Does language reflect affordances?

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Introduction

Affordances were originally defined by James Gibson, in the late 1970's, as possibilities for action that the environment offers to living beings. In Gibson's view, when we perceive the world surrounding us and the objects in it, we actually perceive potential actions.

More recently, a growing body of behavioral and neurophysiological research conducted on objects manipulation and grasping has revealed that the simple visual perception of a graspable object is able to automatically evoke a sort of action simulation in the motor system, activating the same neural circuits that fire during object manipulation and grasping (e.g. Grafton et al. 1997; Chao and Martin 2000; Grèzes and Decety 2002). Such finding points to the concrete existence, at least in the specific field of grasping, of affordances, intended as the motor simulations of possible actions triggered by the perception of visually presented manipulable objects (Tucker and Ellis 1998; Ellis and Tucker 2000; Grèzes et al. 2003).

However, experiments also show that sensory-motor responses to visual stimuli presentation are modulated by many factors related to agents' experience and to the properties of the perceived objects (e.g. orientation, semantic type, constituency, shape, dimension). In particular artifacts and tools, when used in experiments, result more effective in activating motor simulations with respect, for example, to natural kinds or geometrical shapes; moreover, artifacts with an affording part (i.e. the part of an object with which agents most typically directly interact and which, for this reason, more than the other ones affords action, such as a handle) cause a greater activation in the sensory-motor regions, especially when such part is spatially aligned with the perceiver's dominant hand (Tucker and Ellis 1998; Gentilucci et al. 2002; Grèzes et al. 2003; Symes et al. 2007; Buccino et al. 2009).

Purposes and Methods

The main research question that guides this work is the following: is language sensitive to the same variables that modulate sensory-motor responses to visually presented objects, at least within the specific domain of grasping? To tackle this issue, a speech corpus of grasp descriptions has been collected and analysed in order to investigate whether the way in which people linguistically describe the action of grasping of a visually presented object is modulated by the same factors that are responsible for modulating brain activity within the domain of grasping (i.e. with relation to the affordance of "graspability").

During an action description task, 30 participants were asked to see a list of 42 images of 33 graspable entities (e.g. jug, tea cup, ladle, banana, baby, chair, sand) presented in sequence on a

computer monitor. For each visual input, they had to describe in the most detailed way how they would have grasped the object (tot.: 1260 grasp descriptions). Graspable entities were chosen according to two parameters, dimension (big/small) and semantic type: artifacts (with or without affording parts), natural kinds, substances and aggregates, humans. Some of the artifacts with affording parts were presented in different orientations (left/right; upright/overturned).

Interviews were audio/video recorded and data from recordings were transcribed. All lexical words used to refer to the effector of the grasp, i.e. the entity that is linguistically presented as the one that comes in contact with the object (e.g. mano, "hand") or to the target of the grasp, i.e. the part of the object-stimulus where the contact with the effector is described to occur (e.g. manico, "handle") were manually extracted from each grasp description and then classified according to the semantic relation established with the entity described as the effector or with the object-stimulus presented during the task (e.g. manico, "handle" = meronym).

This study aims to discover whether different objects-stimuli elicit different linguistic descriptions, either in terms of references to the effector or the target of the grasp (which are likely to indicate which component of the grasp event linguistically described is most salient, from a cognitive point of view), or in terms of lexical choices used to describe the action.

Results

The three main results of the analysis can be summarized as follows:

1. the target of the grasp is named in most grasp descriptions provided for artifacts and humans (and participants usually indicate it by producing meronyms, which in most cases denote objects' affording parts), whereas it is much less frequently mentioned for substances and natural objects;
2. within the category of artifacts, the target is explicitly indicated more often for artifacts provided with affording parts, with respect to artifacts without affording parts;
3. within the category of artifacts with affording parts, the target is explicitly indicated more often for stimuli representing upright objects, with the affording part spatially aligned with informants' dominant hand.

The analysis conducted on the grasp descriptions suggests that linguistic behaviour is influenced by the same factors that behavioural and neurophysiological researches indicate as able to modulate motor responses, namely the objects' semantic type and the salience of the affording part with respect to other possible graspable parts of the objects. This is in line with the assumption that describing an action requires an imagery process, during which the experience of concrete interactions with objects is re-enacted (something similar to what happens when action simulations are automatically triggered by object perception, even if no actual reach-and-grasp movement is executed).

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