Alice in Legoland: a study on the acquisition of novel abstract concepts and words

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1. Introduction

Studies inspired by embodied and grounded (EG) theories of cognition have dominated research on human cognition of the last years. One of the most important challenges these theories need to face concerns the way abstract concepts and words are represented. This work aims to test the Words As social Tools (WAT) proposal (Borghi & Cimatti 2009, Borghi & Binkofski 2014) on abstract concepts. In line with EG views, according to WAT both abstract and concrete concepts are grounded in perception, action and emotional systems. However, WAT goes beyond standard EG views since it proposes that linguistic information plays a major role for abstract

conceptual representation, and since it posits a crucial role of conceptual acquisition. Specifically, during acquisition abstract concepts would benefit more than concrete ones from linguistic experience (Wauters *et al.* 2003). Aim of the present work is to investigate the acquisition of concrete and abstract concepts and words, and verify its impact on conceptual representation. In Experiment 1, participants explored and categorized novel concrete and abstract entities, and were taught a novel label for each category. Later they performed tasks to verify a) whether language had a major weight for abstract than for concrete words representation, and b) whether this difference had consequences on bodily responses (activation of the mouth). In Experiment 2, the association between abstract words and the mouth was further verified by a rating task with everyday concepts and words.

2. Experiment 1

2.1 Stimuli

For the stimuli, by assembling Lego bricks we created 6 categories of concrete entities and 6 of abstract entities, each including 4 members. The members of each concrete category were similar from a sensorimotor point of view, as it is the case for real life concrete categories (e.g. cup). Each category was defined by the global shape of its exemplars and by one colored detail, constant across the exemplars (e.g. "a jagged pile of bricks with a yellow protrusion"). The abstract entities were created gluing members of concrete categories on cardboards and arranging them in complex spatial relations. Hence each abstract category was defined by the spatial relation existing among the component concrete entities, e.g. "the two objects have one contact point". While the spatial relation was kept constant across the category exemplars, the component concrete entities could vary in shape, size, and color, thus the category members differed greatly from a sensorimotor point of view, as real life abstract categories do (e.g. freedom). A rating task confirmed that the objects and relations we created were respectively evaluated as more concrete and more abstract, confirming the validity of our operationalization. We then created two sets of novel labels (e.g. Set 1: "calona", Set 2: "mifeso"). For half of the participants labels of Set 1 were used to designate concrete entities and labels of Set 2 abstract entities; for the other half the mapping was inverted. Furthermore, we assigned a linguistic description to each novel category. While descriptions of concrete entities referred to their perceptual characteristics and parts, those of abstract entities referred exclusively to the spatial relations between their

parts. According to a further rating task, descriptions did not differ in imageability and abstractness.

2.2 Method and results

Due to space limits and to the complexity of the experiment, here we will briefly illustrate the procedure and discuss only the most relevant results of the tests we performed.

Training 1 – The experimenter handed the novel entities to the participant, who could manipulate them; for concrete items (objects), participants could turn them over in their hands, for abstract items (relations) they could touch the objects glued on the cardboard.

Test 1 – Free Categorization task. Participants were required to sort the pictures of concrete items and then of abstract ones in 6 groups. Both the groups and the RTs were recorded. Sorting criteria used for concrete entities were basically the same across participants (i.e. perceptual criteria): the high level of agreement was due to the high perceptual and sensorimotor similarity of concrete exemplars. On the other hand sorting criteria used for abstract entities strongly differed: participants were divided into two groups accordingly, i.e. perceptual- and spatial-strategy groups (spatial criteria were the ones used also by the experimenters to create the novel abstract categories). The variable Strategy (perceptual vs. spatial) was used in the later tests.

Training 2 – The experimenter taught half of the participants a linguistic label and a description for each category exemplar.

Test 2 – Recognition task. Participants were required to respond if the two stimuli they saw on the computer screen belonged to the same category; if they did not, they had to refrain from responding. Half of the participants were required to answer "yes" by pushing a button, the other half by responding "yes" with a microphone. Results on accuracy showed a better performance with abstract stimuli of participants who had received the linguistic training, in line with our prediction that abstract categorization should benefit more from language. Furthermore, while for concrete stimuli there was no difference between the perceptual and the spatial strategy groups, for abstract stimuli the perceptual strategy group made more errors than the spatial strategy one. The association between language and abstract stimuli was confirmed by the RTs analysis, which showed that participants using a perceptual strategy who responded with the microphone were faster with abstract stimuli if they had received the linguistic training than if they had not. The RTs analysis confirmed the association between language and mouth responses as well: participants who had not undergone linguistic

training responded faster with the keyboard than with the microphone, while the keyboard advantage was not present for linguistically trained participants.

2.3 Discussion

Overall, results were in line with the hypotheses advanced on the basis of the WAT theory. They indeed demonstrated that: a. abstract concepts were more difficult to form than concrete ones; b. participants relied more on the linguistic input for abstract than for concrete concepts; c. while concrete concepts activated preferentially hand responses, this was not true for abstract concepts.

3. Experiment 2

The results of Experiment 1 are rather straightforward. However, an objection could be raised: it is possible that linguistic information, which determines an activation of the mouth, is useful not to form abstract categories, but categories whose exemplars are highly dissimilar. To control for this confound, we performed an online rating task with everyday concepts and words.

3.1 Participants and stimuli

We selected 60 terms from the database of Italian words by Barca *et al.* (2011), and divided them into 3 groups: abstract terms; concrete terms composed by members which differ greatly from each other; concrete terms whose members do not differ much from each other. Words were balanced for Adult Written Frequency, Length, Age of Acquisition, Familiarity and Imageability.

3.2 Method

Participants were asked to evaluate on a 7-point scale how much an effector (mouth or hand) is involved in a possible action with the target items (a variation of the procedure by Ghio *et al*. 2013).

3.3 Results and discussion

Results showed a general higher involvement of the hand than of the mouth effector; crucially, this advantage of the hand was present with both compact and heterogeneous concrete concepts but it was not present with

abstract concepts. This result confirms the predictions of the WAT view of a preferential association between concrete concepts and hand responses; in addition it rules out the possible objection that linguistic information – hence the mouth effector – is recruited with categories whose members are rather dissimilar.

4. Conclusion

Results confirmed the predictions of the WAT. They demonstrated that linguistic information is more activated for abstract than concrete concepts representation; this activation has a bodily counterpart since, differently from concrete concepts, abstract ones are not more associated with hand responses: this suggests an important role of the mouth for abstract concepts representation. Importantly, the different acquisition modality for concrete and abstract categories was not a priori established (see Borghi *et al.* 2011) but rather emerged: participants relied more on perceptual similarity for concrete objects, on linguistic/social input for abstract concepts categorization.

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