Research Article

Representation of Categories

Metaphorical Use of the Container Schema

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Abstract. In the present study we investigated whether the mental representation of the concept *categories* is represented by the *container* image schema (Lakoff & Johnson, 1980). In two experiments participants decided whether two pictures were from the same category (animal or vehicle). Pictures were presented inside or outside a frame that should activate the *container* schema. We found that performance to pictures was influenced by the frame in congruence with the metaphorical mapping (*same category – inside bounded region; different category – not in same bounded region*). These results show that the concept *categories* is metaphorically represented by *containers*.

Keywords: conceptual metaphor, abstract concepts, grounded cognition, image schema

Recent theories have postulated that mental representations and sensory-motor processing share mechanisms. According to these theories, the mental representations of concepts are determined by the sensory-motor experiences that an organism has (e.g., Barsalou, 1999; Glenberg, 1997; Goldstone, 1994). Concrete concepts are physical entities in the world (e.g., *garbage can*). The body has physical experiences with such concept by perception (e.g., seeing or touching a garbage can) and interaction (e.g., throwing something in the garbage can or taking a full garbage bag out of the garbage can). According to theories of grounded cognition, such sensory-motor experiences form the mental representation of the concept (e.g., *garbage can*). In contrast, abstract concepts (e.g., *ideas*) are not physical entities in the world. Even though our bodies cannot have direct physical experiences with abstract concepts, some theories, however, provide a framework in which mental representations of abstract concepts can still be grounded in sensory-motor experience (e.g., Barsalou, 1999; Barsalou & Wiemer-Hastings, 2005; Barwise & Perry, 1983; Lakoff & Johnson, 1980; Langacker, 1986). Lakoff and Johnson's Conceptual Metaphor Theory (CMT) has been one of the most influential of such frameworks. Lakoff and Johnson claim that people represent abstract concepts in terms of concrete concepts by metaphorical mapping. In the present paper we investigated how a particular abstract concept, *categories*, is represented. In the light of the CMT, we specifically investigated the idea that people represent the abstract concept *categories* in terms of the concrete concept *containers*. Metaphorical mapping such as those between *categories* and *containers* may explain how even abstract concepts could be formed by sensory-motor experiences (e.g., Barsalou, 1999; Barwise & Perry, 1983; Langacker, 1986).

Lakoff and Johnson (1980) claimed that metaphorical sentences such as "Are tomatoes *in* the fruit or vegetable category?" reflect underlying conceptual mappings (e.g., *categories are containers*). By this they mean that the mental structure of a concrete concept (e.g., *container*) is mapped onto an abstract concept (e.g., *category*). During this mapping the image schematic structure of concrete concepts is preserved. Image schemata are conceptual structures representing spatial relations and movements in space. They are argued to be formed by interaction of our body and senses with objects in the world during our childhood (Mandler, 1992) and ensuingly used to comprehend concepts in the world (Johnson, 1987; Lakoff & Johnson, 1999). For instance, activation of the *container* schema should make experiences like pouring water in a cup (a container being filled) coherent. According to the CMT not only the concrete situation as described above, but also the abstract concept *categories* should also activate the *container* schema through metaphorical mapping (Gibbs, 1994; Johnson, 1987; Lakoff & Johnson, 1980, 1999).

Interestingly, the CMT provides a theory about the origins of metaphorical mappings. Some metaphorical mappings, called primary metaphors, are directly formed by concrete situations (Grady, 1997 as cited in Lakoff & Johnson, 1999). Since categories are containers is a primary metaphor we will focus on this sort of conceptual mapping. Primary metaphors such as *categories are containers* are assumed to be formed directly through concrete experience where the abstract and concrete concept co-occur (e.g., kitchen tools and socks are put in different drawers) (Johnson, 1987, 1997; Lakoff & Johnson, 1980, 1999). People can interact with the concrete concept (e.g., *containers*) while the abstract concept (e.g., *categories*) is present. The correlation between the concepts in such a situation provokes a metaphorical link between the concrete and abstract concept. Later, in situations where only the abstract concept is present (e.g., reasoning about categories) this metaphorical link causes the mental representation of the concrete concept (e.g., *container schema*) to be used to understand the abstract concept in that situation.

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There is now a growing body of evidence in support of the CMT, such as for the metaphor *time is space* (Boroditsky, 2000; Casasanto & Boroditsky, 2008), *similarity is closeness* (Boot & Pecher, 2010; Casasanto, 2008), *good is up* (Crawford, Margolies, Drake, & Murphy, 2006; Meier & Robinson, 2004) and *power is up* (Giessner & Schubert, 2007; Moeller, Robinson, & Zabelina, 2008; Schubert, 2005; Zanolie et al., 2010), *social attachment is closeness* (Williams & Bargh, 2008a) and *affection is warmth* (Williams & Bargh, 2008b; Zhong & Leonardelli, 2008). In the present study we wanted to extend these findings to the metaphor *categories are containers*. Importantly, we wanted to investigate whether the *container* image schema would be activated even in the absence of any linguistic expression that might contain the metaphor.

According to Lakoff and Johnson metaphorical mappings are independent from metaphorical language. The conceptual mapping is assumed to be necessary to understand the abstract concept, and thus should get activated in any situation in which the abstract concept needs to be understood. In the present study we did not use metaphorical language nor literal language. We used pictures to activate the concept of interest. The concept *categories* was activated by pictures from the same or different categories (e.g., *animal* and *vehicle*). The *container* image schema was activated by a black line frame that included (in the container) or excluded (out of the container) the pictures. In this way we minimized effects due to activation of possible polysemous words (e.g., *in* and *out*, see Murphy, 1996) or lexical associations.

Nonlinguistic studies so far almost always used paradigms in which the stimuli contained features of the concrete concept (e.g., space) as well as the abstract concept (e.g., time). The features of the concrete concept were irrelevant to the task, whereas the features of the abstract concept were relevant. For instance, in a study by Casasanto and Boroditsky (2008) participants estimated presentation times of visual stimuli (e.g., a dot). Estimations were influenced by the spatial displacements of the stimuli, although displacement was task-irrelevant and uncorrelated with presentation duration. The bigger the displacement of the stimuli on the screen the longer participants estimated the presentation duration of the stimuli. Thus, Casasanto and Boroditsky (2008) showed that the conceptual mapping *time is space* is not only active during language processing but also during processing of visual nonlinguistic materials. They also showed that participants' performance was affected by the task-irrelevant spatial dimension. These results suggest that people use the mental representation of *space* in order to fully understand *time*. Similarly, in the present study we used stimuli that contained the task-irrelevant concrete concept (e.g., container) as well as the task-relevant abstract concept (e.g., categories).

An important question that we focused on in the present study is whether the image schema plays a role during representation of the abstract concept or during selection of the response. According to the CMT, image schemata are part of the representation of the abstract concept. There is some evidence, however, that irrelevant information can sometimes affect responses in situations with high uncertainty. For example, participants' judgments of justice in conditions of uncertainty (e.g., when there is no information about the others' outcome) were influenced by irrelevant information (e.g., affect, Van den Bos, 2003; Van den Bos, Lind, Vermunt, & Wilke, 1997). In studies investigating activation of image schemata during processing of abstract concepts a similar type of uncertainty might play a role as well. When participants have to choose from many response options (e.g., ratings on a Likert scale) and are uncertain about the accuracy of their choice, irrelevant information may affect responses. For instance, Schubert (2005) asked participants to judge animal pictures on respect on a scale from 1 (not at all) to 9 (very much). The pictures of the animals could be presented at the top or bottom of the screen. He found that participants gave higher ratings to powerful animals when presented at the top compared to the bottom of the screen. These results indicate that *power* is partly represented by *verticality*. In addition, however, participants might have used irrelevant information (i.e., picture position) to facilitate performance (i.e., judging animals on respect) in cases where they were uncertain about the correct response. Because judging animals on respect is subjective and perhaps unusual for the participants, it is possible that the irrelevant information (position of picture) might have influenced the response selection in congruence with the metaphor (e.g., animals presented at the top are more powerful than animals presented at the bottom). In sum, while it is obvious that the conceptual metaphor (e.g., *power is up*) was active during performance, it is unclear whether the image schema affected representation or response selection.

In the present study we tried to minimize such response uncertainty. In Experiment 1 participants decided whether two pictures were from the same or different categories. We used only two categories that were easy to distinguish (*animals* and *vehicles*). Additionally, we provided feedback to give confidence about the accuracy of responses. Because this task was very easy, and uncertainty was minimized, it was unlikely to induce the use of irrelevant information during response selection. The irrelevant information in our task was the position of a rectangular frame that was presented with the pictures. Both or only one picture could be presented inside the frame. The frame visualized a bounded region that should activate the *container* schema in its concrete meaning. The task itself should activate the concept *categories* that in turn should activate the *container* schema. The congruent trials were those in which the activation of the *container* schema matched for the irrelevant frame and the category decision (*things from the same category are in the same bounded region* or *things from different categories are not in the same bounded region*). Incongruent trials were those in which the *container* schema mismatched for the irrelevant frame and the category decision (*things from the same category are not in the same bounded region* or *things from different categories are in the same bounded region*). Equal numbers of congruent and incongruent trials were presented so that the irrelevant information (frame) was not predictive or helpful to select the correct response, which should further discourage participants from using the irrelevant information. If we still obtained an effect of the image schema on categorization decisions in congruence with the metaphor, this would support the idea that the *container* image schema is an essential part of the representation of the concept *category*.

In summary, our aim of the present study was to investigate the mental representation of the concept *categories*. In the light of the CMT we examined whether *categories* is metaphorically represented by *containers*. Additionally, we examined whether this metaphorical mapping occurs during a conceptual task on nonlinguistic stimuli and whether the metaphorical mapping occurs during mental representation of the abstract concept rather than during response selection. The conceptual metaphor *categories are containers* is of special interest, because it has not been investigated previously.

Moreover, two important factors were controlled in order to exclude confounding effects. First, the target pictures were centered on the screen and the distance between them was identical between trials. In this way eye movements were minimized and the conceptual mapping *similarity is closeness* could not influence outcomes (see Boot & Pecher, 2010; Casasanto, 2008). Second, differences in visual complexity between trials in which both pictures were presented inside the frame and trials in which one was outside the frame could not affect the predicted interaction because both configurations appeared in both the congruent and incongruent conditions.

If the concept of *categories* is conceptually represented by *containers*, we would expect to find an interaction. Performance for pictures from the same category should be better when presented both inside the frame than when one was outside the frame, whereas performance for pictures from different categories should be worse when presented both inside the frame than when one was outside the frame.

Experiment 1

Method

Participants and Design

Forty psychology students participated. They received course credits or a chocolate bar as a reward for their effort. Position of the pictures with respect to the frame and same versus different category were manipulated within subjects, type of categorization was manipulated between subjects. In order to counterbalance the materials over the experimental conditions, 20 participants decided whether two pictures were both animals or not (Animal condition), the other 20 participants decided whether two pictures were both vehicles or not (Vehicle condition).

Materials

We selected 10 pictures of animals and 10 pictures of vehicles from Bonin, Peereman, Malardier, Meot, and Chalard (2003), Stanfield and Zwaan (2001) and Zwaan, Stanfield, and Yaxley (2002), http://leadserv.u-bourgogne.fr/bases/pictures/), Pecher, Zanolie, and Zeelenberg (2007), and similar line drawings found on the Internet. We created 10 pairs of animals (using each animal two times) and 10 pairs of vehicles (using each vehicle two times), and 10 pairs of an animal with a vehicle. In the Animal condition (both animals or not) the vehicle pairs were not used, and in the Vehicle condition (both vehicles or not) the animal pairs were not used. Thus, in each task 20 pairs were presented. The pairs were presented next to each other in the center of the screen. The relative position of the two pictures (left or right) was counterbalanced across repetitions of the pair (two relative positions). The pairs were presented together with a frame that was a black lined square of 8 cm by 8 cm. This frame was either presented in the middle so that both pictures were inside the container or moved 4 cm to the left or right from the center, so that only one picture was in the container and one outside. For each formed pair we created two identical slides in which the container was in the middle, one with the container on the right and one with the container on the left (four frame positions of which two were identical). All slides were presented twice (two presentations). This resulted in 320 trials for each condition (Animal or Vehicle). Additionally, 16 practice trial slides with another set of pictures of animals and vehicles were created. The congruent trials were the slides with two objects from the same category presented both inside the container and slides in which the pictures were from different categories and one was presented inside and the other outside the container. Incongruent trials were slides in which both pictures were animals or vehicles but one was presented outside and the other inside the container and slides in which the pictures were from different categories and both presented inside the container. Examples of the four conditions are shown in Figure 1.

Procedure

The instruction and stimuli were presented on a computer screen. Participants were told that two categories were used in this experiment: animals and vehicles. Participants were randomly assigned to the Animal or Vehicle Condition. In the Animal Condition participants had to decide if the two pictures presented together on the screen were both animals or not. In the Vehicle Condition participants had to decide whether the two pictures were both vehicles or not. They were told to use the z-button and m-button to respond on a QWERTY keyboard. The mapping of the responses to buttons was counterbalanced. The pictures were presented with the frame at different positions. Participants were told to ignore the frame and focus on the pictures during the task. They started with the 16 practice trials. Each trial started with a fixation point (+) presented for 500 ms. Then the target slide appeared for 1,800 ms or until a response was given. Feedback was given for incorrect answers (*Fout* – Dutch translation for *Incorrect*) and responses slower than 1,800 ms (*Te langzaam* – Dutch translation for *Too slow*) which remained on the screen for 1,500 ms. There was no delay between the trials. After the practice trials the 320 experimental trials were presented in random order. The same procedure was used for the experimental trials as for the practice trials. All 320 trials were presented in random order without a break.

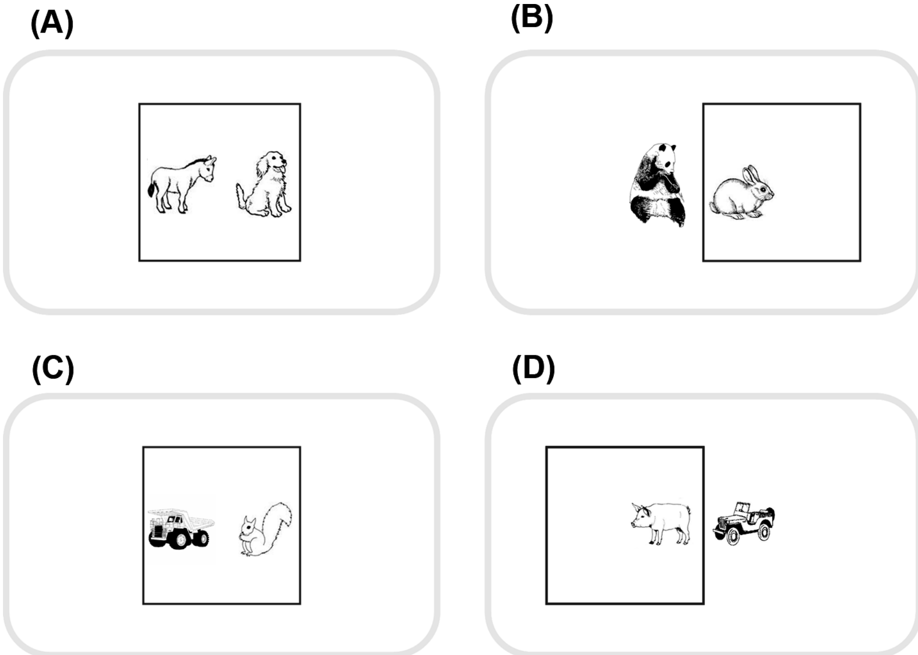

Figure 1. The four conditions of Experiment 1 in the Animal Task. In the Same-In Condition both animal pictures were presented in the frame (A), in the Same-In-Out Condition one animal picture was presented in and one outside the frame (B), in the Different-In Condition an animal and a vehicle picture were both presented in the frame (C), and in the Different-In-Out Condition one of the pictures (animal or vehicle) was presented in and one outside the frame (D). The pairs of pictures were horizontally centered. The frame was either presented in the center or 4 cm from the center to the left or right on the screen.

Results

We analyzed all reaction times of correct responses within 2 standard deviations from each subject's mean. This trimming procedure resulted in a removal of 5.6% of the correct reaction times in the Animal Condition and 4.8% in the Vehicle Condition. The means and error rates with the within-subject standard error of the mean (see Loftus & Masson, 1994) for each Task Condition are shown in Figure 2.

The reaction times and error rates were submitted to a 2 (Category: Same vs. Different) × 2 (Container: Both Inside vs. One Outside) repeated measures ANOVA with Task (animal vs. vehicle) as a between-subjects factor. In the reaction times we obtained an interaction effect of Category and Container, $F(2, 38) = 25.79$, $MSE = 180.3$, $p < .001$. This interaction effect was not significantly different between the Animal Task and the Vehicle Task, $F < 1$. With paired sample t tests with Bonferroni correction for multiple comparison we found that participants responded faster to pictures from the same category that were both presented inside the container than when one was presented outside the container, $t(19) = 7.50$, $SE = 3.0$, $p < .001$, whereas participants did not respond differently to pictures from different categories both presented inside the container or one outside, $p > .25$. Furthermore we found that participants responded faster to pictures if they were presented both inside the container than when one was presented outside the container, $F(2, 38) = 23.61$, $MSE = 234.9$, $p < .001$. We also found an overall effect of Category, $F(2, 38) = 14.80$, $MSE = 528.5$, $p < .001$. The interaction effect of Category and Task Condition, $F(2, 38) = 5.03$, $MS = 2657.9$, $p < .05$ shows that only in the Animal Task Condition participants responded faster to pictures from the same category than to pictures from different categories, $F(1, 19) = 16.16$, $MSE = 606.3$, $p < .01$, while in the Vehicle Task Condition there was no difference in reaction times between the Same and Different Category, $F(1, 19) = 1.51$, $MSE = 450.0$, $p > .10$.

In the error rates we found an interaction effect of Category and Container, $F(2, 38) = 10.47$, $MSE = .004$, $p < .005$. This interaction effect was not significantly different for the Animal Task and the Vehicle Task, $F < 1$. With paired sample t tests with Bonferroni correction for multiple comparison we found that participants responded more accurately to pictures from the same category that were both presented inside the container than when one was presented outside the container, $t(19) = 3.50$, $SE = .004$, $p < .005$, whereas participants did not respond differently to pictures from different categories that were both presented inside the container or one outside the container, $t(19) = 1.00$, $SE = .005$, $p > .10$.

Furthermore we found an overall effect of Category, $F(2, 38) = 14.81$, $MSE = .000$, $p < .001$. The interaction effect of Category and Task Condition, $F(2, 38) = 6.44$, $MS = .002$, $p < .025$ shows that only in the Animal Task

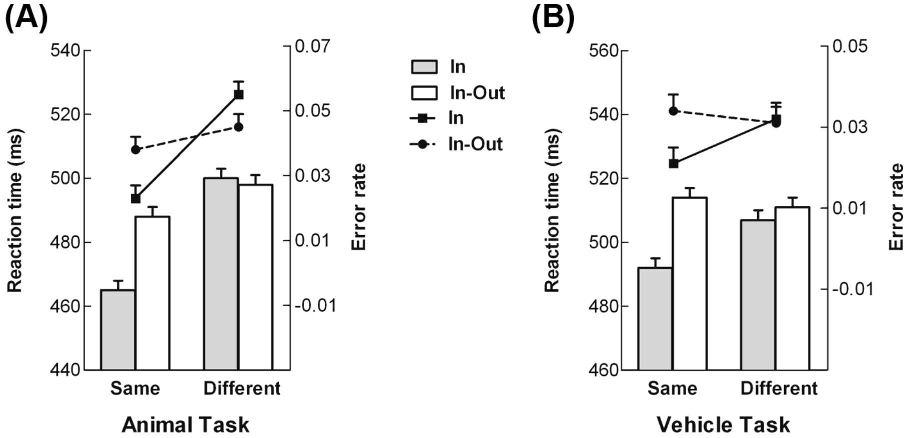

Figure 2. Mean reaction times in milliseconds and error percentages for the Animal Task Condition (A) and Vehicle Task Condition (B) in Experiment 1. The error bars present the within-subject standard error of the mean (Loftus & Masson, 1994) for each Task Condition.

Condition participants responded more accurately to pictures from the same category than pictures from different categories, $F(1, 19) = 17.01$, $MSE = .000$, $p < .0025$ while in the Vehicle Task Condition there was no difference in error rates between the Same and Different Category Conditions, $F(1, 19) = 1.07$, $MSE = .000$, $p < .30$.

We obtained the expected interaction effect in both the reaction times and error rates. With paired sample *t* test we found that this interaction effect was predominantly present in the same category condition. Performance was better to pictures from the same category when presented in the frame compared to one outside the frame, whereas performance on different categories was not influenced by different frame positions. The lack of significance on the *different categories* side was probably due to the main effects of Container and Category. Nevertheless, the interaction effect in both the reaction times and error rates clearly shows that the position of the frame influences the responses on *same category* and *different category* differently. In order to ascertain that the interaction was robust we replicated Experiment 1 with a different set of materials. This replication also showed a significant interaction between Category and Container, $F(2, 38) = 12.01$, $MSE = 226.7$ $p < .01$.[1]

Discussion

Experiment 1 showed that the frame (*container*), even though it was irrelevant for the task, still influenced the category decision task. We obtained an interaction effect in both the reaction times and accuracy. Performance was better to pictures from the same category when both rather than one were presented inside the container, whereas performance was not different to pictures from different categories when both compared to one were presented inside the container. These results support the idea that the concept *categories* is metaphorically represented by the image schema *containers*.

Experiment 2

In the next experiment we wanted to eliminate an alternative explanation. In Experiments 1 participants had to make a binary decision (Same/Different Category or Animal/Nonanimal) over stimuli with binary values (Both Inside/One Outside or simply Inside/Outside). To simplify the task, participants might have taken advantage of these binary values by aligning them (e.g., Same Category with Both Inside). Such alignment of polarities has been suggested by Proctor and Cho (2006) as an explanation for a variety of binary decision tasks. There are two reasons why such alignment seems unlikely in the present series of experiments. First, each combination of binary values was equally likely, so there was no benefit to participants to use a specific alignment. Second, if participants used such alignment they should have made many errors. In contrast to this prediction, however, the error rates were extremely low (well below 0.1% in most cases). Nevertheless, to exclude alignment as an explanation we performed Experiment 2 in which container position was manipulated at more than two levels. In Experiment 2 pictures from the same category and different categories were not only presented *both inside* or *one outside* the frame (as in Experiment 1) but also *both outside* the frame. If participants in Experiment 1 used alignment of the binary values, the interaction effect between category (same vs. different) and container (both inside vs. one outside) should disappear.

On the other hand, if the image schema affects performance, we expect to obtain again an interaction between

[1] In Experiment 1 the pictures were from a small subcategory of Animal (four legged mammals) and Vehicle (motor driven vehicles). Thus, the same category pictures were visually quite similar. We replicated Experiment 1 with a different set of pictures (20 line drawings of animals and 20 line drawings of vehicles from the same sources as in Experiment 1) to extend the findings of Experiment 1. The subset we used in the replication were more varied pictures from different subcategories. For example, for animals, beside four-legged mammals, we used also winged animals, an insect, fish, and reptiles and for Vehicles, beside four-wheeled transport, we used also aviations, boats, and nonmotorized transport. By using a more varied set of pictures that were visually less similar we showed that the conceptual mapping generalizes to broader categories.

category and frame position. Moreover, we expect the effect of frame position to be graded. In terms of the metaphorical mapping, two things inside the container are members of the same category, whereas something outside the container is not in the same category as something inside the container. However, two things outside the container might be members of the same or different categories (e.g., two things that are not food could be two animals or one animal and one vehicle). Therefore, we expect that same category decisions will be fastest when both pictures are inside the container, slowest when one picture is inside the container, and somewhat intermediate when both pictures are outside the container. For different category decisions the effect should be opposite. As in the previous experiments visual complexity was equated for the congruent and incongruent trials and thus should not affect the predicted interaction effect.

Method

Participants

Thirty psychology students who did not participate in Experiment 1 received course credits for participating.

Materials

We selected the same line drawings (10 animals and 10 vehicles) as in Experiment 1. The same 10 pairs of animals (using each animal two times) and 10 pairs of an animal with a vehicle were used as in the Animal Condition of Experiment 1. The pictures were presented together with

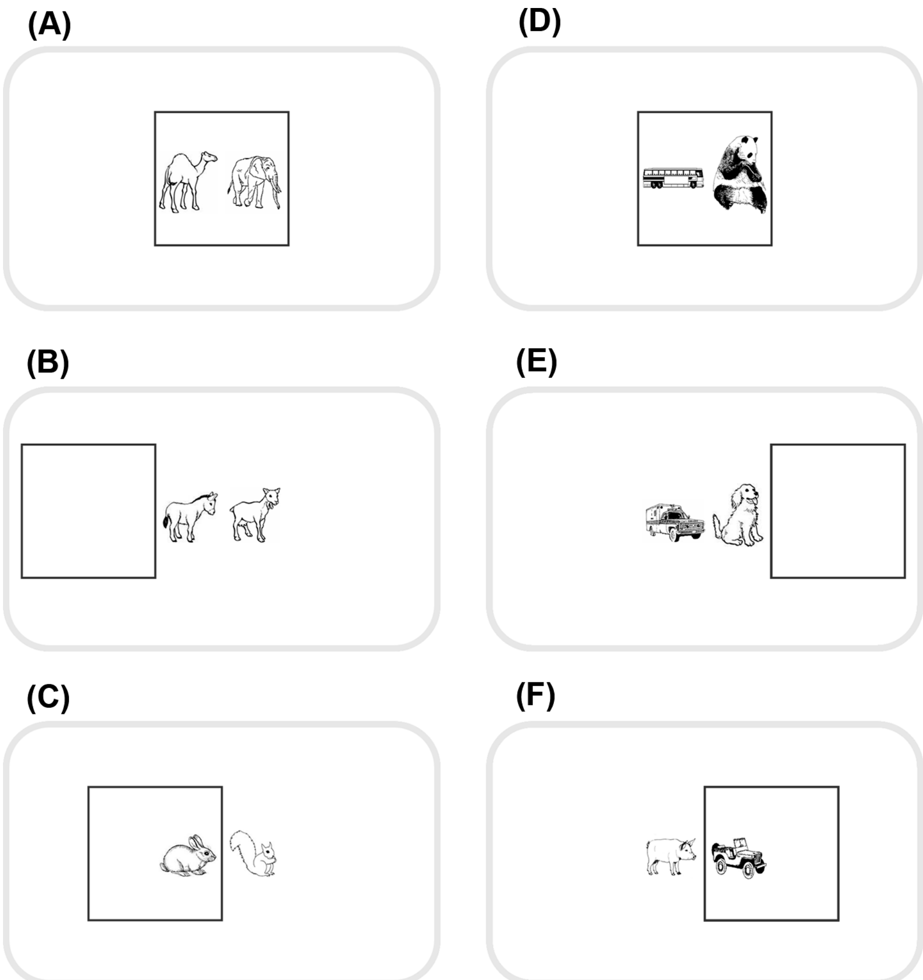

Figure 3. The six conditions of Experiment 4. In the Same-In Condition two animal pictures were presented in the frame (A), in the Same-Out Condition both animal pictures were presented outside the frame (B), in the Same-In-Out Condition one animal picture was presented in and one outside the frame (C), in the Different-In Condition an animal and a vehicle picture were both presented in the frame (D), in the Different-Out Condition both the animal picture and the vehicle picture were presented outside the frame (E), and in the Different-In-Out Condition one of the pictures (animal or vehicle) was presented in and one outside the frame (F). The pairs of pictures were horizontally centered. The frame was either presented in the center, 4 cm from the center to the left or right on the screen, or 8 cm from the center to the left or right on the screen.

the frame in the same way as in Experiment 1 with an additional third condition in which the frame was moved 8 cm to the left or right from the center, so that both pictures were outside the container (altogether six frame positions of which two were identical). Again, the relative position of the two pictures was counterbalanced across repetitions of the pair, but without mirroring the pictures as we did in Experiment 1. Each slide was presented twice. This resulted in 480 trials. Additional 18 practice trial slides with the same set of pictures as in the practice trials of the Animal Condition of Experiment 1 were created. Examples of the six conditions are shown in Figure 3.

Procedure

The procedure was the same as in the Animal Condition of Experiment 1. After the 18 practice trials, the 480 experimental trials were presented in random order. Participants could take a break after 240 experimental trials.

Results and Discussion

We analyzed all reaction times of correct responses within 2 standard deviations from each subject's mean. This trimming procedure resulted in a removal of 4.7% of the correct reaction times. The means and error rates with the within-subject standard error of the mean (see Loftus & Masson, 1994) for each Task Condition are shown in Figure 4. All *t* tests used a Bonferroni correction for multiple comparisons.

The reaction times and error rates were submitted to a 2 (Category: Same vs. Different) × 3 (Container: Both Inside, Both Outside, One Outside) repeated measures ANOVA. In the reaction times we obtained an interaction effect of Category and Container, $F(2, 58) = 13.44$, $MSE = 137.6$, $p < .001$. This interaction was due to significant effects of frame position on same category decisions. Participants responded faster to pictures from the *same category* that were both presented *inside* the container ($M = 504$) than when *one was presented outside* the container ($M = 531$), $t(29) = 7.00$, $SE = 3.8$, $p < .001$. Additionally we found that the effect in the *same category* condition of the three positions of the frame was graded. Participants responded faster when the pictures from the s*ame category* were *both presented outside* the container ($M = 516$) than when *one was presented outside* the container ($M = 531$), $t(29) = 6.38$, $SE = 2.3$, $p < .001$, and when they were *both presented inside* the container ($M = 504$) than when they were *both presented outside* the container ($M = 516$), $t(29) = 3.75$, $SE = 3.2$, $p < .005$. In contrast, reaction times to pictures from different categories were not significantly affected by frame position, all *p*s > .05.

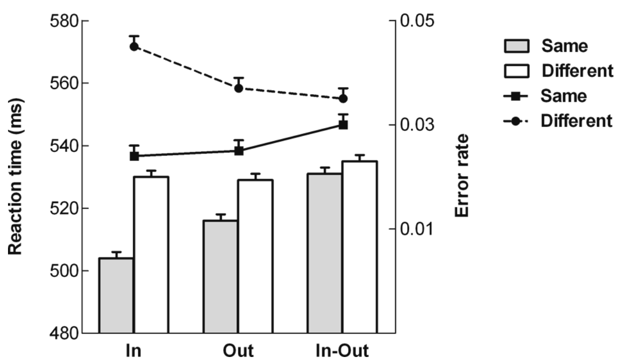

Figure 4. Mean reaction times in milliseconds and error percentages for the category decision tasks in Experiment 4. The error bars present the within-subject standard error of the mean (Loftus & Masson, 1994).

Furthermore, we found a main effect of Container, $F(2, 58) = 34.27$, $MSE = 107.4$, $p < .001$. Participants responded faster to pictures presented *both inside* the container ($M = 517$) compared to *both outside* ($M = 523$), $t(29) = 2.62$, $SE = 2.08$, $p < .05$, and *one outside* the container ($M = 533$), $t(29) = 7.92$, $SE = 2.0$, $p < .001$. Participants were also significantly faster to respond to pictures presented *both outside* compared to *one outside* the container, $t(29) = 6.21$, $SE = 1.61$, $p < .001$. Moreover, participants were faster to respond to pictures from the same category (two animals) than to pictures from different categories (one animal and one vehicle), $F(1, 29) = 10.04$, $MSE = 928.3$, $p < .005$.

In the error rates we found an interaction effect of Category and Container, $F(2, 58) = 5.26$, $MSE = .0002$, $p < .01$. Participants made slightly less errors to pictures from the *same category* that were *both presented inside* the container ($M = .024$) than when *one was presented outside* the container ($M = .030$), this difference approached significance, $t(29) = 2.26$, $SE = .003$, $p < .10$. The other differences were in the predicted direction, but none of these were significant. Furthermore, we found a main effect of Category, $F(1, 29) = 22.53$, $MSE = .0003$, $p < .001$. Participants responded more accurate to pictures from the same category (two animals) than to pictures from different categories (one animal and one vehicle).

The present experiment showed that the frame (*container*) influenced the reaction times in the category decision task in a graded fashion across three different positions, consistent with the metaphor. These results tell us that the effect obtained in Experiment 1 was not due to alignment of binary values. The interaction between category and container is still present when we used a third value. These data are in line with the idea that we use image schemata of concrete concepts to understand abstract concepts.

General Discussion

In the present study we investigate the mental representation of *categories* in the light of the CMT (Lakoff & Johnson, 1980, 1999). The CMT holds that abstract concepts (e.g., *categories*) are metaphorically represented by concrete concepts (e.g., *containers*). Participants had to perform a category decision task on pictures that were presented together with a container. In Experiment 1 category decisions were affected by whether both pictures were inside the container or not. In Experiment 2 we controlled for binary alignment and again obtained an effect of the position of pictures relative to the container. These findings are congruent with the idea that the concept *categories* is metaphorically represented by the concept *containers*. Because our paradigm used pictorial material and an easy task in which the correct response was absolutely clear these results are not likely to be due to activation of linguistic metaphors or use of irrelevant information for response selection.

Beside the expected interaction effect, a main effect of Container was obtained in the reaction times for all experiments. Participants responded faster when pictures were presented inside the container than when one or both pictures were presented outside the container. A possible explanation is that the frame drew people's visual spatial attention more to what was inside the frame than to what was outside. This main effect of Container may explain why responses to pictures from different categories were not faster when one picture was outside the container (Congruent condition) than when the pictures were both inside the container (Incongruent condition). Probably, the effect of congruence was counteracted by the main effect of Container.

The interaction effects in the present study are consistent with previous research investigating the metaphorical mapping of other abstract concepts with nonlinguistic materials. Several studies have shown interactions between concrete and abstract domains using visual stimuli that contained both the concrete and abstract concept (Boot & Pecher, 2010; Breaux & Feist, 2008; Casasanto, 2008; Casasanto & Boroditsky, 2008; Crawford et al., 2006; Meier, Hauser, Robinson, Friesen, & Schjeldahl, 2007; Schubert, 2005). These effects were congruent with the metaphor (e.g., participants judged animals as more powerful when presented higher compared to lower on the screen). When nonlinguistic materials are used, results are no longer due to presentation of metaphorical language. Even though it might be possible that participants verbalized the task, it is unlikely that they verbalized the metaphor *categories are containers*. Thus, the present study showed that even in a nonlinguistic context the metaphorical mapping occurs. As we discussed earlier, in some of these previous studies it was not clear whether it was the mental representation of abstract concepts or the response selection process that was affected by image schemata. In the present study we minimized the likelihood that the image schema affected response selection. Nevertheless, participants' performance was influenced by the frame in congruence with the *container* image schema (Lakoff & Johnson, 1999; Lakoff & Núñez, 2000). In addition to recent studies these findings provide evidence for the CMT of Lakoff and Johnson (1980, 1999).

At present it is still an open question to what extent the CMT holds for all metaphors found in language. Only for a number of metaphors (e.g., *similarity is closeness, power is up,* and *time is spatial movement*) experimental evidence is available that supports the idea that abstract concepts are understood by conceptual metaphorical mapping, as has been shown in the present study. Although the evidence suggests that the role of metaphors is widespread, there are still many metaphors that have not yet been investigated. To our knowledge, the present study is the first to provide evidence for the mapping of *containers* on *categories*.

The evidence for the role of metaphors has implications for theories on sensory-motor grounding of cognition. Such theories propose that mental representations of concepts are grounded in sensory-motor experience (e.g., Barsalou, 1999; Glenberg, 1997; Goldstone, 1994). In line with this view, the CMT framework proposes that image schemata formed by bodily interaction are the building blocks of concrete concepts (Johnson, 1987) as well as of abstract concepts through the mechanism of conceptual mapping.

Although image schemata refer to basic bodily experiences, they do not represent full and rich sensory-motor experiences. Beside the *container* image schema, the concept *categories* has other features, such as the fact that there is visual similarity among exemplars or that exemplars of a category have the same function. In addition to image schemata, abstract concepts might also be represented by simulations of introspective experiences and specific situations in which the abstract concept plays a role (Barsalou, 1999; Barsalou & Wiemer-Hasings, 2005). Together with these proposals, the growing body of evidence for the role of image schemata supports the idea that, like those for concrete concepts, mental representations of abstract concepts can be grounded in sensory-motor experiences.

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References

Barsalou, L. W. (1999). Perceptual symbol system. *Behavioral and Brain Sciences, 22*, 577–660.

Barsalou, L. W., & Wiemer-Hasings, K. (2005). Situating abstract concepts. In D. Pecher & R. A. Zwaan (Eds.), *The grounding of cognition: The role of perception and action in memory, language, and thinking*. Cambridge: Cambridge University Press.

Barwise, J., & Perry, J. (1983). *Situations and attitudes*. Cambridge: MIT Press.

Bonin, P., Peereman, R., Malardier, N., Meot, A., & Chalard, M. (2003). A new set of 299 pictures for psycholinguistic studies: French norms for name agreement, image agreement, conceptual familiarity, visual complexity, image variability, age of acquisition, and naming latencies. *Behavior Research Methods, Instruments, & Computers, 35*, 158–167.

Boot, I., & Pecher, D. (2010). Similarity is closeness: Metaphorical mapping in a conceptual task. *Quarterly Journal of Experimental Psychology, 63*, 942–954.

Boroditsky, L. (2000). Metaphorical structuring: Understanding time through spatial metaphors. *Cognition, 75*, 1–28.

Breaux, B. O., & Feist, M. I. (2008). The color of similarity. In B. C. Love, K. McRae, & V. M. Sloutsky (Eds.), *Proceedings of the 30th Annual Conference of the Cognitive Society* (pp. 253–258). Austin, TX: Cognitive Science Conference.

Casasanto, D. (2008). Similarity and proximity: When does close in space mean close in mind? *Memory & Cognition, 36*, 1047–1056.

Casasanto, D., & Boroditsky, L. (2008). Time in the mind: Using space to think about time. *Cognition, 106*, 579–593.

Crawford, L. E., Margolies, S. M., Drake, J. T., & Murphy, M. E. (2006). Affect biases memory of location: Evidence for the

spatial representation of affect. *Cognition & Emotion, 20*, 1153–1163.
Gibbs, R. W. (1994). *The poetics of mind: Figurative thought, language, and understanding*. New York: Cambridge University Press.
Giessner, S. R., & Schubert, T. W. (2007). High in the hierarchy: How vertical location and judgments of leaders' power are interrelated. *Organizational Behavior and Human Decision processes, 104*, 30–44.
Glenberg, A. M. (1997). What memory is for?. *Behavioral and Brain Sciences, 20*, 1–55.
Goldstone, R. (1994). Influences of categorization on perceptual discrimination. *Journal of Experimental Psychology: General, 123*, 178–200.
Johnson, M. (1987). *The body in the mind: The bodily basis of reason and imagination*. Chicago: University of Chicago Press.
Johnson, C. (1997). Metaphors vs. conflation in the acquisition of polysemy: The case of SEE. In M. K. Hiraga, C. Sinha & S. Wilcox (Eds.), *Cultural, psychological and typological issues in cognitive linguistics* (152, pp. 155–169). Amsterdam: John Benjamins.
Lakoff, G., & Johnson, M. (1980). *Metaphors we live by*. Chicago: Chicago University Press.
Lakoff, G., & Johnson, M. (1999). *The philosophy in the flesh: The embodied mind and its challenge to the western thought*. New York, NY: Basic Books.
Lakoff, G., & Nú?ez, R. E. (2000). *How the embodied mind brings mathematics into being*. New York, NY: Basic Books.
Langacker, R W. (1986). An introduction to cognitive grammar. *Cognitive Science, 10*, 1–40.
Loftus, G. R., & Masson, M. E. J. (1994). Using confidence intervals in within-subject designs. *Psychonomic Bulletin & Review, 1*, 476–490.
Mandler, J. M. (1992). How to build a baby: II. Conceptual primitives. *Psychological Review, 99*, 587–604.
Meier, B. P., Hauser, D. J., Robinson, M. D., Friesen, C. K., & Schjeldahl, K. (2007). What's "up" with God? Vertical space as a representation of the divine. *Journal of Personality and Social Psychology, 93*, 599–710.
Meier, B. P., & Robinson, M. D. (2004). Why the sunny side is up: Association between affect and vertical position. *Psychological Science, 15*, 243–247.
Moeller, S. K., Robinson, M. D., & Zabelina, D. L. (2008). Personality dominance and preferential use of the vertical dimension of space: Evidence from spatial attention paradigms. *Psychological Science, 19*, 355–361.
Murphy, G. L. (1996). On metaphoric representation. *Cognition, 60*, 173–204.
Pecher, D., Zanolie, K., & Zeelenberg, R. (2007). Verifying visual properties in sentence verification facilitates picture recognition memory. *Experimental Psychology, 54*, 173–179.
Proctor, R. W., & Cho, Y. S. (2006). Polarity correspondence: A general principle for performance of speeded binary classification tasks. *Psychological Bulletin, 132*, 416–442.
Schubert, T. W. (2005). Your highness: Vertical positions as perceptual symbols of power. *Journal of Personality and Social Psychology, 89*, 1–21.
Stanfield, R. A., & Zwaan, R. A. (2001). The effect of implied orientation derived from verbal context on picture recognition. *Psychological Science, 12*, 153–156.
Van den Bos, K. (2003). On the subjective quality of social justice: The role of affect as information in the psychology of justice judgments. *Journal of Personality and Social Psychology, 85*, 482–498.
Van den Bos, K., Lind, E. A., Vermunt, R., & Wilke, H. A. M. (1997). How do I judge my outcome when I do not know the outcome of others? The psychology of the fair process effect. *Journal of Personality and Social Psychology, 72*, 1034–1046.
Williams, L. E., & Bargh, J. A. (2008a). Experiencing physical warmth promotes interpersonal warmth. *Science, 322*, 606–607.
Williams, L. E., & Bargh, J. A. (2008b). Keeping one's distance: the influence of spatial distance cues on affect and evaluation. *Psychological Science, 19*, 302–308.
Zanolie, K., Van Dantzig, S., Boot, I., Wijnen, J., Schubert, T., Giesner, S., & Pecher, D. (2010). *Mighty metaphors: Behavioral and ERP evidence that power shifts attention on a vertical dimension.* Manuscript submitted for publication.
Zhong, C., & Leonardelli, G. J. (2008). Cold and lonely. *Psychological Science, 19*, 838–842.
Zwaan, R. A., Stanfield, R. A., & Yaxley, R. H. (2002). Language comprehenders mentally represent the shapes of object. *Psychological Science, 13*, 168–171.

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