Unconstraining theories of embodied cognition

Dantzig, Saskia van; Zeelenberg, René; Pecher, Diane

Postprint / Postprint
Zeitschriftenartikel / journal article

Zur Verfügung gestellt in Kooperation mit / provided in cooperation with:
www.peerproject.eu

Empfohlene Zitierung / Suggested Citation:
Dantzig, S. v., Zeelenberg, R., & Pecher, D. (2009). Unconstraining theories of embodied cognition. *Journal of Experimental Social Psychology*, *45*(2), 345-351. https://doi.org/10.1016/j.jesp.2008.11.001

Unconstraining Theories of Embodied Cognition

Saskia van Dantzig, René Zeelenberg, Diane Pecher

PII: S0022-1031(08)00216-3
DOI: 10.1016/j.jesp.2008.11.001
Reference: YJESP 2187

To appear in: *Journal of Experimental Social Psychology*

Received Date: 25 March 2008
Revised Date: 29 October 2008
Accepted Date: 3 November 2008

Please cite this article as: van Dantzig, S., Zeelenberg, R., Pecher, D., Unconstraining Theories of Embodied Cognition, *Journal of Experimental Social Psychology* (2008), doi: 10.1016/j.jesp.2008.11.001

Unconstraining Theories of Embodied Cognition

Saskia van Dantzig[1], René Zeelenberg[2], Diane Pecher[2]

[1] Erasmus University Rotterdam, Leiden University

[2] Erasmus University Rotterdam

Word count: 5488 (including footnotes)

Address correspondence to:

Saskia van Dantzig

Leiden University, Department of Psychology

Wassenaarseweg 52, Room 2B11

P.O. Box 9555

2300 RB Leiden, The Netherlands

Phone: +31 71 5276667

Email: sdantzig@fsw.leidenuniv.nl

Abstract

The *approach/avoidance effect* refers to the finding that valenced stimuli trigger approach and avoidance actions. Markman and Brendl (2005) argued that this effect is not a truly embodied phenomenon, but depends on participants' symbolic representation of the self.

In their study, participants moved valenced words toward or away from their own name on the computer screen. This would induce participants to form a 'disembodied' self-representation at the location of their name, outside of the body. Approach/avoidance effects occurred with respect to the participant's name, rather than with respect to the body.

In three experiments, we demonstrate that similar effects are found when the name is replaced by a positive word, a negative word or even when no word is presented at all. This suggests that the 'disembodied self' explanation of Markman and Brendl is incorrect, and that their findings do not necessarily constrain embodied theories of cognition.

Unconstraining Theories of Embodied Cognition

Many studies have demonstrated that positive and negative words automatically trigger approach or avoidance actions (e.g., Chen & Bargh, 1999; Rotteveel & Phaf, 2004; Solarz, 1960; Wentura, Rothermund, & Bak, 2000). This phenomenon, called the *approach/avoidance effect,* has been brought forward as an example of embodied cognition (e.g., Niedenthal et al., 2005). It shows that cognitive processing involves the activation of the sensorimotor system. In studies of this phenomenon, participants typically respond to valenced words by making an arm movement toward or away from the word. For example, in the study by Chen and Bargh (1999), participants categorized positive and negative words by pulling a joystick toward themselves or pushing it away. In response to positive words, participants were faster to pull the joystick than to push it away. In response to negative words, in contrast, they were faster to push the joystick away than to pull it toward themselves. Based on these findings, Chen and Bargh concluded that valenced words are evaluated automatically. This automatic evaluation involves the activation of particular arm movements that are associated with approach and avoidance. They defined arm flexion as an approach reaction (pulling a positive stimulus toward oneself) and arm extension as an avoidance reaction (pushing a negative stimulus away).

However, other studies have shown that arm movements cannot be unambiguously connected to approach or avoidance. Arm flexion can also be associated with withdrawing from an aversive stimulus (avoidance), and arm extension can be interpreted as reaching for a desired stimulus (e.g., Seibt, Neumann, Nussinson, & Strack, 2008). Approach and avoidance effects have even been found when participants do not move their arms with respect to the stimulus, but instead make button presses that result in an apparent movement of the stimulus toward or away from the participant (van Dantzig, Pecher, & Zwaan, 2008).

To resolve the ambiguity, Markman and Brendl (2005) suggested that it is not the direction of motion as such that defines whether a movement is associated with approach or avoidance, but rather the direction of motion with respect to the *self*. Usually, the self is represented as located within the body. The location of the self in space is therefore confounded with that of the body. Markman and Brendl tried to deconfound the representations of self and body. In their study, participants viewed a computer screen displaying a corridor, which produced an illusion of depth. The participant's name (representing the self) was presented in the center of the corridor, and emotionally valenced words appeared either in front of the name or behind the name, as illustrated in Figure 1. Participants responded to the words by moving a joystick backward or forward. Participants who received the *positive toward* instruction were told to move positive words toward their own name and to move negative words away from it. Conversely, participants in the *negative toward* condition were instructed to move negative words toward their own name and positive words away from it. Depending on the location of the word (behind or in front of the participant's name), moving the word toward the name could imply a pulling motion or a pushing motion. Moving the word away from the name could also require either pulling or pushing, depending on whether the word appeared in front of the name or behind it.

Markman and Brendl reasoned that if evaluative movements are made with respect to the representation of the self rather than to the body, participants in the *positive toward* condition should be faster than participants in the *negative toward* condition, regardless of the direction of bodily motion. Their results confirmed this hypothesis. Participants were faster to move positive words toward their name (the representation of the self) and negative words away from their name, irrespective of whether that implied a pulling or a pushing motion. Similar findings were obtained in a study by Brendl, Markman and Messner (2005). In this study, target words were presented to the left and right of the participant's name, and participants moved a joystick sideways to move the words toward or away from their name. Again, response times were faster when participants moved positive words toward their name and negative words away from their name. Based on their findings, Markman and Brendl (2005) concluded that the connection between stimulus evaluation and bodily action is not direct, but mediated by abstract representations of approach and avoidance behavior and the self. Building further upon this conclusion, they argued that a purely embodied account of cognition is insufficient to explain all of cognition. In addition to perceptual and motor representations, embodied theories of cognition must also include more abstract or symbolic representations. In other words, they suggest that their findings constrain theories of embodied cognition.

However, this argument hinges on the assumption that the phenomenon studied in their experiment is a true instance of the approach/avoidance effect. This assumption is debatable, for a number of reasons. First, Markman and Brendl (2005) suppose that their participants form a representation of the self at the location of their own name on the screen. One could, however, wonder if the manipulation of merely presenting the participant's name on the computer screen is sufficient to trigger participants to form such a disembodied self representation.

Second, if one assumes that participants do indeed form some kind of disembodied representation of the self, one would expect this representation to be weaker than a representation of the self located within the body. After all, people typically represent the self as integrated within the body. The body is therefore the default location of the self. As a consequence, approach/avoidance effects with respect to a disembodied self on the computer screen should be smaller than approach/avoidance effects with respect to the 'self-within-body'. After all, it is very unlikely that people would show stronger approach or avoidance reactions toward a non-physical representation of the self than to their own body. In experiments studying the approach/avoidance effect with regard to the body, the effect sizes (η^2) typically lie in the range of .08 to .23 (Chen & Bargh, 1999; Rotteveel & Phaf, 2004; Wentura et al., 2000). Instead of being smaller than these numbers, the effect size in Markman and Brendl's experiment is .41, almost twice as large as the largest of the effect sizes observed in body-related approach/avoidance studies[1]. This observation suggests that the results of their study may not reflect a true approach/avoidance effect, but rather that they are (at least partially) caused by a different process.

A possible candidate for such a different process is categorization. In Markman and Brendl's (2005) experiment, participants classified words into a positive or a negative category, by moving the words with respect to their name. Participants may have used their name as a category label, referring to the category of words that had to be moved toward it. Thus, for participants who moved positive words toward their own name, their name represented the positive category. On the other hand, for participants who moved negative words toward their own name, their name denoted the negative category. It is quite likely that the latter group of participants had trouble using their name as a negative category label, because one's own name typically has a strong positive value. This is demonstrated, for example, by the name-letter effect (e.g., Koole, Dijksterhuis, & van Knippenberg, 2001), which refers to the finding that people like the letters (especially the initials) of their own name better than other letters of the alphabet. The name-letter effect correlates with measures of self-esteem. The positive bias of the own name thus appears to reflect the fact that most people have quite a favourable view of themselves (e.g., Greenwald & Farnham, 2000; Koole et al., 2001).

If participants consider the Markman and Brendl task as a categorization task, using their names as category labels, we expect them to perform this categorization task more easily when the valence of the category label (the participant's name) matches the items that have to be sorted within that category (positive words) than when the category label mismatches the category members (negative words). This prediction is in line with the findings of Markman and Brendl (2005). In addition, the categorization hypothesis also predicts that a similar congruency effect should be obtained when the participant's name is replaced by another strongly positive word. Conversely, if the name is replaced by a negative word, the opposite effect should be found. Participants should be slower to move positive words toward the negative word, and faster to move negative words toward it. These predictions were tested in the current study, in which we followed the procedure of Markman and Brendl, but either replaced the participant's name with the strongly positive word 'Love' (Experiment 1) or the strongly negative word 'Hate' (Experiment 2). When the word 'Love' was used instead of the name, we expected the same pattern of results as in the Markman and Brendl study. When the word 'Hate' was used, we expected to find the opposite pattern of results.

Experiment 1

Method

Participants. Thirty-seven students from the Erasmus University Rotterdam participated in the experiment, in return for course credit or a small monetary fee (€ 5,-). One participant, with an error rate higher than 30%, was excluded from the analysis. Participants were randomly assigned to one of the two instructions.

Stimulus Materials and Apparatus. Thirty-two positive and thirty-two negative words were selected from a normed list. The words on this list had been rated on a 7-point scale (1 = extremely negative, 7 = extremely positive) by 29 participants. Word frequencies of the selected words were retrieved from the CELEX database (Baayen, Piepenbrock, & van Rijn, 1993). The positive central word 'Liefde' (Love) received a valence rating of 6.4 and has a log frequency of 2.23 per million. The negative target words had an average valence rating of

2.0 (*SD* = 0.23) and a log frequency of 1.06 per million (*SD* = 0.41). The positive target words had an average valence rating of 6.0 (*SD* = 0.29) and a frequency of 1.27 per million (*SD* = 0.45). Most of the words were nouns (42 words), the others were adjectives (8 words) and verbs (14 words). The complete stimulus list is provided in the Appendix. In addition to the target stimuli, a set of comparable, but slightly less extremely valenced words were selected to function as practice and warm-up trials[1].

Words were presented on a 22-inch computer screen, with a resolution of 1248 by 1024 pixels, using E-Prime stimulus presentation software (Schneider, Eschman, & Zuccolotto, 2002).

Participants were instructed to 'move' the target words toward or away from the central word (which was presented in a rectangular box) by making a mouse movement [2]. The mouse speed was set at a low value, such that a response required a considerable movement of the mouse (approximately 10 cm in forward or backward direction). The mouse acceleration rate was set to zero, such that the cursor's position on the screen was linearly related to the position of the mouse on the table. The cursor remained invisible to the participants. It was placed in the middle of the screen at the start of each trial, and its position was continuously tracked during the participant's response. Prior to the experiment, a pilot study was run to verify that the original findings of Markman and Brendl (2005) could be replicated with our slightly altered design and Dutch stimulus set. The design and results of this pilot study are described in more detail in Footnote 3. Despite the methodological differences, the results of Markman and Brendl's original study were replicated in our pilot study.

Procedure. Participants were randomly assigned to one of the two conditions. Participants in the *Positive toward* condition were instructed to move positive words toward the central word 'Love' and negative words away from it. Participants in the *Negative toward* condition were instructed to move positive words away from the central word 'Love', and negative words toward it.

Participants sat at a distance of approximately fifty centimetres from the computer screen, and held the mouse with their preferred hand. The central word 'Love' was presented on a rectangular block in the middle of the screen for the duration of the experiment.

Participants initiated each trial by placing the mouse on a black cross drawn on the tabletop (approximately twenty-five centimetres from the table's edge), and clicking the left mouse button. After an interval of 50 ms a target word appeared either in front of the central word or behind it. Participants responded to the valence of the target word by pushing the mouse forward or pulling it backward. The target word remained on the screen until the cursor had reached the upper or lower border of the screen or until 4000 ms had passed.

The experiment started with two practice blocks, followed by four experimental blocks. The first practice block used the words 'goed' ('*good*') and 'slecht' ('*bad*'). The second practice block used various emotionally valenced words, similar to the words used in the experimental blocks. During the practice blocks, participants received feedback after each trial. During the experimental blocks, no immediate feedback was given anymore. Instead, after each block, subjects received feedback on their average accuracy during that block. They were complimented when accuracy was higher than 97 % and urged to be more accurate when accuracy was below 90 %. Each block started with two warm-up trials, followed by thirty-two experimental trials. Each target word was presented twice, once in each position.

Results

We expected that the motion-congruency effect should be primarily found in the response initiation time, because this measure is thought to reflect central processes such as stimulus evaluation, response selection and motor planning (Rotteveel & Phaf, 2004). Other measures, such as movement time, were not expected to be affected by the experimental conditions. Movement time is considered to be relatively independent of the response initiation time, and is affected more by physical characteristics of the response such as the distance and speed of the mouse movement.

The response initiation time was defined as the time at which the cursor had been moved 50 pixels from its starting point in vertical direction. This measure combined a high sensitivity to true responses with a low responsiveness to small random mouse movements. Responses that were incorrect, slower than 2500 ms or faster than 200 ms were removed from the analysis. In addition, response times more than 2 standard deviations from the subject mean were considered outliers and filtered out. In total, 4.6 % of the data were excluded because of errors and 8.0 % were removed because of outlying reaction times. The average response times per condition are presented in Table 1. Data were analyzed by subject and by item, using an independent samples t-test with Instruction (Positive toward vs. Negative toward) as between-participant factor.

As predicted, participants in the Positive toward condition responded faster (M = 863 ms) than those in the Negative toward condition (M = 986 ms). This effect was significant both in the subject analysis, $t_1(34) = 2.51$, $p < .05$, *Cohen's d* = .86, and in the item analysis, $t_2(63) = 18.06$, $p < .001$, *Cohen's d* = 2.24.

Experiment 2

Experiment 2 tested the hypothesis that participants perform the task more easily when the valence of the central word matches the items that have to be moved toward the central word. Thus, when the central word is a negative word (i.e., *Hate*), participants are expected to be slower in the *Positive toward* condition than in the *Negative toward* condition (i.e., the opposite pattern of Experiment 1 is predicted).

Method

Participants. Thirty-six students from the Erasmus University Rotterdam participated in the experiment, in return for course credit or a small monetary fee (€ 5,-).

Materials and Procedure. Experiment 2 followed the same procedure as Experiment 1, but the central word ‘Hate’ was used instead of ‘Love’. This word has a valence rating of 1.52 and a log frequency of 1.57 per million.

Participants were randomly assigned to one of the two instructions. Those in the *Positive toward* condition received the instruction to move positive words toward the central word ‘Hate’ and negative words away from it. Participants in the *Negative toward* condition were instructed to move positive words away from ‘Hate’ and negative words toward it.

Results

Responses that were incorrect, slower than 2500 ms or faster than 200 ms were removed from the analysis. Reaction times beyond 2 standard deviations from the subject mean were filtered out. In total, 6.6 % of the data were excluded because of errors and 5.9 % were removed because of outlying reaction times. The average response times per condition are presented in Table 1. Data were analyzed by subject and by item, using an independent samples t-test with Instruction (Positive toward vs. Negative toward) as between-participant factor.

The effect of Instruction was significant: both when analyzed by subject, $t_1(34) = 2.60$, $p < .05$, *Cohen’s d* = .89, and by item, $t_2(63) = 12.23$, $p < .001$, *Cohen’s d* = 1.52. Interestingly, however, the effect was in the opposite direction of our predictions. As in Experiment 1, participants in the *positive toward* condition responded faster ($M = 803$) than those in the *negative toward* condition (M = 923).

Discussion

The categorization hypothesis predicts that the categorization of words is facilitated when the valence of the central word is congruent with the valence of the words that have to be moved toward it. Most participants regard their own name as a strongly positive word (reflecting a healthy positive self-image). According to the categorization hypothesis, they should therefore respond faster when they move positive words toward their name than when they move negative words toward it. The same pattern of results occurred when the participant's name was replaced by another strongly positive word ('Love'), as predicted by the categorization hypothesis. However, when the name was replaced by a negative word ('Hate'), the opposite pattern did not emerge. Participants were still faster in the positive toward condition than in the negative toward condition. This finding is incompatible with the categorization hypothesis. Together, the results of Experiment 1 and 2 and the pilot experiment suggest that the valence of the central word is not of central importance in causing the results. Participants are always faster in the positive toward condition than in the negative toward condition, irrespective of the central word. Clearly, the presence of the participant's name on the screen is also not crucial for the effect. In Experiment 3, this was investigated further by presenting no word in the middle of the screen (i.e., the rectangular box in the centre of the screen was empty). If the same pattern of results occurs as in the other experiments, this would indicate that the effect is likely to be the result of an artifact of the task.

Experiment 3

Method

Participants. Seventy-six students from the Erasmus University Rotterdam participated in the experiment, in return for course credit or a small monetary fee (€ 5,-). Five participants were excluded because their error rate was above 30%, leaving a total of 71 participants.

Materials and Procedure. Experiment 3 followed the same procedure as the previous experiments, but an empty block was presented in the middle of the screen. Participants were randomly assigned to one of the two instructions. Those in the *Positive toward* condition received the instruction to move positive words toward the central block and negative words away from it. Participants in the *Negative toward* condition were instructed to move positive words away from the central block and negative words toward it.

Results

Responses that were incorrect, slower than 2500 ms or faster than 200 ms were removed from the analysis. In addition, response times more than 2 standard deviations from the subject mean were considered outliers and filtered out. In total, 5.4 % of the data were removed because of errors and 3.1 % were removed because of outlying reaction times. The average response times are presented in Table 1. Participants in the Positive toward condition responded faster (M = 880) than those in the Negative toward condition (M = 934). This effect was significant in the item analysis, $t_2(63) = 10.66$, $p < .001$, *Cohen's d* = 1.33. In the subject analysis, the effect was significant only when tested one-sided, $t_1(69) = 1.67$, $p <$ 05, *Cohen's d* = 0.40.

The effect of instruction was numerically smaller in this experiment than in the previous experiments. To investigate if this difference was significant, an overall analysis was performed on the data from all three experiments. The data were submitted to a 2 x 3 between-subjects Analysis of Variance (ANOVA) with Instruction (positive toward vs. negative toward) and Central Word ('Love', 'Hate', no word) as variables. This analysis revealed a main effect of Instruction, $F(1,132) = 24.26$, $p < .001$, $\eta^2 = .10$. Importantly, the interaction between Instruction and Central Word was not significant, $F < 1$, indicating that the size of the effect was not significantly influenced by the central word. It appears that participants are always faster in the Positive toward condition than in the Negative toward condition, regardless of what is presented in the center of the screen (positive word, negative word or no word).

General Discussion

An important issue in cognitive science regards the question to which degree sensorimotor processes are involved in cognition. In recent years, the *embodied cognition view* is gaining momentum, which suggests that cognition is strongly intertwined with the systems of perception and action, using representations that are directly derived from these systems (e.g., Barsalou, 1999; Glenberg, 1997; Pulvermüller, 1999). Proponents of this view often refer to the growing number of studies that demonstrate how cognition interacts with perception and action. These studies, applying a wide range of paradigms, have shown that the sensorimotor system is involved in many cognitive processes, such as conceptual processing (e.g., Martin, Ungerleider, & Haxby, 2000; Pecher, Zeelenberg, & Barsalou, 2003; Solomon & Barsalou, 2004), memory (e.g., Glenberg, 1997) and language (e.g., Glenberg & Kaschak, 2002; Zwaan, Stanfield, & Yaxley, 2002; Zwaan & Taylor, 2006). Based on this empirical evidence, it can be concluded that cognition at least partially involves the systems of perception and action. Clearly, cognition is not completely amodal and symbolic. However, the question remains whether cognition can be *completely* grounded in perception and action. In other words, can all cognitive tasks be performed with analogue, sensorimotor representations, or do some cognitive tasks require more symbolic, abstract representations? The latter position is taken by Markman and Brendl (2005). They claim that "perceptual and motor representations alone may not be sufficient to account for cognitive processing, because phenomena that at face value seem prime examples of lower-order perceptual and motor processing may nonetheless involve higher-order symbolic processing" (p. 10). The phenomenon addressed in their study is the approach/avoidance effect; the finding that valenced words automatically trigger approach or avoidance reactions. According to Markman and Brendl, their study demonstrates that approach/avoidance actions are not executed with respect to the body, but with respect to a symbolic, disembodied representation of the 'self'. Although the representation of the self is usually located within the body, they argue that it is not necessarily tied to the body. Markman and Brendl tried to separate the representations of the self and the body, by presenting the participant's name on the computer screen. They assumed that this manipulation induced participants to form a disembodied self-representation, located at the position of the name on the screen. As a result, they argued, participants demonstrated approach/avoidance effects with respect to their own name (the self). Participants responded faster when moving positive words toward their own name and negative words away from it, than when moving positive words away from their name and negative words toward it. Based on this finding, Markman and Brendl conclude that phenomena that have been put forward as prime examples of embodied processing, such as the approach/avoidance effect, may involve higher order symbolic representations. Theories of embodied cognition must specify how such higher order symbolic representations play a role in cognition.

A number of objections can be posed against this line of reasoning. First, the idea that Markman and Brendl's results are caused by a disembodied self-representation is undermined by our findings. We have demonstrated that the same results are found when the participant's name is replaced by a positive word (Experiment 1), a negative word (Experiment 2), or even an empty block (Experiment 3). The presence of the participant's name on the screen is clearly not crucial for the results. This makes Markman and Brendl's explanation in terms of approach/avoidance unlikely. The alternative categorization hypothesis has also proven to be incorrect by the results of Experiment 2 and 3. It is therefore more likely that the effect is due to another mechanism.

A possible candidate for this mechanism may be '*polarity correspondence*' (Proctor & Cho, 2006). According to the polarity correspondence hypothesis, dimensions of stimulus and response are asymmetric, with one pole of the dimension being more 'salient' or 'marked' than the other pole. Proctor and Cho (2006) use the more neutral terms + polarity and – polarity. For example, on the dimension of valence, positive is coded as + polarity and negative is coded as – polarity. Responses may also be coded asymmetrically; a Yes or True response is coded as + polarity, while a No or False response is coded as – polarity. The polarity correspondence principle can be defined in the following way:

> For a variety of binary classification tasks, people code the stimulus alternatives and the response alternatives as + polarity and – polarity, and response selection is faster when the polarities correspond than when they do not.
> (Proctor and Cho, 2006, p. 118)

With regard to the current study, one might assume that the responses are coded asymmetrically, with the toward response possibly being coded as + polarity and the away response as – polarity. As a result, in the *positive toward* condition there is correspondence between stimulus valence and direction of the response. In the *negative toward* condition, however, polarity of the stimulus does not correspond with the polarity of the response. Due to the polarity correspondence, responses in the Positive toward conditions would be faster than those in the Negative toward condition. It is important to note, however, that the assignments of polarities to the toward and away responses has not been determined independently, but rather is used as an ad-hoc explanation for our current findings.Although more research will be needed to verify this alternative explanation, our experiments have clearly shown that the effect cannot be explained in terms of approach/avoidance with respect to a disembodied self, and thus that the explanation of Markman and Brendl (2005) is incorrect.

The second objection against the argumentation of Markman and Brendl (2005) regards the necessity of symbolic representations in explaining approach/avoidance effects. The original incentive of their study was the observation that approach and avoidance responses cannot be unambiguously associated with specific motor actions. To resolve this ambiguity, they proposed that approach and avoidance actions are performed with reference to the 'self', rather than to the body. However, a symbolic disembodied representation of the self is not necessary to account for the ambiguity found in approach/avoidance studies. It can also be solved by defining approach and avoidance as flexible action plans, represented in terms of their perceivable effects (e.g., Puca, Rinkenauer, & Breidenstein, 2006; Seibt et al., 2008; Strack & Deutsch, 2004; van Dantzig et al., 2008). Approach and avoidance are not hard-wired muscular responses. They can be realized in different ways (involving either flexion or extension of the arm), but their effects are unambiguous. Approach actions *reduce* the distance between a stimulus and oneself, either by pulling the stimulus toward oneself (flexion), or by reaching for the stimulus (extension). On the other hand, avoidance actions *increase* distance between a stimulus and the self, either by withdrawing from the stimulus (flexion) or by pushing the stimulus away (extension).

There is common consensus that motor control involves a hierarchical system (e.g.

Hamilton & Grafton, 2007; Haruno et al, 2003). Actions are represented at various levels of abstraction. At the highest level, actions are represented in terms of their goals or outcomes. At the middle level, actions are represented in terms of the movement kinematics (e.g. shape of the hand and the motion trajectory). At the lowest level, actions are represented in terms of muscle activations. This hierarchy is also found in the organization of the brain. Whereas some brain areas encode actions at the level of muscle activation, other areas encode the goal or intention of actions (e.g. Fogassi et al., 2005; Grafton & Hamilton, 2007). A similar hierarchy may be found in perceptual processing. Perceptual information is coded at increasing levels of complexity by subsequent cortical areas. The sensorimotor system thus processes perceptual and motor information in a hierarchical manner, with information becoming more and more complex and abstract as it travels upstream (cf. Damasio's (1989) notion of *convergence zones*). Higher-level sensorimotor representations are necessary to enable an organism to interact flexibly with a dynamic environment. Without such representations, the sensorimotor system would only be able to respond in a reflex-like manner.

The idea that cognition is grounded in the systems of perception and action does not necessarily imply that cognitive concepts are mapped directly onto very low-level sensorimotor representations. It is more likely that concepts are linked to the perceptual and motor system at a higher level of representation (e.g. the level of the action goal). Such higher-level representations obviously are more abstract than the low-level representations, but they are still firmly grounded in perception and action.

Markman and Brendl (2005) concluded that their results "constrain theories of embodied cognition by suggesting that the ease of a particular movement depends crucially on representations of the task that go beyond simple learned motor actions" (p. 9). One could argue that our findings do not oppose their conclusion but rather confirm it. As becomes apparent in our experiments, embodiment effects such as the approach/avoidance effect are easily overridden by manipulations of rather arbitrary aspects of the task (e.g., a word or empty block presented in the center of the computer screen). We agree that higher-level representations may be necessary to explain how such arbitrary task characteristics influence the speed of response selection and execution. However, we do not agree that these higher-level representations are completely symbolic and disembodied. By means of their hierarchical connections to lower-level representations, they may still be embodied and grounded in the sensorimotor system.

Footnotes

[1.] In Markman and Brendl's (2005) experiment, the proportional difference in reaction times between the congruent and incongruent condition was .33. This is much higher than the proportional differences found in other studies (Chen & Bargh, 1999; Rotteveel & Phaf ,2004; Wentura et al., 2000), which lie in the range of .01 to .15.

[2.] As in the original Markman and Brendl experiment, the words on the screen did not actually move.

[3.] Prior to the experiment, a pilot study was run to verify that the original findings of Markman and Brendl (2005) could be replicated with our slightly altered design and Dutch stimulus set. The pilot study largely followed their original procedure, with a few modifications. Thirty-eight students from the Erasmus University Rotterdam participated in return for course credits. The participant's name was presented in the middle of the corridor. On every trial, an emotionally valenced word was presented in front of or behind the participant's name. Participants were instructed to judge the valence of the target word by making a mouse movement. Half of the participants received the *Positive toward* instruction. They had to move positive words toward their name and negative words away from their name. The other half of the participants received the *Negative toward* instruction. They had to move positive words away from their name and negative words toward their name. The data were analyzed using a 2 x 2 x 2 mixed measures Analysis of Variance (ANOVA), with Word Valence (positive vs. negative) and Word Position (in front of name vs. behind name) as within-participant factors and Instruction (congruent vs. incongruent) as between-participant factor. There was a main effect of Instruction, $F(1, 36) = 7.71$, $p < .01$, $\eta^2 = .17$. Participants were faster to respond to stimuli in the positive toward condition (*M* = 820 ms, *SE* = 38.2) than in the negative toward condition (*M* = 962 ms, *SE* = 33.2). This pattern was true for all valence-position combinations, as confirmed by separate t-tests (*p*-values ranged between .008 and .027). No interaction effects were found. There were no main effects or interaction effects for the error scores. The results from the pilot study indicate that the modifications of our design did not affect the main outcomes of the experiment. This cleared the way for our actual manipulation of replacing the participants name with a strongly positive or negative word.

Table 1

Mean Response Times (in Milliseconds) and Error Rates (in Percentages) as a Function of Instruction for Experiment 1 ('Love'), Experiment 2 ('Hate') and Experiment 3 (no word). Standard Errors are within Brackets.

	Response Time (ms)		Error Rate (%)	
Central Word	Positive Toward	Negative Toward	Positive Toward	Negative Toward
'Love'	863 (31.4)	986 (38.0)	3.8 (1.30)	5.3 (1.14)
'Hate'	803 (16.1)	923 (43.5)	5.7 (.98)	8.0 (1.55)
No word	857 (21.5)	915 (27.7)	4.6 (.99)	5.5 (.93)

Figure 1. Display as used in Markman and Brendl (2005) study and the pilot experiment in the present study.

(Figure added in separate file)

References

Baayen, R. H., Piepenbrock, R. v., & van Rijn, H. (1993). The CELEX lexical database [CD-ROM]. Philadelphia: University of Pennsylvania, Linguistic Data Consortium.

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

Brendl, M., Markman, A. B., & Messner, C. (2005). Indirectly measuring evaluations of several attitude objects in relation to a neutral reference point. *Journal of Experimental Social Psychology, 41*, 346-368.

Chen, S., & Bargh, J. A. (1999). Consequences of automatic evaluation: immediate behavior predispositions to approach or avoid the stimulus. *Personality and Social Psychology Bulletin, 25*, 215-224.

Damasio, A. R. (1989). Time-locked multiregional retroactivation: A systems-level proposal for the neural substrates of recall and recognition. *Cognition, 33*, 25-62.

Fogassi, L., Ferrari, P.F., Gesierich, B., Rozzi, S., Chersi, F., & Rizzolatti, G. (2005). Parietal lobe: from action organization to intention understanding. *Science, 308,* 662-666.

Glenberg, A. M. (1997). What memory is for. *Behavioral and Brain Sciences, 20*, 1-55.

Glenberg, A. M., & Kaschak, M. P. (2002). Grounding language in action. *Psychonomic Bulletin and Review, 9*, 558-565.

Greenwald, A. G., & Farnham, S. D. (2000). Using the implicit association test to measure self-esteem and self-concept. *Journal of Personality and Social Psychology, 79*, 1022-1038.

Hamilton, A. F de C., & Grafton, S. T. (2007). The motor hierarchy: from kinematics to intentions. In Rossetti Y, Haggard P & Kawato M (eds.) Sensorimotor foundations of higher cognition, Attention and Performance XXII. Oxford New York: Oxford University Press.

Koole, S. L., Dijksterhuis, A., & van Knippenberg, A. (2001). What's in a name: implicit self-esteem and the automatic self. *Journal of Personality and Social Psychology, 80*, 669-685.

Markman, A. B., & Brendl, M. (2005). Constraining theories of embodied cognition. *Psychological Science, 16*, 6-16.

Martin, A., Ungerleider, L. G., & Haxby, J. V. (2000). Category-specifity and the brain: The sensory-motor model of semantic representations of objects. In M. S. Gazzaniga (Ed.), *The New Cognitive Neurosciences* (2nd ed., pp. 1023-1036). Cambridge, M.A.: MIT Press.

Niedenthal, P.M., Barsalou, L.W., Winkielman, P., Krauth-Gruber, S., & Ric, F. (2005). Embodiment in attitudes, social perception, and emotion. *Personality and Social Psychology Review, 9*, 184-211 .

Pecher, D., Zeelenberg, R., & Barsalou, L. W. (2003). Verifying different-modality properties for concepts produces switching costs. *Psychological Science, 14*, 119-124.

Proctor, R. W., & Cho, Y. S. (2006). Polarity correspondence: a general principle for performance of speeded binary classification tasks. *Psychological Bulletin, 132,* 416-442.

Puca, R. M., Rinkenauer, G., & Breidenstein, C. (2006). Individual differences in approach and avoidance movements: how the avoidance motive influences response force. *Journal of Personality, 74*, 979-1014.

Pulvermüller, F. (1999). Words in the brain's language. *Behavioral and Brain Sciences, 22*, 253-336.

Rotteveel, M., & Phaf, R. H. (2004). Automatic affective evaluation does not automatically predispose for arm flexion and extension. *Emotion, 4*, 156-172.

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). *E-Prime User's Guide*. Pittsburgh: Psychology Software Tools Inc.

Seibt, B., Neumann, R., Nussinson, R., & Strack, F. (2008). Movement direction or change in distance? Self and object related approach-avoidance motions. *Journal of Experimental Social Psychology, 44,* 713-720.

Solarz, A. K. (1960). Latency of instrumental responses as a function of compatibility with the meaning of eliciting verbal signs. *Journal of Experimental Psychology, 59*, 239-245.

Solomon, K. O., & Barsalou, L. W. (2004). Perceptual simulation in property verification. *Memory & Cognition, 32*, 244-259.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Bulletin, 8*, 220-247.

van Dantzig, S., Pecher, D., & Zwaan, R. A. (2008). Approach and avoidance as action effects. *Quarterly Journal of Experimental Psychology,* 61, 1298-1306.

Wentura, D., Rothermund, K., & Bak, P. (2000). Automatic vigilance: the attention-grabbing power of approach and avoidance-related social information. *Journal of Personality and Social Psychology, 78*, 1024-1037.

Zwaan, R. A., Stanfield, R. A., & Yaxley, R. H. (2002). Language comprehenders mentally represent the shapes of objects. *Psychological Science, 13*, 168-171.

Zwaan, R. A., & Taylor, L. J. (2006). Seeing, acting, understanding: motor resonance in language comprehension. *Journal of Experimental Psychology: General*.

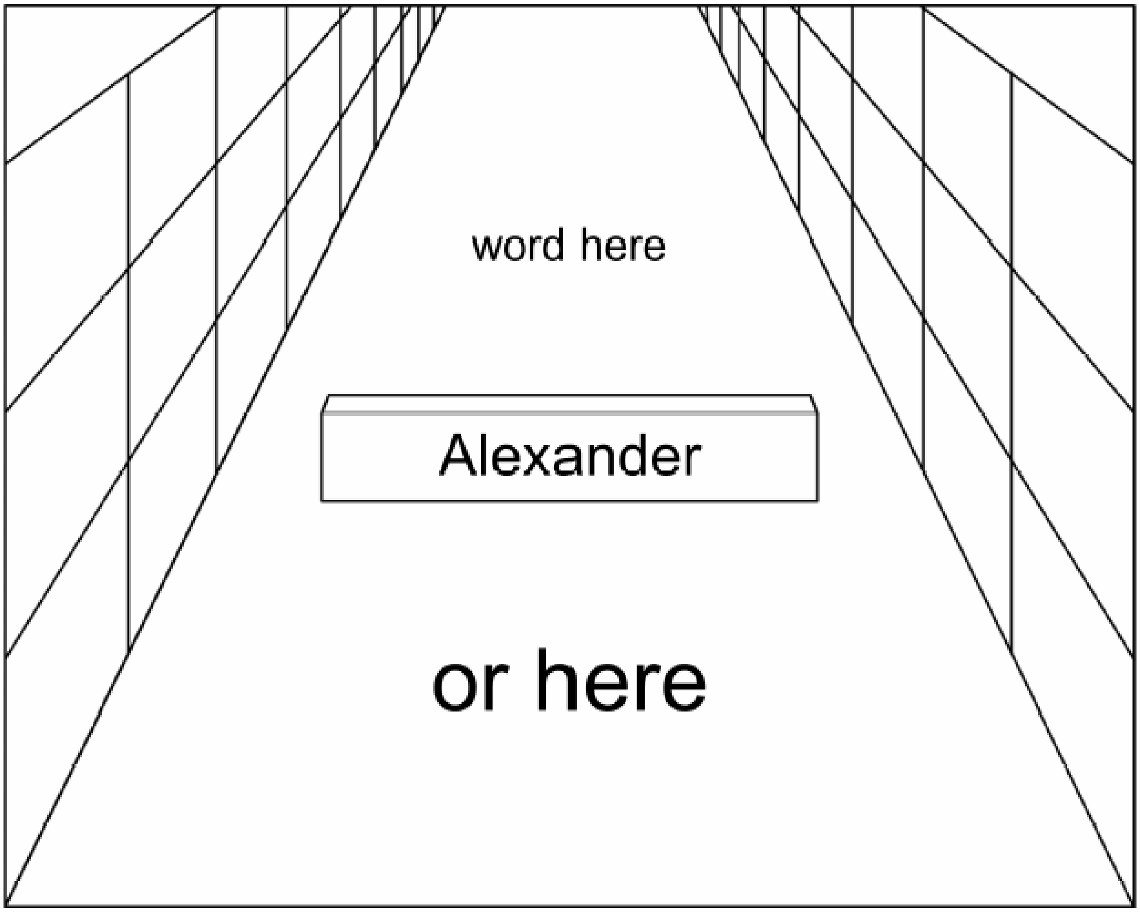
Author note

Saskia van Dantzig, Leiden University, Department of Psychology, P.O. Box 9555, 2300 RB Leiden, The Netherlands. This research was supported by a VIDI grant from the Netherlands Organization for Scientific Research (NWO) to Diane Pecher. We would like to thank Sandra Langeslag and Bruno Bocanegra for collecting the word valence norms.

Appendix

Positive items				*Negative items*			
Dutch	**English**	**Valence**	**Log Freq**	**Dutch**	**English**	**Valence**	**Log Freq**
beloning	reward	5.59	1.28	agressie	aggression	1.76	1.30
briljant	brilliant	6.07	0.60	bedrog	deceit	2.03	1.11
cadeau	present	5.48	1.11	beroerd	miserable	2.04	0.85
creatief	creative	6.17	0.95	crisis	crisis	2.07	1.54
engel	angel	6.07	1.18	dode	dead person	1.97	1.36
feest	party	6.07	1.60	duivel	devil	1.86	1.57
geluk	happiness	6.41	2.02	dwang	coercion	1.97	1.08
geschenk	gift	5.69	1.04	falen	to fail	2.28	0.78
gezond	healthy	6.24	1.62	fataal	fatal	1.69	0.60
hemels	heavenly	6.17	0.30	gevangen	imprisoned	2.10	1.34
hoop	hope	5.93	1.92	kanker	cancer	1.41	1.26
humor	humor	6.31	1.23	klagen	to complain	2.17	0.85
ideaal	ideal	6.14	1.46	kwaal	disease	2.10	0.95
kameraad	comrade	6.1	1.28	kwellen	to harass	1.86	0.30
lach	laughter	6.31	1.57	kwetsen	to hurt	2.00	0.48
makker	buddy	5.76	0.60	monster	monster	2.38	1.18
paradijs	paradise	6.45	1.26	moord	murder	1.41	1.58
plezier	pleasure	6.07	1.80	oorlog	war	1.52	2.29
pret	fun	5.9	0.90	ramp	disaster	1.79	1.28
prima	fine	5.86	1.28	ruzie	fight	2.00	1.54
strelen	to caress	5.86	0.70	schelden	to curse	2.14	0.48
succes	success	6.03	1.93	schoft	villain	2.00	0.85
triomf	triumph	5.69	1.04	stikken	to choke	1.97	0.48

trouw	faithful	6.03	1.42	tragisch	tragic	2.14	0.85
vreugde	gladness	6.43	1.61	triest	sad	1.97	0.95
vriend	friend	6.52	2.16	verraad	treachery	1.86	1.11
welkom	welcome	5.62	1.30	verrot	rotten	2.10	0.00
wijsheid	wisdom	6.28	1.40	vijandig	hostile	2.03	0.90
winst	profit	5.52	1.58	wanhoop	despair	1.72	1.36
zalig	blissful	5.9	0.78	wraak	revenge	2.24	1.26
zoen	kiss	5.86	0.90	zeuren	to whine	2.21	0.48
zonnig	sunny	6.38	0.78	ziekte	illness	1.76	1.94
	average	*6.03*	*1.27*		*average*	*1.95*	*1.06*


word here
Alexander
or here