. They were all native Italian speakers and undergraduate foreign-language students at the University of Pisa (only one of them had already graduated). There were five males and 25 females. They were aged between 20 and 27, with a mean of 22.6 (and a standard deviation,[19] henceforth SD, of 1.52). All participants were informed about the purpose of the study and gave their consent to the experimental procedure. In order to maintain anonymity, they received an ID number (from one to 30) and filled in a form with their name, ID number, age, weight, length and hand dominance. Participation in the experiment was voluntary and unpaid.

[19] Standard deviation (σ, or SD) is a measure of variability used in statistics to express to what extent the data values are dispersed from the mean. A high standard deviation indicates that the data are spread over a wide range of values, whereas a low standard deviation shows that the data are concentrated tightly around the mean of the data values.

The interviews were audio and video recorded at the Laboratory of Phonetics and Phonology of the University of Pisa (Department of Philology, Literature and Linguistics).[20] Each session involved only two people at a time: the interviewer (the present author) and one student. During the experimental session, volunteers were seated on a chair before a PC monitor, placed at a distance of about 60 cm from their eyes, while the interviewer was seated on their left. A video camera was placed to the left of the PC monitor, pointed towards the participants so that both the monitor and the informant were framed (Figures 2.1, 2.2).

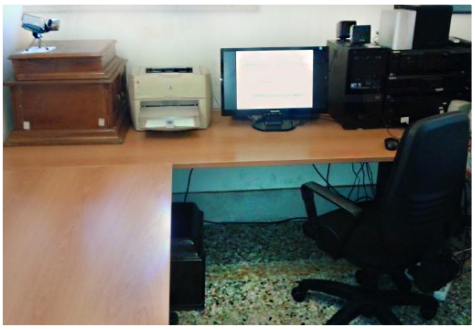

Figure 2.1. The experimental setting.

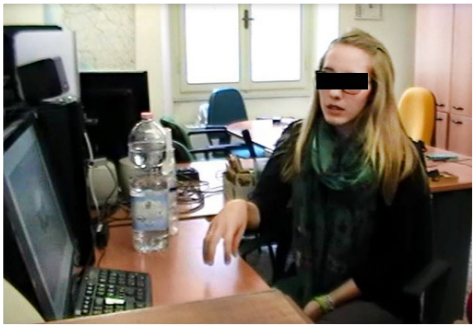

Figure 2.2. The recorded interviews: an example.

2.3.2. Visual stimuli presentation

The visual stimuli adopted in the experiment (cf. Table 2.1) were 42 pictures of concrete entities that are presented in Figure 2.3. They were all photographs of real objects taken against a white background: 22 were taken by myself (e.g., hairdryer, banana, plate, ladle), while the others are public domain copyright-free images retrieved from the web (e.g., dummy, sword, chair, child).

Only two pictures (the running man and the standing woman) had a realistic background (in this case, a city setting). This made the task easier for the participants to carry out, as they were thus better able to imagine a real context in which they might have to take hold of a person.

Within the category of artifacts with affording parts, there are some distinctions to be made between different objects. Whereas most of them have a real handle, i.e., only one protruding part that is specifically designed for facilitating the grasp (as is the case with the umbrella, the tea-cup and the hairdryer), there are also objects that have more than one part that could possibly be grasped. For

[20] Information about the laboratory can be found at the URL: https://laboratorio-fonetica.fileli.unipi.it/.

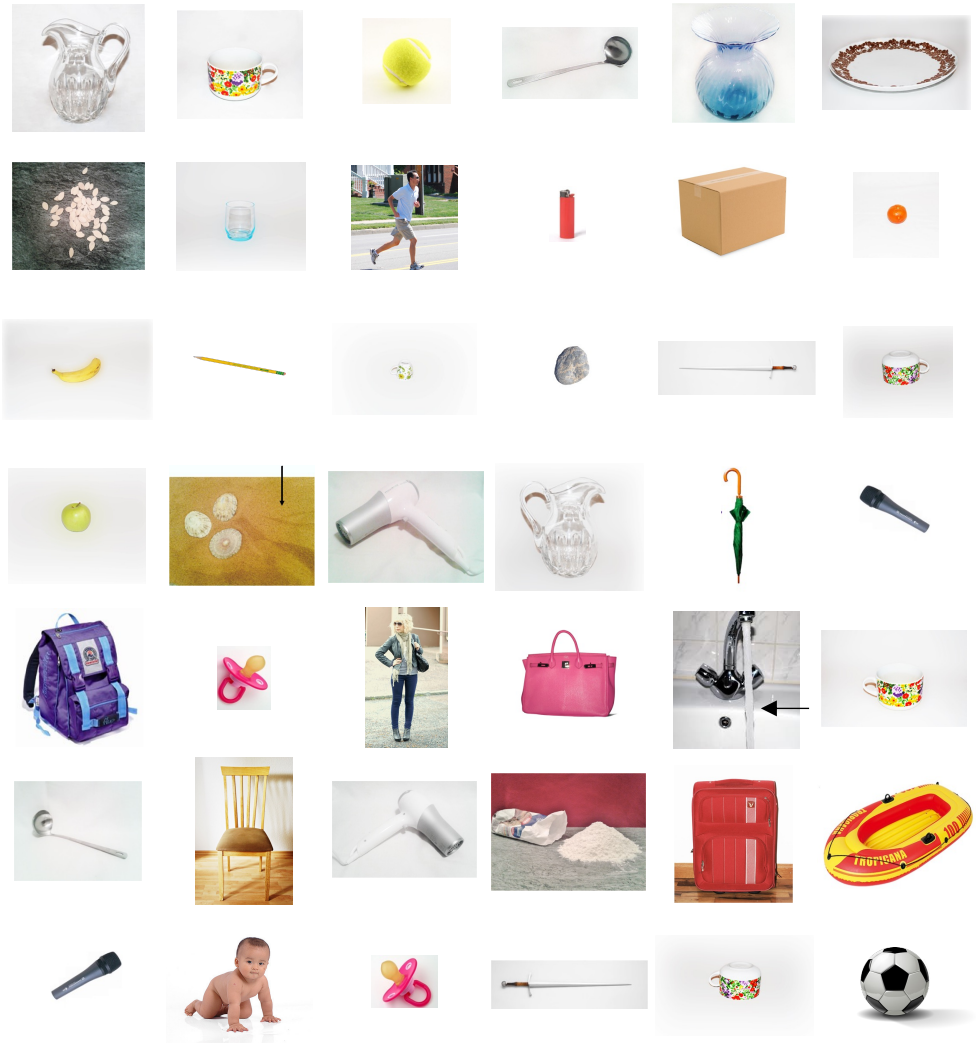

Figure 2.3. List of pictures used as stimuli in the grasp description task.

instance, the rubber boat has two handles, but it also has a rope going round it, as well as some plastic rings holding the rope.

The chair is included in the list of artifacts with affording parts even though it does not have a specific part designed for grasping, because, compared to artifacts without affording parts, it is characterised by having more than one discrete and visually distinguishable part that could attract the grasp. Moreover, these parts are not equivalent to one another: in particular, the back of the kind

of chair chosen as a visual stimulus is the part probably best suited for grasping because it stands at the height of human hands. The seat and especially the legs are more difficult to grasp.

The category of substances and aggregates groups together four different stimuli: flour, pumpkin seeds, sand and water. These entities occupy a different position on a scale of individuation that ranges from substances (water) to granular aggregates (flour, sand) to collective aggregates (pumpkin seeds) to individuals (Clausen et al. 2010). The status of an entity on this scale is determined by several features, such as the canonical mode of interaction that people have with an entity, the ease of distinguishability of its constituent elements, the size of such elements and the spatial and/or temporal contiguity between them (Wierzbicka 1988; Middleton et al. 2004; cf. De Felice 2015b). Water represents a liquid, a canonical example of a substance; its minimal elements are continuous and visually indistinguishable. Sand and flour are aggregates of minimal particles that can be visually distinguished (especially the grains of sand) but are still very small and humans do not usually interact with them. By contrast, pumpkin seeds are presented as an aggregate, because in the picture they are collected in a mound (cf. Figure 2.3); however, their minimal elements are larger than, for example, a grain of sand and are therefore more clearly distinguishable. The single seeds are also more accessible, and humans do interact with them (for example, when eating the seeds one by one).

From a morphosyntactic point of view, the words that denote these four entities in Italian are diverse in nature: the words for water, flour and sand are mass nouns (for example, when combined with the numeral *due*, 'two', as in *due acque*, *due farine*, *due sabbie*, they may only refer to two different *kinds* of water, flour and sand, respectively; cf. Chierchia 1998). By contrast, the word *seme*, 'seed' is a count noun (e.g., *due semi*, 'two seeds'), but it is worth noting that in Italian both count and mass terms may refer to aggregates, understood as collections of relatively small and homogeneous entities (Middleton et al. 2004).[21] Therefore, the mound of pumpkin seeds can be considered as intermediate between two different categories, distinguished both perceptively and linguistically: that of individual objects, denoted in Italian by count nouns, and that of granular aggregates, mostly denoted in Italian by mass nouns; cf. Clausen et al. 2010).[22] Since the seeds are very small and usually occur together, they are presented in a mound

[21] For example, *riso*, 'rice' is a mass noun. There are languages in which also small fruits and vegetables are mass nouns. For instance, Wierzbicka (1988: 313) reports that the Russian words for peas and beans (*gorox, gorošek, fasol'*) are mass nouns, just like the words for rice and flour (*ris, muka*).

[22] Pumpkin seeds might be considered, following Wierzbicka (1988: 338), "pluralia mostly", because they are possible to count but usually are not counted (cf. Eng. *peas*).

in order to investigate which type of grasp they afford (whether more similar to that of the sand or to that of the lighter).

2.3.3. The grasp description task

The PowerPoint presentation on the computer monitor started with a white slide with black writing that explained the task. Participants were asked to look at a list of images representing various objects and to describe, in as much detail as possible, how they would grasp them ("Osserva bene gli oggetti che vedrai rappresentati; quindi, descrivi nella maniera più dettagliata possibile come prenderesti gli oggetti"). Moreover, it was explicitly specified by the interviewer that the description had to be given verbally, and not be replaced or complemented by gestures and pointing to the monitor. When only one answer was provided, informants were asked if they could think of grasping the presented object in some other way (otherwise, similar requests were formulated).

The pictures of objects (see Figure 2.3 for the images and Table 2.1 for the list of stimuli) were then presented in the order shown in Table 2.2, alternating with empty white slides.

1. jug (R)	15. coffee cup (U)	29. water
2. tea-cup (R)	16. stone	30. tea-cup (L)
3. tennis ball	17. sword (R)	31. ladle (R)
4. ladle (L)	18. tea-cup (R, U)	32. chair
5. vase	19. apple	33. hairdryer (L)
6. plate	20. sand	34. flour
7. pumpkin seeds	21. hairdryer (R)	35. trolley case
8. glass	22. jug (L)	36. rubber boat
9. running man	23. umbrella	37. microphone (L)
10. lighter	24. microphone (R)	38. baby
11. box	25. backpack	39. dummy (R)
12. mandarin	26. dummy (L)	40. sword (L)
13. banana	27. standing woman	41. tea-cup (L, U)
14. pencil	28. handbag	42. football

Table 2.2. Object stimuli adopted in the experiment (R: right orientation; L: left orientation; U: upside-down) and their order of presentation.

2.4. The GraDes corpus: orthographic transcription of the video-recorded interviews

The total duration of the recordings is more than six hours of speech (06:51:25), ranging from a minimum of 00:08:07 to a maximum of 00:21:08 per participant, with a mean of 00:13:43 minutes (SD=00:03:54). The descriptions of grasps provided by the 30 interviewees were all transcribed and collated in a single speech corpus, the *GraDes* (*Grasp Descriptions*) *corpus*, following the CHAT format (MacWhinney 2000).

The CHAT transcription system is nowadays one of the best-known methods for generating transcripts from oral materials, mainly because it allows researchers to notate only what they consider relevant to their purposes. For instance, it is possible to adopt an advanced and very fine-grained transcription that also considers proxemic activities, gestures, facial expressions, paralinguistic materials, hesitations, phonological and prosodic features, and many other aspects of human verbal interaction. Another option, however, is to choose a very basic format for transcription and coding that results in a broad transcription (min-CHAT). The conventions and principles of the CHAT transcription system are described in detail in the CHAT manual (MacWhinney 2000).

All CHAT files are made up of three major components: the file headers, the main tier and the dependent tiers. These three parts are designed to contain different material and for this reason each one has its own notations. There is a rich set of transcription markers, as the manual illustrates, but the symbols and codes adopted in this study are those described in Moneglia (2005) that were adopted for the creation of the C-ORAL-ROM corpus (Cresti and Moneglia 2005).

The next three sections (Sections 2.4.1–2.4.3) provide a detailed description of the features that were considered relevant and notated in the transcripts. Some excerpts from the transcriptions of the interviews will be given to exemplify the notation system.

2.4.1. Metadata

Metadata contain all possible information about the recorded session and are included in transcripts as a set of 'headers'. These file headers provide information about the setting and the participants of the communicative event that is being transcribed. As shown in (1), headers are lines of text inserted in a fixed order that are introduced by the '@' sign followed by the header name. A small number of headers are made up only of the header name; these are called 'bare headers', notably the '@Begin'/'@End' headers that are obligatorily used to mark the starting/ending point of the transcript. Most headers, however, also require entries that specify the value of the header name. Necessary headers of this type are the '@Languages' and '@Participants' headers, which give

information about the main language of the dialogue and about the participants (identified here by a three-letter or three-number ID, and a role). Another compulsory header is the '@ID' header; this line may encode a richer set of data about the participants.

(1) @Begin
@Languages: Italian
@Participants: 001 Informant, IDF Interviewer
@ID: Italian|001|Informant|23|male|right-handed|
@ID: Italian|IDF|Interviewer|||
[…]
@End

Each file contains the transcript of a single interview. So, there are always two participants: one is the *informant*, identified with a progressive number (from 001 to 030); the other is the *interviewer*, identified by my initials. In the '@ID' line, other information about the informant is inserted manually: age, gender, hand dominance.

In the initial part of the file, also the date and location of the interview are specified and a brief description of the experimental setting is given, as exemplified in (2):

(2) @Location: Pisa, Italy
@Date: 24-MAR-2014
@Room Layout: Phonetics Lab, University of Pisa; the informant is sitting at a computer monitor, the interviewer is sitting to his/her left; the interview is filmed using a video camera placed on the left, oriented towards the informant.

All transcripts are linked to a video in a *.mov file format and contain information about it (its name, which coincides with the name of the informant in the dialogue, and the duration of the recording):

(3) @Media: 001, video
@Time Duration: 00:09:13

As exemplified in (4), some additional header lines also give information about the transcription itself: only phenomena relevant to the present study are notated, so the transcription is 'coarse'; all data are transcribed by a single person; overlapping was not accurately transcribed. The '@Situation' header precedes the transcription and describes the task being performed:

(4) @Transcription: coarse
@Transcriber: Irene De Felice
@Warning: overlapping was not accurately transcribed.
@Situation: the informant is presented with a sequence of pictures of objects on the computer monitor and he/she is asked to describe how he/she would grasp them.

After the '@Situation' heading, a list of '@G' headings signals the beginning of so-called *gems* that further subdivide the file. Each gem is named according to the names of the objects involved in the task and identifies the part of the transcript that corresponds to the part of the dialogue that follows the presentation of a specific stimulus. '@G' headers also improve the readability of the transcript, since each '@G' line roughly corresponds to a change of the image presented to the informant on the computer monitor:

(5) @G: jug (right orientation)
[…]
@G: tea-cup (right orientation)
[…]
@G: football
[…]

2.4.2. Main tier

The main tier contains the transcription of what the participants actually said.

Unlike written language, the textual organisation of spoken language is built on utterances, which are the linguistic units of speech analysis. Defining an utterance is not a trivial issue (cf. Moneglia 2005: 15–16) and it is not clear how to draw a dividing-line between different utterances. From a perceptual point of view, they are not only natural units of speech bounded by the speaker's silence, even though in many cases they begin and end with a pause.

Cresti (2000) assumes that a systematic correspondence exists between the information pattern of the utterance and its prosodic patterns. Thanks to this correspondence, we are able to segment the speech flow into utterances by perceiving different prosodic patterns within it (Cresti 1994, 2000). In this view, utterances are defined as the minimal linguistic units such that they allow a pragmatic interpretation in the world (Cresti 2000). They are autonomous and concluded from a pragmatic point of view (Quirk et al. 1985) and are the linguistic counterparts of communicative acts (Austin 1962). Intonation plays a fundamental role in identifying them: all utterances have a profile of terminal intonation (Karcevsky 1931; Crystal 1975). Since a single utterance can also be further

divided into various tone units (*simple* vs. *compound utterances*), there are different kinds of prosodic boundaries: on the one hand, those that terminate a sequence of tone units and mark the accomplishment of an illocutionary act (i.e., *terminal breaks*); on the other hand, those that only signal the flow of the same prosodic programme within a compound utterance (i.e., *non-terminal breaks*).[23] It is worth noting that the annotation of prosodic breaks does not constitute a transcription of prosody.

In line with these theoretical assumptions, the transcription of the interviews recorded in this study is performed in the CHAT standard format and follows the specifications described in Moneglia (2005), adopted for the creation of the C-ORAL-ROM corpus.

The main tier is the core of the transcript and contains the speech transcription. Each line of this part begins with an asterisk, followed by a three-letter speaker ID, a colon and the orthographic transcription of the speech (in the Roman alphabet, with words separated by a single space).

The segmentation of the speech flow into utterances is performed by means of perceptive judgements and distinguishes between two types of prosodic breaks. It is useful to quote the passage in which different kinds of prosodic breaks are defined (cited from Moneglia 2005: 17):

- *prosodic break*: perceptively relevant prosodic variation in the speech continuum such as to cause the parsing of the continuum into discrete prosodic units.
- *terminal prosodic break*: given a sequence of one or more prosodic units, a prosodic break is considered terminal if a competent speaker assigns to it, according to his or her perception, the quality of concluding the sequence.
- *non-terminal prosodic break*: given a sequence of one or more prosodic units, a prosodic break is considered non-terminal if a competent speaker assigns to it, according to his or her perception, the quality of being non-conclusive.

All utterances are assumed to end with a perceptively relevant prosodic break that has a terminal value and is marked with the double forward slash ('//'), whereas non-terminal prosodic parsing is signalled with a single forward slash ('/'), as exemplified in (6):

[23] A similar distinction between strong and weak breaks is found in Buhmann et al. (2002).

(6) @G: coffee cup (u-d)
*007: questa la prenderei / sempre / mettendo la mano / come se dovessi afferrare una pallina //[24]
*IDF: mhmh //
*007: oppure cercherei / di mettere / il dito nell'occhiello // per poterla poi rigirare //[25]
*IDF: ok //

There are also three more types of terminal breaks (cf. Moneglia 2005: 26 ff.), which mark interrogative utterances (ending with a '?' tag), intentionally suspended utterances ('…') and interrupted utterances ('+'), respectively:

(7) *002: perché se magari devo fermarlo per chiamarlo / non lo so / per un +[26]
*IDF: mi basta che lo prenda in qualche modo //[27]
*002: per un braccio // o per la maglia // o per [/] forse per il polso //[28]

The '[/]' symbol is used to mark a retracting break, a special type of non-terminal break, as exemplified in (8). Retractions are the most frequent fragmentation phenomenon in spontaneous speech, and they are generally associated with speaker hesitation.

As opposed to interruptions, retracting is usually accompanied by the complete or partial repetition of the preceding linguistic material and by a prosodic break (Moneglia 2005: 27). Errors followed by a correction are not distinguished from other kinds of retraction. The symbol '[/]' is inserted in the position where the restart begins, as exemplified in (8).

(8) *002: mah io lo prenderei per / non lo so / eh / per [/] per chiedergli qualcosa //[29]

All fragmentary words are immediately preceded by the ampersand symbol '&'.

In the transcripts collected for this study, the sequence 'yyyy' indicates linguistic material that is not relevant to the analysis and is therefore not

[24] 'I would always take hold of this by placing my hand as if I were having to grasp a ball'.
[25] 'Or I would try to put my finger into the hole of the handle to turn it the right way round'.
[26] 'Because if I have to stop him to talk to him, I don't know, for a...'.
[27] 'It's enough if you take hold of it in some way'.
[28] 'By his arm or by his top or perhaps by his wrist'.
[29] 'Well I would grab hold of him I don't know to ask him something'.

transcribed; 'xxx' indicates a sequence of unintelligible words. Moreover, 'hhh' is used to signal laughing, and angle brackets '<' and '>' are used to identify which part of the utterance – as long as it is not restricted to the word that immediately precedes the string – is affected by this paralinguistic event (other types of behaviour, such as shouting, coughing, etc., are considered irrelevant to the purposes of the study and are deliberately not notated in the transcripts).

Table 2.3 summarises the symbols adopted in the transcription.

Symbol	Description
/	Non-conclusive prosodic break
//	Conclusive prosodic break
+	Conclusive prosodic break such that the utterance is interrupted by the listener or by the speaker him- or herself
…	Conclusive prosodic break such that the utterance is left intentionally suspended by the speaker
?	Conclusive prosodic break such that the utterance has an interrogative value
[/]	Non-conclusive prosodic break caused by a false start (retracting phenomena with complete or partial repetitions)
&	Speech fragments
hhh	Paralinguistic elements (laughing)
xxx	Incomprehensible word or sequence of words
yyyy	Non-transcribed audio signal

Table 2.3. Symbols adopted in transcripts (adapted from Moneglia 2005).

2.4.3. Dependent tiers

Dependent tiers are inserted below a main line and contain a variety of material of interest to the researcher, such as comments, event descriptions, etc. (for a complete list of the possibilities offered by CHAT, see MacWhinney 2000; cf. also Moneglia 2005: 37 ff.). Here, only three dependent tiers are adopted, as exemplified in (9):

– %com: the comment tier is a general-purpose line, in which the transcriber can insert notations of various kinds relevant to the study or the comprehension of the transcript;[30]
– %tim: in the present study, this tier is used to notate the duration of the untranscribed parts of the transcript;
– %exp: this level, too, is used in connection with the 'yyyy' string in the main line and contains information about what happened during the untranscribed part of the interview.

(9) *IDF: yyyy //
%tim: 15:20:22-17:34:21
%exp: the interviewer talks with the informant about subjects that are not relevant to the present study.

After having described the methodology and the transcription system used in the experiment, we can now turn to the analysis of the data collected during the interviews.

[30] In the study described in De Felice (2014a), this line has been used to annotate the gestures that accompanied the linguistic descriptions for six stimuli (the jug and the tea-cup, in all conditions).

Chapter 3
Analysis of the grasp descriptions (Part I)

This chapter describes the first piece of linguistic analysis conducted on the transcripts of the interviews recorded during the experiments (the second part of the analysis is described in Chapter 4). First, I will illustrate the purpose of this analysis and the annotation conducted on the transcripts (Section 3.1). Then, the results of the annotation will be presented in the following sections, which will be dedicated to different categories of visual stimuli: artifacts (Section 3.2), further subdivided into artifacts without affording parts, artifacts with affording parts, and artifacts with affording parts that were presented with different orientation; humans (Section 3.3); natural kinds (Section 3.4); substances and aggregates (Section 3.5). Finally, some general remarks will be made (Section 3.6) and briefly discussed (Section 3.7).

3.1. The analysis of the linguistic descriptions of grasps

The assumption underlying this first analysis of the transcripts is that the linguistic descriptions of grasps provided by informants may be very telling about the relation between language and affordances (in particular, here, the affordance of grasping). As already mentioned, the concept of affordances is an inherently relational one which takes into account both the agents' abilities and the object's physical properties ("An affordance points both ways, to the environment and to the observer": Gibson 1979: 129). The general purpose of this book is to verify whether linguistic production is sensitive to the same variables that modulate sensory-motor responses to object stimuli. Therefore, this first analysis seeks to verify:

(i) whether linguistic descriptions of grasps reflect different conceptualisations of the grasp event, where more attention is focused either on the object or on the agent, depending on the presentation of object stimuli of different categories;

(ii) whether objects with affording parts are more likely to attract attention, and therefore to be named, than objects with no affording parts.

3.1.1. Purposes of the analysis and preliminary assumptions

This chapter describes an analysis of the transcripts that focuses on the explicit mention of the effector or the target of the grasp, which are defined as follows:

- the *effector* of the grasp is the entity that is linguistically presented as the one that comes into contact with the object;
- the *target* of the grasp is the part of the object stimulus where contact with the effector is described as occurring.

It can be assumed that the target or the effector of the grasp are explicitly mentioned when they are the focus of attention, i.e., when informants conceptualise them as prominent and are thus inclined to name and characterise them in finer detail (cf. Langacker 1987: 110–113; see also *infra*, Section 3.7). The purpose of this first analysis is to investigate whether, and if so how, the number of references to the effector and the target of the grasp varies according to different types of stimuli; in other words, whether the presence of the effector or the target of the grasp in the event linguistically described is modulated by the presentation of different kinds of graspable objects.[31]

Since we are concerned with affordances, which are primarily related to the most immediate and direct interaction with the object (affordances are automatically activated by object visual perception), only the participant's first grasp description for each stimulus was considered. Therefore, all first descriptions provided by the 30 informants for the 42 object stimuli were collected (tot. 1260). The segmentation of speech into different parts corresponding to single descriptions was a simple task, because in most cases they are clearly delimited by syntactic and/or utterance boundaries. These grasp descriptions were collected and imported into a single file. The methodology adopted to conduct the analysis of this material will be described in the two next sections.

3.1.2. Extraction of target-related and effector-related words

First of all, all lexical words used to refer to the effector or to the target of the grasp (as defined in the previous section) were manually extracted from each

[31] Therefore, in this analysis, any information relating to the *modality* of grasping, and in particular to the verbal lexicon used to describe the kind of action performed by the effector on the target (e.g., *stringere* in *prendere un oggetto stringendo le dita*, 'pick up an object by tightening one's fingers'), is not taken into account.

grasp description. For instance, consider the following three descriptions, produced for the microphone, the upside-down tea-cup, and the box, respectively:

(1) a. *027: allora // questo / lo prenderei con la mano sinistra // e basta //
'so I would take this with my left hand, and that's it'
b. *027: la prenderei dalla parte superiore / con la destra //
'I would take hold of it by the upper part, with my right hand'
c. *010: con le mani / ai lati //
'with my hands, at the sides'

In (1a), only the effector of the grasp is indicated (*con la mano sinistra*) and two words, *mano*, 'hand' and *sinistra*, 'left', are extracted. In (1b), we have both a reference to the effector, i.e., *con la destra* (effector-related word: *destra*, 'right hand') and a reference to the target of the grasp, i.e., *dalla parte superiore* (target-related words: *parte*, 'part', *superiore*, 'upper'). In (1c), the informant referred to the effector (*mani*, 'hands') as well as to the target of the grasp (*lati*, 'sides').

Effector-related words denote the entity that is linguistically presented as the effector of the grasp; therefore in most cases they refer to the hand, as in the case of *mano* ('hand'), *destra* ('right hand'), *sinistra* ('left hand'), or to parts of the hand (such as *dito*, 'finger', *pollice*, 'thumb', *indice*, 'index finger', etc.). However, sometimes participants referred to different body parts (e.g., the arm, the mouth) or, very rarely, even to an instrument (e.g., a glass, used for water).

On the other hand, we have defined the target of the grasp as the part of the object stimulus towards which the action is directed and where contact with the effector is described as occurring. Therefore, target-related expressions generally denote a specific part of the stimulus presented (e.g., *manico*, *impugnatura*, 'handle'); however, informants may also use nouns, adjectives and adverbs pertaining to the visuo-spatial domain to indicate the specific part of an object with which the effector comes into contact (e.g., *parte superiore*, 'upper part'; *lato destro*, 'right-hand side'; *centro*, 'centre'; *base*, 'base').

A detailed analysis of the target-related and effector-related words extracted from the transcripts will be presented in Chapter 4 (for the methodology adopted, see in particular Section 4.1) and will focus on how reference to the effector or the target of the grasp is actually made by informants. As already stated, the purpose of this first analysis is only to investigate whether the presence of an explicit reference to the effector and/or to the target of the grasp varies in relation to different types of stimuli.

3.1.3. The classification of grasp descriptions

All 1260 grasp descriptions were manually classified according to the presence of one or more words denoting the target or the effector of the grasp. If more than one target- or effector-related word is found in a single description, they are counted as one. This is because even if the informants repeat information or reformulate what they say, the reference to the effector (or to the target) of the grasp is always one and unvaried, as the following example shows:

(2) *011: mh / dal [/] dal manico dell'oggetto // dall'impugnatura / con una mano //
'mm, by the handle of the object, by the grip, with one hand'

In this excerpt, one word relating to the effector of the grasp (*mano*) and two different words denoting the target of the grasp (*manico*, *impugnatura*) are extracted from the transcript. However, the description actually shows just one reference to the effector and one to the target: *manico* ('handle') and *impugnatura* ('grip') denote exactly the same object part.

Descriptions involving a disjunctive conjunction were split into two different descriptions. For instance, in example (3), only *con la sinistra* is considered to refer to the effector of the first grasp description. By contrast, descriptions involving a coordinating conjunction, as in (4), are obviously considered as a single grasp description, since they simply refer to a grasp performed with two body parts jointly used to perform the action.

(3) *006: il bicchiere con la sinistra / o con la destra //
'the glass with the left hand, or with the right hand'

(4) *012: dallo schienale con una mano // e con l'altra mano dalla parte davanti //
'by the back with one hand, and with the other hand in front'

Therefore, at this level of analysis, the maximum information a single, complete description can provide is just *one* reference to the effector and *one* reference to the target, even if both the effector and the target of the grasp may be referred to by more than one word, or by a plural word. As a consequence, the maximum number of references for each object stimulus is 30 to the effector and 30 to the target (tot. 60 references), and this only in the event that 100% of the participants named both the effector and the target of the grasp in their first description provided for the stimulus.

Table 3.1 presents an example of the classification, taken from the transcripts for the leftward-oriented jug (words referring to the effector or to the target of the grasp are in italics).

Transcript	Effector	Target
*018: allora // questa / con la *mano sinistra* // potrei afferrare il [/] il *manico* // 'well, this one with my left hand, I could grab the handle'	1	1
*015: eh / questo // dal *manico* // 'this one by the handle'	0	1
*020: questa / sempre con [/] dal *manico* // però con la *mano sinistra* / mi verrebbe da prenderla // 'this one always with… by the handle, but with my left hand, I would grasp it'	1	1
*013: con le *mani* // 'with my hands'	1	0

Table 3.1. Presence of a reference either to the effector, or to the target of the grasp, or to both, in the grasp descriptions.

The results of this classification are analysed by considering the different categories of object stimuli in turn: artifacts (Section 3.2), humans (Section 3.3), natural kinds (Section 3.4), substances and aggregates (Section 3.5).

3.2. Artifacts

Within this category, linguistic data from artifacts without affording parts will be analysed first (Section 3.2.1). We will then turn to artifacts with affording parts, presented with or without a difference in orientation (Sections 3.2.2–3.2.3). Finally, the two groups of stimuli will be compared and some further observations will be made (Section 3.2.4). This differentiation is necessary not only because this is the most numerous class of stimuli but also because some relevant intra-category differences emerge, as the following sections will illustrate.

3.2.1. Artifacts without affording parts

This first class of artifacts brings together the eight visual stimuli representing objects without affording parts.

Figure 3.1 shows the number of references to the effector and to the target of the grasp (*x* axis) contained in the descriptions provided for different object stimuli (*y* axis). The total number of references collected from the 30 transcripts is shown beside the bars.

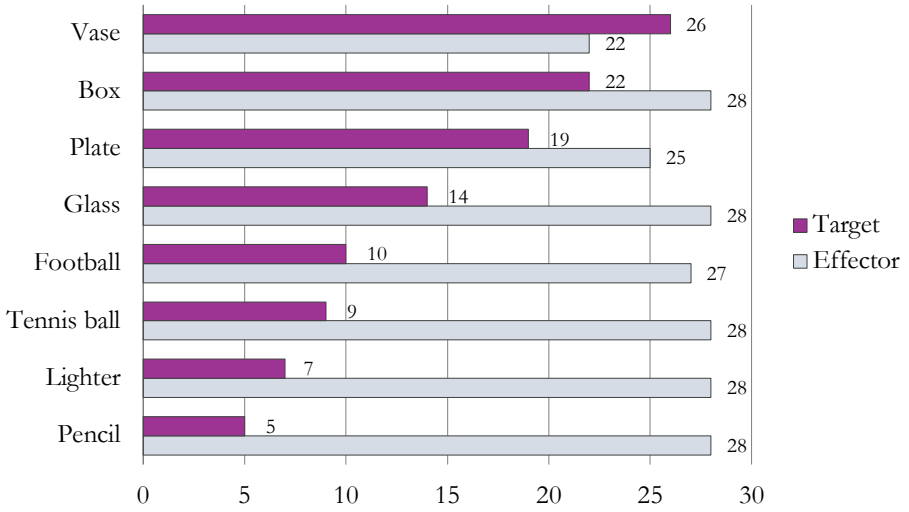

Figure 3.1. References to the effector (tot. 214) and to the target (tot. 112) found in grasp descriptions for artifacts without affording parts.

The distribution shown by the graph is clearly not due to chance; stimuli are different from one another with respect to the presence of a reference to either the effector or the target of the grasp (χ^2 (7, N=326)=23.082, p<0.01).[32]

The number of descriptions that contain an explicit mention of the effector is high for most visual stimuli (mean=26.75; SD=2.19) and shows no great variation, ranging from a minimum of 22 to a maximum of 28 descriptions per stimulus. On the other hand, references to the target of the grasp (mean=14; SD=7.6) vary a lot: only five out of 30 descriptions collected for the pencil contain a mention of the target of the grasp, whereas 26 descriptions for the vase contain this kind of information.

Although the visual stimuli in this category have all been classified as artifacts without affording parts, it seems that at least for some of them the lexical choices made by informants reveal the high salience of some of the objects' parts. In

[32] Statistical tests were performed using the SPSS (Statistical Package for Social Science) software for Windows (SPSS Inc., Chicago, IL, USA); on this, cf. Field (2013). Chi-square statistics are given with degrees of freedom and sample size in parentheses, the Pearson chi-square value, and the significance level.

particular, the vase has far more mentions of the target than expected (standardised residual[33]= 2.3), as Table 3.2 shows.

		Vase	Box	Plate	Glass	Football	Tennis ball	Lighter	Pencil	Tot.
E	freq.	22	28	25	28	27	28	28	28	214
	st. res.	-1.7	-0.8	-0.7	0.1	0.6	0.8	1	1.4	
T	freq.	26	22	19	14	10	9	7	5	112
	st. res.	2.3	1.2	1	-0.1	-0.8	-1	-1.4	-1.9	

Table 3.2. References to the effector (E) and to the target (T) found in grasp descriptions for artifacts without affording parts: cross-tabulation and standardised residuals.

This is not surprising. Among the stimuli in this category, the vase is the object that, more than others, is made up of identifiable parts, some of which are particularly suitable for grasping, such as the neck or the edge. These are frequently named by informants. The most frequent target-related word found in transcripts is *collo* ('neck', eight occurrences), named as a possible target for the grasp. It is worth noting that the vase is also the only stimulus for which the frequency of references to the target (26) exceeds the frequency of references to the effector (22).

3.2.2. Artifacts with affording parts (with no difference in orientation)

For artifacts with affording parts, first we give data from visual stimuli presented with no difference in orientation (Figure 3.2).

For this category, the difference between stimuli with relation to the number of references to the effector or to the target of the grasp is not significant ($\chi^2(6, N=322)=6.453$, $p>0.05$). However, we see important differences from the previous group of stimuli (cf. Figure 3.1).

[33] When using the chi-square of contingency tables with more than two rows or columns and a significant value of χ^2 is obtained, it is possible to consider standardised residuals to understand which cell or cells are most responsible for the significance of the test and this knowledge helps in interpreting the results. In particular, when the standardised residual of a cell exceeds the value of ±1.96 (corresponding to an alpha of 0.05) or ±2.58 (corresponding to an alpha of 0.01), the cell deviates from its theoretical value enough to be regarded as an 'abnormal' cell, which contributed to the significance of the chi-square test. Standardised residuals with a positive or negative value indicate that the cell is, respectively, over-represented or under-represented in the actual sample compared to the expected frequency (Field 2013).

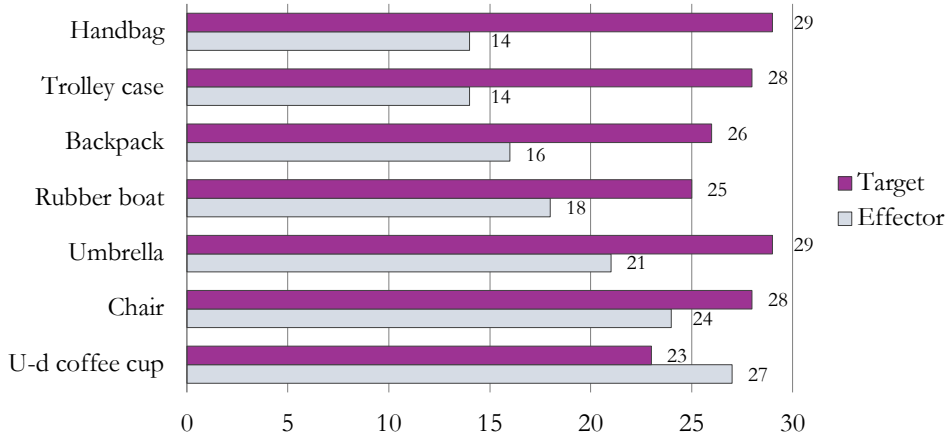

Figure 3.2. References to the effector (tot. 134) and to the target (tot. 188) found in grasp descriptions for artifacts with affording parts presented with no difference in orientation.

Descriptions that contain references to the effector of the grasp are now generally less frequent and there is more variation among different stimuli (mean=19.14; SD=5.05). On the other hand, the target of the grasp is mentioned in most grasp descriptions (mean=26.86; SD=2.27). These results appear to be the opposite of those described in the previous section.

		Handbag	Trolley case	Backpack	Rubber boat	Umbrella	Chair	U-d coffee cup	Tot.
E	freq.	14	14	16	18	21	24	27	134
	st. res.	-0.9	-0.8	-0.4	0	0	0.5	1.4	
T	freq.	29	28	26	25	29	28	23	188
	st. res.	0.8	0.7	0.3	0	0	-0.4	-1.1	

Table 3.3. References to the effector (E) and to the target (T) found in grasp descriptions for artifacts with affording parts presented with no difference in orientation: cross-tabulation and standardised residuals.

Looking in detail at Figure 3.2 and Table 3.3, we notice that within this category the upside-down coffee cup is the visual stimulus that elicited the fewest mentions of the target (23) and the most mentions of the effector (27). It is also the stimulus for which the largest gap between the observed and the expected values (standardised residuals: 1.4 and -1.1) is recorded (although the result of the chi-square test is not significant). These values are more similar to those presented for artifacts without affording parts than to those obtained from other stimuli of this category: only in this case does the frequency of references to the effector exceed the frequency of references to the target. This is probably because the object presented is upside-down and very small; for this reason, its handle or other graspable parts are not judged to be probable targets of the grasp

and are thus rarely mentioned by informants (*manico*, 'handle' occurs very seldom), who in most cases described a simple and undifferentiated power grasp, directed either at the sides of the object (*lato*, 'side') or the bottom of the cup (*fondo*, 'bottom'; *alto*, 'the upper part'). On the other hand, the handbag and the umbrella are the stimuli for which there are the most descriptions (29 out of 30) that contain one or more references to the target of the grasp, followed by the trolley case and the chair (28 occurrences).

3.2.3. Artifacts with affording parts (with different orientation)

For this second group of artifacts with affording parts (presented with different orientation), data from the rightward-oriented and leftward-oriented stimuli will first be merged, in order to discover if the objects used as stimuli differ from one another in relation to the number of mentions of either the target or the effector of the grasp (Figure 3.3), irrespective of orientation. Later, in Section 3.2.3.1, we will verify whether object orientation and participant handedness have an effect on the descriptions provided by informants (both factors were discussed in Section 1.3.3).

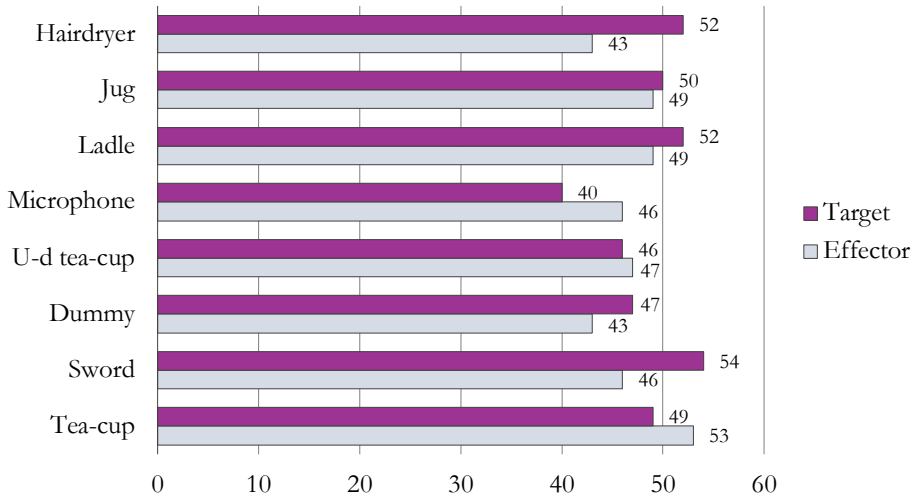

Figure 3.3. References to the effector (tot. 376) and to the target (tot. 390) found in grasp descriptions for artifacts with affording parts presented with different orientation.

Looking at Figure 3.3, we notice that, in general, descriptions that contain references to the effector of the grasp are slightly less frequent (mean=47; SD=3.12) than those containing an explicit reference to the target of the grasp (mean=48.75; SD=4.15).

These results are in line with those illustrated for the first group of artifacts with affording parts (cf. Figure 3.2): in that case, too, the target was mentioned more frequently than the effector of the grasp.

As already observed for the first group of artifacts with affording parts, the differences between the objects used as stimuli in relation to the mention of either the target or the effector are ultimately not significant ($\chi^2(7, N=766)=2.101$, $p>0.05$; cf. also Table 3.4). In other words, different stimuli do not elicit a significantly different number of references to either the effector or the target of the grasp described.

		Hair-dryer	Jug	Ladle	Micro-phone	U-d tea-cup	Dummy	Sword	Tea-cup	Tot.
E	freq.	43	49	49	46	47	43	46	53	376
	st. res.	-0.5	0.1	0	0.6	0.2	-0.2	-0.4	0.4	
T	freq.	52	50	52	40	46	47	54	49	390
	st. res.	0.5	0	0.1	-0.6	-0.2	0.2	0.4	-0.4	

Table 3.4. References to the effector (E) and to the target (T) found in grasp descriptions for artifacts with affording parts presented with different orientation: cross-tabulation and standardised residuals.

However, a more detailed analysis is required for this second category of artifacts with affording parts (eight objects, 16 stimuli), since there is another variable that has to be considered besides object typology: the different horizontal orientation of the object stimuli presented.

3.2.3.1. Comparing data from left-handed and right-handed informants: the effects of object orientation and hand dominance

Is it possible that congruence (or incongruence) between object orientation and hand dominance influences grasp descriptions? To answer this question, we must compare not only the data obtained from the two groups of object stimuli (rightward-oriented vs. leftward-oriented), but also the descriptions provided by the two groups of informants (right-handed vs. left-handed). Since we are concerned only with object orientation, and the differences in grasp descriptions elicited by distinct types of object stimuli are not at issue here, we will compare only the overall results obtained from the rightward-oriented and the leftward-oriented objects.

Table 3.5 summarises the number of references to the target and to the effector of the grasp found in descriptions provided by the left-handed informants (seven informants, tot. 112 descriptions) for rightward-oriented and leftward-oriented objects.

Stimulus	Target	Effector
Rightward-oriented	44	35
Leftward-oriented	48	34
Tot.	92	69

Table 3.5. References to the target and to the effector of the grasp for rightward-oriented and leftward-oriented artifacts provided by the left-handed participants.

Considering all descriptions provided for the 16 object stimuli, we find 92 references to the target of the grasp (mean=5.75 per stimulus; SD=1.2) and 69 references to the effector (mean=4.31 per stimulus; SD=1). Thus, the target of the grasp is named more frequently than the effector of the grasp. However, we notice a slight tendency to name the target of the grasp, usually the handle, especially when the object is leftward-oriented rather than the opposite (the references to the target elicited by leftward-oriented objects are 48, whereas those elicited by rightward-oriented objects are 44). On the other hand, references to the effector are slightly more frequent in the grasp descriptions provided for the rightward-oriented objects than for the leftward-oriented objects (35 vs. 34).

Looking at the descriptions elicited for the 16 stimuli by the right-handed informants (23 informants, tot. 368 descriptions; see Table 3.6), references to the target are 298 (mean=18.63 per stimulus; SD=1.96), whereas references to the effector are 307 (mean=19.19 per stimulus; SD=1.7). In this case, too, there is a slight difference between the two orientations: references to the target appear to predominate in the rightward rather than in the leftward condition (152 vs. 146). By contrast, descriptions that contain a mention of the effector are mostly found in relation to leftward-oriented (156) rather than to rightward-oriented objects (151).

Stimulus	Target	Effector
Rightward-oriented	152	151
Leftward-oriented	146	156
Tot.	298	307

Table 3.6. References to the target and to the effector of the grasp for rightward-oriented and leftward-oriented artifacts provided by the right-handed participants.

Table 3.7 provides an overall view of the data already presented in Tables 3.5 and 3.6: instead of object orientation (rightward vs. leftward condition) and hand dominance (right-handed vs. left-handed informants), we consider here whether

the orientation of the affording part (for the 16 object stimuli) is spatially aligned with the dominant hand of the 30 informants or not (tot. 480 descriptions).

Condition	Target	Effector
+ Spatial alignment	200	185
- Spatial alignment	190	191

Table 3.7. References to the target and to the effector of the grasp in the condition of spatial alignment and non-spatial alignment between object orientation and hand dominance.

In light of these data, we can conclude that in the descriptions provided by both groups of informants the target of the grasp is named especially when it is spatially aligned with the dominant hand (cf. also De Felice 2014a).

Spatial alignment has only a very slight, statistically non-significant effect on the number of references to the target or the effector of the grasp ($\chi^2(1, N=766)=0.331$, $p>0.05$). In the case of this group of stimuli, the probability of finding an explicit mention of the target or the effector appears to critically depend neither on the orientation with which the object is presented nor on the hand dominance of the informant.

Nonetheless, this result was to be expected. The initial hypothesis that guided the linguistic analysis of the transcripts was that the presence of linguistic material relating to the target of the grasp may reflect the salience of the parts that more than others attract the grasp (in other words, the salience of affording parts). Results show that with regard to the number of references to the target of the grasp (which in most cases, for these objects, effectively denote affording parts; cf. Section 4.2.3.1) there is only a slight difference between the descriptions provided for the stimuli that are spatially aligned with the dominant hand of informants and those for the stimuli that are not spatially aligned. This suggests that the salience of the affording parts does not depend on a mere spatial alignment effect between object orientation and hand dominance. The handle always maintains its strong affording power regardless of the object's orientation. Nevertheless, spatial alignment turns out to have a small 'facilitation' effect: in the grasp descriptions collected from both groups of informants, explicit mentions of either the target or the effector are more frequent for object stimuli that are, respectively, spatially aligned and non-spatially aligned with the dominant hand of the informant (Table 3.7).

3.2.4. General observations about the artifact category: the effect of affording parts on linguistic production

The main difference between the two groups of artifact stimuli (with or without affording parts) regards the information about the effector or the target of the grasps in the descriptions provided by informants.

First of all, explicit references to the effector or the target of the action (e.g., the hand, the handle) are more frequently produced for artifacts with affording parts (e.g., the tea-cup) than for those without (e.g., the football). As already stated, since we have 30 grasp descriptions for each object, the total number of (effector/target) references collected for each stimulus may range, in theory, from 0 to 60: 0 in the very unlikely case that none of the thirty informants named the effector or the target of the grasp; 60 in the case that all 30 informants mentioned both the effector and the target. Notably, the artifact stimuli that elicited the lowest number of references to either the target or the effector are all objects without affording parts, namely, the pencil (33 effector/target references in total), the lighter (35 references), the tennis ball, and the football (37 references). For these object stimuli, most informants provided very short descriptions, with only one reference to either the effector or the target of the grasp. The eight artifacts without affording parts have a mean of 40.75 references for each stimulus (SD=6.23; references per informant per object: 1.36).

By contrast, the artifact stimuli that are characterised by the highest number of references are the rightward-oriented sword (54 references), the chair, the rightward-oriented jug (52 references each), the rightward-oriented ladle, the upright tea-cup (in both orientations), and the upside-down leftward-oriented tea-cup (all with 51 effector/target references). For these objects, most descriptions contain a reference to both the effector and the target of the grasp. The 23 artifacts with affording parts have a mean of 47.3 references for each stimulus (SD=4.02; references per informant per object: 1.58).

Therefore, grasp descriptions provided for artifacts with affording parts usually contain a higher number of references to either the effector or the target of the action compared to the descriptions provided for artifacts without affording parts. In addition, a more interesting difference can be observed between the two groups. As the data given in Figure 3.4 show, the descriptions provided for the eight artifacts without affording parts contain more references to the effector (214) than references to the target of the grasp (112), while, on the other hand, descriptions provided for the 23 artifacts with affording parts contain more references to the target (578) than to the effector (510) of the grasp.

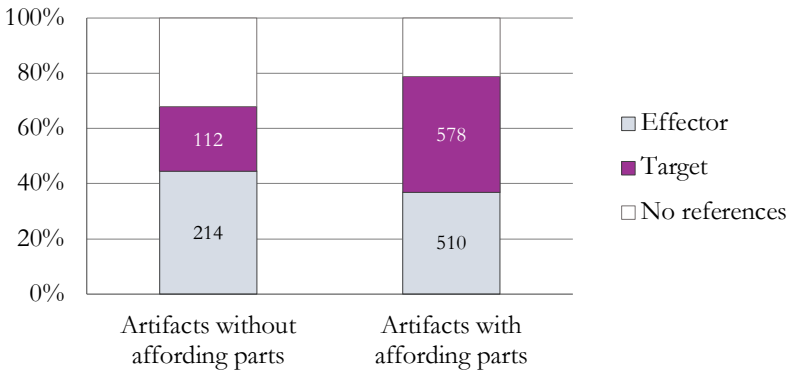

Figure 3.4. References to the effector and to the target of the grasp for artifacts without affording parts and artifacts with affording parts.

There is an evident difference between the descriptions provided for artifacts with and without affording parts in relation to the number of references to the effector or the target of the grasp ($\chi^2(1, N=1414)=35.367$, $p<0.001$). Descriptions provided for the eight artifacts without affording parts are characterised by a higher number of references to the effector (mean=26.75; SD=2.19) and a lower number of references to the target of the grasp (mean=14; SD=7.6) compared to those provided for the 23 artifacts with affording parts, in which the number of references to the target is much higher (mean=25.13; SD=2.8), and even exceeds the number of references to the effector (mean=22.17; SD=3.82).

These results indicate that the salience of the affording part is reflected in the linguistic production. When artifacts present affording parts, most informants explicitly name the target of the grasp, which in most cases coincide exactly with the affording parts of the objects (as will be illustrated in more detail in Sections 4.2.2.1 and 4.2.3.1). Moreover, the more often the target of the grasp is named, the less often the effector of the grasp is mentioned. Therefore, linguistic elements can be seen as indications of a shift of attention towards the parts of the objects that allow and facilitate the grasp. On the other hand, when artifacts do not present affording parts, subjects typically name their hand or their fingers. However, they mention the target of the action much less frequently.

3.3. Humans

We can now turn to the linguistic analysis of the descriptions provided for the stimuli belonging to the human class. Figure 3.5 shows the number of references to the effector and to the target of the grasp contained in the descriptions

provided for different object stimuli, i.e., the standing woman, the running man and the baby (tot. 90 descriptions).

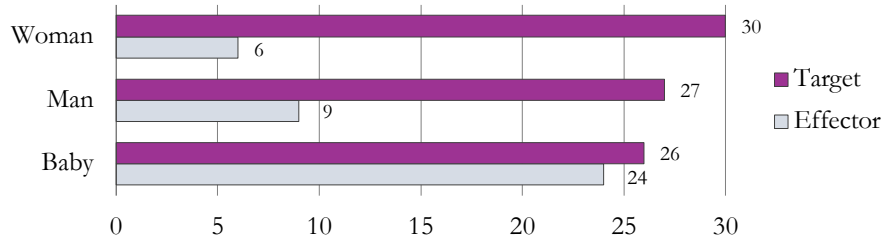

Figure 3.5. References to the effector (tot. 39) and to the target (tot. 83) found in grasp descriptions for humans.

In the descriptions provided for the three human beings, the number of references to the target of the grasp is very high (mean=27.67; SD=1.7) compared to the number of references to the effector (mean=13; SD=7.87). However, there are evident differences between the descriptions provided for these three stimuli ($\chi^2(2, N=122)=10.588$, $p<0.01$). In particular (cf. Table 3.8), we observe that the image of the baby stimulates a particularly high number of mentions of the effector of the grasp (which is the main reason for the outcome of the chi-square test). This is because most participants specified that they would grasp the baby with two hands and described a very delicate and careful grasp (cf. Section 4.3.1). For the woman and the man, words relating to the effector are much rarer in the transcripts.

		Woman	**Man**	**Baby**	**Tot.**
E	freq.	6	9	24	39
	st. res.	-1.6	-.7	2	
T	freq.	30	27	26	83
	st. res.	1.1	.5	-1.4	

Table 3.8. References to the effector (E) and to the target (T) found in grasp descriptions for humans: cross-tabulation and standardised residuals.

On the other hand, in all descriptions collected for this group of stimuli there is a high number of mentions of the target of the grasp, which even exceeds that found for the category of artifacts with affording parts (as will be discussed in detail in Section 4.3.1, the target is mostly indicated by body parts, such as *braccio*, 'arm', *gomito*, 'elbow', *ascelle*, 'armpits').

3.4. Natural kinds

There are four natural kinds among the stimuli adopted in the experiment: the stone, the mandarin, the banana, and the apple. For these object stimuli, informants provided a total number of 120 grasp descriptions containing 148 references to either the effector or the target of the grasp (Figure 3.6).

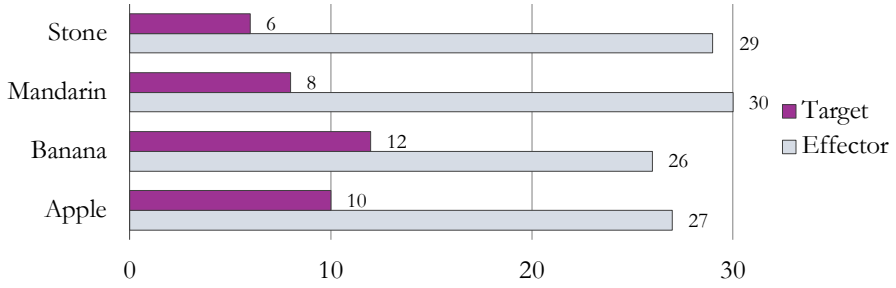

Figure 3.6. References to the effector (tot. 112) and to the target (tot. 36) found in grasp descriptions for natural kinds.

There is no significant difference between the four stimuli (cf. also Table 3.9) with respect to the number of references to either the effector or the target of the grasp found in transcripts (χ^2 (3, N=148)=2.435, p>0.05). Almost all descriptions collected for each stimulus contain an explicit mention of the effector of the grasp (mean=28 per stimulus; SD=1.58). On the other hand, mentions of the target are much rarer, ranging from six to 12 occurrences (mean=9 per stimulus; SD=2.24).

		Stone	**Mandarin**	**Banana**	**Apple**	**Tot.**
E	freq.	29	30	26	27	112
	st. res.	2.5	1.2	-2.8	-1	
T	freq.	6	8	12	10	36
	st. res.	-2.5	-1.2	2.8	1	

Table 3.9. References to the effector (E) and to the target (T) found in grasp descriptions for natural kinds: cross-tabulation and standardised residuals.

In general, this category is characterised by a higher number of references to the effector to the grasp and fewer mentions of the target than any other category of stimuli analysed so far.

3.5. Substances and aggregates

Within this group of object stimuli there are four elements: water, sand, pumpkin seeds, and flour.

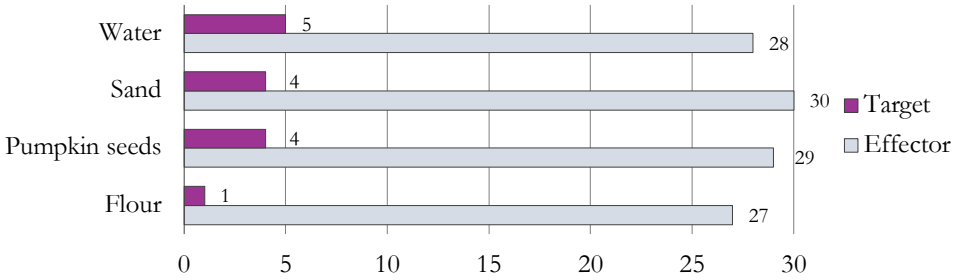

Figure 3.7. References to the effector (tot. 114) and to the target (tot. 14) found in grasp descriptions for substances and aggregates.

As Figure 3.7 shows, this class of stimuli is characterised by a very high number of references to the effector of the grasp (mean=28.5 per stimulus; SD=1.12) that exceeds that observed for other categories analysed so far (even natural kinds). On the other hand, mentions of the target of the grasp are rarer, compared to those of other stimuli (mean=3.5; SD=1.5).[34] In fact, they are the rarest of all stimuli: only for the pencil did we observe such a low frequency of references to the target of the grasp (five references, as for the water).

Such a low number of references to the target of the grasp is due to the difficulty in recognising and naming the specific parts of these entities that might serve this function, in other words, the exact point where contact with the effector is meant to occur, also because of their consistency (at least in the case of substances and granular aggregates, which have no constituent parts that allow for an easy and stable grasp). This topic will be explored in more depth in the next chapter (cf. in particular Sections 4.5.2, 4.6.1.3 and 4.6.2.2).

3.6. General results

To verify whether a correspondence exists between the mention of the target/effector of the grasp and the kind of object stimulus presented, we can now merge data from the different object stimuli into five categories. First of all, let us consider absolute frequencies (Table 3.10).

[34] Given the low frequency of references to the target of the grasp, chi-square and standardised residuals have not been calculated.

Class of stimuli	No. stimuli	References to the E	References to the T	Tot.
Humans	3	39	83	122
Artifacts (with AP)	23	510	578	1088
Artifacts (without AP)	8	214	112	326
Natural kinds	4	112	36	148
Substances and aggregates	4	114	14	128
Tot.	42	989	823	1812

Table 3.10. References to the effector and to the target found in grasp descriptions for the five classes of stimuli.

It is evident that mentions of the effector are, in general, more frequent (tot. 989; mean=23.55; median=25; SD=5.36) than mentions of the target (tot. 823; mean=19.6; median=23; SD=8.8). However, some important differences between the five different categories emerge; these are also highly significant from a statistical point of view, as a chi-square test reveals ($\chi^2(4, N=1812)=155.3$, $p<0.001$; see Table 3.11).

Class of stimuli		References to the E	References to the T	Tot.
Humans	freq. st. res.	39 -3.4	83 3.7	122
Artifacts with AP	freq. st. res.	510 -3.4	578 3.8	1088
Artifacts without AP	freq. st. res.	214 2.7	112 -3	326
Natural kinds	freq. st. res.	112 3.5	36 -3.8	148
Substances and aggregates	freq. st. res.	114 5.3	14 -5.8	128
Tot.		989	823	1812

Table 3.11. References to the effector and to the target found in grasp descriptions for the five classes of stimuli: cross-tabulation and standardised residuals.

While for the class of human beings the references to the target are twice as frequent as the references to the effector, for artifacts with affording parts the two values are much closer. As we look at the data from artifacts without

affording parts, from natural kinds, and especially from substances and aggregates, the number of references to the effector increases greatly over that of references to the target.

To better understand the most relevant results of this first analysis, we can consider the following graph (Figure 3.8), which shows the percentages of references to the target and to the effector of the grasp as against the total number of references collected for each category.

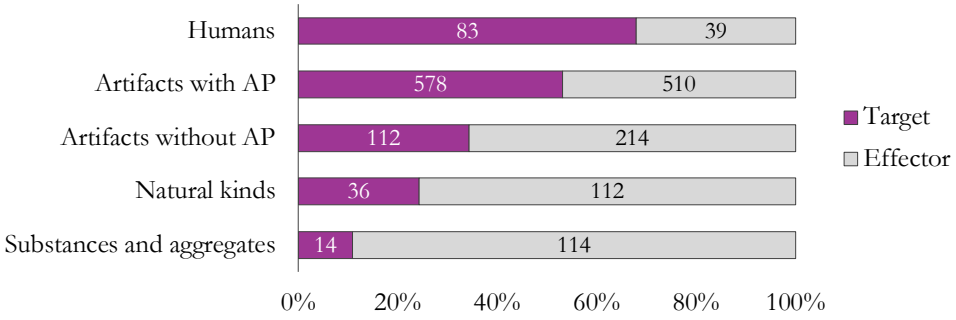

Figure 3.8. References to the target and to the effector found in grasp descriptions for the five classes of stimuli.

This 100% stacked bar graph illustrates more clearly what we noted above: that substances and aggregates are characterised by a very high number of references to the effector of the grasp compared to references to the target. For natural kinds and artifacts without affording parts, the number of references to the target increases, although most mentions still refer to the effector. With the artifacts with affording parts, and especially with humans, the percentage of mentions of the target exceeds that of mentions of the effector of the grasp.

3.7. Interim discussion

On the basis of the data distribution shown in Figure 3.8, we can create the following implicational scale:

humans > artifacts with AP > artifacts without AP > natural kinds > substances and aggregates

The further to the left the object stimulus lies, the more likely it is that the target of the grasp will be named in the descriptions, and the less likely it is that the effector of the grasp will be mentioned.

This implicational scale makes for a very good description of the data presented in the previous sections. We observed that the mean frequency of

references to the effector increases, moving from left to right (humans: mean=13; artifacts with affording parts: mean=22.17; artifacts without affording parts: mean=26.75; natural kinds: mean=28; substances and aggregates: mean=28.5). Parallel to this, the frequency of references to the target decreases (humans: mean=27.67; artifacts with affording parts: mean=25.13; artifacts without affording parts: mean=14; natural kinds: mean=9; substances and aggregates: mean=3.5).

These differences in grasp descriptions are all the more interesting given that the grasp events imagined and described by informants during the presentation of different visual stimuli share many fundamental commonalities (regardless of the kind of stimulus presented). First of all, they all involve an effector (typically the hand or part of the hand) directly controlled by the person who is presented with the object stimulus; this person always has the same intention (to grasp the entity) and the same role in the described event, in other words, s/he is the agent performing the grasp. Secondly, all events imagined and described involve an object of the grasp, which is always a concrete (and in some way manipulable) entity. Finally, the events of grasp imagined by participants are always made up of an invariable succession of phases: an initial phase, in which the chosen effector starts its movements toward the target; a medial phase, in which the effector draws close to it; and a final phase, in which the effector touches a specific part of the object presented assuming a specific position to ensure a firm hold.

Despite these similarities, data plainly demonstrate that the descriptions provided by informants differ significantly from one another. This clearly indicates that different object stimuli influence the way in which very similar events are conceptualised and linguistically described; in other words, the way in which the grasp events are *construed*. The notion of construal, which has been widely explored in cognitive linguistics, especially by Langacker and Talmy,[35] refers to a fundamental ability of human cognition "to conceive and portray the same situation in alternate ways" (Langacker 2019: 140). Since speakers always have available a wide array of linguistic structures to express a particular event (both in terms of lexical choices and grammatical structures), the way in which such an event is actually described depends on how the speaker conceptualises it, and on how s/he consequently chooses to communicate it linguistically.

Since the only variable in this study is the kind of object stimulus presented (its category and its physical characteristics), the fact that informants explicitly code the target of the grasp proves that they are paying most attention to that specific facet of the event, because it is perceived as particularly salient from a conceptual point of view. In other words, the choice to include (or not to

[35] Both authors proposed detailed classifications of construal phenomena, for instance in Langacker (1987, 1993, 2007, 2019) and Talmy (1988, 2000).

include) in their descriptions overt linguistic material referring to the target or the effector of the grasp is a basic linguistic device exploited by informants to render more prominent the elements that are the focus of attention (since they are conceptualised as such) and to characterise them in finer detail, and to leave the others, which are less salient, unmentioned and backgrounded (Langacker 1987: 110–113; Croft and Cruse 2004: 46–58; cf. also Langacker 1993, 2019 and the notion of "windowing of attention" outlined in Talmy 2000: 257–309).

Therefore, the analysis of the descriptions of grasp, whose main results are summarised in Figure 3.8, clearly reflects shifts of attention from the agent (the effector) to the object (the target) of the grasp in relation to the presentation of different kinds of stimuli. This finding chimes in well with the results from behavioural and neurophysiological research (cf. Chapter 1), which demonstrate that the category of the visual or linguistic stimuli adopted in experiments is of primary importance in affecting and modulating affordances, intended as "motor representations of interactions between effector and object" (Barbieri et al. 2007: 422): artifacts (and especially artifacts with affording parts) are particularly effective in activating motor simulations of grasping and manipulation compared to stimuli belonging to other categories, such as natural objects (cf. Section 1.3.2).

However, before delving into a broader and more comprehensive discussion of these results (which will be developed in Section 4.7), we should now undertake a more in-depth analysis of the transcripts, with the aim of investigating the lexical expressions used by informants in denoting the effector and the target of the grasp.

Chapter 4
Analysis of the grasp descriptions (Part II)

The analysis set out in Chapter 3 revealed that the number of explicit references to either the target or the effector of the grasp found in informants' answers reflects a different construal of the grasp event, which is more focused on the agent or on the object involved in the action in relation to different categories of stimuli (cf. Section 3.7). In this chapter, the linguistic content of the transcripts will be examined in more detail, to highlight which lexical expressions are used by informants to denote the effector and the target of the grasp, and most importantly to understand whether and, if possible, why the frequency and distribution of lexical choices are influenced by the category of the presented stimuli.

There are two main methodological differences between the analysis presented in this chapter and that set forth in Chapter 3. The first is that while in the previous analysis each description was only supposed to contain a maximum of one reference to the effector and one reference to the target of the grasp, in this more in-depth study *all* lexical expressions extracted from answers will be given, in order to highlight how the linguistic reference to the effector and the target of the grasp is made.[36] The second significant difference is that this second study also aims to go beyond, and to broaden, the simple concepts of *reference to the effector* and *reference to the target* on which the previous analysis was based, where effector and target were defined as follows (Section 3.1.1):

- the *effector* of the grasp is the entity that is linguistically presented as the one that comes into contact with the object;
- the *target* of the grasp is the part of the object stimulus where contact with the effector is described as occurring.

In this chapter, certain kinds of lexical expressions that are *related* to the effector of the grasp or to its target are also taken into consideration, even if they do not indicate the effector or the target in a direct and precise form, but qualify or quantify it. For instance, the meronym *dita*, 'fingers', perfectly specifies the part of the hand with which a grasp may be performed, but there is a significant difference between *due dita*, 'two fingers', and *tutte le dita*, 'all my fingers', since

[36] Repetitions of the same word within the same description, as frequently happens in speech, are counted as a single occurrence.

these expressions describe a precision or a power grip, respectively. This very basic example shows that, even if in most cases expressions of quantity alone do not suffice to make explicit either the effector or the target of the grasp, they are well worth considering in this more detailed analysis.

4.1. Semantic annotation: methodological issues

In order to conduct the qualitative and quantitative analysis of the words used to indicate either the effector or the target of the grasp, all lexical words used with reference to the effector and the target of the grasp were first extracted: nouns, adjectives, adverbs, together with secondary adpositions expressing spatial relations (for the reasons explained in Section 4.1.2).

For instance, from a grasp description such as "sempre con tutta la mano, nella parte alta del manico" ('again with my whole hand, on the upper part of the handle'),[37] produced for the leftward-oriented ladle, I extracted *tutta* ('whole'/'all') and *mano* ('hand') as referring to the effector, and *parte* ('part'), *alta* ('upper'), *manico* ('handle') as referring to the target. A total number of 3545 words were extracted and collected.

Then, all words were classified using a set of semantic categories. This method is based on research conducted on feature norms, which are semantic properties of concepts collected empirically with a property generation task.[38] All different schemas proposed to classify semantic feature norms (e.g., McRae et al. 2005; Vinson and Vigliocco 2008; Wu and Barsalou 2009; Kremer and Baroni 2011; Montefinese et al. 2013; Lenci et al. 2013) share the idea that the properties generated by informants may be classified according to the semantic relation that they establish with a given stimulus. In the present work, too, the words that refer to the effector or the target of the grasp are classified according to the semantic relation that they establish with the entity described as the effector or with the object stimulus presented during the task. For instance, the word *picciolo*, 'stalk', denotes a part of the apple, and is classified as a meronym. However, this classification, although being to some extent based on the one proposed in Lenci et al. 2013 (which will also be adopted to classify the feature norms collected in the experiment described in Chapter 5; cf. in particular Section 5.2.4) presents many peculiarities and strictly speaking cannot be compared to any existing classification. This is mostly due to the specificity of the

[37] Since this chapter will be replete with examples taken from transcripts, they will be incorporated into the text, as quotations of the informants' speech enclosed within double quotation marks. In order to facilitate reading, the notations and symbols described in Chapter 2 (cf. in particular Section 2.4.2), as well as retractions and repetitions, are not given.

[38] This topic will be addressed in more detail in Chapter 5 (cf. in particular Section 5.1).

experiment conducted, which is not a property generation task, but rather an action description task. In particular, the only stimuli adopted are images representing graspable entities (cf. Section 2.3.2). Therefore, when informants describe the effector of the grasp (e.g., the hand), they are actually *introducing* an element that is not provided as a stimulus, nor is it a property of the visual stimulus itself (e.g., a tea-cup), but it is part of the grasp event that participants are asked to imagine and describe.

4.1.1. The classification of effector-related words

The semantic categories into which all effector-related words were classified are the following (for each category, a few effector-related words are cited as examples, together with an illustrative sentence):

a) HAND *mano* ('hand'), *mani* ('hands')
e.g., *prendere la mela con la* mano ('take hold of the apple with my *hand*')

b) MERONYM *dita* ('fingers'), *palmo* ('palm'), *pollice* ('thumb')
e.g., *prendere la mela con le* dita ('take hold of the apple with my *fingers*')

c) HOLONYM *braccio* ('arm'), *braccia* ('arms')
e.g., *prendere la scatola con tutte le* braccia ('take hold of the box with both *arms*')

d) QUANTITY *due* ('two'), *tutto* ('whole'/'all')
e.g., *prendere la scatola con* due *mani* ('take hold of the box with *both* hands')

e) SPACE *destra* ('right'), *sinistra* ('left')
e.g., *prendere la mela con la mano* destra ('take hold of the apple with my *right* hand')

f) PERCEPTUAL *concavo* ('concave')
e.g., *prendere l'acqua con la mano* concava ('take the water with a *concave* hand')

g) SIMILES (based on perceptual properties) *coppa* ('cup'), *contenitore* ('container')
e.g., *prendere la sabbia con le mani a forma di* coppa ('take the sand with my hands in the form of a *cup*')

h) OTHER BODY PART *piede* ('foot'), *bocca* ('mouth')
e.g., *prendere il ciuccio con la* bocca ('take hold of the dummy with my *mouth*')

i) INSTRUMENT *bicchiere* ('glass'), *tazza* ('cup')
e.g., *prendere l'acqua col* bicchiere ('take the water with a *glass*')

In most cases, the semantic categories into which all words relating to the effector extracted from the transcripts were placed pertain to the domain of a manual grasp (categories a–g). However, in very few cases, informants referred to a grasp performed in a non-canonical form, either with another body part, such as the mouth (h), or with an instrument (i).[39]

Each semantic class is now presented in detail.

HAND (HND). In the linguistic descriptions of grasp brought together in this study, the word *mano*, 'hand', is the most frequent word relating to the sphere of the effector (for frequency data relative to effector-related words, cf. Section 4.6.1). Not the fingers, or the arms, but simply the hand. Therefore, frequency data extracted from transcripts strongly suggest that in the awareness of informants the basic (I would be tempted to say prototypical) effector of the grasp is the hand.[40] The first class of effector-related words is thus constituted by the lemma *mano*, together with *pugno*, 'fist', which also refers to a hand, but shaped in a particular way (this is the only word that not only denotes the hand but also expresses a modality). This also allows us to consider the hand as the central node of a chain, arm > hand > fingers, in which a hand has fingers and is part of an arm (cf. Cruse 1986: 160).

MERONYM (MER). Considering reference to the hand as the basic indication of the effector (mostly relying on frequency data, since 40% of lexical items extracted with relation to the effector were collected in the HAND category), other effector-related words were classified in terms of the relation that they establish with the word *mano* and all of the words referring to the parts of the hand (such as fingers, the palm) were collected in the category of (hand) meronyms. Expressions denoting the fingers are the most frequently attested within this class, and they can be considered as canonical meronyms of the hand (Cruse: 1986: 162).

HOLONYM (HOL). Holonyms are words referring to the whole of which the hand is a part (typically *braccio*, 'arm'). The arm is here considered as a holonym of the hand, and not as a separate effector (i.e., another body part), because reference to the arms always implies that the hands are involved in the action together with the arms, as the detailed qualitative analysis provided in the next sections will show. For instance, when subjects describe the grasp of a large box and refer to arms, it is implicitly understood, and often explicitly stated, that the

[39] Expressions pertaining to the semantic classes listed from (b) to (g) could, in theory, also relate to another body part or to an instrument; however, in the transcripts, they occur only in the description of a manual grasp.

[40] See *infra*, Section 4.6.1.1, for a more detailed discussion.

hands hold the objects, and the arms help to bear it. Therefore, the grasp performed with two arms is always a grasp performed with the hands and *also* the rest of the arm, as a sort of extension of the effector required by an object's size.

QUANTITY (QUA). This category is for number words, quantifiers, and all words expressing quantitative properties or attributes of the effector (or parts of the effector) involved in the grasp. Sometimes, informants felt the need to specify that the 'whole hand' is involved in the action (*mano intera*), or that the grasp of a pencil is performed by 'two fingers' (*due dita*), or that an apple can be grasped with 'only one hand' (*una mano sola*).[41]

SPACE (SPA). A single category gathers together all words denoting spatial relations referring to the effector of the grasp. Since the hands are two different effectors opposed to one another on a lateral axis, participants mostly adopted spatial terms to refer to the side of the effector considered, i.e., (*mano*) *destra* or *sinistra* ('right' or 'left' hand); the left-right orientation of the hands is relative to the body of the informant, and can therefore be defined as egocentric (cf. Meini 2010: 23–25). Other kinds of words denoting spatial concepts with reference to the effector are very rare and will be discussed during the analysis.

PERCEPTUAL (PER). This class brings together adjectives that express perceptual properties of the effector, for example, with relation to the hand's shape, such as *mano concava* ('concave hand').

SIMILES, BASED ON PERCEPTUAL PROPERTIES (SPP). This class groups together all nouns denoting a concrete entity mentioned by informants in order to better describe a temporary property of the effector of the grasp, usually a particular hand shape. The nouns collected in this category are in most cases presented by informants as similes and analogies (e.g., "con la mano come se fosse un cucchiaio", 'with the hand as if it were a spoon').

OTHER BODY PART (OBP). For the very few cases in which a different body part (e.g., the foot or the mouth) is described as being the effector of the grasp, the category *other body part* was introduced.

INSTRUMENT (INS). In a few cases, the grasp described is performed by an instrument (e.g., a cup, a container) and the *instrument* category is adopted.

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[41] I considered as expressions of quantity not the occurrences of the lemma *uno*, 'a/one' (e.g., *una mano*), which in Italian functions also as an indefinite article, but the adjectives or adverbs that emphasise it (*una mano sola*, *soltanto una mano*, *un'unica mano*).

4.1.2. The classification of target-related words

The semantic categories into which all of the words referring to the target of the grasp were gathered are the following:

a) ENTITY *mela* ('apple'), *tazza* ('cup')
e.g., *prendere la* mela ('take the *apple*')

b) MERONYMS *picciolo* ('stalk'), *manico* ('handle')
e.g., *prendere la mela dal* picciolo ('take the apple by the *stalk*')

c) QUANTITY *due* ('two'), *tutto* ('all')
e.g., *prendere le* due *gambe della sedia* ('take *two* legs of the chair')

d) SPACE *sopra* ('above'), *lateralmente* ('laterally')
e.g., *prendere lo scatolone* lateralmente ('take the box from the *side*')

e) PERCEPTUAL *rosso* ('red'), *tondo* ('rounded')
e.g., *prendere la parte* rossa *del ciuccio* ('take the *red* part of the dummy')

f) SIMILES (based on perceptual properties) *pallina* ('small ball'), *sabbia* ('sand')
e.g., *prendere la farina come la* sabbia ('take the flour in the same way as the *sand*')

g) ASSOCIATED ENTITY *borsa* ('bag'), *sciarpa* ('scarf')
e.g., *prendere la donna per la* sciarpa ('take the woman by the *scarf*')

Again, each of these semantic classes will be briefly discussed in turn.

ENTITY (ENT). Whereas in the previous chapter I only took into consideration references to the target of the grasp that are effective in indicating the precise point of the object towards which the effector is directed (this point usually being expressed either with meronyms or spatial expressions, for which see *infra*), the analysis is now also extended to some linguistic expressions that still relate to the object stimulus. For example, when a participant, before a picture of a tea-cup, says: "I would grasp this tea-cup", he is not providing an informative answer, because he is simply repeating the information already provided in the initial instruction ('describe in the most detailed way how you would grasp this object') and naming the object stimulus. However, at this finer-grained level of analysis, also the words denoting the object as a whole were extracted from the descriptions and classified, when they clearly relate to (or are even presented as) the target of the grasp (e.g., *prendere la tazza*, 'take hold of the tea-cup'; *mettere una mano intorno alla tazza*, 'put my hand around the tea-cup'). Synonyms and hypernyms were also extracted, together with object names (e.g., *oggetto*, *strumento*, 'object', 'instrument').

MERONYM (MER). This category gathers together all expressions relating to object parts that are presented as constituting the target of the grasp, such as the stalk of a fruit, or the handle of an umbrella.

QUANTITY (QUA). This category brings together all expressions of quantity (e.g., number words, quantifiers) such as *due*, 'two', *tre*, 'three', *entrambe*, 'both', *tutto*, *tutti*, 'all', and periphrasis expressing quantity. Such expressions often modify meronyms or spatial expressions that denote the target of the grasp (e.g., the *two* sides of the rubber boat). However, they may also refer to the object stimulus (e.g., *un po' di farina*, 'a small amount of flour').[42]

SPACE (SPA). The reference to the target of the grasp is often made using lexical expressions that pertain to the domain of space. I gather together here, into a single, broad category, a very rich set of words that are used to denote spatial notions:

- nouns: such as *lato* ('side'), *base* ('base'), *centro* ('centre')
  e.g., prendere entrambi i *lati* dello scatolone ('take both *sides* of the box')
- adjectives: such as *inferiore* ('lower'), *destro* ('right'), *sinistro* ('left')
  e.g., prendere lo scatolone dalla base *inferiore* ('take the box from the *lower* base')
- adverbs: such as *lateralmente* ('laterally'), *frontalmente* ('frontally')
  e.g., prendere lo scatolone *lateralmente* ('take the box *sideways*')
- prepositions: such as *dietro* ('behind'), *sotto* ('under')
  e.g., prendere lo scatolone con una mano *sotto* all'oggetto ('pick up the box with one hand *under* the object')

As regards prepositions, some further remarks have to be added. Italian has many locative prepositions, but according to morphosyntactic and semantic criteria, only the polysyllabic, secondary adpositions expressing spatial relations were considered (according to the Italian grammatical tradition, the so-called *preposizioni improprie*, 'improper prepositions', such as *sotto*, 'under', *sopra*, 'above', *davanti*, 'in front of', *dietro*, 'behind', *intorno*, 'around'). Secondary prepositions[43]

[42] This argument mostly regards the grasp descriptions provided for substances and aggregates and will be developed more fully in Section 4.5.2.

[43] Rizzi (1988: 521–522) distinguishes between three classes of Italian polysyllabic prepositions: i) those that mandatorily require a monosyllabic preposition (e.g., *accanto a*, 'beside'); ii) those that may admit a monosyllabic preposition, which is always *a* (e.g., *sopra*, 'above', *sotto*, 'under'); iii) those that are directly followed by the noun phrase and do not admit any other preposition (e.g., *verso*, 'towards').

usually govern their complement by the intervention of certain other prepositions; however, most of them are polyfunctional, and the same words may function as adverbs (e.g., prepositional use: *guardare intorno alla stanza*, 'to look around the room', vs. adverbial use: *guardarsi intorno*, 'to look around').[44] As discussed in Meini (2010: 42 ff.), in these cases it is better to use the label 'intransitive prepositions' (Klima 1965; Jackendoff 1983; Rizzi 1988: 528; Graffi 1994: 46–47; cf. also the discussion in Salvi and Vanelli 2004: 174) rather than 'adverbs', or 'prepositional adverbs': it is evident that the specific meaning of these lexical elements always remains a relational one (i.e., it refers to the spatial relation between at least two entities).

The main reason why only this kind of preposition was included in the present study is that secondary prepositions (even the most frequent ones and those that admit the intransitive construction, such as *sotto*, 'under', *sopra*, 'above') are characterised by a semantic value[45] more restricted to the spatial domain, and from this point of view they can be considered more similar to lexical words. This is a semantic property that secondary adpositions share with phrasal prepositions of the type [preposition + noun + NP] (e.g., *in mezzo a*, 'in the middle of'; cf. Meini 2010: 44); for this reason, also phrasal prepositions expressing spatial relations are included in the present analysis. On the other hand, primary prepositions are more polyfunctional, that is to say, they generally convey a wider range of meanings (not restricted to the spatial domain) than secondary prepositions.

Deictic elements, such as *lì* ('there'), *qui*, *qua* ('here') that occur when the participant does not describe the target of the grasp linguistically, but points to (or touches) the monitor (e.g., "lo prenderei proprio qui", 'I would take this right here'), were excluded from the analysis. These descriptions do not comply with the requested task, that is, to provide a complete *verbal* description. However, such cases are few.

PERCEPTUAL (PER). All expressions (mostly adjectives) denoting perceptual properties that refer to the target of the grasp are included in this category, such as *largo*, 'wide', *rosso*, 'red' (e.g., *la parte larga*, 'the wide part', *la parte rossa*, 'the red part'). Since this is not a numerous class, different kinds of perceptual properties (such as colour, shape, size, etc.) are not distinguished from one another.

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[44] Examples taken from Rizzi (1988: 507).

[45] "A secondary adposition (pre- or postposition) is one which expresses not a grammatical but an objective meaning, and which may be morphologically complex and/or transparent, such as *below*, *during*. A primary adposition is one which expresses an elementary objective or a grammatical meaning and is morphologically simple, such as *of*, *in*" (Lehmann 1985: 304).

SIMILES, BASED ON PERCEPTUAL PROPERTIES (SPP). This category collects all the words denoting a concrete entity that informants explicitly liken to the visual stimulus presented during the action description task. Such entities, therefore, do not constitute the target of the grasp (they were not considered in the study presented in Chapter 3). However, they have been extracted for this broader analysis of grasp descriptions since they are produced during the action description task to refer to the object stimulus. For example, the tea-cup might be likened to the jug because both have handles and both are containers used to contain liquids.

ASSOCIATED ENTITY (AEN). In very few cases, the grasp described by informants is directed at an entity associated with the real target of the grasp. For instance, if the target of the grasp is a woman, the subject may choose to grasp not the woman herself (e.g., a body part), but an accessory, for example, her bag, her scarf.

The effector-related and target-related words extracted from the transcripts will be presented following the order adopted in the previous chapter: artifacts (without affording parts, Section 4.2.1; with affording parts, presented with no difference in orientation, Section 4.2.2; with affording parts, presented with both a rightward and a leftward orientation, Section 4.2.3), humans (Section 4.3); natural kinds (Section 4.4); substances and aggregates (Section 4.5). However, in order to enable a more in-depth qualitative analysis, each object stimulus will be considered separately. For each stimulus, all effector-related and target-related words extracted from the descriptions will be listed together with the number of their occurrences.

4.2. Artifacts

4.2.1. Artifacts without affording parts

This first group of artifacts contains eight object stimuli: the box, the glass, the lighter, the pencil, the plate, the football, the tennis ball, and the vase.

4.2.1.1. Detailed analysis

(1) BOX

a. Effector-related words	b. Target-related words
HND: *mani* (26), *mano*.[46]	ENT: *oggetto*, *pacco*, *cartone*, *scatolone*.
MER: *palmi* (3), *pollice*, *dita*, *palmo*.	QUA: *due* (2).
HOL: *braccia* (7), *corpo* (2).	SPA: *lati* (11), *sotto* (5), *base* (2), *lato* (2), *lateralmente* (2), *facce*, *intorno*, *superiore*, *attorno*, *esterni*, *laterale*, *giù*.
QUA: *due* (12), *entrambe* (9), *tutte* (5), *tutto*.	PER: *corto*, *piccole*, *piccoli*.
SPA: *destra*, *sinistra*.	

For the box, the most frequent word that relates to the effector is *mani*, 'hands', with 26 occurrences, followed by *braccia*, 'arms' (seven occurrences) and *palmi*, 'palms' (only three occurrences). Clearly, frequency data suggest that the object affords a two-handed grasp: because of its size, participants also mentioned the arms: but in most cases, the arms are indicated as only a further support for a two-handed grasp ("con entrambe le mani, aiutandomi con le braccia", 'with both hands and the aid of my arms'). The effort required to grasp the large box is often emphasised by expressions of quantity ("proprio con tutto il corpo, andrei a mettere le mani giù, entrambe le mani giù sotto il pacco", 'with my whole body, I would go to put my arms down, both hands right under the packet').

With regard to the target of the grasp, informants typically named either the sides of the object (*lati*) or its bottom (*sotto*, *base*).

(2) GLASS

a. Effector-related words	b. Target-related words
HND: *mano* (23).	ENT: *bicchiere* (7), *oggetto*.
MER: *pollice* (8), *dita* (8), *indice* (2), *mignolo*.	QUA: *tutto*.
QUA: *sola* (5), *tutta* (3), *quattro*, *tutte*, *piena*, *entrambe*.	SPA: *parte* (5), *intorno* (4), *circonferenza* (2), *verso* (2), *dietro* (2), *lato* (2), *lati*, *metà*, *sotto*, *davanti*, *frontale*, *opposta*, *bassa*, *attorno*, *retro*.
SPA: *destra* (4), *sinistra* (2).	

The frequencies of effector-related words indicate that the object is mostly grasped with only one hand, either the left or the right ("una sola mano, la mano destra", 'just one hand, the right hand'). The target of the grasp is usually referred to using words pertaining to the spatial domain ("questo lo afferro al lato", 'I take hold of this at the side'; "semplicemente, quattro dita dietro e il pollice sempre che tiene il davanti", 'four fingers inside and with the thumb holding it in front').

[46] When the word frequency is different from 1, it is indicated between round brackets.

(3) LIGHTER

a. Effector-related words
HND: *mano* (19), *pugno* (2), *polso*.
MER: *pollice* (11), *dita* (9), *indice* (5), *palmo* (2), *medio*.
QUA: *tutta* (4), *due* (3), *tre* (2), *sola* (2), *quattro*, *tutto*, *pieno*.
SPA: *destra* (2), *mezzo*.

b. Target-related words
ENT: *accendino* (2), *oggetto*, *corpo*.
SPA: *sopra* (3), *davanti* (2), *parte*, *intorno*, *sotto*, *dietro*.

Also with regard to the lighter, most descriptions indicate a grasp performed with only one hand ("con una mano sola, proprio tenendolo racchiuso dentro la mano", 'with just one hand, holding it inside my hand'), but it is worth noting the high number of mentions of the fingers ("con tre dita sul corpo", 'with three fingers on the body'), probably due to the fact that the lighter affords a precision grip. Only one informant mentioned the wrist as the effector of the grasp, probably as a metonymic expression for *mano* ("questo lo prenderei con tutto il polso", 'I would take hold of this with the whole of my wrist'). Sometimes the effector of the grasp is indicated as the object as a whole ("con tutta la mano circonderei l'oggetto e stringerei", 'I would enclose the object with my whole hand and tighten my grip'), otherwise, in a very few cases, informants referred to specific parts of the object, always in spatial terms ("accendino, tutta la mano, con le quattro dietro, me lo metto sul palmo, il pollice davanti", 'lighter, my whole hand, with four fingers behind I put it on my palm, the thumb in front').

(4) PENCIL

a. Effector-related words
HND: *mano* (9).
MER: *dita* (16), *pollice* (14), *indice* (12), *medio* (6), *punta* (2), *anulare*, *dito*.
QUA: *due* (8), *tre* (3), *sola* (3).
SPA: *destra* (2), *mezzo*, *sinistra*.

b. Target-related words
ENT: *matita*.
MER: *punta*.
SPA: *parte* (3), *lato*, *lungo*, *lunghezza*, *mezzo*, *zona*, *dietro*, *superficie*.

As with the glass and the lighter, the pencil is also always grasped with only one hand ("questa con una mano sola", 'this with only one hand'), but we observe a very high frequency of mentions of the fingers (even the fingertips), because the object is very thin and affords a precision grip ("ok, matita… sì, la prenderei con la punta delle dita, quindi le prime, indice, medio e, da dietro, il pollice", 'ok, pencil, yes, I would take hold of it with the tip of my fingers, the first fingers, index and middle finger, and from behind, the thumb').

A few participants also specified the precise place the grasp would have been directed at, namely, in the middle part of the object or near its tip ("con tre dita, la parte in mezzo, diciamo", 'with three fingers, the middle part, let's say').

(5) PLATE

a. Effector-related words	b. Target-related words
HND: *mano* (17), *mani* (6).	ENT: *piatto* (2).
MER: *pollice* (7), *indice* (4), *dita* (3), *palmo* (3), *medio*.	QUA: *due*.
QUA: *due* (5), *quattro* (2), *sola* (2), *tutte* (2), *piena*, *entrambe*, *ambedue*.	SPA: *sotto* (8), *bordo* (5), *lati* (3), *parte* (2), *sopra* (2), *bordi*, *lato*, *estremità*, *fondo*, *inferiore*, *superiore*, *lateralmente*.
SPA: *destra* (3).	

Looking at effector-related words, we notice that, when referring to the plate, some participants opted for a one-handed grasp, others for a two-handed grasp. In both cases, the target is the edge of the plate, grasped either by one ("con una mano, da un bordo", 'with one hand, at the edge') or by two sides of the dish ("appoggerei tutte e due le mani sul bordo", 'I would put both hands on the edge').

Informants also indicated another kind of action, putting the hand under the plate ("questo piatto lo posso prendere con una mano, con il palmo, da sotto", 'I can take this plate with one hand, on my palm, from underneath'). However, such descriptions do not refer properly to a grasp but only to a way of holding a plate.

(6) FOOTBALL

a. Effector-related words	b. Target-related words
HND: *mani* (27), *mano*.	ENT: *pallone*.
MER: *palmi*.	QUA: *tutto*.
QUA: *due* (20), *entrambe* (6), *tutte* (6).	SPA: *lati* (5), *lato* (2), *poli*, *opposti*, *sotto*, *attorno*.
	SPP: *pallina*.

Effector-related words clearly indicate that the most typical kind of grasp afforded by the football is a two-handed grasp ("con tutte e due le mani", 'with both hands').

In some cases, informants also referred linguistically to a grasp directed at the sides of the spherical object ("con due mani, ai lati, cercando di non farlo scappare", 'with two hands, at the sides, trying not to drop it') or with their hands around it ("il pallone lo prenderei con due mani che si chiudono attorno al pallone", 'I would take the ball with two hands to enclose it'), always referring to the target of the grasp in spatial terms.

(7) TENNIS BALL

a. Effector-related words	b. Target-related words
HND: *mano* (29), *pugno*.	ENT: *pallina* (4), *palla* (4).
MER: *dita* (6), *palmo* (4), *pollice*.	QUA: *tutta*, *completamente*.
QUA: *tutta* (10), *tutte* (3), *piena* (3), *intera* (2), *sola*, *due*, *tre*, *quattro*, *cinque*, *tutto*.	SPA: *intorno* (3), *alto* (2), *sopra* (2), *parte*, *dietro*.
SPA: *destra* (4), *sinistra*.	

In all grasp descriptions provided by informants, only one hand is involved as the effector of the action, and in most cases participants referred to a power grasp ("con una mano, l'afferrerei con una mano intera", 'I would grasp it with one hand, with my whole hand').

The target of the grasp is usually described in spatial terms, but sometimes the whole object is mentioned ("con tutta la mano intorno alla palla", 'with my whole hand around the ball').

(8) VASE

a. Effector-related words	b. Target-related words
HND: *mani* (17), *mano* (2).	ENT: *vaso* (4), *oggetto* (2), *corpo*, *brocca*, *ampolla*.
MER: *dita* (3), *pollice* (3), *indice* (2), *medio* (2).	MER: *collo* (8), *pancia* (2), *imboccatura*.
QUA: *due* (13), *tutte* (9), *entrambe* (5), *tre*, *quattro*.	QUA: *due*.
	SPA: *parte* (7), *intorno* (4), *basso* (3), *base* (2), *centro* (2), *circonferenza*, *lati*, *sotto*, *inferiore*, *superiore*, *dietro*, *su*, *verso*, *attorno*.
	PER: *stretta* (2), *rotonda*, *rigonfiamento*, *sottile*, *larga*.

Regarding the words extracted from the descriptions provided by informants, the vase appears to be grasped in most cases with two hands. Only rarely did informants refer to a one-handed grasp ("con una mano lo posso prendere, se non è troppo pesante", 'I can take it with one hand if it is not too heavy'). Object parts are sometimes named, such as the neck ("questo con entrambe le mani per il collo", 'this with both hands by the neck') or the mouth, but in most cases these parts are indicated by words pertaining to the spatial or perceptual domain ("stringendolo intorno alla parte più stretta", 'taking tight hold of it at the narrowest part').

4.2.1.2. General observations

We can now compare results from the analysis of effector- and target-related words for artifacts without affording parts.

Stimulus	Effector					Target					
	HND	MER	HOL	QUA	SPA	ENT	MER	QUA	SPA	PER	SPP
Box	**27**	6	9	**27**	2	4	-	2	**29**	3	-
Glass	**23**	19	-	12	6	8	-	1	**26**	-	-
Lighter	22	**28**	-	14	3	4	-	-	**9**	-	-
Pencil	9	**52**	-	14	4	1	1	-	**10**	-	-
Plate	**23**	18	-	14	3	2	-	1	**27**	-	-
Football	28	1	-	**32**	-	1	-	1	**11**	-	1
Tennis ball	**30**	11	-	24	5	8	-	2	**9**	-	-
Vase	19	10	-	**29**	-	9	11	1	**27**	6	-
Tot.	**181**	145	9	166	23	37	12	8	**148**	9	1
%	**34.5**	27.7	1.7	31.7	4.4	17.2	5.6	3.7	**68.8**	4.2	0.5

Table 4.1. Classification of effector-related (tot. 524) and target-related words (tot. 215) provided for the artifacts without affording parts.

The analysis previously conducted (Section 3.2.1) has shown that, for this class of objects, the number of descriptions that contain an explicit mention of the effector is high for most visual stimuli and shows no great variation. We can now venture some further remarks about the semantic classification of the words extracted for the effector of the grasp.

The frequency and the classification of words referring to the effector of the grasp indicates that the reference to the hand (or the hands) is the most widely present in the descriptions of the vase, the tennis ball, the football, the plate, the glass, and the box; only for the pencil and the lighter does the number of mentions of the hand's meronyms exceed the number of mentions of the hand itself. This is clearly related to the size of the object: the lighter and the pencil are the two smallest objects within this class of stimuli and may afford a pinch grasp. On the other hand, meronymic expressions are rarer for the football and the box, which are large objects; moreover, only for the box (which is the largest object stimulus) are the arms also named as the effectors of the grasp, together with the two hands.

Expressions of quantity are especially frequent for the box, the football, and the vase, and in most cases this is due to the fact that two effectors (both the right and the left hands) are involved in the action (cf. the high frequency of words such as *due*, 'two', *entrambe*, 'both', for these objects).

Regarding the target of the grasp, we have already observed (Section 3.2.1) that the number of references to the target varies a lot among the different object

stimuli. It is particularly low for the pencil, the lighter, the tennis ball, and the football but is higher for the box and the vase.

For all object stimuli, most words referring to the target of the grasp pertain to the spatial domain. However, such kinds of lexical expressions are less frequently produced for the spherical objects (the tennis ball and the football) and the smallest ones (the lighter and the pencil), for which internal subspaces, such as the sides, the upper or the lower part, etc. are less salient, or more difficult to identify (especially for the two balls, which have a continuous surface).

The main characteristic of this first class of object stimuli is that they do not have any specific part designed to facilitate grasping (such as a handle). Nevertheless, parts of the object are sometimes named with regard to the pencil and especially the vase, which has a more complex shape and is made up of identifiable parts, some of which are particularly suitable for grasping (such as the neck) and can be named by informants.

4.2.2. Artifacts with affording parts (with no difference in orientation)

In this category, we find artifacts that have one part typically involved in the grasp and designed for that purpose (the coffee cup, the backpack, the handbag, the rubber boat, the trolley case, the umbrella), or have more than one prominent part suitable for grasping (the chair).

4.2.2.1. Detailed analysis

(9) CHAIR

a. Effector-related words	b. Target-related words
HND: *mani* (18), *mano* (5).	ENT: *sedia* (3).
MER: *dita* (4), *pollice*, *pollici*, *palmi*.	MER: *schienale* (12), *spalliera* (3), *cuscino* (2), *aste*, *buchi*, *spazio*, *gambe*, *sedile*, *seduta*, *spalline*, *stecche*.
HOL: *braccia*.	QUA: *due* (2).
QUA: *due* (8), *entrambe* (3), *tutte* (2), *otto*.	SPA: *parte* (11), *sotto* (7), *dietro* (4), *superiore* (3), *sopra* (3), *basso* (2), *lati* (2), *alta*, *base*, *esterne*, *estremità*, *metà*, *inferiore*, *davanti*, *laterali*, *verticali*, *lateralmente*.
SPA: *destra*, *sinistra*.	

The chair is generally grasped with two hands. Most informants said that they would direct their grasp at a specific part of the object. Frequently this is the back of the chair, or otherwise its seat or its legs ("potrei prenderla dallo schienale, con le mani ai lati dello schienale", 'I could take it by the back, with my hands at the sides of the back'). We observe that the vast majority of grasps are directed at the upper part of the object; this is the part most suited for grasping because it usually reaches human hands. The middle part, i.e., the seat, is chosen

more rarely, whereas the lowest part (the support), which is reachable only with difficulty, is mentioned only once ("dalle gambe sotto, con le mani", 'down by the legs, with my hands'). The holes in the backrest were considered as parts of the chair: some informants explicitly named them as the parts most suited for grasping ("dalla spalliera, mettendo le dita tra gli spazi verticali", 'by the backrest, putting my fingers in the vertical spaces').

(10) COFFEE CUP (UPSIDE-DOWN)

a. Effector-related words	b. Target-related words
HND: *mano* (19), *mani*.	ENT: *tazza* (4), *corpo*, *tazzina*.
MER: *dita* (13), *palmo* (2), *pollice*, *indice*, *punta*.	MER: *manico* (2).
QUA: *tutte* (5), *due* (2), *cinque*, *tutta*.	QUA: *due*.
SPA: *destra* (2), *verso* (2), *basso* (2), *sinistra*, *interno*.	SPA: *sopra* (6), *alto* (4), *fondo* (4), *parte* (4), *intorno* (3), *inferiore* (3), *lati* (3), *basso* (2), *base*, *cerchio*, *finale*, *lato*, *dentro*, *sotto*, *minore*, *cima*.
SPP: *gru*, *conca*.	PER: *stretta*.
	SPP: *pallina*.

For the upside-down coffee cup, we observe a strong tendency to describe a grasp performed with the whole hand ("questa la prenderei con tutta la mano e le dita intorno alla tazza", 'I would take it with my whole hand and my fingers around the cup'), most frequently directed at the bottom of the cup, i.e., the upper part of the upside-down object ("allora questo lo prenderei con una mano da sopra, dalla parte più stretta in cima", 'so I would take this with one hand from above, by the narrowest part at the top'; "non so, da sotto, cioè sì da sopra, in questo caso dal fondo", 'I don't know, from below, that's to say, from the top, in this case from the bottom').

The handle is named as the target of the grasp in very few cases ("sempre con pollice e indice intorno al manico", 'again with the thumb and index finger around the handle'). It is worth noting that in two cases the shape of the hand is described by referring to a cup and a crane ("con la mano messa a conca, quindi… però con il palmo rivolto verso il basso, e la prenderei per il fondo e la solleverei", 'so with my hand in the form of a bowl … but with my palm facing downwards, I would take it from the bottom and pick it up'), and in one case the coffee cup is likened to a tennis ball.

Although this object stimulus presents an affording part, i.e., a part specifically designed for grasping, informants largely ignore it. It seems that, when the cup is upside-down, the handle in part loses its capacity to attract the grasp (we could say its 'affording power'). The fact is we usually take a cup by its handle when it is filled with some liquid and we are going to drink its content. However, when a cup is upside-down, we cannot use it directly for drinking, and probably

we are about to put it in the cupboard to keep it clean, or to leave it on the draining board to dry off. Besides the influence of possible subsequent actions on the kind of grasp described by informants (even shown a static picture and without any request to act), we should also consider the small size of the object. In the case of a large cup, the handle would offer a more economic, comfortable and firm grasp than a grasp with a single hand stretched to hold the object or a two-handed grasp. However, in this case, taking the handle of the upside-down small coffee cup would require a very precise and controlled hand shape, which is far from producing any benefit or advantage, except when the cup is needed to drink from (in which case it would be put the right way up again).

(11) HANDBAG

a. Effector-related words	b. Target-related words
HND: *mano* (11), *pugno*.	ENT: *borsa* (2).
MER: *dita* (3), *pollice*, *falangi*.	MER: *manico* (23), *manici* (6), *bretella*, *manica*, *maniglie*, *tracolla*.
HOL: *braccio*.	QUA: *due*, *tutti*.
QUA: *sola*, *quattro*.	SPA: *intorno* (2), *sotto*.
	SPP: *zaino*.

Regarding the handbag, all participants described a grasp directed at the handle, mostly performed with one hand. No other kind of grasp is mentioned. The only difference that emerged regards the number of handles mentioned by the informants, either one or two ("la borsa la prenderei dal manico", 'I would take the handbag by its handle'; "prendendo entrambi i manici, con una sola mano", 'taking both handles, with just one hand'). Probably due to the presence of a handle at its top, the bag is likened to the backpack ("dal manico, come lo zaino", 'by the handle, as with a backpack').

In many cases, the effector of the grasp is not named; otherwise, participants indicate a single hand ("qui la borsa intuitivamente stringendo il pugno dal manico", 'here the bag instinctively gripping the handle') or the fingers.

(12) RUBBER BOAT

a. Effector-related words	b. Target-related words
HND: *mano* (9), *mani* (6).	ENT: *canotto* (2).
MER: *dito*, *dita*.	MER: *manici* (5), *corde* (3), *corda* (2), *maniglie* (2), *filo* (2), *maniglia*, *cordino*, *cordoncini*, *elastici*, *passantine*.
HOL: *braccio* (3), *braccia* (2).	QUA: *due*.
QUA: *due* (3), *tutte* (3), *entrambe* (2), *intero*.	SPA: *parte* (3), *interno* (2), *sotto* (2), *intorno* (2), *lati*, *lato*, *bordi*, *bordo*, *destra*, *sinistra*, *punta*, *dentro*, *superiore*.
SPA: *destra*.	PER: *lunghi*, *gonfia*.

In most cases participants described a grasp directed at one part of the rubber boat, namely, the handles, i.e., the part best suited to grasp ("dagli appositi manici, con tutte e due le mani", 'by the handles meant for that purpose, with both hands'), but also the rope that is tied around it ("afferrando il canotto con le corde che ha per tirarlo", 'grasping the dinghy by the rope it has for pulling it'), or the rings where the rope is inserted. Otherwise, the inflated sides are a good target, which can be grasped with two hands and sometimes also with the arms ("con due mani, però se è troppo largo probabilmente mi serviranno anche le braccia", 'with two hands, but if it is too big, I would probably also use my arms').

(13) BACKPACK

a. Effector-related words	b. Target-related words
HND: *mano* (10), *mani* (3).	ENT: *zaino* (2), *oggetto*.
MER: *palmo*, *dita*.	MER: *manico* (5), *laccio* (5), *maniglia* (2), *aggancio*, *attacco*, *attaccatura*, *braccioli*, *bretella*, *bretelle*, *lacci*, *cinghia*, *cinghie*, *fascetta*, *fibbia*, *gancetto*, *tracolle*.
HOL: *braccio*.	QUA: *due*.
QUA: *due* (2), *sola* (2), *entrambe*, *tutte*, *solo*.	SPA: *parte* (6), *sopra* (5), *superiore* (5), *alto* (2), *finale*, *lati*, *dietro*, *alta*.
	PER: *azzurro*, *piccolo*.
	SPP: *valigetta*.

Most of the thirty descriptions provided for the backpack refer to using only one hand which is directed at a specific part of the object, either the top handle ("dal manico superiore, stringendo le dita", 'by the upper handle, tightening my fingers') or the shoulder straps ("dalle bretelle, usando tutte e due le mani", 'by the shoulder straps, using both hands').

Words denoting parts of the object are the most frequent. However, expressions pertaining to the spatial domain are also found: for instance, two informants mentioned that they would grasp the object with two hands, at its sides ("lo prenderei con entrambe le mani dai lati", 'I would take it with both hands at the sides').

It is interesting to note that the presence of the handle suggests comparing the backpack to a briefcase ("come prima cosa, lo afferrerei dal laccio che è in alto, come se dovessi tirar su una valigetta", 'first of all, I would grasp it with the handle on top, like picking up a briefcase').

(14) TROLLEY CASE

a. Effector-related words	b. Target-related words
HND: *mano* (6), *mani* (4), *pugno*.	ENT: *oggetto*.
MER: *dita* (2).	MER: *manico* (20), *maniglia* (2),
HOL: *braccia*.	*cinghietta*, *fascetta*, *pezzettino*.
QUA: *due* (2), *entrambe* (2),	SPA: *superiore* (7), *parte* (3), *sopra* (3),
quattro, *tutta*, *sola*.	*sotto*, *dietro*, *alta*, *cima*, *bordo*, *lati*,
SPA: *destro*.	*davanti*, *lateralmente*, *attraverso*, *intorno*.

Most of the thirty descriptions for the trolley case contain a mention of the handle, which is the word most frequently used ("la valigia la prenderei per il manico, con le dita intorno al manico stesso", 'I would take the case by the handle, putting my fingers around the handle').

In contrast, the effector of the grasp is rarely mentioned; only in six cases do we find *mano* ("dal manico superiore, usando tutta la mano", 'by the upper handle, using my whole hand'), whereas mentions of only parts of the hand are even rarer. Only a few informants described a two-handed grasp ("andrei con due mani sul bordo dell'oggetto", 'I would go at it with two hands at the edge of the object').

(15) UMBRELLA

a. Effector-related words	b. Target-related words
HND: *mano* (15), *mani* (2),	ENT: *ombrello* (5).
pugno.	MER: *manico* (18), *impugnatura* (4),
MER: *dita* (3), *pollice*, *palmo*.	*tela*, *fusto*, *corpo*, *collino*.
QUA: *tutta* (2), *due*,	QUA: *due*.
entrambe, *quattro*, *sola*.	SPA: *intorno* (4), *parte* (4), *alto*, *estremità*,
SPA: *destra* (3), *sinistra*.	*finale*, *lato*, *metà*, *mezzo*, *basso*.
	PER: *verde*, *ricurvo*.

In the case of the umbrella, as with the trolley case, most participants described a one-handed grasp directed at the handle ("dall'impugnatura, con tutta la mano", 'by the handle, with my whole hand'). Again, *manico* ('handle') is the most frequent target-related word. In five answers, participants mentioned only the handle ("per il manico", "dal manico", 'by the handle').

Otherwise the object can be grasped by its shaft ("posso prenderlo dal mezzo, col palmo, stringendo con le dita", 'I can take it by its shaft, with the palm of my hand, tightening my grip with my fingers').

4.2.2.2. General observations

Table 4.2. summarises results from the analysis of effector- and target-related words for artifacts with affording parts presented with no difference in orientation.

In the previous analysis (Section 3.2.2), we observed that, for this group of artifacts with affording parts, there are, in general, more references to the target of the grasp than to the effector (except for the upside-down coffee cup). Looking in more detail at the types of words relating to the effector, we notice that words referring to the hand are the most frequent for all objects; however, the number of mentions of the fingers is particularly high for the upside-down coffee cup, which is the smallest object stimulus within this category.

Stimulus	**Effector**						**Target**					
	HND	MER	HOL	QUA	SPA	SPP	ENT	MER	QUA	SPA	PER	SPP
Chair	**23**	7	1	14	2	-	3	25	2	**42**	-	-
Coffee c.	**20**	18	-	9	8	2	6	2	1	**37**	1	1
Handbag	**12**	5	1	2	-	-	2	**33**	2	3	-	1
Rubber b.	**15**	2	5	9	1	-	2	**19**	1	18	2	-
Backpack	**13**	2	1	7	-	-	3	**25**	1	22	2	1
Trolley c.	**11**	2	1	7	1	-	1	**25**	-	23	-	-
Umbrella	**18**	5	-	6	4	-	5	**26**	1	15	2	-
Tot.	**112**	41	9	54	16	2	22	155	8	**160**	7	3
%	**47.9**	17.5	3.8	23.1	6.8	0.9	6.2	43.6	2.3	**45.1**	2	0.8

Table 4.2. Classification of effector-related (tot. 234) and target-related words (tot. 355) provided for the artifacts with affording parts presented with no difference in orientation.

Considering the words extracted that relate to the target, some differences between objects emerge. In particular, meronymic expressions (which mostly consist of mentions of an object's handle) are generally more frequent than words pertaining to the spatial domain. However, this is particularly evident for the handbag, for which we register the highest number of words denoting the object's meronyms and the lowest number of words relating to the spatial domain.

As the analysis conducted for each object has revealed, the number of mentions of an object's parts reflects a strong and clear tendency to prefer the handle, i.e., the affording part, as the target of the action. Words denoting the handle (the lemmas *manico*, *impugnatura*, *maniglia*) are 92, i.e., 59% out of the total number

of words relating to meronyms. When two or more different object parts compete (as in the case of the backpack and, marginally, the rubber boat), other meronymic expressions occur, but the handle is still preferred. The only stimulus that is not aligned with this pattern is the upside-down coffee cup, for which in most cases participants named a power grasp from above (or laterally), similar to the grasp of a tennis ball, and did not mention the handle.

4.2.3. Artifacts with affording parts (with different orientation)

With regard to the eight artifacts with affording parts that during the experiment were presented with different orientation (the hairdryer, the jug, the ladle, the microphone, the dummy, the sword, and the upright/upside-down tea-cup), each stimulus will be analysed separately; but, as already done in Chapter 3, the content of the descriptions provided by the two groups of informants, right-handed (R-H) vs. left-handed (L-H), will also be compared.

4.2.3.1. Detailed analysis

(16) HAIRDRYER (RIGHTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (12).	ENT: *phon* (4), *oggetto*.
MER: *dita* (4), *pollice* (2), *palmo*.	MER: *manico* (12), *impugnatura* (6).
QUA: *sola* (2), *tutte* (2), *tutta*, *tutto*, *quattro*, *intera*.	SPA: *parte* (6), *intorno* (2), *lato*, *inferiore*.
SPA: *destra*.	PER: *lunga*, *stretta*.
L-H:	L-H:
HND: *mano* (3).	MER: *manico* (7).
MER: *dita* (2), *palmo*.	SPA: *lato*, *intorno*.
QUA: *tutta*.	
SPA: *sinistra*.	

With regard to effector-related words, we observe that in both groups of informants the reference is always to only one hand, sometimes indicated as a 'whole' hand ("il phon, mano intera, stringerei il manico del phon", 'the hairdryer, my whole hand, I would grasp the handle of the hairdryer'), whereas meronyms for the hand are rarely indicated ("semplicemente lo impugnerei e lo tirerei su, quindi normalmente, con tutte le dita", 'I would simply take hold of it and pick it up, so normally, with all my fingers').

The most frequent target-related words are *manico* and *impugnatura*, both meaning 'handle' ("dall'impugnatura, con tutta la mano", 'by the handle, with my whole hand'). Sometimes, the reference to the object (and in most cases to the handle) is made using words pertaining to the perceptual or spatial domain

("impugnerei la parte più lunga e più stretta, di lato", 'I would take hold of the longest and narrowest part, from the side'). We should also note that in one case a left-handed informant described a grasp directed at the rightward-oriented handle but performed with his dominant (left) hand ("lo prendo per il manico, con la mano sinistra tendenzialmente, avvolgendo le dita intorno al manico", 'I tend to take it with my left hand, wrapping my fingers around the handle').

(17) HAIRDRYER (LEFTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (18).	ENT: *phon*.
MER: *dita* (2), *pollice* (2), *palmo*.	MER: *manico* (13), *impugnatura* (2).
QUA: *sola*, *intera*, *quattro*, *tutta*.	SPA: *parte* (3), *intorno* (3), *lato* (2), *sotto*, *sopra*.
SPA: *sinistra* (4), *destra* (2).	PER: *concava*, *stretta*.
L-H:	L-H:
HND: *mano* (2).	MER: *manico* (7).
MER: *dita*, *palmo*.	SPA: *intorno*.
QUA: *solo*.	
SPA: *sinistra*.	

In the descriptions provided for the leftward-oriented hairdryer, in most cases the object is grasped using only one hand (the plural word *mani* is never used), by its handle ("il phon, con una sola mano intorno al manico", 'the hairdryer, with just one hand around the handle'). Sometimes, the target of the grasp is indicated with adjectives pertaining to the spatial domain, or to the domain of visual perception ("con una mano, di lato, nella parte più stretta", 'with one hand, from the side, at the narrowest part'). As for the effector of the grasp, we observe that in five cases (mostly within the right-handed group) informants specified that they would use the left hand to grasp the object ("questo lo prenderei con la mano sinistra dal manico", 'I would take it by the handle with my left hand').

(18) JUG (RIGHTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (15), *mani* (2), *pugno*.	ENT: *brocca* (3).
MER: *dita* (4), *pollice* (3).	MER: *manico* (16), *impugnatura*, *manica*, *occhiello*.
QUA: *quattro* (3), *due* (2), *cinque*, *tutte*.	SPA: *parte* (4), *intorno* (2), *sotto*, *dietro*, *sopra*, *destra*, *posteriore*, *base*.
SPA: *destra* (6) *sinistra*.	L-H:
L-H:	MER: *manico* (6).
HND: *mano* (6).	SPA: *parte*, *superiore*, *intorno*.
MER: *dita* (2).	
QUA: *tutta*.	
SPA: *destra* (2).	

With regard to the rightward-oriented jug, most descriptions contain an explicit reference to a single hand as the effector of the grasp and to the handle as the target ("con la mano destra, afferrerei il manico", 'I would take hold of the handle with my right hand'). However, spatial terms are sometimes used with reference to the jug, and in most cases they refer to the handle ("con la mano dalla parte destra della caraffa", 'with my hand on the right-hand part of the jug', where 'the right-hand part of the jug' clearly refers to the handle).

It is worth noting that eight informants (two of them were left-handed) specified that they would use the right hand to perform the grasp ("la prenderei per il manico, con la mano destra, nonostante io sia mancino", 'I would take hold of it by the handle, with my right hand, even though I am left-handed').

Only in a few cases did participants describe a two-handed grasp ("con la mano destra prenderei il manico, con la sinistra la terrei sotto", 'I would grasp the handle with my right hand and with my left hand I would hold it underneath').

(19) JUG (LEFTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (10), *mani* (4), *pugno*.	ENT: *caraffa*.
MER: *dita* (3), *pollice* (2).	MER: *manico* (11), *collo* (4), *impugnatura* (2).
QUA: *due* (5), *tutta*, *tutte*, *quattro*.	SPA: *intorno* (3), *lato* (2), *parte*, *sotto*, *sopra*.
SPA: *sinistra* (8), *destra* (2).	L-H:
L-H:	MER: *manico* (5).
HND: *mano* (3).	SPA: *davanti*, *intorno*.
MER: *dita*.	
SPA: *sinistra* (2).	

Similarly, the leftward-oriented jug is also predominantly grasped using only one hand, by the handle ("la prenderei dal manico, usando tutta la mano", 'I would take it by the handle, using my whole hand'). Only in a few cases did informants describe a two-handed grasp that sometimes still involved the handle ("metterei una mano di sotto e l'altra la metterei al manico", 'I would put one hand under it and the other on the handle'); otherwise, it can be directed at the neck of the jug ("con tutte e due le mani dal collo", 'by the neck and with two hands').

Since this jug is leftward-oriented, ten participants (eight of whom are right-handed) mentioned that they would use the left hand ("con la mano sinistra, perché se è girato di qua, con la sinistra, cioè perché mi viene spontaneo farlo così", 'with my left hand, because if it is facing this way, with my left hand, because it comes naturally to do it that way'). Only two right-handed informants

explicitly named the right hand as the effector of the grasp of the leftward-oriented jug ("la prenderei comunque con la destra", 'I would at all events take it with my right hand').

(20) LADLE (RIGHTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (11).	ENT: *mestolo*.
MER: *dita* (4), *pollice* (4), *indice* (3), *medio* (2).	MER: *manico* (19), *impugnatura* (2), *cucchiaio*.
QUA: *sola* (2), *quattro*.	SPA: *parte* (3), *sotto* (2), *cima* (2), *destra*, *destro*, *estremità*, *lato*, *metà*, *intorno*.
SPA: *destra* (8).	SPP: *penna*.
L-H:	L-H:
HND: *mano* (4).	ENT: *mestolo*.
MER: *pollice* (2), *indice* (2), *medio* (2), *dita* (2).	MER: *manico* (5).
QUA: *solo*.	SPA: *parte*, *alta*.
SPA: *sinistra* (2), *destra*.	

Looking at effector-related words, first of all, we notice that in the descriptions provided for the rightward-oriented ladle, the object always appears to be grasped with only one hand ("questo sempre con solo una mano, dal manico", 'this I would always take with only one hand, by the handle'). However, compared to other artifacts with affording parts, fingers are frequently mentioned, probably because of the thin shape of the handle that, in one case, is likened to a pen ("con la mano destra, come una penna, appoggiando sul medio, e indice e pollice che lo fermano", 'with my right hand, as with a pen, resting on my middle finger, and with my index finger and thumb to keep it in place').

With regard to target-related words, it is clear that the handle of the ladle is the preferred target and *manico*, *impugnatura*, 'handle', are the words most frequently used, even though among meronyms we also find *cucchiaio*, 'spoon', referring to the part opposite the handle. Words pertaining to the spatial domain are often used in association with meronyms, to specify which part of the long handle of the ladle is the target of the grasp ("da metà manico", 'half way down the handle').

Most descriptions containing an indication of which hand would be involved in the action of grasping refer to the right hand; however, two left-handed informants preferred their dominant hand ("in questa posizione esatta, probabilmente lo prenderei con la mano sinistra", 'in this exact position, probably I would take it with my left hand').

(21) LADLE (LEFTWARD-ORIENTED)

a. Effector-related words
R-H:
HND: *mano* (18), *pugno*.
MER: *dita* (4), *pollice* (3), *indice* (3), *medio*.
QUA: *tutte* (2), *tutta* (2).
SPA: *destra* (5), *sinistra*.
L-H:
HND: *mano* (2).
MER: *dita* (3), *pollice* (2), *indice* (2), *medio*.
QUA: *due*.
SPA: *sinistra*.

b. Target-related words
R-H:
ENT: *mestolo* (4).
MER: *manico* (17), *impugnatura* (2).
SPA: *parte* (7), *intorno* (3), *sinistra* (2), *estrema*, *inizïale*, *verso*, *vicino*, *metà*, *fondo*, *alta*, *sotto*, *superiore*.
SPP: *penna* (2).
L-H:
MER: *manico* (4), *asta*.
SPA: *parte* (2), *esterna*, *alta*.
PER: *lunga*.

Regarding the leftward-oriented ladle, we may observe that participants always described a one-handed grasp usually directed at the handle ("prenderei per il manico, anche questo premendo le dita intorno al manico", 'I would take it by the handle, here again pressing my fingers around the handle'). Also, in this orientation, fingers are frequently mentioned and in two cases the ladle is likened to a pen ("metterei la mano sull'impugnatura, chiudendo tra indice e pollice", 'I would put my hand on the handle, closing up my index finger and thumb').

Five informants specified that they would use their right hand in order to grasp the leftward-oriented ladle. Notably, they are all right-handed participants who preferred to choose their dominant hand as the effector, rather than the hand that was spatially aligned with the target of the grasp ("lo prenderei sempre con la mano destra, però farei un movimento rotatorio, dal momento che c'è il manico del mestolo a sinistra", 'I would again take it with my right hand, but I would make a circular movement, since the ladle handle is on the left').

(22) MICROPHONE (RIGHTWARD-ORIENTED)

a. Effector-related words
R-H:
HND: *mano* (12).
MER: *dita* (4), *pollice*, *medio*, *anulare*, *mignolo*.
QUA: *sola* (3), *due* (2), *quattro*, *tutta*, *tutte*.
SPA: *destra* (2), *destro*.
L-H:
HND: *mano* (2), *pugno*.
MER: *palmo*, *dita*.
QUA: *solo*.

b. Target-related words
R-H:
ENT: *microfono* (2), *oggetto*.
MER: *manico* (4), *impugnatura* (4), *gambo*.
SPA: *parte* (8), *verso*, *finale*, *fondo*, *lato*, *cima*, *metà*, *sotto*, *lateralmente*, *basso*, *intorno*.
PER: *fine* (2), *spessa*, *stretta*.
L-H:
MER: *manico* (4), *impugnatura*, *tasto*.
SPA: *parte* (2), *centrale*, *intorno*.

Considering the effector-related words extracted from descriptions provided by informants, the rightward-oriented microphone is mostly grasped with a single hand ("microfono, con una sola mano", 'microphone, with just one hand'). The fingers are rarely mentioned, but always in relation to a power grasp ("chiudendo tutte le dita intorno al microfono", 'closing up all my fingers around the microphone').

Only in 14 cases did informants explicitly mention the handle of the microphone, and visuo-spatial expressions are generally preferred ("sulla parte meno spessa", 'at the narrowest part').

Only three right-handed informants specified that they would use their right hand to perform the grasp.

(23) MICROPHONE (LEFTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (15), *pugno*.	ENT: *microfono* (2), *oggetto* (2), *corpo*.
MER: *dita* (3), *pollice*.	MER: *manico* (6), *impugnatura* (4), *gambo*.
QUA: *sola* (3), *tutta* (2), *tutte*, *piena*.	SPA: *parte* (5), *intorno* (2), *lato*, *sotto*.
SPA: *sinistra* (7), *destra* (2), *opposto*.	PER: *stretta*.
L-H:	SPP: *phon*.
HND: *mano* (3).	L-H:
MER: *palmo*, *dita*.	MER: *manico* (4).
SPA: *sinistra* (3).	SPA: *sinistra*.

As already noted for the rightward orientation, for the leftward-oriented microphone, too, there are only 15 explicit references to the handle of the object ("con tutta la mano sull'impugnatura", 'with my whole hand on the handle'). In one case, the microphone is likened to a hairdryer.

The grasps described are always performed with only one hand, but ten informants answered that they would prefer to use the left hand ("con la mano sinistra, dal manico diciamo", 'with my left hand, in other words by the handle'). Significantly, seven of these participants are right-handed. For them, the choice of the left hand as effector is less natural and only due to the spatial orientation of the handle.

(24) DUMMY (RIGHTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (9).	ENT: *ciuccio*.
MER: *dita* (9), *indice* (3), *dito* (3), *pollice* (2).	MER: *manico* (7), *impugnatura* (2), *anello*, *gancetto*, *laccio*, *occhiello*.

QUA: *due* (5), *sola* (3), *solo* (2), *tre*, *tutta*, *tutte*.
SPA: *destra* (3).
L-H:
HND: *mano* (2).
MER: *dita* (2), *pollice*, *indice*.
QUA: *due*.
SPA: *destra*.

SPA: *parte* (11), *finale*, *interno*, *sotto*, *superiore*.
PER: *tonda*, *rossa*.
L-H:
MER: *manico* (3), *occhiellino*.
SPA: *esterno*, *bordo*.

For the rightward-oriented dummy, most effector-related words refer to a single hand ("con tutta la mano, sì", 'yes, with my whole hand'), but also to fingers, probably because the object's size affords a precision grip ("questo, anche qui, lo prenderei con due dita", 'this again I would take with two fingers').

Among target-related words, we observe a high number of different words all referring to the small handle of the dummy, among which the most frequent is *manico* ("questo sempre lo prenderei dall'occhiellino, per motivi di igiene", 'I would always take this by the handle, for reasons of hygiene').

Words pertaining to the domain of space or expressing perceptual properties are rather rare, and in most cases they refer to the handle ("il ciuccio lo prenderei dal di sotto", 'I would take the dummy from the bottom part').

(25) DUMMY (LEFTWARD-ORIENTED)

a. Effector-related words
R-H:
HND: *mano* (8).
MER: *dita* (6), *pollice* (2), *indice* (2), *dito* (2), *medio*.
OBP: *bocca*.
QUA: *due* (4), *tutta* (3), *tre*, *piena*, *solo*, *sola*.
L-H:
MER: *dita* (2), *pollice*, *indice*.
QUA: *due*.

b. Target-related words
R-H:
ENT: *ciuccio* (2).
MER: *manico* (6), *aggancio*, *anellino*, *gancino*, *mammella*, *manichino*, *tondino*.
SPA: *parte* (7), *sotto* (2), *opposta*, *finale*, *intorno*.
PER: *tonda*.
L-H:
MER: *manico* (4), *manichino* (2), *occhiello*.
SPA: *dietro*.

For the leftward-oriented condition, this object appears to be grasped using one hand and, in particular, with the fingers ("allora, il ciuccio lo prendi con due dita dal manico", 'so I take the dummy by the handle with two fingers').

Again, we observe many different expressions, apart from *manico*, used to indicate the handle, which always constitutes the preferred target of the grasp ("questo lo prenderei qua, da questo occhiello", 'I would take it here by the small handle').

(26) SWORD (RIGHTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (11), *mani* (3), *pugno*.	ENT: *pugnale*.
MER: *dita* (4), *pollice* (3), *palmo* (2).	MER: *manico* (11), *impugnatura* (9), *elsa* (2), *punta*.
QUA: *due* (3), *tutta* (2), *tutte* (2), *quattro*, *intero*.	SPA: *parte* (5), *intorno* (3), *fondo*, *lateralmente*.
SPA: *destra*.	L-H:
L-H:	MER: *manico* (4), *impugnatura* (2), *elsa*.
HND: *mano* (4).	SPA: *intorno*.
MER: *dita*, *palmo*.	
QUA: *tutta*.	

For the rightward-oriented sword, we find mentions of both the hand and the fingers, but always with reference to a power grasp ("questa prendendo l'impugnatura, stringendola fra il pollice e le altre dita", 'I would take this by the hilt, grasping it between thumb and the other fingers'). Since the object seems to be heavy, sometimes the use of both hands is required ("credo che sia pesante, sembra, quindi con tutte e due le mani dal manico", 'I think it looks heavy, so by the handle and with two hands'). The number of words relating to the handle of the sword is particularly high, because, for reasons of safety, the object does not afford any other kind of grasp ("questa sicuramente con una mano dall'impugnatura, senza ombra di dubbio", 'this I would definitely take by the hilt using my hand, without a doubt').

(27) SWORD (LEFTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (11), *pugno* (2), *mani*.	ENT: *spada* (2).
MER: *dita* (2), *palmo*.	MER: *manico* (9), *impugnatura* (7), *elsa*, *lama*.
QUA: *due*, *tutta*, *tutte*.	SPA: *parte* (2), *sopra* (2), *lateralmente*, *intorno*, *attorno*.
SPA: *sinistra* (7).	L-H:
L-H:	MER: *manico* (3), *impugnatura* (2), *elsa*, *lama*.
HND: *mano* (2).	
MER: *dita*, *palmo*.	
SPA: *destra*, *sinistra*.	

For the leftward-oriented sword, too, we observe a very high number of meronyms that refer to the handle of the object (its hilt), whereas spatial expressions used to indicate the target are rather rare ("con una mano, lateralmente", 'with one hand, from the side').

Surprisingly, some participants also mentioned the blade; in one case, this answer was given by a right-handed informant, and was therefore the result of a

spatial alignment effect ("istintivamente mi verrebbe di prenderla dalla lama", 'instinctively I would want to take it by the blade'); in another case, however, it came from a left-handed subject ("il primo istinto sarebbe di afferrarlo per la lama, sollevarlo con la destra", 'my first instinct would be to take hold of it by the blade, to lift it up with my right hand'). Nevertheless, most spatial expressions relating to the effector show that informants (especially the right-handed ones) described a grasp performed with the left hand ("afferrerei la spada dalla parte del manico con la sinistra", 'I would take hold of the sword by the handle using my left hand').

(28) TEA-CUP (RIGHTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (6), *mani* (3).	ENT: *tazza* (4), *tazzina*.
MER: *dita* (10), *indice* (8), *pollice* (6), *dito* (4), *medio*.	MER: *manico* (14), *manica*.
QUA: *due* (10), *tre* (2), *tutte* (2), *solo* (2), *solamente*.	SPA: *intorno* (3), *parte* (2), *dentro* (2), *destra*, *sotto*, *sopra*, *dietro*.
SPA: *destra* (2).	L-H:
L-H:	ENT: *corpo*.
HND: *mano* (2).	MER: *manico* (5), *occhiello*.
MER: *indice* (4), *pollice* (3), *dito* (2), *medio*.	SPA: *interno*, *parte*, *sopra*, *intorno*.
QUA: *solo*.	
SPA: *destra* (2).	

The tea-cup is the only object stimulus presented with four different orientations. In this first case, the object is upward- and rightward-oriented. Considering effector-related words, we observe that, in the descriptions provided by both groups of informants, spatial expressions referring to the effector always indicate the right hand ("questo sempre per il manico con la destra", 'this always by the handle with my right hand'). In many cases, participants mentioned the fingers: this is because the target of the grasp, in most descriptions, is the handle of the cup, which may afford a precision grip ("con le tre dita della mano prenderei il manico", 'I would grasp the handle with the three fingers of my hand').

The most frequent target-related word is *manico*, often combined with a spatial expression ("l'afferrerei con tutte e due le mani, con un dito dentro l'apposito manico", 'I would grasp it with both hands, with one finger inside the handle'), but there are also two other types of grasps described (from above, from the body). Only a few informants described a two-handed grasp.

(29) TEA-CUP (LEFTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mani* (6), *mano* (4).	ENT: *tazza*.
MER: *dita* (8), *indice* (3), *pollice* (2), *dito*, *medio*.	MER: *manico* (12), *impugnatura*, *manica*, *cerchiettino*.
QUA: *due* (9), *tutte* (4), *entrambe*.	SPA: *lato* (4), *parte* (3), *sinistra* (2), *alto*, *sotto*, *verso*, *opposto*, *intorno*, *dentro*, *sopra*, *laterale*.
SPA: *sinistra* (5), *destro*, *destra*.	PER: *grossa*.
L-H:	SPP: *brocca* (2).
HND: *mano* (3).	L-H:
MER: *dita* (2), *dito*, *pollice*, *indice*, *medio*.	MER: *manico* (6), *occhiello*.
QUA: *due* (2).	SPA: *sinistra*, *base*, *lato*.
SPA: *sinistra* (2), *destra*.	

For the tea-cup with the leftward-oriented handle, we again observe that most descriptions refer to a one-handed grasp directed at the handle, sometimes involving the fingers. In two cases, the tea-cup is likened to the jug ("la tazza girata di qua, uguale alla brocca, cioè farei in modo di comunque avere l'indice dentro il cerchiettino, il pollice sopra e il medio sotto", 'with the cup facing this way, like a jug, so I would make sure I had my index finger inside the handle, with my thumb above and my middle finger below').

The most striking difference from the previous stimulus is that there are seven descriptions that explicitly mention the left hand, five of which are produced by right-handed informants ("sempre usando, sì, penso la mano sinistra, perché il manico è verso sinistra", 'I think I would always use my left hand, because the handle points leftwards'). Only in a few cases is the effector of the grasp the right hand. In such rare cases, it seems that hand dominance predominates over spatial compatibility ("dal manico, con l'indice destro e le altre dita che la sostengono", 'by the handle, with my index finger inside and the other fingers holding it up').

The target of the grasp is, in most cases, the handle, usually indicated by meronyms, but sometimes also by spatial terms ("questa la prenderei dalla parte sinistra, con due dita magari", 'I would take hold of this on the left, maybe with two fingers). Otherwise, different parts of the object may constitute the target of the grasp and they are usually indicated with words pertaining to the spatial or perceptual domain; for example, participants may describe a grasp directed at the side opposite the handle ("ok, tazzina girata così, io la prenderei con la destra, dalla parte quella grossa", 'Ok, with the cup turned that way, I would take it with my right hand, by the biggest part'), or from above ("la prenderei probabilmente dall'alto", 'I would probably take it from above').

Also in this case, only a few informants described a two-handed grasp (*mani*, 'hands', has only 6 occurrences).

(30) TEA-CUP (UPSIDE-DOWN, RIGHTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (10), *mani* (2).	ENT: *tazza* (6), *tazzina*, *corpo*.
MER: *dita* (8), *palmo* (3), *pollice* (2), *dito*, *indice*, *medio*.	MER: *manico* (4).
QUA: *due* (4), *tre* (2), *tutta* (2), *tutte* (2), *cinque*, *sola*.	SPA: *parte* (6), *fondo* (5), *sopra* (3), *sotto* (2), *inferiore* (2), *alto* (2), *verso*, *base*, *interno*, *lati*, *intorno*.
SPA: *destra*.	SPP: *bicchiere* (3), *tazzina* (2).
L-H:	L-H:
HND: *mano* (2).	ENT: *corpo*.
MER: *dita*, *pollice*, *indice*.	MER: *manico*.
QUA: *tutte*.	SPA: *lato*, *basso*.
SPA: *sinistra*.	SPP: *tazzina* (2), *pallina*.

When the tea-cup is upside-down, it appears that the references to the effector do not change very much compared to the two upright tea-cups: both references to the hand and to parts of the hand are present. But what we notice is a difference in target-related words. Now the references to the handle are very few ("probabilmente manico, una mano, quindi due dita o tre", 'probably the handle, one hand, so two or three fingers').

On the other hand, words denoting the upper side of the object (i.e., the base of the upside-down tea-cup) in spatial terms become more frequent, and in particular *fondo*, 'bottom' ("con tutta la mano, da sopra, e quindi dal fondo della tazza", 'with the whole hand, from above, and then from the bottom of the cup'). References to the object as a whole, such as *tazza*, *tazzina* ('cup', 'little cup') are more numerous.

Also, comparison with other object stimuli is meaningful. The upside-down tea-cup is likened to the glass, to the tennis ball and to the upside-down small coffee cup. These objects are all significant: the glass and the tennis ball, unlike the tea-cup, have no affording parts; the coffee cup is upside-down (as is the tea-cup), a condition in which in most cases, as shown in (10), its handle is not considered a good target for the grasp (it has only three mentions), exactly as happens with this tea-cup.

(31) TEA-CUP (UPSIDE-DOWN, LEFTWARD-ORIENTED)

a. Effector-related words	b. Target-related words
R-H:	R-H:
HND: *mano* (15), *mani* (4).	ENT: *tazza* (3), *corpo* (2), *oggetto*.
MER: *dita* (3), *palmo* (2), *pollice*, *indice*.	MER: *manico* (4).
QUA: *due* (3), *tutta* (2), *tutte* (2), *piena*.	SPA: *fondo* (4), *sopra* (4), *alto* (2), *parte* (2), *verso*, *basso*, *base*, *esterno*, *lato*, *sotto*, *inferiore*, *superiore*, *laterale*, *lateralmente*, *intorno*.
SPA: *destra* (5), *sinistra* (2).	
L-H:	L-H:
HND: *mano* (2).	ENT: *tazza*.
MER: *dita* (3), *dito*.	MER: *manico* (3), *occhiello*.
QUA: *due*.	SPA: *alto*, *verso*, *lato*, *sopra*.
SPA: *destra* (2).	

For the leftward-oriented upside-down tea-cup, we again observe a high number of mentions of the hand, notably the right hand (both within the left-handed and the right-handed group). The handle is only in rare cases considered a good target for the grasp ("questa la prenderei sempre mettendo un dito nell'occhiello", 'this I would always take by putting my finger inside the handle'); spatial expressions relating to the bottom of the tea-cup, or to its upper part, are more frequent ("dall'alto, con tutta la mano e facendo toccare il palmo con il fondo della tazzina", 'from above, with my whole hand and with the bottom of the cup touching the palm of my hand'; "con una mano, da sopra", 'with one hand, from above').

Sometimes, the side of the object is also preferred to the handle ("allora questa la prenderei con la mano destra, lateralmente", 'so this I would take with my right hand, from the side').

4.2.3.2. General observations

In Table 4.3, the results of the analyses of effector- and target-related words extracted for the artifacts with affording parts (presented with different orientation) are compared.

In order to make for a clearer comparison between the different stimuli, data from the leftward and the rightward orientation condition are merged together.

Stimulus	Effector					Target				
	HND	MER	OBP	QUA	SPA	ENT	MER	SPA	PER	SPP
Hairdryer	**35**	17	-	14	9	6	**47**	23	4	-
Jug	**42**	15	-	16	21	4	**47**	25	-	-
Ladle	36	**40**	-	9	18	6	**51**	40	1	3
Microphone	**34**	16	-	16	16	8	30	**32**	5	1
Dummy	19	**38**	1	26	4	3	**36**	30	3	-
Sword	**35**	16	-	13	10	3	**55**	18	-	-
Tea-cup	24	**60**	-	34	14	7	**43**	35	1	2
Tea-cup (u-d)	**35**	30	-	22	11	16	13	**54**	-	8
Tot.	**260**	232	1	150	103	53	**322**	257	14	14
%	**34.9**	31.1	0.1	20.1	13.8	8	**48.8**	39	2.1	2.1

Table 4.3. Classification of effector-related (tot. 746) and target-related words (tot. 660) provided for the artifacts with affording parts presented with different orientation.

If we consider the frequency data of effector-related words extracted for this group of artifacts, we notice that in most descriptions the reference to the hand(s) is the most frequent, except for the ladle, the dummy, and the upright tea-cup, for which participants produced a higher number of words denoting the fingers or other parts of the hand. This is not by chance: these three object stimuli are those that have the smallest handles compared to the other objects (such as the microphone or the jug), affording a grip performed with only two or three fingers (expressions of quantity are also particularly frequent for the dummy and the tea-cup).

Target-related words mostly denote meronyms. Their frequency values usually exceed (or are at least almost equal to) the frequency of words pertaining to the spatial domain (especially for the sword, whose handle is particularly salient because it allows an agent to avoid touching the blade). In the vast majority of cases, these meronyms denote the affording parts of objects, i.e., those explicitly designed to be grasped. The most frequent lemmas are those denoting a generic handle (*manico*, *maniglia*, *impugnatura*), which occur 288 times and constitute 89.4% of meronyms. However, only in the case of the upside-down tea-cup are spatial relations far more frequent than meronymic expressions. This is because the object presented is upside-down: for this reason, its handle is not judged to be a probable target of the grasp and thus is rarely mentioned by informants, who in most cases described a simple and undifferentiated power grasp directed either at the upper part of the upside-down cup or its side.

The difference in the production of right- vs. left-handed informants will be discussed in Section 4.6.1.2.

4.3. Humans

We now turn to the analysis conducted on the three stimuli representing humans (the little baby, the woman and the man).

4.3.1. Detailed analysis

(32) BABY

a. Effector-related words	b. Target-related words
HND: *mani* (18), *mano*.	ENT: *bambino*, *bimbo*.
MER: *dita* (2), *pollice*, *pollici*, *palmi*.	MER: *braccia* (10), *ascelle* (9), *fianchi* (2), *pancia* (2), *vita* (2), *girovita*, *gambe*, *testa*, *schiena*, *spalle*, *torace*, *tronco*, *mani*, *cosce*, *dorso*.
HOL: *braccia* (4).	
QUA: *due* (10), *entrambe* (6), *tutte* (5).	SPA: *sotto* (18), *zona*, *davanti*, *dietro*, *centrale*.

In most of the descriptions provided for the baby, the grasp indicated is performed with two hands, and the baby is grasped under its armpits or under the arms ("con i palmi e le dita per contenere, per evitare che cada, da sotto le braccia", 'with the palms of my hands and my fingers to take hold of it, to make sure it doesn't fall, from under his arms'). However, many other body parts are named in relation to the target of the grasp ("mettendo le mani sotto la pancia del bambino", 'putting my hands under the baby's tummy').

Regarding the effector, most informants opted for a two-handed grasp, but in a few cases we find mention of the arms ("con le braccia, penso che lo prenderei", 'I think I would take it with my arms'). We notice a high number of quantity expressions; this is mostly due to the fact that informants often specified that they would grasp the child with both hands.

(33) WOMAN

a. Effector-related words	b. Target-related words
HND: *mano* (3), *mani* (3).	MER: *braccio* (8), *ascelle* (3), *gomito* (3), *mano* (3), *spalla* (3), *vita* (3), *braccia*, *fianco*, *fianchi*, *spalle*, *tronco*, *capelli*.
QUA: *due* (2).	SPA: *sotto* (2), *interno*.
	AEN: *borsa*, *sciarpa*, *vestiti*.

For the standing woman, the references to the effector of the grasp are very few. The most frequent description expresses a grasp (probably a one-handed grasp, even when not explicitly stated) directed at the woman's arm ("con una

mano, penso dal braccio", 'with one hand, I think by her arm'). However, there are other possible targets always made up of body parts, such as the hand, the waist, and many more ("per i capelli", 'by the hair').

Clothes and accessories are rarely chosen as a target of the grasp ("andrei per la sciarpa", 'I would go for the scarf'). Clothes were not considered as parts (meronyms) of the woman, but as associated entities. Because of their spatial contiguity, the target of the grasp shifts from the woman herself to the garments and accessories that she wears. However, clothes and accessories in some sense are parts of the visual stimulus provided to the informants; therefore, words such as *vestiti*, 'clothes', *sciarpa*, 'scarf' precisely denote the part at which the grasp is directed (i.e., the target of the grasp).

(34) MAN

a. Effector-related words	b. Target-related words
HND: *mano* (3), *mani* (3).	ENT: *corpo*.
MER: *pollice*, *dita*.	MER: *braccio* (8), *mano* (3), *ascelle* (2), *gomito* (2), *polso* (2), *spalla* (2), *dorso*, *braccia*, *busto*, *pugno*, *schiena*, *vita*, *ginocchio*, *petto*.
HOL: *braccia*.	SPA: *parte* (3), *intorno* (2), *dietro*, *bassa*, *sotto*.
QUA: *due*, *quattro*, *tutte*.	AEN: *maglietta* (3), *maglia*, *camicia*.

The predominant description provided for taking hold of the running man is a one-handed grasp directed at one of his body parts, in most cases his arm, or else his elbow ("per la parte del gomito", 'by the part around the elbow'), or his hand, but informants mentioned a variety of body parts. We can reasonably assume that in most cases only one hand is involved in the action, but only in three cases did the informants explicitly mention the hand as the effector of the action, whereas a two-handed grasp is mentioned three times. In a few cases, participants also described a grasp directed towards the man's clothes ("lo prenderei forse per la camicia, sì", 'yes, I think I would take him by the shirt').

It is worth noting that one informant answered that he would grasp the man with two arms, one under the back and the other under the knees ("con le braccia, da una parte prendo la parte delle ginocchia, dall'altra della schiena", 'with my arms, on one side I take the part around the knee, on the other, at the back'). As already observed, we can reasonably assume that the hands, too, and not only the arms, are involved as effectors of the grasp. The entity is very large; therefore, as already noted in the case of the box, it also requires the use of the arms.

4.3.2. General observations

Looking at Table 4.4, we can compare the data extracted and classified for the category of human beings.

Stimulus	Effector				Target			
	HND	MER	HOL	QUA	ENT	MER	SPA	AEN
Baby	19	5	4	**21**	2	**35**	22	-
Woman	**6**	-	-	2	-	**29**	3	3
Man	**6**	2	1	3	1	**27**	8	5
Tot.	**31**	7	5	26	3	**91**	33	8
%	**44.9**	10.1	7.3	37.7	2.2	**67.4**	24.5	5.9

Table 4.4. Classification of effector-related (tot. 69) and target-related words (tot. 135) provided for humans.

In the case of the two adults, we observe a strong tendency to name a body part as the target of the grasp, whereas clothes and accessories are chosen as possible targets only in three and five cases, respectively. The body parts best suited for the grasp are usually those that protrude most, i.e., the arms and the hands.

As for the baby, we observe a different tendency: protruding body parts such as the arms and the hands are rarely named, probably because they are considered too fragile. Most grasps, described as bimanual grasps, are directed at the sides of the baby. In some cases, the arms are involved in the action, to provide further support for the little child.

As expected, no informant described a precision grip: the reference is always to a power grasp performed with the whole hand. In the rare cases in which the fingers are mentioned, they are never indicated as the effector of a pinch grasp.[47]

4.4. Natural kinds

This paragraph presents the results of the analysis conducted on the four natural kinds (the mandarin, the apple, the banana, and the stone).

[47] In general, mention of the fingers is not closely related to the description of a pinch grasp. On this topic, see the discussion in Section 4.6.1.1.

4.4.1. Detailed analysis

(35) MANDARIN

a. Effector-related words	b. Target-related words
HND: *mano* (26), *pugno*.	ENT: *mandarino* (4),
MER: *dita* (5), *pollice* (2), *indice* (2),	*oggetto* (2), *frutto*.
palmo (2), *palmi*.	QUA: *tutto*.
QUA: *tutta* (4), *sola* (3), *solo* (2),	SPA: *sopra* (3), *intorno* (3),
piena (2), *due*, *tre*, *tutte*, *tutto*.	*bordo*, *lato*, *lati*, *attorno*.
SPA: *destra*, *dentro*.	SPP: *pallina* (6), *palla*.

In most descriptions, the mandarin is grasped with only one hand; therefore, the references to the hand (in particular, *mano*) are the most numerous among the effector-related words ("questo con tutta la mano, col palmo, direttamente", 'this with my whole hand, with the palm, directly'). Only five participants named the fingers and not simply the hand ("questo con tre dita, dai lati", 'this with three fingers, from the sides').

As to target-related words, we note that sometimes the whole object is explicitly indicated as the target of the grasp ("con la mano ad avvolgere il mandarino", 'with my hand to completely contain the madarin'). However, in most cases, the target is indicated in terms of spatial relations ("con una mano sola, da sopra, cioè lo sollevo da sopra praticamente", 'with just one hand, from above, so practically I pick it up from above'). It is worth noting that seven informants explicitly referred to the similarity between this stimulus and the tennis ball.

(36) APPLE

a. Effector-related words	b. Target-related words
HND: *mano* (17), *pugno*.	MER: *picciolo* (4), *gambetto*.
MER: *dita* (7), *palmo* (3), *pollice* (3),	QUA: *tutta*.
indice (2), *dito*.	SPA: *parte* (2), *sopra* (2),
QUA: *tutta* (3), *due* (2), *sola* (2),	*laterale*, *destra*, *intorno*.
tre, *piena*, *tutte*, *tutto*.	SPP: *pallina* (2), *mandarino*.
SPA: *destra*, *sinistra*.	

By looking at effector-related words produced for the apple, we can easily observe that they all indicate a grasp performed by a single hand and, in particular, a whole hand, as many adjectives suggest. Accordingly, the target of the grasp described in the vast majority of cases is the whole object ("questa anche con tutto il palmo e le dita intorno", 'this too with the whole of my palm and enclosing it with my fingers'). Informants named the stalk only in five cases ("dal picciolo, con due dita", 'by the stalk, with two fingers'), whereas some of them also referred to the part of the apple that would be in contact with the hand

(describing a grasp either from above or laterally). In three cases the grasp directed at the apple is explicitly said to be similar to that directed at the tennis ball and the mandarin.

(37) BANANA

a. Effector-related words	b. Target-related words
HND: *mano* (18), *mani* (2).	ENT: *oggetto*.
MER: *dita* (6), *palmo* (3), *pollice* (2), *indice*.	MER: *picciolo* (3), *gambo*.
QUA: *sola* (3), *due* (2), *tre* (2), *tutta* (2), *quattro*.	QUA: *tutta*.
SPA: *destra*, *mezzo*, *interno*.	SPA: *sopra* (2), *alto*, *centro*, *là*, *qua*, *intorno*, *circonferenza*, *mezzo*, *metà*, *lato*, *punte*, *punta*.
	SPP: *coltello*, *mandarino*.

For the banana, again, most informants described a general one-handed grasp directed at the whole object ("banana, la impugno tutta", 'banana, I pick up the whole thing'), whereas some of them referred to the fingers, and only a few named two hands. The target of the grasp is usually denoted by spatial terms ("con due dita che stringono la circonferenza", 'with two fingers tightly around the circumference'). Only in four cases is the stalk of the banana explicitly mentioned ("dal picciolo, con tre dita", 'by the stalk, with three fingers').

Again, we find an explicit comparison is made with the mandarin, as well as one with *coltello*, 'knife' ("la banana, la impugnerei come impugnerei un coltello, quindi la prenderei che me la faccio passare in mezzo al palmo e poi la stringerei", 'I would take hold of the banana as I would a knife, so I would put it in the middle of my palm and grasp it').

(38) STONE

a. Effector-related words	b. Target-related words
HND: *mano* (23).	ENT: *pietra* (2), *oggetto*, *sasso*.
MER: *dita* (6), *palmo* (3), *pollice*, *dorso*, *polpastrelli*.	QUA: *tutto* (2).
OBP: *piede*.	SPA: *sopra* (3), *alto*, *parte*, *sotto*, *intorno*, *superficie*, *attorno*.
QUA: *tutta* (7), *sola* (4), *tutto* (2), *piena*, *intera*, *tutte*.	PER: *ampia*.
SPA: *destra*, *dentro*.	SPP: *pallina* (4), *mandarino*, *arancia*.

In most descriptions, the stone is grasped with the whole hand, as indicated by the high frequency of words expressing quantity ("questo con tutta la mano, direttamente", 'with my whole hand, directly'). The fingers are rarely mentioned, and always with reference to a power grasp ("la pietra la prenderei sicuramente solo con la mano aperta, e le dita a chiusura", 'I would definitely take the stone with my open hand, and the fingers closed'). Only in one case is the foot

indicated as the effector involved in the action instead of the hand ("mah… con un piede", 'well… with my foot').

Since the stone has no meronyms, reference to the target of the grasp is made through spatial or perceptual expressions ("questo, credo forse appoggiando sopra il pollice e le altre dita sotto", 'I think I would perhaps put my thumb on top and the other fingers underneath'). Otherwise, the target is explicitly made up of the whole object ("una mano intorno a tutto all'oggetto", 'one hand around the whole object'), or it is left unexpressed.

It is worth noting that in six cases participants referred to the similarity with the tennis ball, the mandarin, and an orange.

4.4.2. General observations

We can now compare the data relating to the four natural kinds and collate them.

Stimulus	**Effector**					**Target**					
	HND	MER	OBP	QUA	SPA	ENT	MER	QUA	SPA	PER	SPP
Mandarin	**27**	12	-	15	2	7	-	1	**10**	-	7
Apple	**18**	16	-	11	2	-	5	1	**7**	-	3
Banana	**20**	12	-	10	3	1	4	1	**13**	-	2
Stone	**23**	12	1	16	2	4	-	2	**9**	1	6
Tot.	**88**	52	1	52	9	12	9	5	**39**	1	18
%	**43.6**	25.7	0.5	25.7	4.5	14.3	10.7	6	**46.4**	1.2	21.4

Table 4.5. Classification of effector-related (tot. 202) and target-related words (tot. 84) provided for natural kinds.

By looking at effector-related words extracted from the descriptions of grasp of a natural kind, it seems that most answers refer to a one-handed grasp performed with the whole hand. *Mano*, 'hand', is the word most frequently named for all stimuli (23 times for the stone; 26 for the mandarin; 18 for the banana; 17 for the apple). The second word most frequently used for the effector is *dita*, 'fingers' (six times for the stone and the banana; five for the mandarin; seven for the apple).

In the previous chapter (cf. Section 3.4), we observed that informants indicated the target of the grasp for natural kinds more rarely than in the case of other categories of objects. Now, we can also add that the target of the grasp is generally described using words pertaining to the visuo-spatial domain even when the object stimulus presents distinguishable parts (the stalks of apples and

bananas). Such parts are rarely mentioned (only nine occurrences in the 60 descriptions provided for the apple and the banana); therefore, they seem not to be regarded as a good target for the grasp, probably because stalks do not play an important role in the actions in which fruits are usually involved. For instance, we rarely hold stalks in our fingers while we are eating or peeling fruits and, when we have to take a banana or an apple in order to move it from one place to another, or to put it in the fridge, we usually prefer a simpler and faster power grasp.

Sometimes the descriptions of the target of the grasp also contain a reference to the object as a whole: this seems to happen especially for objects that lack specific parts, *viz.* the stone and the mandarine. For these objects, explicit references to other object stimuli affording an undifferentiated one-handed grasp (such as the tennis ball) are also found.

4.5. Substances and aggregates

This section details the results of the analysis conducted on the last category of object stimuli, the one that brings together substances and aggregates (water, flour, sand, and pumpkin seeds).

4.5.1. Detailed analysis

(39) WATER

a. Effector-related words
HND: *mani* (20), *mano* (7).
MER: *dita* (2), *palmo*, *palmi*.
QUA: *due* (7), *tutte* (3), *entrambe* (2).
SPA: *perpendicolare*, *verso*, *alto*.
PER: *concava*.
SPP: *conca* (6), *coppa* (5), *contenitore* (3), *conchetta* (2), *ciotola*, *piscinetta*, *utensile*.
INS: *bicchiere*, *recipiente*.

b. Target-related words
ENT: *acqua* (3).
SPA: *sotto* (5).
SPP: *sabbia* (2).

The most frequent grasp type that participants mentioned for the water is with two cupped hands ("la prenderei con due mani, quindi chiudendo le due mani a conchetta in modo da poter mantenerla dentro, altrimenti con una mano sola non ci si riesce, perché scappa", 'I would take it with two hands, so closing my two hands like a shell so as to keep it inside, otherwise with one hand you can't do it because it falls out'; "metterei le due mani a mo' di piscinetta, come si dice, di contenitore", 'using both my hands I would form a kind of small pool, as it were, a container'). The equivalent action performed with only one cupped

hand is chosen only by seven informants ("usando la mano a coppa, come un utensile", 'using my hand in the form of a cup, like a utensil').

In two cases, the grasp described is performed using a container ("con un bicchiere, fondamentalmente", 'with a glass, basically'). Lastly, one informant said, with great uncertainty and hesitation, that she would grasp the water with her fingers, but obviously this action does not enable a person to hold the substance ("con le dita", 'with my fingers').

The only spatial term used in relation to the water is *sotto*, 'under', because in the picture the water flows from a tap ("ci infilo le mani sotto, ma visto che è liquida è difficile che riesca a fermarla", 'I put my hands under it, but since it's liquid it's difficult to stop it'). It is also worth noting that, in two cases, the water is likened to the sand ("mi aiuterei con le mani, come faccio per la sabbia", 'I would do it with the aid of my hands, as with the sand').

(40) SAND

a. Effector-related words	b. Target-related words
HND: *mano* (17), *mani* (10), *pugno* (3), *pugnetto*.	ENT: *sabbia* (8).
MER: *dita* (4), *palmo* (2).	MER: *granelli*.
QUA: *due* (3), *entrambe* (3), *tutta* (2), *tre*, *quattro*, *solo*, *piena*, *intero*.	QUA: *quantità* (3), *più* (3), *manciata* (3), *pugno* (2), *mucchi*.
SPA: *sinistra*, *destra*, *parte*, *sotto*, *perpendicolare*.	SPA: *attorno*, *dentro*, *interno*, *alto*, *basso*.
SPP: *coppa*, *conca*, *conchetta*, *braccio*, *contenitore*, *mestolo*, *utensile*, *cucchiaio*.	

According to the descriptions provided by the informants, the sand can be grasped either with one or two hands ("cercherei diciamo di afferrarla con un pugno", 'I would try to grasp it with my fist, let's say'; "con due mani", 'with two hands').

Again, we observe a large number of references to containers or instruments (even to the arm of a digger!) used by participants to describe cup-shaped hands ("farei una conca tipo con la mano", 'I would make something like a bowl with my hand'; "con tutta la mano usandola come un mestolo, insomma, un utensile", 'with my whole hand, basically using it like a ladle, a utensil').

In a few cases, the target of the grasp is indicated in spatial terms ("chiuderei appunto le dita attorno alla sabbia, stringendo il più possibile", 'I would close my fingers around the sand, as tightly as possible'); otherwise, only the sand itself is named ("aprirei la mano, raccoglierei la sabbia", 'I would open my hand, I would gather the sand').

It is interesting to note the high frequency of words expressing the quantity of sand that would be grasped ("dovessi effettivamente prenderne una manciata,

penso delle mani, più che altro, sì", 'I would in effect have to take a handful, with my hands, I think, more than anything else').

(41) FLOUR

a. Effector-related words
HND: *mano* (14), *mani* (10), *pugnetto* (2), *pugno* (2).
MER: *dita* (5), *palmo*.
QUA: *due* (6), *entrambe* (3), *sola*, *piena*, *intera*, *tutte*.
SPA: *destra*.
SPP: *coppa* (3), *conchetta*, *contenitore*, *mestolo*, *cucchiaio*.
INS: *bicchiere*, *tazza*.

b. Target-related words
ENT: *farina* (3).
QUA: *manciata* (3), *po'*, *più*, *poca*, *quantità*, *mucchietto*.
SPA: *intorno*.
SPP: *sabbia*, *acqua*.

For the flour, the type of grasp most frequently described is with the whole hand or the fist ("a mano piena", 'my whole hand'). Only in one case did a participant indicate the fingers referring to a pinch grip ("se ne devo prendere poca, anche con due dita", 'If I had to take just a little, also with two fingers').

More interestingly, a large number of participants described the shape of the hand by likening it to a container ("usando una mano come una coppa per raccogliere la farina", 'using one hand like a cup to pick up the flour'). In these descriptions, the effector of the grasp is still a body part (either one or two hands); therefore, participants pointed out a similarity between their hands and a container. Surprisingly, however, two informants also named a real container (*bicchiere*, 'glass' and *tazza*, 'cup') as the effector of the grasp ("mi aiuterei con una tazza, per raccoglierla", 'I would use the help of a cup to pick it up'). These two words relating to the effector have been grouped together in the INSTRUMENT category because they actually denote the thing with which the flour comes into contact. It is interesting to note that the body effector that controls the instrument, i.e., the hand holding the glass and the cup, is never explicitly mentioned.

(42) PUMPKIN SEEDS

a. Effector-related words
HND: *mano* (10), *mani*, *pugno*.
MER: *dita* (17), *pollice* (7), *indice* (7), *punta* (2), *palmo*, *unghie*.
QUA: *due* (10), *tutta* (2), *tutte*.
SPA: *sinistra*, *destra*.

b. Target-related words
ENT: *semi*.
MER: *semino* (2).
QUA: *manciata* (4), *uno* (*alla volta*) (3), *uno* (*per volta*) (2), *uno* (*ad uno*) (2), *tutti*, *singolarmente*, *più*.
SPA: *sotto*, *sopra*, *attorno*.
SPP: *sabbia*.

When shown a picture representing a mound of pumpkin seeds, most participants described a grasp directed at a single seed. Moreover, because of the very small size of these objects, they often named the fingers (typically the thumb and the index finger), thus denoting a pinch grip ("pollice e indice, afferro il semino", 'thumb and index finger, I pick up the seed'). However, there are also a few mentions of a grasp performed with the whole hand, in a fist-like manner ("con tutta la mano", 'with my whole hand'), whereas only in one case do we find a reference to a bimanual grasp ("li raccoglierei con tutte e due le mani", 'I would pick them up with both hands').

Regarding the target of the grasp, it should be borne in mind that in the picture the pumpkin seeds are presented as a compact mound, similar to the mounds of sand and flour (typical mass entities), but nevertheless discrete physical objects can be distinguished in the image. It seems that in this grasp description task the pumpkin seeds presented in a mound are mostly regarded as an aggregation of individual items, with each one being a possible target of the grasp ("questi li raccoglierei uno ad uno, quindi sempre con le dita", 'I would pick these up one by one, so again with my fingers'). This is probably due to the most usual mode of interaction that participants have with the seeds, which are commonly eaten one by one.[48] This is also the reason why references to parts of the hand (especially fingers) are so numerous. The single seeds are rarely mentioned in an explicit form (such as *semino*, 'little seed'), but mostly by means of lexical expressions denoting quantity, such as 'one by one' or 'singularly' ("raccogliendoli o uno ad uno con due dita...", 'picking them up either one by one with two fingers...').

However, as already said, there is also a competing grasp description reflecting a different conceptualisation of the object stimulus. In a few answers, the seeds are grasped imaginatively with the whole hand ("con tutta la mano, cercando di prenderne il più possibile, come per raccogliere della sabbia", 'with my whole hand, trying to pick up as many as possible, like picking up sand'; this example is also significant, because the informant stated a similarity between the pumpkin seeds and the sand). In such descriptions, it seems that the mass interpretation, prompted by the presence of a 'mound' of seeds, overcomes the identification of the single aggregated objects.

It is worth noting that sometimes two competing grasp strategies are mentioned: e.g., "senza prendere una manciata, uno alla volta con due dita", 'without taking a handful, one at a time with two fingers'.

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[48] The mode of interaction with the relevant entity, as well as the possibility of distinguishing its constituent elements, are also important in determining a noun's classification; cf. Wierzbicka (1988).

Looking at the very few occurrences of the lemma *seme/semino* ('seed'/'little seed'), when the reference to the entity is plural participants seem to conceptualise the seeds as an aggregate and describe a power grasp ("tutta la mano, chiudendo le dita attorno ai vari semi", 'my whole hand, closing my fingers around the various seeds'); instead, when they refer to the single seed, they indicate a single 'particle' of the mound and describe a pinch grasp. This is the reason why *semino* was included in the category of meronyms (cf. Cruse 1986), whereas *semi* better denotes the entity represented in the picture, i.e., the seeds aggregated in a mound.

4.5.2. General observations

Table 4.6 collects all data extracted and classified for the category of substances and aggregates (cf. De Felice 2015b: 184).

Stimulus	Effector-related words							Target-related words				
	HND	MER	QUA	SPA	PER	SPP	INS	ENT	MER	QUA	SPA	SPP
Water	**27**	4	12	3	1	19	2	3	-	-	**5**	2
Sand	**31**	6	13	5	-	8	-	8	1	**12**	5	-
Flour	**28**	6	13	1	-	7	2	3	-	**8**	1	2
Pumpkin s.	12	**35**	13	2	-	-	-	1	2	**14**	3	1
Tot.	**98**	51	51	11	1	34	4	15	3	**34**	14	5
%	**39.2**	20.4	20.4	4.4	0.4	13.6	1.6	21.1	4.2	**47.9**	19.7	7.1

Table 4.6. Classification of effector-related (tot. 250) and target-related words (tot. 71) provided for substances and aggregates.

When considering effector-related words, we observe that the grasp of the sand and the flour is mostly described as involving one or two hands, whereas for the pumpkin seeds the fingers are most frequently named. However, the most striking point is that there is a very high number of references to containers, either as the real instrument with which the entity is grasped (four cases), or mentioned to describe the shape of the hand (De Felice 2015b: 185–186; this argument will be explored further in Section 4.6.1.3).

It is no accident that containers are named especially for the water, the flour and the sand: these are mass entities, both from a linguistic and a conceptual point of view. Their component parts are continuous and not clearly distinguishable from one another. The action of grasping implies a form of control over the grasped entity. In the case of substances and mass entities, this control cannot be achieved with the hands, as participants sometimes explicitly stated (e.g.,

for the water: "con una sola mano non ci si riesce, perché scappa", 'you can't do it with just one hand because it drips out'). Instead, for the pumpkin seeds, containers and instruments are never mentioned, because an agent can grasp the single seeds with a pinch grip, or also a fistful of seeds, with the whole hand (and, in this case, a certain quantity of seeds will remain in the person's hand, whereas with the water this is almost impossible).

Therefore, it seems that the number of explicit mentions of containers points to a distinction within this class of object stimuli (De Felice 2015b: 184–186). Water is a liquid substance that cannot be grasped with the hands unless they are cupped, i.e., shaped like (and linguistically compared to) a container; otherwise, a real container, such as a glass, must be used. The flour and the sand can be grasped with a pinch grasp or with a power grasp (a fistful of flour or of sand), but again hands are often assimilated to containers; moreover, for the flour (whose particles are smaller than those of the sand), a real container is indicated as the instrument with which the action can be performed (as for the water). On the other hand, the mound of pumpkin seeds is mostly regarded as an aggregate of individual elements; containers are never mentioned, whereas the fingers are very often indicated as effectors of the grasp.

A similar distinction between these object stimuli can be made by considering target-related words. It seems that the expression of the quantity of the entity that can be grasped is quite frequent for the flour and the sand, and especially for the pumpkin seeds, whereas it is never found in the descriptions provided for the water. This is hardly surprising: again, the pumpkin seeds and the water are at the two opposite ends of a scale of individuation (Clausen et al. 2010; De Felice 2015b: 185–186). For the seeds, we have observed that participants gave two different kinds of descriptions that reflect a conceptualisation of the mound either as a unit or as an aggregate of discrete entities (in which each seed is a possible target for the grasp). The sand, the flour and the water could be associated with words expressing their quantity, but, in fact, this happens quite rarely, and never in the case of the water. This is not because water cannot be quantified, which obviously it can; rather, it is probably because the quantification of the amount of water that one can grasp is not relevant from a cognitive point of view. Again, we should consider not only the consistency of the entity, but also the way in which we generally use water flowing from a tap. Very rarely do we have to pay attention to the exact quantity of the substance we are taking; therefore, quantity is not an aspect of the water that we usually consider salient. Pumpkin seeds, on the other hand, we do often eat one by one. The sand and the flour are in between: since they are granular aggregates made up of solid particles, a human is able to grasp a certain quantity of sand or flour, even by using only his or her hands (whereas this is not possible with water). However,

it would still be difficult to determine this quantity using linguistic means, unless with vague quantifying expressions (such as 'a lot'), whereas seeds, in Italian, are denoted by a count noun and can be quantified with number words.

Many studies point out that the morphosyntax of nouns referring to masses/aggregates and individual objects is systematically related to differences in how people perceive and interact with the entities denoted by nouns (e.g., Middleton et al. 2004), as also reflected in the different degree of concreteness attributed to the underlying concepts (mass nouns are overall judged as 'more abstract' than count nouns; see Strik Lievers et al. 2021). The results emerging from this study accord very well with this statement.

4.6. General results

4.6.1. Words related to the effector of the grasp

Table 4.7 summarises the results of the analysis of effector-related words carried out in this chapter (both frequencies and percentages, calculated on the total number of target-related words extracted for each category, are shown).

Stimulus		HND	MER	HOL	OBP	QUA	SPA	PER	SPP	INS	Tot.
Humans	freq.	31	7	5	-	26	-	-	-	-	69
	%	**44.9**	10.1	7.3	-	37.7	-	-	-	-	
Artifacts with AP	freq.	372	273	9	1	204	119	-	2	-	980
	%	**38**	27.9	0.9	0.1	20.8	12.1	-	0.2	-	
Artifacts without AP	freq.	181	145	9	-	166	23	-	-	-	524
	%	**34.5**	27.7	1.7	-	31.7	4.4	-	-	-	
Natural kinds	freq.	88	52	-	1	52	9	-	-	-	202
	%	**43.6**	25.7	-	0.5	25.7	4.5	-	-	-	
Substances and aggregates	freq.	98	51	-	-	51	11	1	34	4	250
	%	**39.2**	20.4	-	-	20.4	4.4	0.4	13.6	1.6	
Tot.	freq.	770	528	23	2	499	162	1	36	4	2025
	%	**38.1**	26.1	1.1	0.1	24.6	8	0.1	1.7	0.2	

Table 4.7. Classification of effector-related words in relation to the different categories of stimuli.

Before commenting on this synoptic table, we can also gather together the categories into which effector-related words have been classified into four

macro-categories. The first collects lexemes that refer to a *body part*, and results from the fusion of the hand (HND), meronym (MER), holonym (HOL) and other body part (OBP) categories. The second brings together spatial (SPA) and perceptual (PER) lexemes into a single *visuo-spatial* class. The third category is *quantity* (unvaried from Table 4.7). Finally, the fourth macro-category groups together the effector-related words denoting *instruments* (mostly containers), which in the vast majority of cases are simply mentioned to describe the shape of the hand (SPP), although sometimes they are explicitly indicated as the instrument with which the described grasp is performed (INS).

Frequency data can be visualised in the mosaic chart in Figure 4.1, in which the five categories of object stimuli are identified by different colours and the area of each of the rectangles that make up the chart is proportional to the observed frequency in the corresponding cell.[49]

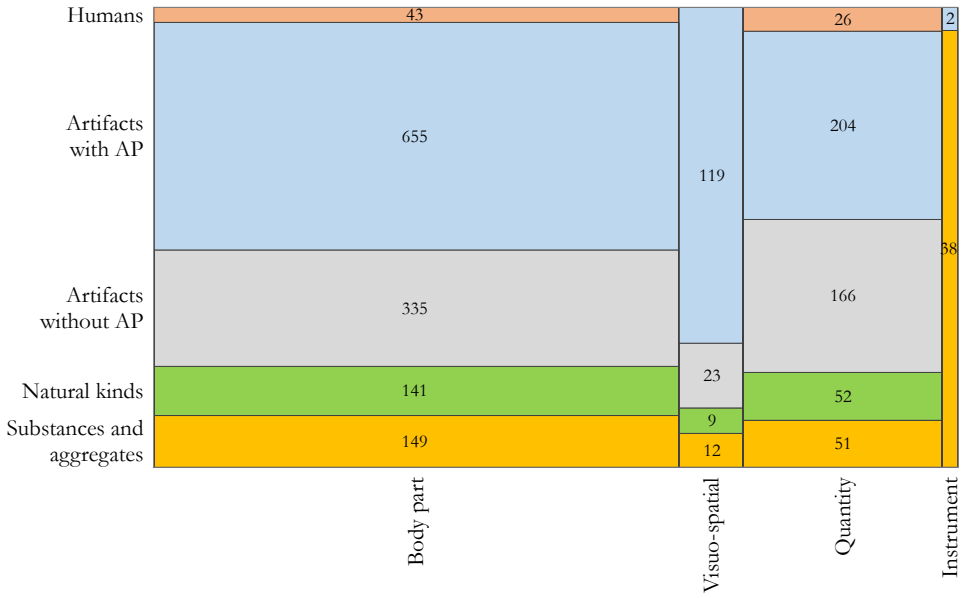

Figure 4.1. Merged classification of effector-related words extracted from the descriptions provided for the different categories of stimuli.

[49] A mosaic chart essentially combines a 100% stacked column chart and a 100% stacked bar chart in one single view. It works like a 100% stacked column chart: within each column, the height of the rectangles represents the proportion of the number of effector-related words observed for each stimulus-category out of the total number of words pertaining to a specific domain. Additionally, the width of each column is proportional to the total value of the column out of the total number of words extracted. Graphs has been created using the *Mekko Chart Creator* add-in for Microsoft Excel (https://www.add-ins.com/mekko_chart_creator.htm).

Taken as a whole, the general results of the analysis on the effector-related words presented in Table 4.7 and Figure 4.1 reveal, in my view, three important aspects that are worth an in-depth discussion: (i) mentions of body parts, and in particular of the hand and its parts are the most frequent category for all object stimuli, followed by modifiers expressing quantity; (ii) visuo-spatial expressions are more frequently produced for artifacts with affording parts than for other stimuli; (iii) references to instruments (SPP and INS in Table 4.7) are almost only found in the case of substances and aggregates, except in two cases (for the upside-down coffee cup). These three topics will be discussed in the following three sections (4.6.1.1–4.6.1.3).

4.6.1.1. The hand and the parts of the hand

Much of the research conducted on grasping in diverse fields, such as kinesiology, robotics, artificial intelligence and rehabilitation, attribute primary importance to the study of the possible configurations of the hand (e.g., MacKenzie and Iberall 1994). Many taxonomies have been proposed in order to classify grasps, mostly considering differences in the shape of the hand. Just to give an example, we may consider the GRASP taxonomy,[50] which is one of the most comprehensive and is based on a definition of grasp as every static hand position with which an object can be held securely with one hand (Feix et al. 2009). In order to build up this taxonomy, most of the extant classifications developed in different fields – from robotics to developmental medicine to biomechanics (e.g., Cutkosky and Wright 1989; Kang and Ikeuchi 1992) – were analysed and compared to determine the maximum number of grasp types. In total, the authors found 147 grasp examples in the literature sources considered, among which they identified only 45 different grasp types (Feix et al. 2009). A further classification, based on the grasp definition provided above, determined only 33 valid grasp types that constitute the taxonomy.

This is just one example of the potential richness of a taxonomy of grasps. If we now consider the data collected in the present study, we observe that even the most widely accepted distinction, i.e., between power and precision grip, is seldom reflected in the linguistic descriptions of grasps (as will be briefly clarified below).

Table 4.7 shows that the most frequent words relating to the effector found in the transcripts simply denote a hand (or two hands). However, there are descriptions that contain words relating to parts of the hand, and therefore might indicate a more specific grasp type. Words denoting a hand's meronyms

[50] The taxonomy was developed within the European Union Project GRASP (http://www.csc.kth.se/grasp/).

constitute 26.1% of the total number of words extracted from the references to the effector, and in the detailed analysis provided for the single objects in the previous sections we have often observed that the mention of fingers (the most frequently named parts of the hand) is likely to indicate a pinch grip (e.g., for the pencil and the lighter; cf. Section 4.2.1.1). However, it should be noted how these words are distributed in the descriptions provided for the object stimuli. Table 4.8 details the number of descriptions given by informants (from 0 to 30) that contain a reference to the whole hand (e.g., *mano*, 'hand', *pugno*, 'fist') compared to the number of descriptions that contain one or more words denoting fingers or parts of fingers (e.g., *dito*, 'finger', *dita*, 'fingers', *pollice*, 'thumb', *indice*, 'index', *punta delle dita,* 'fingertips', etc.).

Stimulus	H	F	Stimulus	H	F	Stimulus	H	F
pencil	9	23	apple	18	8	vase	19	4
pumpkin seeds	10	23	banana	19	7	jug (L)	16	4
tea-cup (R)	10	21	tennis ball	29	6	handbag	12	4
dummy (R)	11	15	mandarin	26	6	baby	19	3
lighter	20	14	stone	23	6	umbrella	18	3
coffee cup (U-D)	19	14	jug (R)	23	6	sword (L)	15	3
tea-cup (L)	13	13	hairdryer (R)	15	6	box	27	2
dummy (L)	8	13	flour	24	5	water	26	2
tea-cup (U-D, R)	14	11	sword (R)	19	5	rubber boat	15	2
glass	23	10	microphone (R)	14	5	trolley case	11	2
ladle (L)	20	10	sand	27	4	backpack	13	1
tea-cup (U-D, R)	20	9	chair	23	4	man	6	1
ladle (R)	15	9	hairdryer (L)	20	4	football	27	0
plate	23	8	microphone (L)	19	4	woman	6	0

Table 4.8. Number of descriptions containing an explicit reference to a 'hand' effector (H) and/or to a 'finger' effector (F).

Words such as *mano*, *mani* ('hand', 'hands') cannot be regarded as necessarily indicating a true power grasp, i.e., a grip performed with the whole hand. Their occurrence may just be due to the generic or under-specified quality of the answer. Similarly, not all references to the fingers necessarily indicate a precision grip (we may think, for example, of a whole-handed grasp of a tennis ball described as a grasp with the fingers bent around the object). However, even if we

arbitrarily assumed that informants used these words in order to describe a precision grip, the stimuli for which at least 50% of the informants named fingers or finger parts are only the pumpkin seeds, the rightward-oriented tea-cup, the rightward-oriented dummy, and the pencil. Therefore, even if there is a tendency to name these effector-related words in describing the grasp of a small or very thin object, this trend is not consistently followed by informants. It is very frequent to find descriptions given for the same object that probably refer to the very same action but contain different effector-related words. For instance, for the leftward-oriented ladle, we have "dal manico, usando indice e pollice", 'by the handle, using my thumb and index finger', as well as "manico, con la mano", 'handle, with my hand'. It is interesting to note that the ladle is explicitly likened three times to a pen during the interviews, but only nine and ten descriptions (for the rightward and the leftward orientation, respectively) contain one or more explicit mentions of the fingers, whereas for the pencil, which is the object most similar to a pen, there are 23.

Moreover, the data given in Table 4.8 show that descriptions making more mentions of the fingers also contain mentions of the hand, and that only for the pencil, the pumpkin seeds, the rightward-oriented tea-cup, and the dummy (in both orientations), are the descriptions in which the fingers are named more frequent than those in which the hand is named.

There is also a certain variation between the answers provided by the same participant for different stimuli. For example, a student described a precision grasp for the leftward-oriented dummy ("con le dita, dal manico", 'with my fingers, by the handle'), whereas for the rightward-oriented dummy he named only the right hand and the handle ("con la mano destra, sempre dal manico", 'with my right hand, also by the handle').

Thus, the object stimuli that afford a precision grip (for instance, the pencil, the dummy and the lighter), for which informants *consistently* named the fingers (either with or without any mention of the hand), are very few. By contrast, the fingers are named also in relation to objects that clearly require a power grasp, such as the vase (e.g., "chiudendo le dita intorno alla circonferenza e alzandolo", 'closing my fingers around the circumference and lifting it up'). Probably, the only indicator of a real precision grip is the reference to 'fingertips' (*punta delle dita*); however, this meronym occurs only five times in the entire corpus (in two descriptions provided for the pencil, two for the pumpkin seeds, and one for the upside-down coffee cup). Expressions of quantity might be helpful to distinguish between descriptions referring to a grasp performed with all the fingers and those referring to a grasp performed with only two or three fingers (likely to indicate a power grasp and a precision grasp, respectively). However, as the analysis of the extractions for the single object stimuli has shown, expressions

of quantity are not always associated with the hand's meronyms: for instance, while 23 descriptions provided for the pencil contain a reference to the fingers, only 10 of them also specify the number of fingers involved in the action (two fingers, three fingers); similarly, 23 descriptions provided for the pumpkin seeds contain a reference to the fingers, but only 10 also indicate the number of fingers required by the grasp (two fingers).

A more in-depth study could be conducted in order to find correspondences between the lexical content of the transcripts of the interviews and a taxonomy of grasps, even a very basic one that only distinguishes between a power and a precision grip, but such an effort goes beyond the scope of this work.[51] Therefore, the impression gained from this analysis is that even the most commonly accepted distinction in grasp taxonomies, i.e., between a power and a precision grasp, seems not to be consistently and clearly reflected in the informants' linguistic production. Although participants were explicitly asked to describe the grasp *in the most detailed way*, there is some inconsistency in signalling different grasp types, both across the descriptions collected for a single object stimulus and within the linguistic production of a single participant. Generic expressions such as 'with my fingers' or 'with my hand', may be used both in reference to large and small objects that, respectively, afford a power and a precision grip. Therefore, the results of this analysis indicate that the *specific configuration* of the hand and its parts during a grasp is not a prominent facet in the conceptualisation of the event, nor apparently is the specific *shape* assumed by the hand during the act of grasping, which is reflected in the scant number of terms referring to the hand that belong to the perceptual domain, as discussed in the next section.[52]

4.6.1.2. The visuo-spatial domain and the effect of spatial alignment

Looking again at Table 4.7 and Figure 4.1, we note that there is only one perceptual adjective produced with reference to the hand, i.e., *concavo* ('concave', for the water stimulus); expressions such as *mano curva*, *mano piatta* ('curved hand', 'flat hand', both in their singular and plural forms), which describe a particular shape assumed by the hand during the act of grasping, do not occur in the entire corpus. Considering the detailed analysis provided for the single objects, we note

[51] Moreover, many descriptions do not contain any reference at all to the effector of the grasp, as the analysis in Chapter 3 has shown (cf. Section 3.6). In such cases, language provides no clues as to whether the effector of the grasp is the hand as a whole, or specifically the fingertips; therefore, no comparison with a grasp taxonomy could be made.

[52] For this reason, a very coarse classification of the kinds of grasps described by informants into four main types (one-handed grasp; two-handed grasp; grasp by affording part; grasp with instrument) has been adopted in some experiments to annotate the type of grasp afforded by objects (see Russo, De Felice et al. 2013; Russo, Frontini et al. 2013; Russo and De Felice 2015).

that words pertaining to the visuo-spatial domain, in most cases, simply specify the side of the hand indicated as the effector of the grasp: almost 90% of the words in this category (145 out of 163) are either *destra* ('right') or *sinistra* ('left'). Moreover, spatial references to the hand are mostly produced in relation to artifacts with affording parts (cf. Table 4.2 and Table 4.3), especially those presented with different orientations. In this regard, we can focus on this class of stimuli (cf. Section 4.2.3.1) and consider how the lemmas *destro* and *sinistro* are distributed across the descriptions provided by the two groups of informants (right-handed vs. left-handed) for the 16 rightward- or leftward-oriented object stimuli.

Object orientation	**Right-handed**		**Left-handed**	
	destro	*sinistro*	*destro*	*sinistro*
Rightward-oriented	24	1	6	4
Leftward-oriented	18	34	4	10

Table 4.9. Occurrences of the lemma destro *('right') and* sinistro *('left') with reference to the effector of the grasp in the descriptions provided for the artifacts with affording parts presented with different orientation.*

Most of the occurrences of *destro* and *sinistro* are produced when the hand chosen as the effector of the grasp described coincides with the orientation of the handle (58 cases for the right-handed group, 16 cases for the left-handed group). For the right-handed group, there is a tendency to specify which hand would be the best effector for the target, described especially when the orientation of the handle does not correspond to the informant's dominant hand (34 vs. 24 cases), as if the informant were signalling the anomaly of choosing the non-dominant hand in order to preserve the spatial compatibility between the effector and the target of the grasp (which in most cases is the handle of the object). However, the same does not hold for the group of left-handed informants, who referred more frequently to their right/left hand when describing a grasp directed at a leftward-oriented rather than a rightward-oriented object (14 vs. 10 cases).

4.6.1.3. Instruments and containers

The analysis conducted in this chapter also considers all words denoting a concrete entity mentioned by informants in order to better describe a temporary property of the effector of the grasp, usually a particular hand shape, expressed by means of similes and analogies (these words were annotated as *similes based on perceptual properties*, or SPP). Strikingly, the data presented in the previous sections show that all these words denote instruments (in particular, containers) and are

almost entirely found in the descriptions provided for substances and aggregates (cf. Table 4.7).

This is not by mere chance: as already discussed (cf. Section 4.5.2), the water, the flour and the sand are entities without a solid surface that can be grasped securely and held in the hand. Consequently, an instrument is required in order to have control over such entities, in particular, a container.

Instructions provided for the task did not ask participants to refer only to a body part as the effector of the described grasp. Informants only had to imagine a situation in which they had to grasp the entities they were seeing on the monitor, and they were required to describe the action they would perform. As a matter of fact, for substances and aggregates, there were four students that simply said that they would use a container (*instrument*, INS, in Table 4.7). However, most participants described, in various ways, a grasp performed with cupped hands; they attributed to their hand the *properties* of an instrument.

The most evident property that a cupped hand shares with a real cup is at the perceptual level: the hand assumes a configuration such that its fingers and its palm together form a curved shape, which looks like a cup. But here the most important property shared by the cup and the hand is probably rooted at a deeper level: both the effector and the object named by informants are the *instrument* used to perform the action of grasping.

Therefore, it is not only the shape of the cup, but crucially its function (i.e., the function to contain something), that constitutes the common ground on which the comparison between the hand and the cup can be established (De Felice 2015b: 185). This is the reason why, leaving aside *coppa* (attested nine times, also because of the collocation *mani a coppa*, 'cupped hands'), the hand may be likened to a container, a spoon, or a ladle (*contenitore*, *cucchiaio*, *mestolo*, three occurrences each). It seems that it is the functional property of these objects, more than their perceptual properties, that allows the analogy with the hand.[53] Otherwise, we would not find the mention of a simple instrument, with the word *utensile*, 'utensil' (two occurrences, e.g., "con tutta la mano, usandola come un mestolo insomma, un utensile", 'with my whole hand, using it basically like a ladle, a utensil'). We should also consider that it is probably no accident that in many examples the verb associated with the effector is *usare* or its near-synonym *utilizzare*, 'to use' (e.g., "usando la mano a coppa, come un utensile", 'using my hand like a cup, like a utensil').

[53] This is in agreement with what was previously noted in Sections 4.6.1.1 and 4.6.1.2, namely that the specific configuration and shape of the hand during the act of grasping does not seem to be a particularly relevant aspect that informants focus on and insist upon in their descriptions.

In the grasp descriptions provided by informants, the hand is generally presented as the instrument used by the agent to perform the action and mostly occurs in a *with*-phrase. The further away the entity to be grasped is from affording an easy, secure and stable manual grip, the more the hand acquires the properties of the instrument most suited for that circumstance (here, a container). A language rich in similes and analogies reflects the overlapping between these two spheres, that of a 'hand-effector' and that of a 'container-effector'. This process may also lead to a complete substitution of the body part-effector by an instrument artifact. Notably, this only happens for substances (see again Table 4.7), in particular for the flour and the water, the entities that afford the most difficult manual interaction (De Felice 2015b: 185–186).

It is worth noting that the similarity between the effector hand and the real container is reflected also at a syntactic level. In the vast majority of cases, the effector of the grasp occurs in a *with*-phrase and plays an Instrument role (e.g., "afferrerei il manico con una mano", 'I would take hold of the handle with one hand'), in exactly the same way as the containers (e.g., "la farina la prenderei con un bicchiere", 'I would take the flour with a glass'). Only in very few cases does the effector of the grasp (always a body part, never a real container) occur as the syntactic subject of the sentence. For example, consider this description for the box: "due mani di lato si avvicinano, stringono e sollevano" ('two hands approach each other and come together and lift up'). In this specific linguistic representation of the event, the hands are not presented as instruments (for the notion of subject instrument, see, for example, Alexiadou and Schäfer 2006). Rather, they are simply the participants involved in the event described by the sentence and are not modified by the event; therefore, they seem to fulfil the Theme role.[54]

4.6.2. Words related to the target of the grasp

We can now turn to the analysis carried out on target-related words, the results of which are given in Table 4.10 (both frequencies and percentages,

[54] The Instrument semantic role presents differences in definition and causes problems of attribution, especially when an inanimate entity occurs as the subject of a sentence. In this regard, Varvara and Ježek (2014: 387) highlight "the importance of distinguishing between semantic roles – relational notions belonging to the level of linguistic representation – and ontological types, which refer to internal qualities of real-world entities". Examples they mention are, for Italian, *la penna scrive nero* ('the pen writes black'), *forbici che tagliano bene* ('scissors that cut well'), in which 'pen' and 'scissors', typically occurring as Instrument in a with-phrase, are the subjects of the two sentences. The authors argue that inanimate nouns denoting instruments in subject position are not instantiations of the Instrument role, but of the Cause, Agent or Theme role. In this regard, also in "due mani di lato si avvicinano, stringono e sollevano", *mani* is presented as a Theme (cf. also Ježek et al. 2014; Ježek and Varvara 2015).

calculated on the total number of target-related words extracted for each category, are shown).

Stimulus		ENT	MER	QUA	SPA	PER	SPP	AEN	Tot.
Humans	freq.	3	91	-	33	-	-	8	135
	%	2.2	**67.4**	-	24.5	-	-	5.9	
Artifacts with AP	freq.	75	477	8	417	21	17	-	1015
	%	7.4	**47**	0.8	41.1	2.1	1.6	-	
Artifacts without AP	freq.	37	12	8	148	9	1	-	215
	%	17.2	5.6	3.7	**68.8**	4.2	0.5	-	
Natural kinds	freq.	12	9	5	39	1	18	-	84
	%	14.3	10.7	6	**46.4**	1.2	21.4	-	
Substances and aggregates	freq.	15	3	34	14	-	5	-	71
	%	21.1	4.2	**47.9**	19.7	-	7.1	-	
Tot.	freq.	142	592	55	651	31	41	8	1520
	%	9.3	39	3.6	**42.9**	2	2.7	0.5	

Table 4.10. Classification of target-related words in relation to the different categories of stimuli.

Also with regard to the target-related words, we can now merge the different semantic classes into some macro-categories and present the frequency data in the form of a mosaic chart (Figure 4.2), as we have already done for the analysis of effector-related words (cf. Figure 4.1).[55] In this case, the 'part' category collects meronyms (MER) and associated entities (AEN), since concrete nouns belonging to these two categories denote the exact part of the stimulus towards which a grasp might be directed. A single visuo-spatial category collects words belonging to the perceptual and spatial domains. The remaining three classes (quantity, entity, similes based on perceptual properties) remain unvaried from Table 4.10.

[55] Compared to the previous chart presented in Section 4.6.1, in the mosaic chart shown in Figure 4.2 (as well as in the next one, presented in Section 4.6.2.1) the *x*-axis and the *y*-axis were switched in order to enhance the readability of the graph.

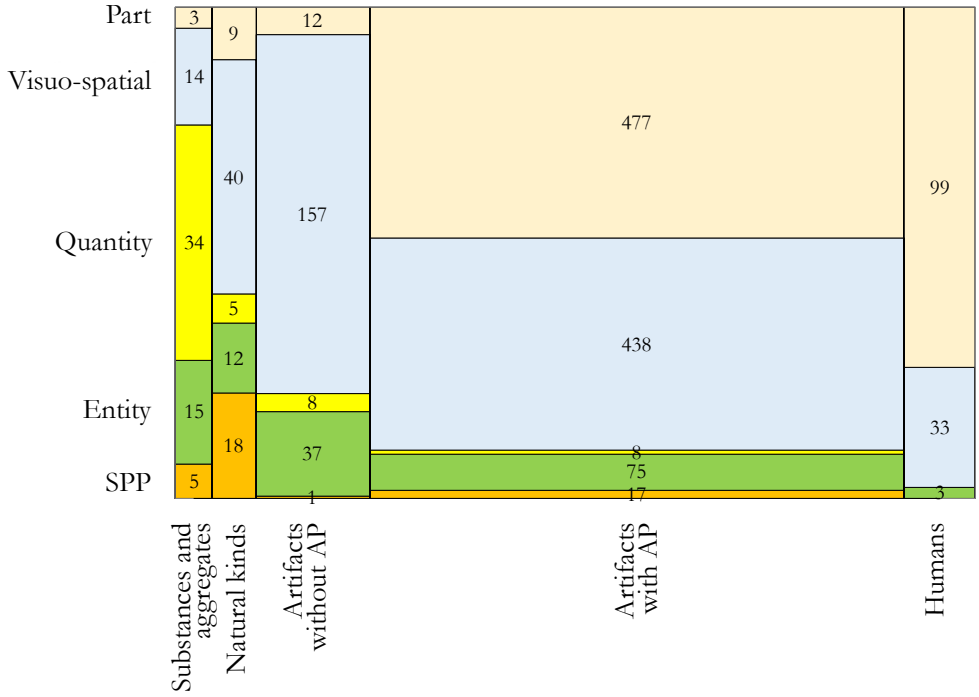

Figure 4.2. Merged classification of target-related words extracted from the descriptions provided for the different categories of stimuli.

The data presented in Table 4.10 and Figure 4.2 clearly show that words belonging to the visuo-spatial domain, and in particular spatial expressions, are absolutely the most frequently named in relation to the target of the grasp, especially for artifacts without affording parts and natural kinds. Object parts, and in particular meronyms, are rarely mentioned for substances and aggregates, or for natural kinds and artifacts without affording parts, whereas they constitute almost half the target-related words extracted for artifacts with affording parts and the vast majority of those extracted for the human stimuli. Taken together, meronyms and spatial expressions even reach 81.8% of target-related words extracted from transcripts. Their distribution relative to the difference in category between object stimuli will be discussed in Section 4.6.2.1. Substances and aggregates deserve a special mention (see Section 4.6.2.2), since this is the only category for which the most frequent target-related words do not pertain to the visuo-spatial domain or denote parts of the stimuli, but are rather modifiers expressing quantity.

4.6.2.1. Meronyms and spatial relations

In the analysis conducted in the previous chapter, we considered expressions that denote the part of the object with which the effector comes into contact as true indicators of the target of the grasp (Section 3.1.1). Such parts may be directly referred to in two different ways: either by words belonging to the spatial domain, which refer to the subspace of an object at which the effector is directed, or by words indicating parts of objects (meronyms). We can now focus on the distribution of such linguistic expressions within the five categories of stimuli, which is shown in the mosaic chart in Figure 4.3 (based on frequency data presented in Table 4.10).

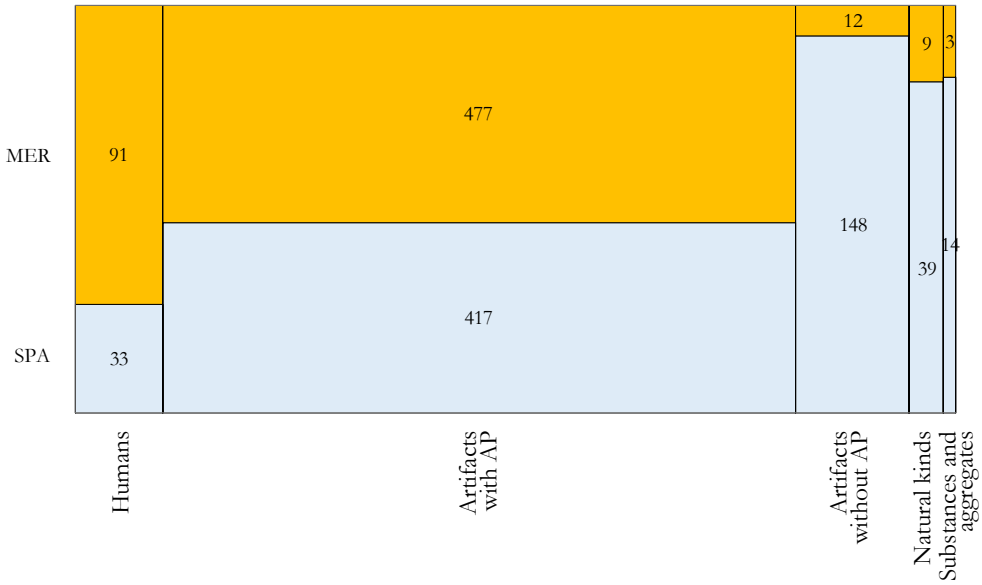

Figure 4.3. Target-related words classified within the SPACE and MERONYM categories extracted from the descriptions provided for the different categories of stimuli.

The results of the analysis described in Chapter 3 revealed an important difference between the object categories (Sections 3.6 and 3.7): the further to the left the object stimulus is on the implicational scale *humans* > *artifacts with affording parts* > *artifacts without affording parts* > *natural kinds* > *substances and aggregates*, the more likely it is that the target of the grasp will be named in the descriptions, and the less likely it is that the effector of the grasp will be mentioned. Accordingly, the stimuli which most frequently trigger mention of the target of the grasp are the humans and the artifacts with affording parts (cf. Figure 3.8). Now, we are able to go a step further and observe that these two categories are also those

in which meronyms are the most frequent word type informants used when referring to the target of the grasp. In particular, for humans (Section 4.3) and artifacts with affording parts (Sections 4.2.2 and 4.2.3), most participants described a grasp directed at a specific part of the object stimulus and the number of meronyms produced exceeds the number of spatial expressions. By contrast, spatial expressions are much more frequent than meronyms in the descriptions produced for artifacts without affording parts, natural kinds, substances and aggregates. As regards artifacts with affording parts, presented with or without any difference in orientation, we observe that even if the target of the grasp is in most cases indicated by lexemes that denote specific object parts, spatial expressions are almost as frequent as meronyms.

A possible explanation for this is that all the parts of an object that can be denoted by meronyms could, in theory, also be indicated by visuo-spatial expressions without compromising the clarity of the description provided. For instance, a grasp directed at the *handle* of a rightward-oriented jug might be also indicated as a grasp directed at *the right part* or *the right-hand side* of the jug, or more precisely at *the thinner part, on the right-hand side* of the object. The opposite does not hold. Therefore, spatial expressions are sometimes used to indicate a part of an object for which there is a specific name in Italian but which does not come to the participant's mind during the interview. Similarly, participants might also prefer to use a spatial expression when they are not sure about how to name a specific part of an object (because there is more than one possible word), or in order to avoid ambiguity (when an object has more than one graspable part). Obviously, spatial expressions may be also used together with meronyms.

When informants explicitly mention the target of a grasp directed at an artifact without affording parts or at a natural kind, they usually resort to lexical expressions belonging to the spatial domain, either because a specific object has no visually distinguishable parts, or because the parts denoted by the meronyms do not afford grasping (as with the stalk of the apple and the banana, or the handle of the upside-down cups). This is the reason why words expressing spatial relations are the most frequent among those found with reference to such stimuli. However, in these cases, we should remember that participants are also less likely to make an explicit reference to the target: the descriptions they provide often lack this information and simply contain a reference to the effector (cf. Sections 3.6 and 3.7).

4.6.2.2. Substances and aggregates

In the analysis presented in Chapter 3 (in particular, cf. Section 3.5), we pointed out that the descriptions given for substances and aggregates were characterised by a very low number of references to the target of the grasp. This is

also confirmed by the present analysis: words that pertain to the spatial domain, as well as references to meronyms, are much rarer compared to other object categories. Interestingly, the types of words most frequently referring to substances and aggregates are expressions of quantity, followed by words denoting the entity itself (cf. Table 4.10). As already discussed (cf. Section 4.1.2), these expressions are not precise indications of the target of the grasp, but nonetheless their distribution is meaningful.

Expressions of quantity referring to the object stimulus never occur for humans, and they are very rarely found in the descriptions of artifacts, both with and without affording parts (only 16 occurrences in 930 grasp descriptions). In the transcripts collected for the four natural kinds, quantity expressions relating to the target of the grasp are slightly more frequent and constitute 6% of the total number of target-related words extracted for this category. However, for substances and aggregates they constitute almost half the words with which participants referred to the flour, the water, the sand and the pumpkin seeds.

This distribution reminds us of the implicational scale already discussed in relation to the probability that the target and the effector of the grasp will be named (*humans* > *artifacts with affording parts* > *artifacts without affording parts* > *natural kinds* > *substances and aggregates*). Interestingly, expressions denoting the entity itself (in most cases occurring as a direct object of a verb of grasp), as well as quantity expressions, are the least frequent in the descriptions given for the humans and the most frequent in those given for substances and aggregates. Probably it is the difficulty in finding a way to describe the grasp of the water, the sand, the flour or the mound of pumpkin seeds that prompts informants to provide extra information in their descriptions. If they are not able to specify *where*, or *towards which part*, they would direct their hand during the grasp (since substances have no easily discernible and/or cognitively salient parts),[56] all they can do is repeat the information already provided by the experimental setting and name the object they are seeing (e.g., *I would grasp… the flour*), or else specify *how much* water, flour, sand, and *how many* seeds they would grasp.

4.7. Analysis of the grasp descriptions: final discussion

A growing body of research conducted in the behavioural and neurophysiological fields demonstrates the close connection between an agent's ability to perceive an object and possibilities for action. In particular, the discovery of canonical neuron circuits, which fire both when an agent is performing an action upon an object and when the agent simply looks at an object related to action,

[56] Cf. Sections 4.5.1–4.5.2.

indicates that perceiving some properties of manipulable entities activates a sort of action simulation in brain circuits (e.g., Grèzes, Armony et al. 2003). For such motoric representations, it is important not only how familiar an agent is with the *objects* themselves but also, above all, how familiar an agent is with the *actions* in which objects are typically involved (cf. Section 1.3.5). As Gentilucci (2002: 1152) states: "from a motor point of view, familiar objects can be represented by the type/types of interaction that we habitually have with them".

This is the reason why artifacts and tools are more effective in activating sensory-motor simulations of grasping and manipulation compared, for example, to natural kinds. And this is also the reason why, within the artifact category, there are specific object features, such as the presence of what we have called affording parts, or the orientation of such parts, that are able to influence sensory-motor responses. A handle is the part of an object that humans usually grasp; thus, by virtue of a sort of memory of past interactions with the object, the same motoric patterns are activated both during the visualisation of an object with a handle and during object grasping. It is useful to recall, in this regard, the experiment conducted by Buccino et al. (2009), in which the largest motor evoked potential area was recorded from hand muscles when subjects looked at images of rightward-oriented cups with a handle; if the handle was located on the left-hand side of the object or was broken, motor activation was much less evident.

The results emerging from the experiment discussed in these chapters chime in well with these findings. In particular, the analysis conducted in Chapter 3 shows that the target of the grasp is named in most grasp descriptions provided for artifacts and human beings, whereas it is less frequently mentioned for substances, aggregates and natural kinds. Moreover, within the category of artifacts, those with affording parts are most frequently referred to as the target of the grasp, compared to artifacts without affording parts. The analysis conducted in this chapter also shows that participants, especially for the category of artifacts with affording parts, usually refer to the target of the grasp by producing meronyms, that is to say, by explicitly naming parts of the stimulus presented.

Within the frame of an action description task built around two 'poles' – the agent, who imagines performing an action, and the visually presented object towards which that imaginary action is directed – the greater number of linguistic references to the target (and a corresponding less frequent mention of the effector of the grasp), together with the explicit mentions of meronyms, are indications of a shift of attention that slides from a focus on the subject towards a focus on the object. This shift turned out to be sensitive to the same factors that behavioural and neurophysiological research indicates as capable of influencing motor responses, namely the object category and the presence of affording parts. The explicit reference made by informants to the stimuli and to their constituent

parts thus reflect, in my view, the greater cognitive prominence of the entities with which humans most typically interact concretely, as well as the greater cognitive prominence of their affording parts, linguistically coded through meronyms.

This study takes into consideration two kinds of stimuli that were not considered in the literature reviewed in Chapter 1: humans and substances and aggregates. Results obtained for the category of humans turned out to be similar to those obtained for artifacts with affording parts: these kinds of stimuli more frequently elicit references to the target of the grasp than to the effector, and this target is usually indicated by meronyms. It is no surprise, of course, that the results point to the cognitive prominence of these two classes of stimuli as opposed to other categories. Artifacts with affording parts, as well as humans, are the kinds of entities with which we most frequently interact (most of our everyday manual actions, and in particular grasping, directly involve or are directed at other humans or at artifacts) and upon which the effect of past interactions is probably stronger. We generally take jugs and cups by their handles, and humans by their hands or arms, because these actions correspond to what we habitually do with such entities, even when the action of grasping is just *one* component of a chain of actions performed to achieve an intended goal (which in the case of artifacts usually corresponds to the action for which the object is designed, such as the action of drinking for a cup, or the action of pouring for a jug). On the other hand, our manual interaction with natural kinds, and in particular with their parts, is much less frequent. We rarely take mandarins and bananas by their stalks, and we usually do not need to pay attention to the exact place on the object to which we direct our action, or to the way we grasp it, since different targets of the grasp, or different kinds of grasp, do not correspond to different relevant actions. The importance of the kind of interaction we usually have with the environment in which we live, as well as with the entities that are part of it, also seems to explain the results for substances and aggregates, in which case the target of the grasp is less frequently named.

Therefore, it is not simply the mere presence *versus* the absence of a clearly distinguishable part of an object stimulus, which could potentially attract the attention of the observer, that explains the results of this analysis. This argument could only explain why parts are frequently named as the target of the grasp for artifacts and humans, and especially through meronyms, but it does not fully explain why there are few mentions of the target of the grasp for other kinds of stimuli (especially natural kinds and substances). In theory, *every description* could contain a reference to the target of the grasp, expressed with meronyms or, at least, in terms of spatial relations.

There is at least one other factor which is worth taking into account, and this is closely connected to a person's familiarity with an object and habitual interactions with it. The target is more likely to be named, either using meronyms or spatial expressions, when the stimulus presents *different* and *competing* possible targets associated with different habitual, highly familiar actions. A part or a subspace of an object is more likely to be named especially if there is another part or another subspace of the object (usually more than one) that might constitute a target for a *meaningfully different* kind of grasp, i.e., a grasp that is preliminary to performing a different subsequent habitual action and to achieving a different goal. For instance, the target of the grasp is rarely mentioned in relation to the stone. The stone has no distinguishable or protruding part, and it has a continuous contour and a regular surface; the right-hand side of a stone does not afford a less effort-consuming, more stable, or safer grasp, compared to its upper part or to its left-hand part. Moreover, and most importantly, the different kinds of grasps that can be performed on a stone are not usually associated with different actions, and this may be another reason why they are rarely indicated in linguistic descriptions, even simply using spatial terms. By contrast, for artifacts with affording parts and humans, it seems that not only do these stimuli have visually distinguishable parts that could constitute a good (i.e., less effort-consuming, more stable, safer) target of the grasp, but also that the grasp of one or another specific part is preliminary to different kinds of actions. For the upside-down coffee cup, as well as for the two upside-down tea-cups, the handle is quite rarely mentioned compared to other artifacts with affording parts (this confirms that it is not the presence of a visually perceivable part *per se* that attracts the grasp; cf. the rare mentions of the stalks of the apple and the banana). Nevertheless, most informants named the target (usually the upper part of the upside-down cup) for these three stimuli.

This probably happens because participants recognise *more possible targets* of the grasp, each one affording different actions: for instance, a grasp with the upper part would be better suited for moving the upside-down cup, a grasp with the handle would enable one to turn the same object upright. The visual perception of an object thus elicits a mental representation of the actions most typically associated with it, and these crucially depend on the condition of the object (its position, its orientation). When conditions change, afforded actions change as well.

Interestingly, this argument is in line with the hypothesis that the motor representations elicited by a single object encode *all* affordances evoked by the stimulus. The fact that different possible actions (in this case, more than one grasp type) are simultaneously activated by a visually presented object is supported by empirical results (cf. Section 1.3.1) and is perfectly in line with our findings.

Chapter 5
Affording parts and object representations

The analysis set out in the previous chapters focused on the reflections affordances have in language. Artifacts constitute a category of particular interest which allows us to make a closer comparison between the results of the present analysis and the research conducted on grasping and manipulation in the neurophysiological, neuropsychological and behavioural fields (cf. Chapter 1). Analysis of the linguistic descriptions collected for artifacts shows that informants, when explicitly asked to describe the action of grasping these kinds of objects, focus most attention on the target of the grasp (the same does not happen for stimuli belonging to other categories, except for humans), in particular on the part of the object that attracts the grasp, which in most cases is explicitly named using meronyms (cf. Sections 4.6–4.7).

In light of these results, we may wonder whether the salience of affording parts, reflected in the production of meronyms, emerges only in connection with the imaginary process called for by the description task, which was narrowly focused on the act of grasping, or is deeply rooted in the conceptualization of artifacts *per se*. In order to address this issue, and to complement the analysis set out in the previous chapters, a follow-up study was conducted on the 14 stimuli of artifacts with affording parts to determine whether the meronyms produced during the action description task point to cognitively prominent semantic features of the concepts of those object stimuli.

A very different methodology was adopted, based on a *property generation* (or feature production) task designed to collect *semantic feature norms* for 14 words. The following sections will introduce semantic norms (Section 5.1) and describe the feature production task conducted on a small set of stimuli – in this case, 14 nouns denoting artifacts with affording parts (Section 5.2). Subsequently, after a brief overview of the general results of the study (Section 5.3), the production of meronyms in the property generation task will be analysed and compared to the production of meronyms in the grasp description task (Sections 5.4–5.5), in order to evaluate the extent to which there is overlap between the type, and number, of meronyms produced in the two tasks. In the last section (Section 5.6), the results of this comparison will be discussed.

5.1. Semantic feature norms: a brief introduction

Semantic norms are widely used, not only in cognitive research, but also in applied and field studies; they are useful to test theories, and as a source of carefully controlled experimental stimuli (Chaigneau et al. 2020). In psychological and cognitive studies, semantic norms are sets of features produced by informants in a property generation (or feature listing) task. Research participants are typically presented with a written word (e.g., *airplane*) and then asked to write a number of properties (e.g., *flies*, *has wings*) that they consider relevant to a description of its meaning (Kremer and Baroni 2011). Once the data have been acquired, they are subjected to a process of normalisation[57] and, lastly, the semantic features produced are classified according to a given set of semantic relation types (categories which capture the semantic relation that each feature establishes with the stimulus; cf. Kremer and Baroni 2011: 100). For instance, the properties *takes off*, *lands*, *flies*, when used to refer to an airplane, relate to the events in which the word's referent is typically involved, whereas *has wings*, *has a motor* relate to the parts of which it is constituted (cf. Section 5.2.4). After this process of normalisation and classification, a distributional analysis may be conducted on feature norms in order to highlight, for example, which kinds of (and how many) features have been produced for a given stimulus, or how many informants produced that particular feature; additional statistical analysis may also be conducted (McRae et al. 2005).

Researchers typically assume that property generation tasks open a window on the representation of a concept that underlies word meaning[58] (e.g., Wu and Barsalou 2009: 174; Kremer and Baroni 2011: 98). According to the embodied cognition view, concepts are deeply rooted in sensory-motor activity and are retrieved through the re-enactment of the concrete experiences people have had with real entities (Gallese and Lakoff 2005; Borghi 2007; Barsalou 1999, 2008). This can also be true when concept retrieval is mediated by words (Borghi 2007). We have already discussed in Sections 1.4.1–1.4.2 recent studies that demonstrate that the comprehension and processing of action-related nouns, and in particular of words denoting graspable tools or artifacts, involve the activation of the motor system (e.g., Cattaneo et al. 2010; Gough et al. 2012; Marino et al. 2013). Such modulation of the cortical motor regions during noun presentation is comparable to the activity observed during the visual perception of the corresponding objects or their images (cf., in particular, Shinkareva et al. 2011).

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[57] Normalisation is necessary because there is great variability in the way informants may list features; cf. Section 5.2.3.

[58] Nevertheless, these two levels, that of lexical meaning, on the one hand, and of the concepts, on the other, have to be set apart from one another; as Murphy notes, "there is a mismatch between words and concepts" (Murphy 2010: 38–39).

The features listed in a property generation task are generally regarded as coming from the concrete interactions of the informant with the referent of the word stimulus. For instance, Cree and McRae (2003: 167) assume that "when participants call to mind features to list in the norming task, they directly tap into representations that have developed through repeated multisensory exposure to, and interactions with, the various objects". However, the nature of semantic norms is not totally clear, in part because cognitive and neural mechanisms underlying feature listing have rarely been directly investigated (Santos et al. 2011: 84). Moreover, as already stated, the most typical way to deduce semantic norms is by presenting informants with a written word and asking them to describe its meaning. Therefore, research participants access the concept in a very specific way, that is, through a particular lexeme. Interestingly, Santos et al. (2011) argue that feature production originates in two distinct (although interacting) systems, that is, the linguistic form system and the situated simulation system. According to the authors, the simple perception of a word can elicit other associated linguistic elements. For instance, the presentation of the word *car* might elicit associated words such as *automobile* and *vehicle*. In addition, the presentation of the word also activates correlated simulations in the brain's modal systems:

> We assume that the simulation system becomes active very quickly once the presented word form is recognized, but that the activation of a simulation proceeds more slowly than the activation of associated linguistic forms. By "simulation" we mean that the brain simulates the perceptual, motor, and introspective states active during interactions with the word's referents […] Recognizing the word "cat," for example, reenacts neural states that represent how cats look, sound, and feel, how one interacts with cats, and how one feels affectively. (Santos et al. 2011: 88)

Therefore, in a feature listing task, both linguistic associations and simulations are probably involved (without excluding the contribution of other possible strategies): early properties have a linguistic relation to the word stimulus and tend to originate in a word association process, whereas properties produced later describe, for instance, associated objects and situations, and tend to originate from situated simulations. Evidence in favour of this account comes from the results that the authors report from two experiments, in which responses linguistically associated with the word stimulus (originating in the linguistic system) are produced earlier, whereas object-situation responses (originating in the simulation system) tend to occur later (cf. Barsalou et al. 2008; Simmons et al. 2008).

As widely discussed in the literature (McRae et al. 2005; Kremer and Baroni 2011; Lenci et al. 2013), there are some limitations to the collection and use of semantic norms. First, since the features are linguistically produced (either in

written or verbal form), it can be the case that a particular aspect of a meaning is underrepresented in the norms, not because it is not relevant to a given concept, but simply because it is not easy to express verbally. Second, it has been observed that informants tend to produce more features that are effective in distinguishing a concept from others in the same category, compared to features that are true for a large number of concepts.[59] Nevertheless, in recent decades semantic norms collected with a property generation task have been widely adopted in cognitive sciences: for instance, they can be used to test theories of semantic memory, to develop computational models, as well as for a multitude of other purposes (McRae et al. 2005: 548; Kremer and Baroni 2011: 98; Lenci et al. 2013: 1220).

Semantic norms have been collected for many languages, for concrete or abstract nouns, as well as for verbs (e.g., McRae et al. 2005; De Deyne et al. 2008; Vinson and Vigliocco 2008; Kremer and Baroni 2011; Frassinelli and Lenci 2012; Montefinese et al. 2013; Lenci et al. 2013). These works differ from one another (to a lesser or greater extent) in the procedure adopted to collect, normalise and classify features. The methodology adopted in the present study and described in the following sections is based on McRae et al. (2005), Kremer and Baroni (2011) and, in particular, on Lenci et al. (2013).

5.2. Methods

5.2.1. Participants and stimuli

Thirty young participants entered the study, 24 females and 6 males. They were all native Italian speakers, and none of them had participated in the grasp description task described in Chapter 2. For the most part, they were undergraduate students at the University of Pisa and the University of Genoa; only four of them had already graduated. Their ages ranged between 21 and 39 (mean=27.2; SD=3.59).

Since this experiment was expressly conducted to investigate whether the meronyms produced during the action description task for artifacts point to cognitively prominent semantic features of the concept of object stimuli, lexical expressions denoting the 14 artifacts with affording parts (the kind of artifacts for which meronyms were more frequently produced) were used as stimuli. These lexical expressions were as follows (in order of appearance): *brocca* ('jug'), *tazza*

[59] However, this may be also a strong point: "general features play only a small role in object identification, language comprehension, and language production precisely because they are not salient and are true of large numbers of concepts" (McRae et al. 2005: 549).

('tea-cup'), *spada* ('sword'), *phon* ('hairdryer'), *microfono* ('microphone'), *borsa da donna* ('women's handbag'), *ciuccio* ('dummy'), *sedia* ('chair'), *trolley* ('trolley case'), *canotto* ('rubber boat'), *zaino* ('backpack'), *ombrello* ('umbrella') and *mestolo* ('ladle').

5.2.2. The survey

The experiment was conducted on the Internet through a web interface created using LimeSurvey software, a free open-source survey tool made available by the Computational Linguistics Laboratory (CoLing Lab) of the University of Pisa.

After receiving an invitation email, in which the purpose of the study was briefly introduced, participants could directly access the online questionnaire that was entitled *Descrizione di parole di uso comune* ('Description of words in common use').

The text on the welcome page[60] was divided into two sections. The first section introduced the survey:

> Thank you for agreeing to participate in this survey!
> You will be presented with 14 words that indicate objects in common use, each one on a different page. Below each word, you will see some blank lines. This is where you should describe the meaning of the word, using up to a maximum of 10 simple short sentences, as illustrated in the following example.
> Dog:
> - is a mammal;
> - is man's best friend;
> - barks;
> - is a pet;
> - has a tail;
> - …

Since the survey focuses on the artifact category, the example provided was a stimulus of a different semantic class, i.e., an animal. The second part of the welcome page set out a few rules that were intended both to help the participant complete the task correctly and to reduce the number of possible free associations:

> RULES: The task you are required to carry out is very simple. I am sure it will not take you very long. However, you have to complete it as carefully as possible, so here are some rules you need to follow:
> 1. Do not hurry. For each word, first focus on its meaning and the aspects you consider most important to describe. Then write the descriptions on the blank lines.
> 2. Describe the meaning of the word in short sentences. Try to be clear and concise.

[60] The original Italian text of the instructions is provided in the Appendix.

3. There are no right or wrong answers; you are absolutely free to explain what you think is the meaning of these words in the way you wish.
4. You are not obliged to fill in all 10 lines for each word.
5. Once you have completed a page, make sure that the data you have entered are correct, because you cannot change them later. When you are sure, click on the 'Next' button, which brings you to the next page.
6. You cannot interrupt the survey and save your answers: the survey can only be saved once you have reached the end and completed the task.

After this initial page, the following 14 pages contained only the title of the survey, the progress bar (which showed the percentage of the survey already completed), the word stimulus with a short reminder of the task, and 10 blank lines (see, for example, Figure 5.1).

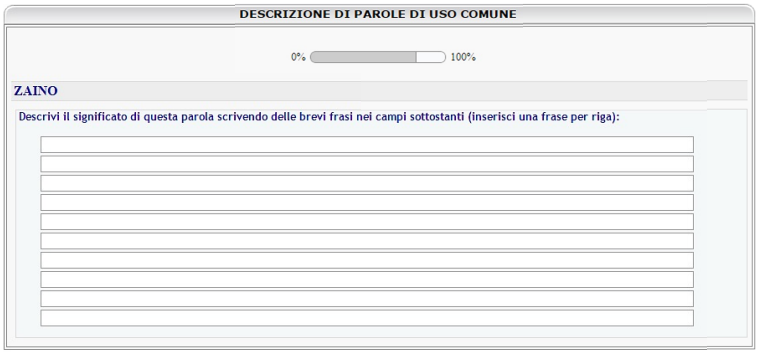

Figure 5.1. Example of a page of the survey for the word zaino*, 'backpack'.*

Once the survey was completed, the participants received a confirmation email.

5.2.3. Normalisation

All answers collected during the survey were imported into a single file, where they were subjected to a long process of normalisation, mostly based on Baroni et al. (2013) and Lenci et al. (2013) (cf. also Vinson and Vigliocco 2008; Kremer and Baroni 2011). This operation was necessary because there was evident and wide variation in the descriptions produced, both between the individual participants and among the features produced by a single informant. In particular, informants often filled the blank lines with long descriptions of stimuli that actually contained more than one property. In such cases, the descriptions were manually split into two or more single features, each one representing a separate core of information. Table 5.1 provides some examples taken from the descriptions collected for the word *brocca* ('jug').

Line	Description	Feature	Normalised Feature
1	È di vetro, terracotta, metallo o plastica 'It is made of glass, terracotta, metal, or plastic'	È di vetro 'It is made of glass'	Vetro 'Glass'
2	È di vetro, terracotta, metallo o plastica 'It is made of glass, terracotta, metal, or plastic'	È di terracotta 'It is made of terracotta'	Terracotta 'Terracotta'
3	È di vetro, terracotta, metallo o plastica 'It is made of glass, terracotta, metal, or plastic'	È di metallo 'It is made of metal'	Metallo 'Metal'
4	È di vetro, terracotta, metallo o plastica 'It is made of glass, terracotta, metal, or plastic'	È di plastica 'It is made of plastic'	Plastica 'Plastic'
5	Ha un collo largo 'It has a wide neck'	Ha un collo 'It has a neck'	Collo 'Neck'
6	Ha un collo largo 'It has a wide neck'	(Ha un collo) largo '(It has a) wide (neck)'	Largo 'Wide'
7	Si usa per versare liquidi 'It is used to pour liquids'	Si usa per versare 'It is used to pour'	Versare 'To pour'
8	Si usa per versare liquidi 'It is used to pour liquids'	(Si usa per versare) liquidi '(It is used to pour) liquids'	Liquido 'Liquid'
9	È un contenitore di vetro che si usa per versare 'It is a glass container used to pour'	È un contenitore 'It is a container'	Contenitore 'Container'
10	È un contenitore di vetro che si usa per versare 'It is a glass container used to pour'	È di vetro 'It is made of glass'	Vetro 'Glass'
11	È un contenitore di vetro che si usa per versare 'It is a glass container used to pour'	Si usa per versare 'It is used to pour'	Versare 'To pour'
12	Può essere di vetro o di coccio 'It can be made of glass or clay'	È di vetro 'It is made of glass'	Vetro 'Glass'
13	Può essere di vetro o di coccio 'It can be made of glass or clay'	È di terracotta 'It is made of terracotta'	Terracotta 'Terracotta'

Table 5.1. Example of feature normalisation for five descriptions provided for the word brocca*, 'jug'.*

A sentence such as *è di vetro, terracotta, metallo o plastica* ('it is made of glass, terracotta, metal, or plastic'), actually contains four different pieces of information about a jug; therefore, each one was isolated and put on a separate line (lines 1–4). Usually, in this process of chunking, adjectives and nouns were split, as were verbs and their direct objects (lines 5–6, 7–8). There were even cases in which a single description was syntactically more complex and contained two or more clauses (lines 9–11). In this process of segmentation and simplification, synonymous features were merged into a single featural representation (cf. lines 2 and 13).

Lastly, each feature was normalised (cf. Lenci et al. 2013: 1222). In this phase, nouns and adjectives were converted into their singular and masculine forms, and verbs into their active or passive infinitive forms (Table 5.1, column 4).

5.2.4. Classification

All normalised features were labelled with a semantic relation type that marks the connection that each feature establishes with the stimulus at a semantic level. For instance, *vetro* ('glass'), derived from the feature *è di vetro* ('it is made of glass'), expresses the material of which a jug may be made, whereas *contenitore* ('container'), derived from the feature *è un contenitore* ('it is a container'), expresses the category of object to which a jug belongs.

Many semantic annotation schemes have been proposed to classify features (cf., for instance, Cree and McRae 2003; McRae et al. 2005; Vinson and Vigliocco 2008; Wu and Barsalou 2009; Lebani and Pianta 2010; Kremer and Baroni 2011; Montefinese et al. 2013). The classification adopted in this study follows the annotation scheme described in Lenci et al. (2013), which is based on Wu and Barsalou (2009) and Lebani and Pianta (2010), but which considers a smaller number of feature types. This scheme is divided into five macro-categories (Lenci et al. 2013: 1222 ff.):

a) taxonomic features;
b) entity features;
c) situational features;
d) introspective features;
e) quantity features.

In what follows, the feature types included in each of these macro-categories are listed, together with some examples of the stimulus-feature pairs.

The taxonomic feature category includes superordinates (*brocca*, 'jug' – *contenitore* 'container'), coordinates (*mestolo*, 'ladle' – *spatola*, 'spatula'), subordinates

and examples (*sedia*, 'chair' – *sedia a dondolo*, 'rocking chair') and approximate synonyms (*brocca*, 'jug' – *caraffa*, 'pitcher').[61]

The second macro-class brings together entity features. It includes part-of relations, such as meronyms (*brocca*, 'jug' – *manico*, 'handle'), holonyms (*microfono*, 'microphone' – *cellulare*, 'mobile phone') and materials (*spada*, 'sword' – *ferro*, 'iron'), but also features referring to qualities that can be directly perceived (*spada*, 'sword' – *lungo*, 'long') or indirectly perceived (i.e., which cannot be apprehended only by direct perception and are often abstract; *borsa*, 'bag' – *costoso*, 'expensive').

The third category is situational features, which contains features referring to the situations and contexts in which the stimulus is typically found, such as events (*tazza*, 'tea-cup' – *bere*, 'drink'), concrete or abstract entities that are found in the same situation as the stimulus (*mestolo*, 'ladle' – *zuppa*, 'soup'; *spada*, 'sword' – *dolore*, 'pain'), ways of performing an action associated with the stimulus (*tazzina da caffè*, 'coffee cup' – [*si usa*] *facilmente*, '[it is used] easily'), locations (*canotto*, 'rubber boat' – *mare*, 'sea') and periods of time (*ombrello*, 'umbrella' – *inverno*, 'winter').

Introspective features express subjective evaluations (*sedia*, 'chair' – *comodo*, 'comfortable') or emotions and feelings.

Finally, quantity features express a quantity (or amount) relating to the stimulus or, more frequently, to one of its properties (*sedia*, 'chair' – *quattro* [*gambe*], 'four [legs]').

5.3. Semantic features produced

For the 14 stimuli considered, the 30 participants produced a total number of 2145 answers (mean= 153.2 answers per stimulus, SD= 12.26), which corresponds to a mean of 5.1 descriptions provided by each informant for each stimulus. All participants understood the task; however, out of the total number of descriptions, 25 (1.2%) were excluded because they did not refer to any particular property of the object. For instance, the informants sometimes provided a comment upon the morphological form of the word used as stimulus (e.g., *ombrello*: *è una parola derivata con suffisso*, 'it is a suffixed word'; *trolley*: *è una parola inglese*, 'it is an English word') or referred to homophones and polysemes (e.g., *phon*: *il suo nome é anche quello di un vento*, 'it is also the name of a wind'; *spada*: *é anche il nome di un pesce*, 'it is also the name of a fish'; *è anche uno dei quattro semi nel gioco di carte della briscola*, 'it is also one of the four suits in the card game *briscola*'). These are

[61] In Lenci et al. (2013) also antonyms (e.g., *freedom – slavery*) and instances (expressed by proper nouns, such as *mountain – Alpi*) were listed among the taxonomic features, but no relation of this type was found in the norms collected.

properties of the word stimulus, rather than properties of the concept of the entity it denotes. Nevertheless, such examples are of particular interest, since they support the idea that lexical processing plays an important role in feature listing tasks based on word presentation (cf. Section 5.1). Moreover, idiomatic expressions were also excluded (e.g., *spada*: *chi di spada ferisce, di spada perisce*, 'he who lives by the sword, dies by the sword').

Considering the remaining 2120 descriptions, the total number of features produced is 3790, corresponding to 844 distinct normalised features.

Each participant produced a mean of 126.3 features (there was a great variety in the number of features produced, ranging from 61 to 261, SD=49.37), which corresponds to a mean of nine features per informant per stimulus. A mean of 270.7 features (SD=33.88) was produced for each lemma.

As already stated, the prime aim of this norming study was to establish a comparison between the target-related words extracted from the grasp descriptions (i.e., the lexical expressions used to indicate the target of the grasp in the action description task presented in the previous chapter) and the semantic features produced by informants in the property generation task. This comparison regarded only 14 artifacts with affording parts and, in particular, focused on the category of meronyms. Accordingly, for the purpose of this book, only a very brief overview of the general results will be provided (cf. also De Felice 2015a).

Regarding the category of stimuli here considered, we observe (see Figure 5.2) a marked predominance of features expressing situational properties (tot. 1918 features, 50.7%), followed by entity features (1370, 36.1%). The remaining features mostly express taxonomic relations (346, 9.1%), whereas properties relating to quantity (81, 2.1%) or to subjective evaluations (75, 2%) are rather rare.

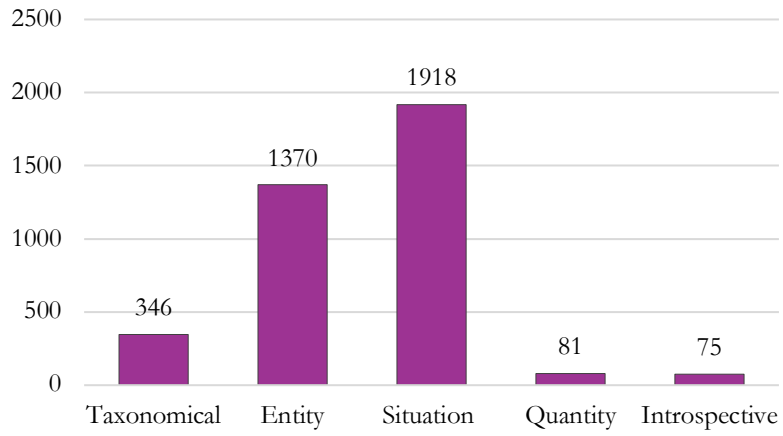

Figure 5.2. Results of the feature norms classification (tot. 3790 features) divided into five semantic macro-categories (adapted from De Felice 2015a: 106).

Looking in more detail at the different kinds of relations within each macro-category, we can add some further remarks.

Table 5.2 gives the general results of the feature classification (the feature types and the codes are the same as those adopted in Lenci et al. 2013 and described in Section 5.2.4), together with the frequency of each feature type and its percentage out of the total number of feature norms.

Feature class	**Feature type**	**Code**	**Freq.**	**%**	**Example**
Taxonomic	Hypernym	isa	284	7.5	*brocca - contenitore*
	Example_of	exa	30	0.8	*sedia - sedia a dondolo*
	Coordinate	coo	26	0.7	*mestolo - spatola*
	Synonym	syn	6	0.1	*brocca - caraffa*
Entity	Meronym	mer	327	8.6	*brocca - manico*
	Holonym	hol	10	0.3	*microfono - cellulare*
	Made_of	mad	395	10.4	*spada - ferro*
	Perceptual property	ppe	525	13.9	*spada - lungo*
	Non-directly perceptual property	pnp	113	3	*borsa da donna - costoso*
Situation	Event	eve	885	23.4	*tazza - bere*
	Entity (concrete)	eco	652	17.2	*mestolo - zuppa*
	Entity (abstract)	eab	15	0.4	*spada - dolore*
	Manner	man	19	0.5	*tazzina - (si usa) facilmente*
	Space	spa	279	7.4	*canotto - mare*
	Time	tim	68	1.8	*ombrello - inverno*
Quantity	Quantity	qua	81	2.1	*sedia - quattro (gambe)*
Introspective	Subjective evaluation	eva	75	1.9	*sedia - comodo*

Table 5.2. Results of the feature classification (adapted from De Felice 2015a: 107).

The two categories of quantity and subjective evaluations are the least represented and bring together only 2.1% and 1.9%, respectively, of the features

extracted. Among taxonomic features, the most numerous are hypernyms (7.5%); only 62 features (1.6%) establish a different kind of taxonomic relation with the word stimulus. Perceptual properties (13.9%) and materials (10.4%) are the most numerous among entity features, followed by meronyms (8.6%). The most numerous semantic class is constituted by situational features, in particular events (23.4%) and, secondly, associated concrete entities (17.2%),[62] while spatial features occur more rarely (7.4%). Since events are the most frequently cited category for these stimuli, they deserve a brief note. The highest frequency values scored by this class of features indicate that the most frequently named properties for the artifacts here considered refer either to what an object is used for (i.e., its function) or to what an agent usually does with it. This is not surprising: artifacts can be defined as "physical objects that have been designed and made by human beings and that have both a function and a use plan" (Vermaas et al. 2011: 14). Both object function and use-plan (a series of goal-directed actions to be carried out by the user to ensure that the artifact's function is realised) are typically represented by events and linguistically expressed by verbs.

Within the event category, considering the features with a frequency value greater than 15, at the top of the ranking we find *contenere*, 'to contain', with 86 occurrences (17 occurrences for the jug, 15 for the handbag and the tea-cup, 13 for the trolley case, 11 for the coffee cup and the backpack, four for the rubber boat). Then, much lower in the ranking, we find the verbs *asciugare*, 'to dry [sth]' (27 occurrences, for the hairdryer alone); *riparare*, 'to protect' (26 occurrences, for the umbrella alone); *sedersi*, 'to sit' (25 occurrences: 24 for the chair and only one for the rubber boat); *bere*, 'to drink' (23 occurrences: 12 for the tea-cup, 11 for the coffee cup); *trasportare*, 'to carry' (20 occurrences: nine for the backpack, six for the trolley case, three for the rubber boat, one for the jug and the ladle); *amplificare*, 'to amplify' (18 occurrences, for the microphone alone); *emettere*, 'to emit' (18 occurrences, for the hairdryer alone, referring to hot or cold hair); *essere_portato*, 'to be carried' (18 occurrences: 11 for the backpack, three for the trolley case and the umbrella, one for the handbag); *essere_gonfiato*, 'to be inflated' (18 occurrences, for the rubber boat alone); and finally *mescolare*, 'to stir' (18 occurrences, for the ladle alone).[63]

It is evident that, in most cases, these verbs express the primary function of the artifacts: typically, containers such as jugs and cups are used to contain liquids, hairdryers are used to dry hair, chairs are used to sit on, ladles are used to transfer liquids and stir, cups are used to drink out of, etc. Otherwise, features

[62] According to Wu and Barsalou (2009: 184), the fact that participants spend more time describing background situations than describing target objects supports the idea that they use situated simulations to generate properties.

[63] Data from De Felice (2015a: 109).

related to the use-plan are produced: for instance, a rubber boat needs to be inflated if it is to perform its function properly.

It is evident that the most typical actions in which artifacts with affording parts are involved constitute a highly prominent feature in their conceptual representation. However, this kind of information cannot be compared with the results obtained from the action description task since that experiment focused narrowly on the action of grasping: subjects were asked to describe how they would grasp the objects, and not to mention the actions that they would perform with them.

We can now come back to the main point of this analysis by presenting a detailed comparison between the meronyms produced (to refer to the target of the grasp) in the grasp descriptions commented on in the previous chapter and the meronyms produced by informants in the semantic feature lists.

5.4. Analysis of meronymic features

In this section, all meronyms produced in the property generation task for each word stimulus will be compared with the target-related meronyms extracted from the grasp descriptions. In the comparative tables that give frequency values (for which, cf. Sections 4.2.2.1 and 4.2.3.1)[64] meronyms produced in both tasks will be marked with an asterisk.

The most frequent meronym produced in the feature listing task for the backpack (Table 5.3) is *bretella* ('strap', 13 occurrences), which is a feature relating to the practical use of a backpack: the straps rest on the shoulders and enables a person to carry the bag. Since they were visible in the picture of the backpack adopted in the action description task, they were sometimes chosen as a target of the grasp, albeit referred to using different words (*bretella*, *tracolla*, *bracciolo*, *cinghia*).

In the semantic feature list, besides the sack (*sacca*), which constitutes the most important part of the bag in terms of its function, the part into which people can put things, other parts that are typically found in backpacks occur frequently, such as various kinds of fastenings for closing the bag (*cerniera*, *fibbia*, *elastico*, *chiusura*, *gancio*), pockets and compartments (*tasca*, *scompartimento*) and, lastly, also the trolley sometimes incorporated into backpacks (*carrellino*).

[64] To make for an easier comparison with the normalised feature norms, all target-related words were reduced to their singular form. For the stimuli that in the grasp description task were presented in different orientations, only data from rightward-orientated stimuli are considered (in order to avoid duplicated data only for some stimuli).

In the grasp description task, such meronyms are almost never found, because most target-related words variously refer to the top handle of the object (*laccio*, *cinghia*, *attacco*, *attaccatura*, *aggancio*, *fascetta*, *fibbia*, *gancetto*), which is explicitly called 'handle' in only seven cases (*manico*, *maniglia*). This part is not directly involved in the main function of the backpack, i.e., as a container (cf. *sacca*, *tasca*, *scompartimento*), nor in the way such bags are usually worn (i.e., on the shoulders). The top handle is only used when the bag is moved a short distance, an action that can also be performed using the shoulder straps.

Property generation task			**Grasp description task**		
Meronym	Freq.	%	Meronym	Freq.	%
*bretella**	13	42	*laccio*	6	24
tasca	9	29	*manico*	5	20
cerniera	2	6.6	*bretella**	2	8
carrellino	1	3.2	*cinghia*	2	8
chiusura	1	3.2	*maniglia*	2	8
elastico	1	3.2	*attacco*	1	4
*fibbia**	1	3.2	*attaccatura*	1	4
gancio	1	3.2	*bracciolo*	1	4
sacca	1	3.2	*aggancio*	1	4
scompartimento	1	3.2	*fascetta*	1	4
			*fibbia**	1	4
			gancetto	1	4
			tracolla	1	4
Tot. meronyms	31		Tot. meronyms	25	

Table 5.3. Meronyms produced in the property generation and in the grasp description task for the backpack.

For the chair (Table 5.4), in both tasks, the most frequently mentioned part is *schienale*, 'backrest', especially in the action description experiment (where also *spalliera*, with a very similar meaning, also occurs). This part is relevant both to the function of the chair (together with the seat and the legs, it supports a sitting person) and for the action of grasping, because it is the part that is closest to hand. Also *cuscino*, *seduta* and *sedile*, which refer to the seat of the chair or to the seat cushion, are shared meronyms between the two groups of features, even if they are more frequent in the property generation task.

Property generation task			**Grasp description task**		
Meronym	Freq.	%	Meronym	Freq.	%
*schienale**	18	30.5	*schienale**	12	48
*gamba**	17	28.7	*spalliera*	3	12
*seduta**	8	13.6	*cuscino**	2	8
bracciolo	7	11.9	*asta*	1	4
ruota	5	8.5	*buco*	1	4
*cuscino**	2	3.4	*sedile**	1	4
*sedile**	2	3.4	*gamba**	1	4
			*seduta**	1	4
			spallina	1	4
			spazio	1	4
			stecca	1	4
Tot. meronyms	59		Tot. meronyms	25	

Table 5.4. Meronyms produced in the property generation and in the grasp description task for the chair.

However, despite these similarities, the frequency values given for other meronyms differ greatly. In particular, the legs of the chair (*gambe*) are mentioned 17 times as a relevant feature of the object (e.g., 'has four legs'), but obviously they do not afford an easy grasp, because they are farther from the hands. Moreover, *ruota* ('caster') and *bracciolo* ('armrest') occur five and seven times, respectively, as conceptual semantic features relating to a chair (but the particular chair presented as a stimulus in the task had neither casters nor armrests). On the other hand, when referring to the target of the grasp, participants often named meronyms of the backrest, such as its vertical slats (*asta*, *spallina*, *stecca*), or the holes or spaces between them (*buco*, *spazio*). These parts are never mentioned in the feature listing task, in which only a reference to the backrest as a whole (*schienale*) is found.

The only meronym named for the coffee cup (see Table 5.5) is the handle, both in the action description and in the property generation task. However, there is an evident difference in the frequency values scored in the two experiments, which is due to the fact that, in the first case, the object stimulus was upside-down, and therefore the handle was rarely named or chosen as the target of the grasp (as already discussed; see, in particular, Section 4.2.2.1, [10] and Section 4.2.2.2).

Property generation task			Grasp description task		
Meronym	Freq.	%	Meronym	Freq.	%
*manico**	15	100	*manico**	2	100
Tot. meronyms	15		Tot. meronyms	2	

Table 5.5. Meronyms produced in the property generation and in the grasp description task for the coffee cup.

Interestingly, the data from the two tasks are quite similar for the tea-cup (Table 5.6). More than half the participants named the handle in the property generation task, as well as for the tea-cup presented in the action description experiment (in which also *occhiello* appears, again referring to the handle).

Property generation task			Grasp description task		
Meronym	Freq.	%	Meronym	Freq.	%
*manico**	17	100	*manico**	20	95.3
			occhiello	1	4.7
Tot. meronyms	17		Tot. meronyms	21	

Table 5.6. Meronyms produced in the property generation and in the grasp description task for the tea-cup.

We can consider now meronyms produced for the handbag (Table 5.7).

Property generation task			Grasp description task		
Meronym	Freq.	%	Meronym	Freq.	%
*tracolla**	12	36.5	*manico**	30	91
*manico**	11	33.3	*bretella*	1	3
cerniera	2	6.1	*maniglia**	1	3
tasca	2	6.1	*tracolla**	1	3
borchia	1	3			
bottone	1	3			
fibbia	1	3			
laccio	1	3			
*maniglia**	1	3			
strass	1	3			
Tot. meronyms	33		Tot. meronyms	33	

Table 5.7. Meronyms produced in the property generation and in the grasp description task for the handbag.

We already pointed out in the last chapter that the handles are the only parts indicated as a possible target of the grasp for this object stimulus (*manico*, *maniglia*, 'handle', *bretella*, *tracolla*, 'strap'). *Manico* is also the most frequently named meronym for the bag in the property generation task, together with *tracolla*, not only because they constitute the parts agents usually interact with when using a bag (carrying it by its handles or its strap), but also because they are the parts most commonly shared among different types of bags. Indeed, other characteristics, such as the presence of either a zip, a clasp or a button fastener (*cerniera*, *fibbia*, *bottone*), of one or more pockets (*tasca*), or of various kinds of ornaments on the bag, such as rhinestones and studs (*strass*, *borchia*), are rather variable among different exemplars of handbags, and are rarely mentioned in the property generation task.

For what regards the hairdryer (see Table 5.8), the object parts found in the list of feature norms produced are very different from those chosen as possible targets of the grasp.

Property generation task			**Grasp description task**		
Meronym	Freq.	%	Meronym	Freq.	%
ventola	6	31.5	*manico**	19	76
*manico**	4	21	*impugnatura*	6	24
pulsante	2	10.4			
beccuccio	1	5.3			
comando	1	5.3			
resistore	1	5.3			
sifone	1	5.3			
spina	1	5.3			
tasto	1	5.3			
testa	1	5.3			
Tot. meronyms	19		Tot. meronyms	25	

Table 5.8. Meronyms produced in the property generation and in the grasp description task for the hairdryer.

Only the handle is considered to be a graspable part (*manico*, *impugnatura*, tot. 25 occurrences), whereas *manico* is attested only four times in the norms. By contrast, in the property generation task, other parts of the object are named, such as *ventola*, 'fan', which is even more frequent than *manico*. The features *testa*, *sifone*, *beccuccio* probably refer to the part of the object from which the air blows, which

interestingly enough can be grasped but is never actually mentioned in the action description task, because it does not correspond to the usual way in which a hairdryer is held. The remaining properties are *pulsante*, *comando*, *tasto* (indicating the buttons) and *spina* ('plug'), all referring to parts more related to the use-plan of a hairdryer, whereas *resistore* ('resistor') is an internal, non-visible part that is obviously not directly graspable.

For the jug (see Table 5.9), the part most frequently named in both tasks (but especially in the grasp description task) is the handle (*manico*). Among the other meronyms listed as semantic features, informants indicated the neck, the mouth, the spout and the belly (*collo*, *imboccatura*, *beccuccio*, *pancia*), which are constituent parts of most jugs, as well as the stopper (*tappo*) that is present in some types of jugs. None of these parts is explicitly mentioned as a possible target of a grasp: the protruding handle is much preferred. The total frequency values are similar, although meronyms are slightly more frequent in the grasp description task.

Property generation task			**Grasp description task**		
Meronym	Freq.	%	Meronym	Freq.	%
*manico**	11	55	*manico**	23	92
beccuccio	5	25	*impugnatura*	1	4
collo	1	5	*occhiello*	1	4
imboccatura	1	5			
pancia	1	5			
tappo	1	5			
Tot. meronyms	20		Tot. meronyms	25	

Table 5.9. Meronyms produced in the property generation and in the grasp description task for the jug.

As Table 5.10 shows, the handle is the part of the object most frequently named also in relation to the ladle.

Property generation task			**Grasp description task**		
Meronym	Freq.	%	Meronym	Freq.	%
*manico**	6	100	*manico**	24	88.9
			impugnatura	2	7.4
			cucchiaio	1	3.7
Tot. meronyms	6		Tot. meronyms	27	

Table 5.10. Meronyms produced in the property generation and in the grasp description task for the ladle.

However, only six informants in the property generation task named it, whereas in the action description task it occurs 26 times. In the latter case, also the concave part of the ladle is mentioned (*cucchiaio*, 'spoon'), involved in a two-handed grasp directed at the two extremities of the object. Interestingly, this is the part most closely related to the object's function (holding, carrying, stirring and serving liquids), but it is never mentioned in the feature listing test.

For the microphone, the meronyms produced in the two experiments are very different (see Table 5.11). There is only one shared lemma (*tasto*, 'button'). With regard to those produced in the feature listing task, *filo* ('cord') and *antenna* (with the same meaning as in English) are optional parts of a microphone and were not present in the picture of a microphone in the second task; *magnete* ('magnet') is an internal, non-visible part that obviously could not be directly grasped. In the action description task, the most frequently named meronyms are *manico* and *impugnatura* (*gambo* denotes the same part), and *tasto* occurs only in a phrase in which the target of the grasp described by the informant was the handle (the part with the button).

Property generation task			**Grasp description task**		
Meronym	Freq.	%	Meronym	Freq.	%
filo	4	57.1	*manico*	8	53.3
antenna	1	14.3	*impugnatura*	5	33.3
magnete	1	14.3	*gambo*	1	6.7
*tasto**	1	14.3	*tasto**	1	6.7
Tot. meronyms	7		Tot. meronyms	15	

Table 5.11. Meronyms produced in the property generation and in the grasp description task for the microphone.

The meronyms produced for the dummy in the property generation task are very few (see Table 5.12). Interestingly, the handle is mentioned more than the teat, which is the part most relevant to the object's function. The handle is also the only part considered a possible target of the grasp (the teat is excluded for hygienic reasons), but it is mentioned in very different ways, although the most frequent lemma is *manico*, together with its near-synonym *impugnatura*; also, we note the presence of the diminutives *occhiellino* and *gancetto*.

Property generation task			Grasp description task		
Meronym	Freq.	%	Meronym	Freq.	%
*manico**	3	60	*manico**	10	58.8
*anello**	1	20	*impugnatura*	2	11.7
tettarella	1	20	*anello**	1	5.9
			gancetto	1	5.9
			laccio	1	5.9
			occhiellino	1	5.9
			occhiello	1	5.9
Tot. meronyms	5		Tot. meronyms	17	

Table 5.12. Meronyms produced in the property generation and in the grasp description task for the dummy.

As shown in Table 5.13, the meronyms produced for the rubber boat in the property generation task are very few.

Property generation task			Grasp description task		
Meronym	Freq.	%	Meronym	Freq.	%
motore	2	33.2	*corda*	5	26.3
appoggio	1	16.7	*manico*	5	26.3
camera d'aria	1	16.7	*maniglia*	3	15.7
tubolare	1	16.7	*filo*	2	10.5
valvola	1	16.7	*cordino*	1	5.3
			cordoncino	1	5.3
			elastico	1	5.3
			passantina	1	5.3
Tot. meronyms	6		Tot. meronyms	19	

Table 5.13. Meronyms produced in the property generation and in the grasp description task for the rubber boat.

Most meronyms refer to features that are typical only of some specific boats: *motore* and *valvola* indicate the presence of an engine together with its accessories; *appoggio* denotes the seat. Only two meronyms relate to the flexible inflated tubes that are typical of all inflatable boats (*camera d'aria*, *tubolare*). However, these words do not occur in the grasp descriptions. When the grasp is directed at such

parts informants avoid technical terms and use words relating to the spatial domain (e.g., *lati*, 'sides'; cf. Section 4.2.2.1).

None of the properties produced during feature listing is mentioned as a possible target of the grasp. In the action description task, the handles are indicated eight times (*manico*, *maniglia*), whereas 10 informants variously referred to the rope surrounding the boat (*corda/cordino/cordoncino*, *filo*, *elastico*) or to the rings through which the rope is inserted (*passantina*). Not all inflatable boats come with these parts; however, they are quite common, and they were present in the picture used as the visual stimulus.

For the sword (Table 5.14), there is an evident difference among the meronyms produced both in the property generation and in the grasp description tasks. In the former case, 16 meronyms refer to the blade (*lama*, or, specifically, its extremity, *punta*), whereas 12 features regard the handle (*manico*, *impugnatura*, *elsa*). The high frequency of words relating to the blade can be explained by the fact that it is the part of the object most connected to the object's function, whereas the handle is closely connected to the object's use (the hilt is specifically designed to take hold of and guide the sword safely, in other words, to use the object). Obviously, between these two main parts that make up the object, the one that affords the safest grasp is the hilt; therefore, *manico*, *elsa* and *impugnatura* are much more frequent in the action description task than *punta*, 'point', which occurs only once.

Property generation task			**Grasp description task**		
Meronym	Freq.	%	Meronym	Freq.	%
lama	13	46.4	*manico**	15	50
*manico**	7	25	*impugnatura**	11	36.7
*impugnatura**	3	10.7	*elsa**	3	10
*punta**	3	10.7	*punta**	1	3.3
*elsa**	2	7.2			
Tot. meronyms	28		Tot. meronyms	30	

Table 5.14. Meronyms produced in the property generation and in the grasp description task for the sword.

For the trolley case (see Table 5.15), the most frequent feature produced by the informants during the property generation task is *ruota/rotella* ('caster/small caster'), which represents the property that distinguishes a trolley case from other suitcases and is closely related to its use. However, the feature 'has a handle' is also produced by half the informants, and *manico*, *maniglia* are the parts of the object most frequently referred to as the target of the grasp.

Property generation task			Grasp description task		
Meronym	Freq.	%	Meronym	Freq.	%
ruota	22	46.9	*manico**	20	80
*manico**	15	31.9	*maniglia*	2	8
cerniera	5	10.6	*cinghietta*	1	4
rotella	3	6.4	*fascetta*	1	4
fodera	1	2.1	*pezzettino*	1	4
lucchetto	1	2.1			
Tot. meronyms	47		Tot. meronyms	25	

Table 5.15. Meronyms produced in the property generation and in the grasp description task for the trolley case.

Other meronyms named for the trolley case in the action description task all refer to the top handle as well (*cinghietta*, *fascetta*, *pezzettino*). Object parts produced in the feature listing task are not the same as those named in the grasp descriptions: this is true not only of the casters, which are too low to afford an easy grasp, but also of the zip, the lining and the lock (*cerniera*, *fodera*, *lucchetto*). It should be pointed out that such parts do not afford a grasp; in particular, *fodera* ('lining') is an internal and, therefore, non-visible part.

For the umbrella (see Table 5.16), the most frequently named part in both tasks is the handle, but especially in the action description task (22 occurrences of *manico* or *impugnatura*).

Property generation task			Grasp description task		
Meronym	Freq.	%	Meronym	Freq.	%
*manico**	14	41.2	*manico**	18	69.3
stecca	8	23.5	*impugnatura*	4	15.5
asta	4	11.9	*tela*	1	3.8
punta	2	5.9	*collino*	1	3.8
telo	2	5.9	*fusto*	1	3.8
bottone	1	2.9	*corpo*	1	3.8
levetta	1	2.9			
pulsante	1	2.9			
raggiera	1	2.9			
Tot. meronyms	34		Tot. meronyms	26	

Table 5.16. Meronyms produced in the property generation and in the grasp description task for the umbrella.

Other possible targets of the grasp only regard the body of the object (*corpo*, *fusto*); in particular, its 'small neck' (*collino*), or the cloth that covers it (*tela*). In the property generation task, we find that, after the handle, the most frequent meronyms denote structural parts, such as the ribs, the shaft, the spoke and the cover (*stecca*, *asta*, *raggiera*, *telo*); otherwise, subjects named parts relating to the use-plan of an umbrella, such as the button or lever used to open it (*bottone*, *levetta*, *pulsante*). These parts were not visible in the object presented during the action description task and were never mentioned.

5.5. Comparison between the two tasks

We can now turn to a more general comparison of the meronyms produced in the property generation task and the grasp description task.

Table 5.17 shows the frequency of meronyms produced in the two experiments.

Stimulus	Property generation	Grasp description
Backpack	**31**	25
Chair	**59**	25
Coffee cup	**15**	2
Dummy	5	**17**
Handbag	**33**	**33**
Hairdryer	19	**25**
Jug	20	**25**
Ladle	6	**27**
Microphone	7	**15**
Rubber boat	6	**19**
Sword	28	**30**
Tea-cup	17	**21**
Trolley case	**47**	25
Umbrella	**34**	26
Tot.	**327**	315

Table 5.17. Total number of meronyms produced in the property generation task and in the grasp description task for the artifacts with affording parts.

The total number of meronyms provided by the 30 informants is quite similar, i.e., 315 in the grasp description task (14 stimuli; mean=22.5 meronyms per stimulus; SD=7.33) and 327 in the property generation task (14 stimuli; mean=23.3 meronyms per stimulus; SD=15.73).

However, there are some evident and significant differences between the number of meronyms produced for each stimulus in the two tasks. A chi-square test conducted on this data yields a highly significant result ($\chi^2(13, N=642)=63.375$, $p<0.0001$), and the analysis of standardised residuals shows that the stimuli for which the observed values differ more from the expected ones (i.e., std. residuals are smaller/larger than ±1.96; cf. fn. 33) are the chair, the coffee cup and the ladle (in relation to the frequencies observed for both tasks).

For the chair, we have already noted that the main difference between the two tasks emerged for the meronym *gamba*, 'leg', produced 17 times in the property generation task but only once in the grasp descriptions, and for the features *seduta*/*sedile* (both referring to the seat), which occur 10 times in the feature list but only two times in the action description task. The coffee cup is characterised by a very low number of meronyms produced with reference to the target of the grasp compared to those listed in the second experiment, and this unquestionably depends on the fact that it was presented upside-down, i.e., with a non-canonical orientation (cf. the discussion in Section 4.2.2.1). For the ladle, on the other hand, informants produced a very low number of meronymic features in the property generation task (there are only six references to its handle), whereas almost all informants (26 out of 30) named the handle (*manico*, *impugnatura*) as the target of the grasp.

5.5.1. Differences and similarities between the meronyms produced in the two tasks

Based on the data presented in Section 5.4, Table 5.18 gives the number of meronyms (both as type and token frequency) produced for each stimulus only during the property generation task, only during the grasp description task, or in both tasks (meronyms produced for each stimulus in both tasks were those marked with an asterisk in the comparative tables given in Section 5.4). For the token frequency, the number of 'shared' meronyms produced in the property generation task and the grasp description task, respectively, are kept separate (e.g., for the chair, five distinct meronyms were produced in both tasks and, more specifically, these five meronyms occur 47 times in the property generation task, 17 times in the grasp description task).

Stimulus	No. of meronyms (type frequency)			No. of meronyms (token frequency)			
	PG only	GD only	PG and GD	PG only	GD only	PG (also in GD)	GD (also in PG)
Backpack	8	11	2	17	22	14	3
Chair	2	6	5	12	8	47	17
Coffee cup	0	0	1	0	0	15	2
Dummy	1	5	2	1	6	4	11
Handbag	7	1	3	9	1	24	32
Hairdryer	9	1	1	15	6	4	19
Jug	5	2	1	9	2	11	23
Ladle	0	2	1	0	3	6	24
Microphone	3	3	1	6	14	1	1
Rubber boat	5	8	0	6	19	0	0
Sword	1	0	4	13	0	15	30
Tea-cup	0	1	1	0	1	17	20
Trolley case	5	4	1	32	5	15	20
Umbrella	8	5	1	20	8	14	18
Tot.	54	49	24	140	95	187	220

Table 5.18. Number of meronyms produced, for each stimulus, only in the property generation task (PG), only in the grasp description task (GD), or in both.

Considering the type frequency values given in Table 5.18, we notice that only in 24 cases are the same meronyms produced for the same stimulus in both tasks:

- for the backpack: *bretella* and *fibbia*;
- for the chair: *cuscino*, *gamba*, *schienale*, *sedile* and *seduta*;
- for the dummy: *anello* and *manico*;
- for the handbag: *manico*, *maniglia*, *tracolla*;
- for the microphone: *tasto*;
- for the sword: *elsa*, *impugnatura*, *manico*, *punta*;
- for the coffee cup, jug, ladle, hairdryer, tea-cup, trolley case and umbrella: *manico*.

It is evident that, in many cases, the only (or almost only) meronym produced for a stimulus in both tasks refers to the handle (*manico*). We will comment more on this issue in Section 5.6.1.

Whereas meronyms produced for the same stimuli in both tasks are quite rare, those produced, for each stimulus, only in the property generation or in the grasp description tasks are quite numerous (54 and 49 distinct meronyms, respectively):

- for the backpack: *carrellino, cerniera, chiusura, elastico, gancio, sacca, scomparti-mento, tasca* (only in PG), *aggancio, attaccatura, attacco, bracciolo, cinghia, fascetta, gancetto, laccio, manico, maniglia, tracolla* (only in GD);
- for the chair: *bracciolo, ruota* (only in PG), *asta, buco, spalliera, spallina, spazio, stecca* (only in GD);
- for the dummy: *tettarella* (only in PG), *gancetto, impugnatura, laccio, occhiellino, occhiello* (only in GD);
- for the handbag: *borchia, bottone, cerniera, fibbia, laccio, strass, tasca* (only in PG), *bretella* (only in GD);
- for the hairdryer: *beccuccio, comando, pulsante, resistore, sifone, spina, tasto, testa, ventola* (only in PG), *impugnatura* (only in GD);
- for the jug: *beccuccio, collo, imboccatura, pancia, tappo* (only in PG), *impugna-tura, occhiello* (only in GD);
- for the ladle: *cucchiaio, impugnatura* (only in GD);
- for the microphone: *antenna, filo, magnete* (only in PG), *gambo, impugnatura, manico* (only in GD);
- for the rubber boat: *appoggio, camera d'aria, motore, tubolare, valvola* (only in PG), *corda, cordino, cordoncino, elastico, filo, manico, maniglia, passantina* (only in GD);
- for the sword: *lama* (only in PG);
- for the tea-cup: *occhiello* (only in GD);
- for the trolley case: *cerniera, fodera, lucchetto, rotella, ruota* (only in PG), *cin-ghietta, fascetta, maniglia, pezzettino* (only in GD);
- for the umbrella: *asta, bottone, levetta, pulsante, punta, raggiera, stecca, telo* (only in PG), *collino, corpo, fusto, impugnatura, tela* (only in GD).

The type frequency data show that there is an evident difference in the production of distinct meronyms in the two experiments: a large number are produced only in one or the other task. However, the token frequency data given in

Table 5.18 show that the meronyms produced in only one of the two tasks are also the least frequent ones, as the next two sections will illustrate in more detail.

5.5.1.1. Meronyms produced in the property generation task: detailed analysis

Among the 327 meronyms produced in the feature listing task, those produced for each stimulus *only* in this task are 140 and are given in Table 5.19 (without differentiating between the stimuli, since details have already been given in Section 5.4).

Meronym	Freq.	Meronym	Freq.	Meronym	Freq.
ruota	27	*antenna*	1	*magnete*	1
lama	13	*appoggio*	1	*pancia*	1
tasca	11	*borchia*	1	*raggiera*	1
cerniera	9	*camera d'aria*	1	*resistore*	1
stecca	8	*carrellino*	1	*sacca*	1
bracciolo	7	*chiusura*	1	*scompartimento*	1
beccuccio	6	*collo*	1	*sifone*	1
ventola	6	*comando*	1	*spina*	1
asta	4	*elastico*	1	*strass*	1
filo	4	*fibbia*	1	*tappo*	1
pulsante	3	*fodera*	1	*tasto*	1
rotella	3	*gancio*	1	*testa*	1
bottone	2	*imboccatura*	1	*tettarella*	1
motore	2	*laccio*	1	*tubolare*	1
telo	2	*levetta*	1	*valvola*	1
punta	2	*lucchetto*	1		

Table 5.19. List of meronyms that are produced, for each stimulus, only in the property generation task, and not in the grasp description task. Tot. 140.

Most of the meronyms were produced only very rarely. In particular, 31 features occur only once, meaning they were produced for just one stimulus and by just one informant. Only three features are produced more than ten times: *ruota*, 'wheel' (27 occurrences: 22 for the trolley case, five for the chair), *lama*, 'blade' (13 occurrences for the sword) and *tasca*, 'pocket' (11 occurrences: nine for the backpack, two for the handbag). These are all object parts that do not afford a

grasp (either because they are not close to hand, such as the casters, or because they do not afford a safe grasp, such as the blade), but are obviously relevant to the function of the object and the activities in which they are usually involved.

It should be also noted that most features regard visible parts of the entities denoted by the word stimuli. Only some meronyms refer to non-visible parts. In particular, *fodera* (produced for the trolley case), *tasca*, *scompartimento* (produced for the backpack) and *raggiera* (produced for the umbrella), denote parts of the object that are visible only when the objects are opened (but consider that *tasca* may refer both to internal and external pockets), whereas *magnete*, *resistore*, and maybe also *valvola* (produced for the microphone, the hairdryer, and the rubber boat, respectively) refer to parts of the objects that are not directly visible and become visible only if the artifacts are disassembled.

These data conform with what Wu and Barsalou (2009: 185) note in relation to property generation:

> When participants receive a noun or noun phrase, they construct a simulation to represent it, scan across the simulation, and describe properties perceived in the simulation. Because simulations are scanned and described in this manner, unoccluded properties are described relatively often, whereas occluded properties are described less.[65]

Among the 327 meronyms produced in the property generation task, the number of those produced, for each object stimulus, *also* by the participants engaged in the grasp description task is 187 (see Table 5.20; for details, see the meronyms marked with an asterisk in Tables 5.3–5.16).

Meronym	Freq.	Meronym	Freq.	Meronym	Freq.
manico	103	*seduta*	8	*cuscino*	2
schienale	18	*punta*	3	*tasto*	1
gamba	17	*impugnatura*	3	*maniglia*	1
bretella	13	*sedile*	2	*fibbia*	1
tracolla	12	*elsa*	2	*anello*	1

Table 5.20. List of meronyms produced in the property generation task that were also produced in the grasp description task. Tot. 187.

It is evident that *manico*, 'handle', is the most frequent meronym: it occurs 103 times and constitutes 31.5% of the total number of meronymic features (327) produced in the property generation task. Compared to this feature, all others

[65] According to Wu and Barsalou (2009: 174), "occluded properties are not visible, whereas unoccluded properties are".

are produced much more rarely, such as *schienale*, 'backrest', and *gamba*, 'leg', referring to the chair (18 and 17 occurrences), as well as *bretella* and *tracolla* ('strap', 'shoulder strap') produced for the backpack (13 occurrences) and the handbag (12 occurrences), respectively.

These data clearly show that the types of meronyms that are produced, for each stimulus, *only* in the property generation task are more numerous than those produced *also* in the other task (compare Table 5.19 and Table 5.20). However, the most frequent meronyms are limited to a few lemmas, and are produced, for the same stimuli, in both tasks. In particular, the feature *manico*, 'handle', stands out for its very high frequency.

5.5.1.2. Meronyms produced in the grasp description task: detailed analysis

Meronyms produced in the grasp description task are 315 in number. Those produced for each stimulus *only* in the grasp description, and not in the property generation task, occur 95 times in total, as shown in Table 5.21.

Meronym	Freq.	Meronym	Freq.	Meronym	Freq.
impugnatura	20	*asta*	1	*elastico*	1
manico	18	*attaccatura*	1	*fusto*	1
laccio	7	*attacco*	1	*gambo*	1
maniglia	7	*bracciolo*	1	*occhiellino*	1
corda	5	*bretella*	1	*passantina*	1
occhiello	3	*buco*	1	*pezzettino*	1
spalliera	3	*cinghietta*	1	*spallina*	1
cinghia	2	*collino*	1	*spazio*	1
fascetta	2	*cordino*	1	*stecca*	1
filo	2	*cordoncino*	1	*tela*	1
gancetto	2	*corpo*	1	*tracolla*	1
aggancio	1	*cucchiaio*	1		

Table 5.21. List of meronyms that are produced, for each stimulus, only in the grasp description task, and not in the property generation task. Tot. 95.

In most cases, the token frequency of these meronyms never exceeds five occurrences, and many of them (24) occur only once. There is a relatively high number of diminutives (such as *fascetta*, *cinghietta*, *cordoncino*, *passantina*, *pezzettino*, *collino*) that are never produced in the property generation task. This diversity can

be explained in view of the fact that diminutives typically occur much more freely in oral than in written discourse (Dressler and Barbaresi 1994): in the grasp description task, meronyms were orally produced in an interview, whereas in the property generation task they were written on a questionnaire in a more formal and controlled situation.

In contrast, the meronyms that are produced, for each stimulus, both in the grasp description and in the property generation task, as shown in Table 5.22, are less numerous, in terms of type frequency, but they occur much more frequently in the descriptions provided by informants (220 tokens; for details, see the meronyms marked with an asterisk in Tables 5.3–5.16). Most meronyms are attested less than five times among the lemmas denoting target-related words, and nine occur only once. Notably, only two distinct meronyms, *impugnatura* (11 occurrences) and *manico* (181 occurrences), both denoting the handle, account for more than 87% of the meronyms produced in the grasp descriptions that were also produced in the property generation task.

Meronym	Freq.	Meronym	Freq.	Meronym	Freq.
manico	181	*cuscino*	2	*punta*	1
schienale	12	*anello*	1	*sedile*	1
impugnatura	11	*fibbia*	1	*seduta*	1
elsa	3	*gamba*	1	*tasto*	1
bretella	2	*maniglia*	1	*tracolla*	1

Table 5.22. List of meronyms produced in the grasp description task that were also produced in the property generation task. Tot. 220.

Therefore, the distinct meronyms produced *only* in the grasp description task are more numerous than those produced also in the other task (cf. Table 5.21 and Table 5.22); however, also in this case (cf. Section 5.5.1.1), the vast majority of tokens are found in the group of 'shared' meronyms. In particular, the most frequent meronyms are limited to a very few lemmas, denote the 'handle' (*manico*, *impugnatura*) and are produced in both tasks.

5.6. Discussion

My analysis has revealed some differences as well as some similarities between the meronyms produced for the 14 artifacts either in the grasp description task or in the property generation task.

First of all, there is a large number of distinct meronyms that emerge only in one or the other task (cf. Table 5.19 and Table 5.21). In part, this is due to an

intrinsic limitation of this comparison, that is to say, to the great difference between the two experiments, not only in the methodology and procedure adopted but also in their purposes. Although both were conducted on the same number of subjects (with similar age) and focused on certain kinds of artifacts, in the grasp description task participants were visually presented solely with an image (without any written material), representing a particular instance of an object, whereas in the property generation task they were presented with only one written word (without any image). Moreover, in the first task, informants were asked to describe, orally, how they would grasp the objects represented, whereas in the second task they were asked to list, in written form, the features that they judged to be relevant to describing the meaning of the words. This meant that in the grasp description task participants could only name those object parts that were actually perceivable in a given picture. For instance, the particular inflatable presented as an example of a rubber boat had no motor; therefore, the motor could not be named in the descriptions of the grasp (conversely, the same rubber boat was equipped with a rope inserted in small rings, but not all rubber boats have ropes and rings, and such meronyms are not listed among the properties generated in the feature listing task). Nevertheless, as previously discussed, there are some object parts produced in the property generation task that could have been named as the target of the grasp but in fact were not: for instance, the neck and the mouth of the jug (*collo*, *imboccatura*).

However, the data given in Tables 5.19 and 5.21 also reveal that most meronyms that occur in only one of the two tasks are produced very rarely. On the other hand, the largest number of meronyms, in terms of token frequency, are lexemes produced for the same stimuli in both tasks (tot. 407 occurrences; cf. Tables 5.20 and 5.22): most meronyms listed during the property generation task are also those that were also produced, in the previous experiment, to refer to the target of the grasp, especially in the case of *manico*.

5.6.1. The conceptual prominence of artifacts' affording parts

The detailed analysis presented in Section 5.5 shows that *manico* is the most frequent meronym occurring in the grasp description task (tot. 199 occurrences), as well as in the property generation task (tot. 103 occurrences).

Since *manico*, *maniglia* and *impugnatura* can be regarded as near-synonyms in this specific case, because they all denote the handle of an artifact, we can merge the occurrences of these lemmas and compare the number of meronyms denoting the handle of an object with the number of any other different meronym (Table 5.23).

Task	Handle	Other meronyms	Tot. meronyms
Property generation	107 (32.7%)	220 (67.3%)	327
Grasp description	238 (75.6%)	77 (24.4%)	315

*Table 5.23. Frequency of the meronyms denoting the handle (*manico*,* maniglia *and* impugnatura*), compared to the frequency of all other meronyms produced in the two tasks.*

As shown in Table 5.23, the percentage of meronyms referring to the handle, compared to all other meronyms, is much higher in the grasp description task than in the property generation task ($\chi^2(1, N=642)=118.4; p<0.0001$). Moreover, for some stimuli (the rubber boat, the microphone and the backpack) the handle is named only in the property generation task and not during the feature listing task. Therefore, we must assume that the differences in the two experiments have a significant impact on token frequency data. Since in the first experiment informants were explicitly asked to imagine a particular action performed on artifacts, i.e., a grasp, meronym production is evidently biased towards the affording parts of the objects *specifically designed* for grasping and closely related to this specific function. When participants have to imagine and describe an action of grasping, as required by the task (Section 2.3.3), their attention focuses on those specific object parts that are more prominent in the conceptualisation of the grasp event, and therefore are also more frequently named (as discussed in Section 3.7). Differently, in the property generation task, several possible events in which objects might be involved are automatically evoked, and there might be many different elements in the focus of attention that are perceived as more salient and therefore explicitly named.

However, the data resulting from the property generation task reveal that the handle is one of the most prominent facets in the conceptualisation of the artifacts under consideration: not only it is the feature most frequently listed among meronyms, considering general results (Section 5.5.1.1), but for six stimuli (namely the umbrella, the dummy, the ladle, the jug, the cup and the coffee cup) it is also the most frequently named meronym. This is hardly surprising. A growing body of research demonstrates that the display of written words denoting manipulable objects (not unlike the visual presentation of real objects) automatically activates affordances, understood as the motor information regarding habitual micro-interactions with their referents (cf. Borghi 2005, 2007; Section 1.4.2). Handles are obviously the parts of an object most typically involved in these 'habitual micro-interactions' that agents carry out with objects, since object grasping is preliminary and often necessary to perform the typical actions for which the artifacts have been designed. Therefore, the high number of meronyms produced *both* in the feature listing *and* in the action description task, with

the primacy of those referring to the handles of objects, not only confirms that a large number of the meronyms produced by informants originate from concrete and repeated interactions with objects (as demonstrated also by the predominance of features expressing situational properties; cf. Figure 5.2), but in addition points to the cognitive prominence of affording parts, which play an important role in the lexico-semantic representations of words denoting graspable objects.

Chapter 6
Final overview

My intention in this book has been to investigate whether linguistic production reflects affordances, understood as motor patterns elicited by object perception. In this final chapter, I would like to briefly retrace the path of the research that I carried out to address this question and to highlight what I believe to be the main contribution made by this study.

6.1. Affordances and language are grounded in action and perception

A growing body of neurophysiological and behavioural studies has provided convincing evidence for the existence of a close relationship between perceptual and motor processes. In particular, as shown in Chapter 1, a number of experiments have demonstrated that the simple visual perception of a graspable object automatically gives rise to a sort of 'action simulation' in the motor system, activating the same neural circuits that fire during object manipulation and grasping. Since the early involvement of the motor system after the visual presentation of a stimulus is able to influence the performance of subsequent actions (causing interference or facilitation effects), action simulations may be regarded as affordances, in the sense of true "preconditions for action" (Greeno 1994: 340). In line with these empirical findings, I have defined affordances as the *motor simulations of possible actions* that are incorporated into object representations and that are automatically triggered by the perception of visually presented objects.

This recruitment of the sensory-motor system is modulated by a number of factors, closely related to agents' real experiences and past interactions with the perceived objects (cf. Sections 1.3.1–1.3.5). Artifacts and tools are typically involved in the actions of manipulation and grasping and, when used as experimental stimuli, they are more effective in activating motor simulations compared to stimuli belonging to different categories, such as natural kinds (Section 1.3.2). Moreover, within the artifacts category, there are specific object features that are able to influence sensory-motor responses. In particular, the presence of an affording part (such as a handle) usually causes greater activation in the sensory-motor regions, especially when this component of the object is spatially aligned with the hand for which brain activity is measured (Section 1.3.3) and is placed within the subject's peripersonal space (Section 1.3.4). The greater activation of the sensory-motor system recorded in these conditions is motivated by the repeated interactions that the observer has had with real objects (since, to use a

tool, agents usually have to manipulate and grasp its affording part, e.g., its handle), and is thus also influenced by the level of familiarity that the observer has with them (Section 1.3.5).

An increasing amount of research shows that the sensory-motor system is activated not only by the visual perception of objects (or images of objects) but also by the linguistic processing of action-related nouns (in particular, those denoting graspable artifacts), verbs and sentences (Section 1.4). Therefore affordances, understood as motor representations, are elicited also by linguistic stimuli, and language processing is grounded, at least in part, in the same brain mechanisms that underlie perception and action. However, so far these findings have not had the impact that I believe they should have in linguistic studies on lexical semantics (Section 1.5).

6.2. Linguistic production reflects affordances

Within this theoretical framework, drawn primarily from the neuroscientific and psychological literature, I conducted a study designed to determine whether language production is affected by the same variables that proved to modulate the activation of affordances. In particular, I focused the study on the affordance of graspability.

In Chapter 2, after a preliminary discussion of some theoretical and methodological issues (Sections 2.1–2.2), I described an action description task in which 30 informants were visually presented with 42 pictures of graspable entities of different categories, shape and size, and were asked to describe how they would grasp them (Section 2.3). The interviews were recorded and transcribed in a CHAT format (Section 2.4). Then the transcripts were subjected to a twofold linguistic analysis.

In the first piece of analysis, described in Chapter 3, I explored the hypothesis that linguistic descriptions of grasps might reflect different conceptualisations of the grasp event, where informants focus most attention on and assign more prominence to either the object or the agent of the grasp, depending on the presentation of object stimuli of different categories, shapes and sizes.

To discover whether such 'shifts of attention' from the agent to the object of the grasp is actually reflected in the transcripts, I first extracted all lexical words used to refer to the effector or to the target of the grasp (which were defined as the entity that is linguistically presented as the one that comes into contact with the object, and the part of the object stimulus where the contact with the effector is described as occurring, respectively). Subsequently, all grasp descriptions were classified according to whether they contained an explicit reference to the target and/or to the effector of the grasp. The assumption was that the target or the

effector of the grasp are more likely to be explicitly named, and described in finer detail, when they attract the informant's attention and when they are conceptualised as a prominent part of the grasp event imagined and described by informants. With this analysis I intended to verify whether, when presented with different stimuli, participants produced a significantly different number of references to the effector and the target of the grasp (Section 3.1).

The results of this analysis, presented in Sections 3.2–3.5 and discussed in Sections 3.6–3.7, have shown that the target of the grasp was named most frequently in grasp descriptions of artifacts and humans, whereas it was less frequently mentioned for substances and natural objects. Moreover, within the category of artifacts, the target was explicitly indicated more often for artifacts having affording parts than for artifacts without them. Accordingly, I have described the distribution of the references to the target and the effector of the grasp in terms of an implicational scale: *humans* > *artifacts with AP* > *artifacts without AP* > *natural kinds* > *substances and aggregates*. The further to the left the object stimulus is, the more likely it is that the target of the grasp will be named in the descriptions, and the less likely it is that the effector of the grasp will be mentioned.

In the second part of the analysis of the transcripts, set forth in Chapter 4, I examined the linguistic content of the transcripts in more detail. In particular, I classified all lexical words used to refer to the effector or to the target of the grasp in a number of semantic categories (Section 4.1), in order to investigate whether the lexical choices made by informants are influenced by the characteristics of the presented stimuli. The results presented in Sections 4.2–4.6 have shown that human beings and artifacts with affording parts are not only the stimuli for which the target of the grasp is most frequently mentioned, but also those for which informants most frequently produced meronyms to refer to the target of the grasp, explicitly naming specific parts of the stimulus presented. By contrast, for artifacts without affording parts, natural kinds, substances and aggregates, informants called on spatial expressions and lexemes pertaining to other semantic categories.

The final discussion that concludes Chapter 4 (Section 4.7) highlights how the results of the two analyses conducted on transcripts are consistent and complementary: the greater number of linguistic references to the target (and the correspondingly less frequent mentions of the effector of the grasp), together with the explicit mentions of meronyms, are reflections of a shift of attention – away from a focus on the subject towards a focus on the object of the grasp. This shift proved to be sensitive to the same factors that behavioural and neurophysiological research indicates as having an influence on motor responses, namely the category the objects belong to and the presence of affording parts. The explicit reference made by informants to the stimuli and to their constituent

parts thus reflects, in my view, the greater cognitive prominence of the entities with which humans most typically interact concretely, as well as the greater cognitive prominence of their affording parts, linguistically encoded through meronyms.

6.3. The cognitive prominence of affording parts in artifact conceptualisation

To complement these results, I conducted a second experiment, described in Chapter 5, to investigate to what extent the prominence given to affording parts (which is particularly evident when comparing data from artifacts with affording parts and artifacts without affording parts) emerges only in connection with the imaginary process required in the grasp description task or whether it is rooted in the conceptualisation of artifacts. Thirty informants were involved in a property generation task designed to build a collection of *semantic feature norms* (Section 5.1) in which 14 written words were used as stimuli. Words denoted the artifacts with affording parts that had already been used as visual stimuli in the grasp description task. Informants were asked to describe the meaning of the linguistic items in short sentences. Semantic features were derived from these descriptions; then these features were subjected to normalisation and were classified according to a given set of semantic relation types (Section 5.2). After a brief overview of the general results of the study (Section 5.3), the meronyms produced in the grasp description task were compared with those listed in the property generation task (Sections 5.4–5.5).

Even though affording parts were more frequently named in the grasp description task (since that experiment specifically focused on grasping and participants' attention was drawn to the affording parts purposely designed for that action), most meronyms listed during the property generation task are the same as those that were produced to refer to the target of the grasp. In particular, the meronyms most frequently produced, both in the grasp description and in the property generation tasks, are those denoting handles (*manico*, *maniglia*, *impugnatura*), the object parts most typically involved in grasp and manipulation. As discussed in Section 5.6, this result confirms that most meronyms produced by informants originate from concrete and repeated interactions with objects and in addition points to the cognitive prominence of affording parts, i.e., the constituent parts that have a key role in the particular modality of interaction required by the artifacts.

6.4. Language and affordances: the need for a multidisciplinary approach

In conclusion, the main purpose of this study was to investigate whether the language reflects affordances. The analysis conducted on the grasp descriptions has revealed that linguistic production proved to be influenced by the very same factors that behavioural and neurophysiological studies have indicated as being able to modulate motor responses, especially the object category and, in the case of artifacts, the presence of affording parts. Moreover, also the spatial compatibility effect that occurs between the orientation of the object and the informant's ipsilateral hand, together with hand dominance, turned out to have an effect (albeit only a slight one) on the linguistic description of the grasp. Describing an action requires an imagery process, during which the experience of concrete interactions with objects is re-enacted; the same happens when action simulations are automatically triggered by object perception, even if no actual reach-and-grasp movement is executed.

Since its inception, this research has been characterised by a multidisciplinary approach to the theme of language and affordances. This is partly due to the multifaceted concept of affordance itself, which can bridge the divide between different disciplines. After its first appearance within the framework of ecological psychology, this notion soon made huge inroads into other fields. Although affordances have been extensively investigated in psychology and neuropsychology, their potential is still largely undervalued in linguistics. In my view, however, the notion of affordance, with the various adaptations and reformulations it has undergone over the years, could readily provide new insights and valuable inspiration in linguistic research, especially (but not exclusively) in cognitive or embodied approaches to semantics.

If, on the one hand, recent trends in neurosciences and psychology have provided new stimuli to linguistic studies, on the other hand, linguists can make an important contribution on questions that have so far primarily been explored using different approaches. In this regard, it is my hope that this work will not only focus attention on the ways in which the notion of affordance can be fruitfully applied to the linguistic domain, but also, in a broader view, on how a signally linguistic perspective can shed new light on the findings that have emerged from other research fields.

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Appendix

Italian text of the instructions given for the property generation task *Descrizione di parole di uso comune* (cf. Section 5.2.2):

Grazie per aver accettato di partecipare a questa indagine!
In questo sondaggio, ti verranno presentate quattordici parole che indicano oggetti di uso comune, ciascuna in una pagina diversa. Sotto ad ogni parola, vedrai delle righe bianche. Qui dovrai descrivere il significato della parola utilizzando fino a un massimo di dieci semplici frasi brevi, come illustrato nell'esempio seguente:
Cane
- è un mammifero
- è il migliore amico dell'uomo
- abbaia
- è un animale domestico
- ha la coda
- …

REGOLE
Il compito che ti si richiede è molto semplice, sono sicura che non ti porterà via molto tempo. Tuttavia andrà svolto con precisione, quindi ecco alcune regole da seguire:
1. Non avere fretta. Per ciascuna parola, prima pensa con attenzione al suo significato e a quali siano gli aspetti che ritieni più importanti per descriverlo, poi riempi i campi a tua disposizione.
2. Descrivi il significato della parola con frasi brevi. Cerca di essere chiaro e sintetico.
3. Non esistono risposte giuste o sbagliate: sei assolutamente libero di spiegare nella maniera che preferisci quello che ritieni essere il significato di queste parole.
4. Non sei obbligato a riempire tutte le dieci righe per ogni parola.
5. Una volta completata una pagina, accertati della correttezza dei dati che hai inserito, poiché non sarà possibile modificarli in seguito. Solo quando sei sicuro, clicca sul pulsante 'Avanti', che ti porterà alla pagina successiva.
6. Non è consentito interrompere il questionario e salvare le proprie risposte: il questionario può essere salvato solo alla fine, dopo che è stato completato.

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Studi Linguistici Pisani pubblica volumi a carattere scientifico nell'ambito della linguistica, declinata nelle sue varie accezioni. La Collana intende ospitare opere originali e innovative sia sul piano dei contenuti che su quello delle metodologie adottate.

Over the last two decades the concept of affordance, which was first introduced in the field of ecological psychology, has steadily gained ground in cognitive science and neuroscience, particularly within the context of embodied theories of cognition, which share the idea that fundamental cognitive functions, such as those supporting thought and language, are deeply influenced by our bodily nature and by our concrete experience of the world. However, the notion of affordance has been little explored from a specifically linguistic perspective.
The research presented in this volume investigates whether, and to what extent, linguistic production reflects affordances, here understood as the neural representations of possible interactions with objects.
The investigation builds on two experiments conducted by the author on the affordance of graspability, one entailing an action description task and the other a property generation task. The results of the analysis carried out on the data collected in these experiments are discussed using a multidisciplinary approach. The findings demonstrate that there is a close connection between linguistic production and affordances, and that the latter also play an important role in the lexico-semantic representations of action-related words denoting graspable objects.

Irene De Felice received her PhD in Linguistics from the University of Pisa in 2015. She worked as a research fellow at the CNR Institute for Computational Linguistics in Pisa (2012-2015) and as a postdoctoral researcher at the University of Pisa (2016-2018). Since 2019 she has been a postdoctoral researcher at the University of Genoa. Her research interests focus primarily on cognitive and historical linguistics.

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