The Quarterly Journal of Experimental Psychology
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t716100704

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First published on: 29 August 2009

To cite this Article Boot, Inge andPecher, Diane(2010) 'Similarity is closeness: Metaphorical mapping in a conceptual task', The Quarterly Journal of Experimental Psychology, 63: 5, 942 — 954, First published on: 29 August 2009 (iFirst)
To link to this Article: DOI: 10.1080/17470210903134351
URL: http://dx.doi.org/10.1080/17470210903134351

THE QUARTERLY JOURNAL OF EXPERIMENTAL PSYCHOLOGY
2010, 63 (5), 942–954

Psychology Press
Taylor & Francis Group

Similarity is closeness: Metaphorical mapping in a conceptual task

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The conceptual metaphor theory states that abstract concepts are represented by image schemas from concrete domains. In the present study we investigated the mapping for SIMILARITY IS CLOSENESS using tasks with nonlinguistic materials. In Experiments 1 and 2 participants decided whether two squares were similar or dissimilar in colour. The spatial distance between the squares was varied. Performance to similar colours was better at shorter distances, whereas performance to dissimilar colours was better at longer distances. In Experiments 3 and 4 participants made distance decisions to similar and dissimilar colours squares. Performance was not affected by similarity. These results show that metaphorical mappings can be found even beyond the context of linguistic metaphors and that the mapping between SIMILARITY and CLOSENESS is asymmetrical.

Keywords: Metaphor; Abstract concept; Image schema; Asymmetry.

"Gravitation can not be held responsible for people falling in love." (2007, http://www.quotationpage.com/quotes/Albert_Einstein/). In this quote Albert Einstein refers to the metaphor LOVE IS A PHYSICAL FORCE. Metaphorical expressions are not only restricted to witty statements or poetic language, but are common phenomena in daily conversations. The use of metaphors in language is not only common but is found to be very systematic too. Source domains (e.g., PHYSICAL FORCE) are consistently used for target domains (e.g., LOVE) in various metaphorical expressions (e.g., *They were attracted to each other*). The systematicity of metaphorical expressions led Lakoff and Johnson (1980) to speculate that this is not merely a linguistic phenomenon, but originates in mental representation. They proposed a structural mental mapping of metaphors in their conceptual metaphor theory (M. Johnson, 1987; Lakoff & Johnson, 1980, 1999; also see Gibbs, 1994).

The conceptual metaphor theory (M. Johnson, 1987; Lakoff & Johnson, 1980, 1999; also see Gibbs, 1994) goes beyond language and makes claims about the mental structure of concepts. Their claims of structural mental mapping of metaphors fits with embodied theories of mental representation. According to these theories the mental representation of concepts depends on the way the body is constructed and interacts with the concepts (e.g., Barsalou, 1999;

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This research was supported by a grant from the Netherlands Organization for Scientific Research (NWO) to Diane Pecher.

http://www.psypress.com/qjep
DOI:10.1080/17470210903134351

Glenberg, 1997; Goldstone, 1994). The body interacts with and perceives objects (e.g., a chair) in the world and by this sensory-motor experience (e.g., seeing a chair, sitting on a chair) a mental representation of that concept (e.g., CHAIR) is formed. In contrast to concrete concepts (e.g., a chair), abstract concepts (e.g., value) are not physically present in the world. The elusiveness of abstract concepts makes it impossible to perceive or physically interact with them. Despite the fact that bodies cannot interact with nonphysical objects, however, some theories have proposed that abstract concepts are also based on sensory-motor experience (e.g., Barsalou, 1999; Barwise & Perry, 1983; Lakoff & Johnson, 1980; Langacker, 1986). The conceptual metaphor theory of Lakoff and Johnson (1980) deals with the problem that abstract concepts are nonphysical by proposing that we represent abstract concepts in terms of concrete concepts by metaphorical mapping. The physical experience with concrete concepts enables their mental representations to be grounded in bodily experiences. These experiences result in the formation of image schemas. Image schemas are conceptual structures that represent spatial relations and movements in space. They are the building blocks of mental representation, which develop during childhood (Mandler, 1992). Image schemas of concrete concepts are mapped onto abstract concepts. This metaphorical link between concrete and abstract concepts is formed by co-occurrence of the two concepts in one experience during childhood (e.g., C. Johnson, 1997). For example, the observation that similar objects are often clustered together (e.g., trees, dishes) gives rise to the metaphorical mapping SIMILARITY IS CLOSENESS (Grady, 1997, in Lakoff & Johnson, 1999.) A mapping of source domain onto target domain makes it possible for the mental representation of abstract concepts to be grounded in experience as well (Gibbs, 1994; M. Johnson, 1987; Lakoff & Johnson, 1980, 1999).

Lakoff and Johnson (1980) made a distinction between more basic metaphors (which they divided into orientational metaphors, e.g., HAPPY IS UP and ontological metaphors, e.g., INFLATION IS AN ENTITY) and structural metaphors. Grady (1997, in Lakoff & Johnson, 1999) elaborated this idea in his theory of primary metaphor. He distinguished *primary metaphors*, which are composed of a single image schema, and *complex metaphors*, which are composed of more than one primary metaphor (Lakoff & Johnson, 1999). The conceptual metaphor theory has been investigated in quite a number of studies with primary metaphors (Boroditsky, 2000; Boroditsky & Ramscar, 2002; Casasanto, 2007a, 2007b, in press; Casasanto & Boroditsky, 2008; Chiao, Bordeaux & Ambady, 2004; Crawford, Margolies, Drake, & Murphy; 2006; Giessner & Schubert, 2007; Meier, Hauser, Robinson, Friesen, & Schjeldahl, 2007; Meier & Robinson, 2004, 2006; Meier, Robinson, & Clore, 2004; Schnall & Clore; 2004; Schubert, 2005; Van Dantzig, Boot, Giessner, Schubert, & Pecher, 2008). In the present study we investigated the primary metaphor SIMILARITY IS CLOSENESS. This primary metaphor is composed of the NEAR–FAR image schema.

According to the conceptual metaphor theory (Lakoff & Johnson, 1980) mapping of the source domain onto the target domain is asymmetrical. The target domain needs the representation of the source domain and not vice versa. The reason for this asymmetry lies in the richness of the concrete concept that is acquired by sensory experience. This sensory experience is exactly what abstract concepts lack. Metaphorical representations of abstract concepts provide a solution for this lack by filling up the poor representation of the abstract concepts. On the other hand, Grady (1997, 2005) uses the conceptual integration or "blending" theory of Fauconnier and Turner (1998) to explain the mapping of metaphors. According to Grady, in the mental representation of primary metaphors, target and source domains are equally richly elaborated. Although this may seem to eliminate the need to make a blend in the first place, Grady still agrees that there is asymmetry of mapping at least for primary metaphors.

In the present study we investigated whether this asymmetry also holds for the conceptual mapping SIMILARITY IS CLOSENESS. In the same way as people talk about similarity in terms of closeness and not vice versa, they should understand similarity in terms of closeness and not vice versa. For example the sentence *These colours are close* can be interpreted literally as well as metaphorically, but *The two cities are similar* can only be interpreted literally and does not mean that there is a small distance in kilometres between the cities. Evidence for asymmetry has been found for other concepts (Boroditsky, 2000; Casasanto, 2007a; Casasanto & Boroditsky, 2008; Meier & Robinson, 2004; Meier et al., 2004; Van Dantzig et al., 2008). Casasanto and Boroditsky (2008) and Casasanto (2007a) obtained evidence of asymmetry with nonlinguistic materials. Participants had to estimate the duration time of the presentation of a stimulus or the length (stationary line) or displacement (e.g., growing line, moving dot) of that same stimulus presented on the screen. The kind of decision that participants had to make on the stimulus (duration time or estimating length/displacement) was randomly assigned on each trial. They found that participants estimated duration times to be longer for longer lines or stimuli with bigger displacements (e.g., moving dot or growing line) than for smaller lines or stimuli with smaller displacements (e.g., moving dot or growing line). They did not find evidence for the opposite mapping; the duration time had no influence on the estimation of the length and displacement of the stimuli. Thus, they found that estimating the duration of a stimulus (TIME) was influenced by spatial displacement (SPACE), but not vice versa. This supports the claim of Lakoff and Johnson (1980) that the conceptual metaphor TIME IS SPACE is asymmetrical.

Another issue in the present study is that we wanted to exclude that the effects were due to metaphorical language. There are a number of theories about metaphorical comprehension, which describe how we comprehend metaphorical *language* (e.g., Gentner, 1983; Glucksberg & Keysar, 1990). These theories and related ones about metaphorical comprehension consider how metaphorical *expressions* are understood and not how mental representations of the abstract concepts themselves are structured. According to these theories mental representations of concrete and abstract concepts are self-sufficient, and a connection between the two concepts (according to a different process depending on the theory) arises only during comprehension of metaphorical expressions. Thus the representations are presumed to be independent of each other in a nonlinguistic context.

In contrast to theories about metaphorical comprehension the conceptual metaphor theory has clear predictions for tasks with nonlinguistic materials. Although Lakoff and Johnson (1980) used language as an important source of evidence for conceptual mappings, their claim is that image schemas are essential to give structure and meaning to abstract concepts. Thus we should expect to find activation of the image schema even in tasks that do not present metaphoric language. Actually, some researchers have argued against the use of language stimuli in tests of conceptual metaphor theory because linguistic evidence for the theory leads to a circular argument (e.g., Murphy, 1996). In addition, Murphy argues that some words that are used in literal and metaphorical contexts may in fact be polysemous (see also Barsalou & Hale, 1993). A word like *rise* can refer to both the physical meaning and the nonphysical meaning (e.g., *Inflation is rising*). Thus, metaphorical expressions like these can be due to polysemy rather than to an underlying metaphorical mapping. In the case of the metaphor SIMILARITY IS CLOSENESS the word *close* would activate both the literal meaning, which belongs to the concept CLOSENESS, and the metaphorical meaning, which belongs to the concept SIMILARITY. Because studies that use language require processing of the concepts in language, it is unclear whether these studies measured the role of metaphor in representation of abstract concepts or measured the lexical link between the concepts.

Others have also recognized the importance of this issue and have used designs in which no linguistic stimuli were presented (e.g., Casasanto & Boroditsky, 2008; Giessner & Schubert, 2007;

Meier et al., 2007). For example, Meier et al. (2007) investigated the conceptual metaphor DIVINITY IS VERTICALITY using God-like, Devil-like, and neutral images. In the study phase, the pictures were presented randomly at different locations on the screen. In the test phase, participants had to recall the location of the images. Participants remembered God-like images at a higher location than neutral images and Devil-like images at a lower location than neutral images. The results of experiments using nonlinguistic material like those of Meier et al. (2007) provide evidence for the conceptual metaphor theory.

A third issue we investigated in the present study was the automaticity of the conceptual mapping. According to the theory, the image schema (e.g., VERTICALITY) is essential to understand the abstract concept (e.g., DIVINITY). The image schema is part of the representation of the abstract concept and causes the abstract concept to be grounded in sensory-motor experience. Therefore, the representation of the abstract concept should be affected by manipulations that also affect the image schema. Moreover, we should expect automatic activation of the conceptual mapping when participants process the abstract concept. We consider the conceptual mapping to be automatic when it will be active during processing of the abstract concept even in a context in which it is inefficient or even harmful for performance.

Evidence for automaticity of the activation of the conceptual mapping for understanding an abstract concept might be found in a task in which participants have no uncertainty about what the response should be. In other domains it has been shown that irrelevant features affect judgements in conditions of uncertainty (e.g., Van den Bos, 2003; Van den Bos, Lind, Vermunt, & Wilke, 1997, for the domain of justice). The same mechanisms may be at work in some studies that investigated the role of image schemas. For example, in the study of Meier et al. (2007) participants had to recall the location of a picture. Since recalling the exact position of a picture on the screen is a difficult task with an almost infinite number of possible responses, participants may have used other (irrelevant) features such as the meaning of the picture. Studies that have investigated SIMILARITY IS CLOSENESS (Breaux & Feist, 2008; Casasanto, 2008) asked participants to give similarity ratings (e.g., on a scale of 1 to 9) for pairs of stimuli that were presented sequentially where it was probably quite hard to decide between, say, a 2 or a 3 as the correct response. This may have introduced the kind of uncertainty that would be susceptible to influences of irrelevant features such as the distance between the stimuli. This may have been especially the case for the stimuli used by Breaux and Feist, which were four colours that were all about equally similar to each other. In our present study, we presented the concepts simultaneously and simply asked participants to say whether the stimuli were similar or different. The task was made very easy by presenting stimuli that were either very similar or very different. Thus we hoped to eliminate the influence of any strategic use of the image schema on performing the task. This allowed us to investigate the role of image schemas for the representation of abstract concepts.

In the present study the stimuli we used were squares of colours. Breaux and Feist (2008) also used colours as stimuli. There were two important differences between our experiment and theirs. First, we used different colour pairs. Breaux and Feist used pairs of shades of blue and green that were not very different in similarity. Our stimuli presented pairs of different colours that were either very similar or not similar at all. Second, we used a different task. Rather than asking participants to give a similarity rating as Breaux and Feist did (see also Casasanto, 2008), we used a speeded similar/dissimilar decision task. In this way we wanted to eliminate the use of the conceptual mapping due to uncertainty. First, by the use of a simple decision task with clear responses we minimized the use of the irrelevant dimension (distance). Second, the irrelevant information (distance) was not helpful for performance. In the decision task distance was orthogonally crossed with similarity, and feedback was provided after each trial. If participants would use distance to speed up their performance they would soon find out that this was counteractive, because distance was not predictive of the correct response. A second advantage of a simple decision task is that it could be performed without the need to compare perceptual details. If perceptual details have to be compared distance may have the opposite effect (Casasanto, 2008).

In Experiment 1, participants made similarity decisions to colour squares presented near to or far from each other. The similarity decision task should activate the concept SIMILARITY, and the different distances between the squares should activate the concept CLOSENESS. According to the conceptual metaphor theory, in order to understand the concept SIMILARITY people need to activate the mental representation of CLOSENESS. This is the process of conceptual mapping in which NEAR is mapped onto SIMILAR and FAR onto DISSIMILAR. If SIMILARITY IS CLOSENESS is a conceptual mapping and not merely a linguistic phenomenon, and if this conceptual mapping is automatic and essential to perform the task, we would expect to find an interaction effect. Performance for similar colours should be better when they are presented near than when they are presented far, whereas performance for dissimilar colours should be worse when they are presented near than when they are presented far.

EXPERIMENT 1

Method

Participants

A total of 30 psychology students received course credits for participating.

Materials

The stimuli were 18 pairs of coloured squares (each 4 × 4 cm). The nine similar pairs each consisted of two different hues of the same colour, and the nine dissimilar pairs each consisted of two different colours. Eight judges (who did not participate in the experiment proper) rated the similarity of the colours on a scale ranging from 1 (*almost the same*) to 7 (*totally different*). The similar colours were judged as very similar (mean scores ranging from 1.3 to 2.9), and the dissimilar pairs were judged as very dissimilar (mean scores ranging from 5.9 to 6.8). We counterbalanced for position of colour (right vs. left) and for distance (near vs. far). In the near condition the distance between the two squares was 1 cm. In the far condition the distance between the two squares was 8 cm. The squares were vertically centred. Each pair was used four times (once in each position by distance combination), which resulted in 72 trials (18 × 2 × 2). An additional set of 20 colour pairs was used for practice.

Procedure

Participants were tested on individual PCs, separated by walls, in groups ranging from 1 to 4. Participants were told that they had to decide whether two colours were similar or dissimilar. On each trial, two squares filled with different colours or hues were presented. Each trial started with a fixation point (+) that was presented in the centre of the screen for 1,000 ms. Then the two squares appeared vertically in the centre and horizontally near or far from each other for 1,800 ms or until a response was given. Participants used the z-button and m-button to respond. The mapping of keys with response was counterbalanced. If participants gave an incorrect response, "Fout" (*incorrect*) appeared in red in the centre of the screen. If participants did not respond after 1,800 ms, "Te Laat" (*too late*) appeared in red in the centre of the screen. The feedback was presented for 1,500 ms. Between each trial a blank screen was presented for 500 ms. First participants received 20 practice trials to familiarize them with the range of similarity used in the experiment. After a brief break the 20 practice trials were followed by the 72 experimental trials.

Results

Mean reaction times and error rates are presented in Table 1. We performed a 2 (similarity: similar and dissimilar) by 2 (distance: near and far)

Table 1. *Mean reaction times and error rates in the similarity decision task in Experiment 1*

	Reaction times		*Error rates*	
Distance	*Similar*	*Dissimilar*	*Similar*	*Dissimilar*
Near	493 (14)	527 (15)	.032 (.010)	.033 (.010)
Far	519 (15)	515 (16)	.040 (.012)	.038 (.013)

Note: Mean reaction times in ms. Standard errors are shown in parentheses.

repeated measures analysis of variance (ANOVA) on the reaction times and error rates. We only analysed the correct reaction times that fell within 2 standard deviations from the participant's mean. This resulted in removal of 4.7% of the reaction times. In the reaction times we obtained a significant interaction, $F(1, 29) = 11.81$, $MSE = 10{,}820.7$, $p = .002$. Post hoc least significant difference (LSD) comparisons (see Loftus & Masson, 1994) showed that participants were faster to respond to similar colours when they were presented near each other than when they were far from each other, $t(29) = 4.70$, $MSE = 5.5$, $p < .001$. However, participants were faster to respond to dissimilar colours when presented far from each other than when they were near each other, $t(29) = 2.17$, $MSE = 5.5$, $p = .02$. In the error rates we did not find an interaction effect between distance and similarity, $F < 1$. Note that very few errors were made.

Discussion

In Experiment 1 we found that participants' performance on the similarity task was influenced by the irrelevant position of the colours. We found interaction effects in the reaction times. Performance was faster to similar colours that were near each other than to those that were far from each other, whereas performance was faster to dissimilar colours that were far from each other than to those that were near each other. The results we found in this paradigm support the idea that the concrete concept CLOSENESS is mapped automatically onto the abstract concept SIMILARITY even beyond the boundaries of language comprehension.

EXPERIMENT 2

In Experiment 2 we wanted to extend our findings. The manipulation of similarity and distance in Experiment 1 each involved two levels. It is possible that participants aligned the binary values close/similar and distant/dissimilar and responded faster when the stimuli were thus aligned than if the opposite combinations were presented. Therefore we introduced a more graded manipulation of distance as was done by Casasanto (2008). If participants in Experiment 1 used such alignment, the interaction between distance and similarity should disappear. If the effect is due to activation of the image schema, however, there should still be an interaction.

Method

Participants

A total of 40 psychology students from the same subject-pool as that in Experiment 1, who had not participated in Experiment 1, received course credits for participating.

Materials

We used the same pairs of squares as those in Experiment 1. The colour pairs were the same, and the distance in the far and near conditions was the same. We added a third medium distance condition. The medium pairs were presented 4 cm from each other. We counterbalanced for position of colour (right vs. left) and for similarity (similar vs. dissimilar). Each slide was presented twice, which resulted in 216 trials ($9 \times 3 \times 2 \times 2 \times 2$) in total. An additional set of 24 colour pairs were used for practice.

Procedure

The procedure was the same as that in Experiment 1 except that the trials were divided over two blocks, each with 108 trials. Between the blocks participants could take a break.

Results and discussion

The mean reaction times and error rates of Experiment 2 are presented in Table 2. We performed a 2 (similarity: similar and dissimilar) by 3 (distance: near, medium, far) repeated measures ANOVA over the reaction times and error rates.

We only analysed the correct reaction times that fell within 2 standard deviations from the participant's mean. This resulted in a removal of 5.1% of the reaction times. In the reaction times we obtained a significant interaction, $F(2, 78) = 4.29$, $MSE = 590.5$, $p = .017$. In the reaction times of the similar condition we found the expected pattern: Reaction times increased as distance increased. Post hoc LSD comparisons (see Loftus & Masson, 1994) showed that participants were faster to respond to similar pairs in the near than in the far condition, $t(39) = 5.89$, $SEM = 3.8$, $p = .01$. Additionally we found that participants were faster to respond to similar pairs in the near than in the medium condition, $t(39) = 2.90$, $SEM = 3.8$, $p = .01$, and participants were faster to respond to similar pairs in the medium than to similar pairs in the far condition, $t(39) = 3.00$, $SEM = 3.8$, $p = .01$. Thus, participants became slower to respond to similar colours when the squares were presented further away from each other. In the dissimilar condition participants did not respond significantly differently to the different distance conditions. We obtained a main effect of distance, $F(2, 78) = 5.43$, $MSE = 590.5$, $p = .017$. The tests of within-subjects contrasts showed that participants were faster to respond to near pairs, $F(1, 39) = 8.84$, $MS = 5{,}467.6$, $p = .005$, and medium pairs, $F(1, 39) = 4.56$, $MS = 19{,}192.3$, $p = .039$, than to pairs presented far from each other, but participants did not respond differently to near and medium pairs, $F(1, 19) = 1.23$, $MS = 465.7$, $p = .274$.

In the error rates we also found an interaction effect between distance and similarity, $F(2, 78) = 3.25$, $MSE = 0.002$, $p = .044$. Post hoc LSD comparisons (see Loftus & Masson, 1994) showed that participants were more accurate to similar pairs in the near than in the far condition, $t(39) = 2.4$, $SEM = 0.005$, $p = .05$, and participants were also more accurate to dissimilar pairs in the medium condition than in the near condition, $t(39) = 2.2$, $SEM = 0.005$, $p = .05$.

While we obtained the expected interaction effect in the reaction times and error rates the effect seemed to be predominantly present in the similar condition. However, interpretation of the interaction is complicated by the influence of main effects (Rosnow & Rosenthal, 1989). In order to interpret the interaction effect correctly we calculated the residuals (by subtracting the means or simple effects from the condition cells) as recommended by Rosnow and Rosenthal. The residuals of the cells are shown in Table 3.

The residuals in the condition cells showed that the participants' reaction times for both the similar and dissimilar pairs were indeed influenced by the three distances in a graded fashion. In particular, increasing distance had a gradually interfering effect for similar pairs and a gradually facilitating effect for dissimilar pairs. In addition to Experiment 1, these results of Experiment 2 with graded distance further support the idea that the concrete concept CLOSENESS is mapped automatically onto the abstract concept SIMILARITY.

Table 2. *Mean reaction times and error rates in the similarity decision task in Experiment 2*

	Reaction times		*Error rates*	
Distance	*Similar*	*Dissimilar*	*Similar*	*Dissimilar*
Near	503 (11)	524 (10)	.026 (.005)	.032 (.005)
Medium	514 (11)	520 (10)	.030 (.006)	.021 (.004)
Far	525 (11)	525 (12)	.038 (.007)	.023 (.005)

Note: Mean reaction times in ms. Standard errors are shown in parentheses.

Table 3. *The residuals of the reaction times in the similarity decision task in Experiment 2*

Distance	*Similar*	*Dissimilar*
Near	− 6	6
Medium	1.5	− 1.5
Far	4.5	− 4.5

EXPERIMENT 3

According to the conceptual metaphor theory the mapping of source domain onto target domain is asymmetrical. (Gibbs, 1994, 1996; M. Johnson, 1987; Lakoff & Johnson, 1980, 1999). The asymmetry of conceptual mapping makes sense in an embodied point of view. Through conceptual mapping the mental representations of abstract concepts can join in the rich sensory-motor representation of concrete concepts. Evidence for asymmetry has been found for other concepts (e.g., TIME IS SPACE; Casasanto & Boroditsky, 2008). In Experiment 3 we examined the asymmetry of the mapping of SIMILARITY IS CLOSENESS. We used the same stimuli as those in Experiment 1. Participants had to decide whether the two squares of colours were presented near or far from each other instead of making a decision about the similarity. If the mapping of SIMILARITY IS CLOSENESS is asymmetrical, we would expect no interaction effect. The similarity of colours should not affect distance decisions.

Method

Participants

A total of 30 students of the Erasmus University Rotterdam from the same subject-pool as that in Experiment 1, who had not participated in Experiment 1, received course credits or a chocolate bar for participating.

Materials

We used the same stimuli as those in Experiment 1.

Procedure

As in Experiment 1, participants were tested on PCs, separated by walls, in groups ranging from 1 to 4. The procedure was the same as that in Experiment 1 with the exception of the task. Participants were told that two squares could be presented in two different distances and that they had to decide whether they were *near* or *far* from each other. They first received 20 practice trials to familiarize them with the range of distances used in the experiment. Again the mapping of the z- and m-keys with response was counterbalanced.

Table 4. *Mean reaction times and error rates in the distance decision task in Experiment 3*

	Reaction times		*Error rates*	
Distance	*Similar*	*Dissimilar*	*Similar*	*Dissimilar*
Near	417 (15)	413 (14)	.014 (.005)	.025 (.008)
Far	408 (14)	406 (14)	.016 (.005)	.012 (.004)

Note: Mean reaction times in ms. Standard errors are shown in parentheses.

Results and discussion

The mean reaction times and error rates of Experiment 3 are presented in Table 4. We performed a 2(distance: near and far) × 2 (similarity: similar and dissimilar) repeated measures ANOVA over the reaction times and error rates.

We only analysed the correct reaction times that fell within 2 standard deviations from the participant's mean. This resulted in a removal of 4.4% of the reaction times. There was no interaction effect in reaction times, $F < 1$, nor in the error rates, $F(1, 29) = 3.028$, $MSE = 0.002$, $p = .092$.

Thus, the similarity of colours did not influence distance decisions. This provides evidence that the mapping between SIMILARITY and CLOSENESS is asymmetrical.

In addition we performed a combined analysis of Experiments 1 and 2. In the reaction times we found a three-way interaction effect (Similarity × Distance × Task), $F(2, 58) = 9.33$, $MSE = 6{,}081.2$, $p = .003$. In the error rates we did not find a significant three-way interaction effect, $F < 1$. Although the absence of an effect of similarity on distance judgement is based on a null effect and should be interpreted with caution, the interaction indicates that at least the effects are different.

EXPERIMENT 4

There is an alternative explanation, however, because the reaction times were lower in

Experiment 3 than in Experiment 1. In Experiment 3 we used the same stimuli as those in Experiment 1, but apparently the task in Experiment 3 was much easier to perform than that in Experiment 1. This may have been due to differences in variation of the relevant dimensions. The relevant feature in Experiment 1 (SIMILARITY) was more variable (nine similar and nine dissimilar pairs) than the relevant feature in Experiment 3 (1 far and 1 near configuration). Therefore, in order to have a more balanced comparison of the two tasks, in Experiment 4 we adjusted the stimuli so that the variability for the relevant and irrelevant features of the task was comparable with those of the task in Experiment 1. In Experiment 4 we used only two colour pairs (one similar pair and one dissimilar pair) and more distances (10 near and 10 far).

If the null effect in Experiment 3 was due to asymmetry of the conceptual mapping of SIMILARITY IS CLOSENESS and not to differences in task difficulty, processing time of the concepts, or saliency of features in the stimuli, we would again expect no interaction effect in Experiment 4. The similarity of colours should not affect decisions in the distance decision task.

Method

Participants

A total of 30 psychology students from the same subject-pool as that in Experiments 1, 2, and 3, who had not participated in Experiments 1, 2, and 3, received course credits for participating.

Materials

The stimuli were 20 pairs of squares (each 2 × 2 cm). The 10 near pairs were presented 2 cm from each other, and the 10 far pairs were presented 4 cm from each other. On the screen there were three rows of 12 position slots each above each other, creating a total of 36 locations (note that these slots were invisible). The middle row was vertically and horizontally centred, the top row was situated 3 cm above, and the bottom row was situated 3 cm below the middle row. On each trial two different position slots were used from the same row. This way, the positions of the squares were always horizontally aligned. For the near condition we created pairs with positions that were separated by 2 cm (one square), and for the far condition we created pairs with positions that were separated by 4 cm (two squares). We used each of the 36 locations in both the near and the far condition in such a way that the position of an individual square was not predictive of the correct response. The squares in the near and far conditions could have either similar colours or dissimilar colours. The dissimilar colours were purple and yellow (participants judged this colour pair the most dissimilar, $M = 6.8$ on a scale of 1−7), and the similar colours were two different hues of orange ($M = 1.6$). We counterbalanced for position of colour (right vs. left) and for similarity (similar vs. dissimilar). Each distance pair was presented four times, which resulted in 80 trials (20 × 2 × 2) in total. An additional set of 18 pairs was used for practice. Instead of being presented next to each other the practice pairs of squares were presented above each other and were vertically aligned. The distances, size, and colours were the same as those in the experimental trials.

Procedure

The procedure was the same as that in Experiment 3.

Results and discussion

The mean reaction times and error rates of Experiment 4 are presented in Table 5. As can be seen, reaction times were more comparable to those of Experiment 1, indicating that the task

Table 5. *Mean reaction times and error rates in the distance decision task in Experiment 4*

	Reaction times		*Error rates*	
Distance	*Similar*	*Dissimilar*	*Similar*	*Dissimilar*
Near	513 (15)	556 (16)	.027 (.006)	.024 (.006)
Far	532 (15)	553 (15)	.035 (.007)	.026 (.006)

Note: Mean reaction times in ms. Standard errors are shown in parentheses.

difficulty was more similar than that of Experiment 3. We performed a 2 (distance: near and far) × 2 (similarity: similar and dissimilar) repeated measures ANOVA over the reaction times and error rates.

We only analysed the correct reaction times that fell within 2 standard deviations from the participant's mean. This resulted in a removal of 4.6% of the reaction times. There was no interaction effect, $F < 1$, and only a main effect of distance, $F(1, 29) = 17.68$, $MSE = 15{,}653.3$, $p < .001$. Far responses were slower than close responses. In the error rates we found no interaction effect or main effects, all $Fs < 1$.

Thus, the similarity of colours did not influence distance decisions. Even though caution should be taken when interpreting null results, this provides further support for the idea that the mapping between SIMILARITY and CLOSENESS is asymmetrical. The results from Experiments 3 and 4 also show that the interaction effect that was found in Experiment 1 was not due to alignment of the two stimulus dimensions. If participants had used such alignments, we also would have expected symmetrical effects.

GENERAL DISCUSSION

In the present study we examined whether the distance between two colour squares influenced performance in a colour similarity decision task. In Experiments 1 and 2 we found an interaction effect between distance and similarity. Participants responded faster to similar colours that were presented near each other than to those far from each other, whereas participants responded faster to dissimilar colours that were presented far than to those near each other.

Experiments 3 and 4 addressed whether or not this effect of distance on the similarity decision task is asymmetrical. In Experiments 3 and 4 we found that the similarity of colours of two squares had no influence on distance decisions. This shows that the conceptual mapping is asymmetrical; SIMILARITY borrows the mental representation of CLOSENESS but not vice versa. This study followed the prediction of the conceptual mapping SIMILARITY IS CLOSENESS (Lakoff & Johnson, 1980, 1999). In addition, these experiments show that the conceptual mapping is automatically activated in a task that used nonlinguistic stimuli.

The present results are consistent with other recent findings that support the SIMILARITY IS CLOSENESS image schema mapping (Breaux & Feist, 2008; Casasanto, 2008). In these studies a variety of stimuli were used (words, objects, colours). An important difference between these studies and our present study is that we minimized uncertainty about what the correct response was. Because the differences between the similar and dissimilar pairs in our present study were very obvious this task was easy to perform. By minimizing the uncertainty about the response, we minimized the strategic use of irrelevant features (distance) to perform the task (e.g., Van den Bos, 2003; Van den Bos et al., 1997). Another factor that discouraged participants from using irrelevant features of the stimulus (distance) is that this irrelevant feature was not helpful to perform the task. Irrelevant features (e.g., distance) might be helpful in judgement tasks, especially when no feedback is provided. Without feedback, participants might continue to use this irrelevant information because it facilitates performance. In our task the use of the irrelevant feature would have resulted in high error scores. As the error rates were very low in Experiments 1 and 2, it is unlikely that distance was strategically used to make similarity decisions. Therefore, our results provide strong evidence for the SIMILARITY IS CLOSENESS image schema mapping.

Interestingly, Casasanto (2008) and Breaux and Feist (2008) obtained the opposite results if the task was to make perceptual similarity judgements. They found that stimuli were judged to be less similar if they were presented near each other than when they were presented further apart. They suggested that the metaphorical mapping may be limited to situations in which conceptual similarity judgements are made. It is possible that similarity ratings for perceptual judgements are affected by noticing more differences in perceptual details if stimuli are near each other than if they are far. Noticing more differences would result in lower similarity ratings. In our present study this may not have played a role, because the difference between similar and dissimilar stimuli was very clear, and participants made binary responses rather than ratings on a scale from 1 to 9.

Our study is in line with prior studies of the conceptual metaphor theory. Whereas some prior results might be explained by metaphorical language, however, our results show that the metaphorical mapping is part of the concept itself. When making a decision on the similarity of colours, participants must have activated the concept SIMILARITY. That this concept was primed by the actual distance between the stimuli indicates that distance is part of the concept. Moreover, the fact that we found an effect in a speeded and easy decision task indicates that distance is a core part of the concept of similarity.

In Experiments 3 and 4 we looked at the asymmetry of the metaphorical mapping SIMILARITY IS CLOSENESS. In line with previous studies that looked at other metaphors (Casasanto & Boroditsky, 2008; Meier & Robinson, 2004; Meier et al., 2004; Van Dantzig et al., 2008) we found that the mapping between SIMILARITY and CLOSENESS is asymmetrical. Thus it seems that we need the representation of the concrete concept CLOSENESS to understand the abstract concept SIMILARITY, but not vice versa. This finding of asymmetry is compatible with the conceptual metaphor theory (Lakoff & Johnson, 1980) and in line with embodied theories of mental representation (e.g., Barsalou, 1999; Glenberg, 1997; Goldstone, 1994). According to embodied theories, mental representations of concepts are constructed by simulating bodily interaction with these concepts (e.g., Barsalou, 1999; Glenberg, 1997; Goldstone, 1994). Although this bodily interaction explanation works well for concrete concepts (e.g., chair), it does not work for abstract concepts (e.g., value). This problem that abstract concepts are nonphysical can be solved by asymmetrical conceptual mapping (Lakoff & Johnson, 1980; see also Grady, 1997, 2005). The mental representation of a concrete concept is built up of image schemas that are elaborated and rich with sensory-motor experiences. This rich and elaborated mental representation can be used to understand an abstract concept with a poorer representation by means of conceptual mapping. This conceptual mapping is asymmetrical since it makes no sense to use other domains of concepts when the mental representation of concrete concepts is sufficient to understand the concept.

To conclude, in the present study we found evidence that the conceptual mapping SIMILARITY IS CLOSENESS is fundamental to the concept of similarity. The effect is automatic and not due to linguistic associations. Moreover, the mapping was found to be asymmetrical. These findings support the conceptual metaphor theory of Lakoff and Johnson (1980, 1999).

Original manuscript received 6 November 2008
Accepted revision received 16 June 2009
First published online 3 September 2009

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