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Embodied Metaphors and Creative "Acts"

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Abstract

Creativity is a highly sought-after skill. Prescriptive advice for inspiring creativity abounds in the form of metaphors: People are encouraged to "think outside the box," to consider a problem "on one hand, then on the other hand," and to "put two and two together" to achieve creative breakthroughs. These metaphors suggest a connection between concrete bodily experiences and creative cognition. Inspired by recent advances in the understanding of body-mind linkages in the research on embodied cognition, we explored whether enacting metaphors for creativity enhances creative problem solving. Our findings from five studies revealed that both physical and psychological embodiment of metaphors for creativity promoted convergent thinking and divergent thinking (i.e., fluency, flexibility, or originality) in problem solving. Going beyond prior research, which focused primarily on the kind of embodiment that primes preexisting knowledge, we provide the first evidence that embodiment can also activate cognitive processes that facilitate the generation of new ideas and connections.

Keywords

creativity, cognitive processes, mental models

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Metaphors about creative thinking abound in everyday parlance. Creativity presumably follows from "thinking outside the box," from considering a problem "on the one hand, then on the other hand," and from "putting two and two together." Such prescriptive advice is common to people in research labs, advertising teams, the halls of higher education, and other contexts in which pioneering, novel approaches to pressing problems are valued. In this article, we report results from five experiments in which we examined the psychological potency of these creative metaphors by investigating whether creative problem solving was enhanced when people embodied them.

Our approach in investigating the power of creative metaphors was inspired by recent advances in the understanding of body-mind linkages in the literature on embodied cognition. According to the embodied-cognition perspective, abstract concepts can become closely tied to the concrete bodily experiences of sensations and movements (Barsalou, 2008; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). A growing body of research has supported this view by showing that people draw on their concrete physical experiences in constructing social reality. For example, holding a warm beverage, as opposed to a cold beverage, increases people's perceptions of the warmth of a stranger's personality (Williams & Bargh, 2008) and their closeness with their significant other (IJzerman & Semin, 2009). Physically moving backward or forward appears to cue memories of past events or thoughts about future events, respectively (Miles, Nind, & Macrae, 2010).

To explain these phenomena, accounts of metaphor-enriched social cognition postulate that metaphors operate through a conceptual mapping process whereby source concepts are mentally associated with superficially dissimilar target concepts (Landau, Meier, & Keefer, 2010; see also IJzerman & Koole, 2010). The use of metaphors may therefore make knowledge from a source domain that is largely concrete and physical (e.g., temperature) more accessible in the context of an abstract target concept (e.g., perceptions of other people; Lakoff & Johnson, 1999). The literal and abstract meanings of some metaphors may thus become intertwined to such an extent that the metaphors themselves achieve a physical reality of their own (Schubert, 2005).

Prior research on embodiment has focused almost exclusively on the kind of embodiment that activates preexisting knowledge structures. For example, the tactile sensation of warmth has been shown to activate knowledge about relational

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closeness (Williams & Bargh, 2008), and making a fist has been shown to increase men's perceptions of themselves as assertive (Schubert & Koole, 2009). In the research reported here, we sought to advance the understanding of embodied cognition by investigating for the first time whether embodiment can prime not only existing knowledge structures, but also cognitive processes necessary for generating new ideas and knowledge. More specifically, we explored whether embodying metaphors for creativity can give rise to novel ideas by facilitating the psychological process of creative problem solving.

Creativity is typically defined as the process of creating something both novel and useful (Amabile, 1996). Both *convergent thinking* and *divergent thinking* are important to creative problem solving (Guilford & Hoepfner, 1971). Convergent thinking entails the search for the best answer or the most creative solution to a problem (Dewhurst, Thorley, Hammond, & Ormerod, 2011; Nemeth, 1986; Simonton, 2003). Divergent thinking entails the generation of many ideas about and alternative solutions to a problem (Guilford, 1967).

Divergent thinking involves at least three distinct components that are complementary but not highly correlated: fluency, flexibility, and originality (Cheng, Sanchez-Burks, & Lee, 2008; Guilford, 1959; Nijstad, De Dreu, Rietzschel, & Bass, 2010; Torrance, 1966). Fluency is the ability to generate a large number of ideas in response to a problem. Fluency is an important antecedent to creativity because the more ideas a person generates about a problem, the more likely he or she will be to arrive at a novel solution for it (Simonton, 1999). Flexibility refers to the extent to which generated ideas differ from each other. Flexibility is indicative of divergent thinking if the generated ideas span multiple conceptual categories, disciplines, or fields of inquiry. Originality is the extent to which an idea is novel in the context of previously known ideas. The originality of ideas can be evaluated either by subjective judgment or by objective statistical frequency (Hocevar, 1979). Notably, good performance on both convergent- and divergent-thinking tasks demonstrates creative cognition because people have to overcome mental fixedness and be cognitively flexible in order to excel at such tasks.

We hypothesized that the embodiment of metaphors for creativity would promote creative problem solving. To maximize the robustness and generalizability of our findings, we utilized measures of creativity that assessed convergent thinking (indicated by the attainment of correct solutions) and divergent thinking (indicated by fluency, flexibility, and originality). We employed different measures of creativity across five studies to ensure not only that any observed effects would generalize to each component of the creative process, but also that the results would not be due to artifacts associated with a given measure of creativity.

Study 1

Across cultures and languages (e.g., English, Korean, Hebrew, and Chinese), metaphors associate creativity with bilateral physical orientations. According to these metaphors, better solutions arise by thinking about a problem "on one hand" and then "on the other hand." In our first experiment, we tested whether physically embodying the two-hands metaphor by making gestures first with one hand and then with the other hand facilitated the three components (fluency, flexibility, and originality) of divergent thinking.

Method

Forty undergraduate participants (12 females, 28 males) were asked to take part in two ostensibly unrelated studies simultaneously: Participants were told that while they came up with novel uses for a university building complex for a study on the generation of creative ideas, they would also take part in a public-speaking study that required them to lift one hand and hold their arm outstretched, as a person might do while talking to a group from a stage. After viewing an instructional video that described the procedure and body posture, participants stood facing the corner of the room, where task instructions were attached either to the walls on both sides (experimental condition) or only the wall on the right side (control condition).

During the first trial, participants read the question of how the university building complex could be used (the question was printed on a piece of paper attached to one or both walls) and verbalized answers while holding their right hand toward the wall with the palm facing up and their left hand behind their back. During the second trial, control participants generated additional ideas while raising the same hand they had raised during the first trial; participants in the experimental condition, however, switched hands by holding their left hand toward the wall and their right hand behind their back while they generated additional ideas. Notably, participants were not aware that they would have to generate answers to the same question on both trials until the second trial began. There was no time constraint for responding in either trial.

We audio-recorded participants' oral responses and had two independent raters code them for fluency (number of ideas generated) and flexibility (number of unique categories reflected by the ideas, e.g., "restaurant," "gymnasium"; interrater $r = .67$). Following Goncalo and Staw (2006), we calculated an objective originality score for each idea by counting the number of times it had been generated in the sample and subtracting that number from the total number of participants. We calculated an originality score for each participant by summing the originality scores for all of his or her ideas; higher scores indicated a greater number of original ideas.

Results

A 2 (condition: experimental, control; between subjects) × 2 (Trial: 1, 2; within subjects) mixed-design analysis of variance (ANOVA) with fluency as the dependent variable showed a main effect of trial, $F(1, 38) = 26.17$, $p < .001$, $\eta_p^2 = .41$; participants in both conditions generated more ideas on the first trial ($M = 11.67$, $SD = 6.04$) than on the second trial ($M = 7.20$,

SD = 3.83). As predicted, there was a significant Condition × Trial interaction, $F(1, 38) = 5.97$, $p = .02$, $\eta_p^2 = .14$; on Trial 2, a greater number of ideas were generated by participants in the experimental condition (M = 8.17, SD = 4.00) than by participants in the control condition (M = 5.75, SD = 3.15), $t(38)$ = 2.02, $p = .05$, $\eta_p^2 = .10$. There was no difference in the number of ideas generated by participants in the two conditions on Trial 1, $t(38) < 1.20$. There was no main effect of condition on fluency, $F < 1$.

Similar patterns were observed for flexibility and originality. There was a main effect of trial on flexibility (Trial 1: M = 7.03, SD = 2.85; Trial 2: M = 2.78, SD = 1.59), $F(1, 38)$ = 78.42, $p = .01$, $\eta_p^2 = .67$, and a main effect of trial on originality (Trial 1: M = 1,036.75, SD = 578.31; Trial 2: M = 673.18, SD = 381.80), $F(1, 38) = 20.70$, $p = .02$, $\eta_p^2 = .35$. Of import, there were significant Condition × Trial interactions for both flexibility, $F(1, 38) = 4.28$, $p = .045$, $\eta_p^2 = .10$, and originality, $F(1, 38) = 6.53$, $p = .02$, $\eta_p^2 = .15$; on Trial 2, the ideas of participants in the experimental condition were characterized by greater flexibility (M = 3.08, SD = 1.74) and originality (M = 768.83, SD = 404.45) than were the ideas of participants in the control condition (flexibility: M = 2.31, SD = 1.25; originality: M = 529.68, SD = 302.63).

Study 2a

One reason why creativity can be sparked by considering a problem from different perspectives is that accessing different alternative solutions helps people overcome cognitive rigidity. This process is well captured by the expression "think outside the box," a platitude often offered to inspire young scientists, industrial designers, and Hollywood scriptwriters alike. In Studies 2a, 2b, and 3, we tested whether enacting this metaphor enhanced creative problem solving. First, in Study 2a, we examined the effect of embodying the outside-the-box metaphor on creative problem solving in a convergent-thinking task.

Method

One hundred two undergraduate students (52 females, 50 males) participated in this study in return for $7. Using polyvinyl chloride (PVC) pipe and cardboard, we constructed a box that measured 5 ft by 5 ft and could comfortably seat one individual. We placed the box in a laboratory and asked participants, who had been told that the study concerned the effects of different work environments, to complete a 10-item Remote Associates Test (RAT; M. T. Mednick, Mednick, & Mednick, 1964) while sitting either inside or outside the box. We also included a control condition in which participants completed the task without the box present.

On the RAT, participants are presented with three clue words (e.g., "measure," "worm," and "video") and must think of a fourth word (e.g., "tape") that relates to each of the three clues. The RAT is a measure of convergent thinking; specifically, it measures individuals' ability to analyze relationships among remote ideas and come up with one correct solution (Dewhurst et al., 2011; Subramaniam, Kounios, Parrish, & Jung-Beeman, 2008; Taft & Rossiter, 1966). We predicted that participants who completed the RAT while seated outside the box—that is, participants who literally embodied the metaphor of thinking outside the box—would be more likely than participants who sat inside the box or who saw no box to overcome cognitive fixedness and correctly link the clue words to arrive at the correct answers.

To rule out potential confounds associated with the experience of being inside the box, after participants had completed the RAT, we had them respond to four feeling items pertaining to safety ("I felt safe"), privacy ("I felt that I had privacy"), confusion ("I felt confused"), and comfort ("I felt comfortable"), using scales from 1 (*strongly disagree*) to 5 (*strongly agree*). In addition, participants completed the 20-item Claustrophobia Scale (α = .86; Öst, 2007), on which they reported the degree of anxiety that they would experience in specific situations, using scales from 1 (*none*) to 5 (*very much*).

Results

As predicted, participants who completed the RAT while they were physically outside the box generated more correct answers (M = 6.73, SD = 0.50) than did participants who were physically inside the box (M = 5.08, SD = 0.51) and control participants (M = 5.43, SD = 0.35), $F(1, 99) = 3.93$, $p < .05$, $\eta_p^2 = .06$. Planned contrasts revealed that the accuracy of participants in the outside-the-box condition was significantly higher than that of participants in the other two conditions, $t(99) = 2.52$, $p < .05$, $\eta_p^2 = .06$. Including feelings of safety, privacy, confusion, comfort, and claustrophobia as covariates did not alter the results, $F(1, 47) = 8.04$, $p < .01$, $\eta_p^2 = .15$, and the effects of the covariates on accuracy were not significant ($F < 3.68$). Mean scores on the RAT did not differ between the inside-the-box and control conditions, a result that suggests that the difference between the inside-the-box and outside-the-box conditions was due to the creativity-fostering effects of thinking outside the box, rather than to creativity-hampering effects of thinking inside the box.

Study 2b

In Study 2b, we extended Study 2a in two ways. First, we investigated whether physically embodying a box by walking in a fixed, rectangular path would yield findings consistent with our results from the inside-the-box condition of Study 2a. Second, whereas we used a measure of convergent thinking to assess creativity in Study 2a, we used measures of divergent thinking to assess creativity in Study 2b, given that outside-the-box thinking is presumably conducive not only to arriving at correct solutions but also to generating many alternative ideas.

Method

One hundred four participants (66 females, 38 males) took part in this study in return for course credit. Participants were randomly assigned to a rectangular-walking, free-walking, or sitting condition. They were run one at a time in a lab and were told that the study concerned how contemplating solutions to problems affected problem solving. All participants were instructed to sit at a desk to write responses down; to justify the walking manipulations, we told participants in the rectangular-walking and free-walking conditions that they would have to leave the desk and walk around the lab so that they could not immediately write down their solutions without contemplation.

Participants completed two divergent-thinking tasks that involved generating ideas: a Droodle task and a Lego task (described in the following paragraphs). Task order was counterbalanced across participants. In the rectangular-walking condition, after reading the instructions for the first task, participants spent 2 min contemplating their answers while they walked along a fixed rectangular path (approximately 6 ft by 8 ft), indicated by duct tape placed on the floor. In the free-walking condition, participants walked as they wished. After they had walked for 2 min, participants wrote down their answers and repeated the same procedure for the second task. Participants in the sitting condition remained seated while they contemplated solutions for 2 min and then wrote them down.

Droodle task. Droodles are ambiguous pictures (Price, Lovka, & Lovka, 2002). Participants were presented with two Droodles, each of which was accompanied by a descriptive caption. For example, a Droodle depicting two lines in a V shape sticking out of a hole, with shorter lines extending from the top of each of those lines at an angle (like a line drawing of two chicken feet), was accompanied by the caption "A bird in a hole, upside down." Participants were asked to generate a new caption for each picture. We assessed participants' out-of-the-box thinking by determining how much their newly generated captions deviated from the provided captions. Two independent judges coded the degree of deviation for each caption, using scales from 0 to 9, with higher numbers indicating greater deviation (interrater r = .62). We calculated an originality score for each participant by averaging his or her mean deviation scores from the two judges.

Lego task. Participants were presented with three pictures of Lego assemblages, each of which was created with two or three Lego blocks, and had to write down up to eight objects the Lego blocks could represent (e.g., a dinosaur, stairs). To complement the subjective measure of originality used for the Droodle task, we used an objective measure of originality that was based on the statistical infrequency of participants' ideas for the Lego task.

We computed a grand dominance-to-rank ratio for each participant as a measure of originality (e.g., Leung & Chiu, 2010; Ward, Patterson, Sifonis, Dodds, & Saunders, 2002). Except for responses that reflected minor variations in inflection (e.g., "stairs" and "stair") and responses that were close synonyms (e.g., "flight" and "airplane"), all different responses were coded as distinct ideas. We calculated each idea's rank by recording its ordinal position on the list of each participant who had generated it and averaging this number across participants. To calculate a dominance-to-rank ratio for each idea, we divided the number of participants who had listed the idea by its rank. We then computed the grand dominance-to-rank ratio for each participant by averaging the dominance-to-rank ratios of his or her generated ideas for each of the three Lego pictures. A high dominance-to-rank ratio indicated low originality. We also obtained scores for fluency (i.e., number of ideas generated) and flexibility (i.e., number of categories reflected by the ideas; interrater r = .70).

Results

As predicted, participants who walked freely generated more original new captions for the Droodles (M = 6.24, SD = 0.94) than did participants who walked along a rectangular path (M = 5.68, SD = 0.95) and participants who did not walk (M = 5.52, SD = 0.96), $F(2, 97) = 5.34$, $p = .01$, $\eta_p^2 = 1.00$. Planned contrasts revealed that the originality scores of participants in the free-walking condition were significantly higher than those of participants in the rectangular-walking and sitting conditions, $F(1, 97) = 10.23$, $p < .01$, $\eta_p^2 = 1.00$. Originality scores in the rectangular-walking and sitting conditions did not differ ($F < .48$).

Likewise, in the Lego task, free-walking participants listed more-original ideas (M = 7.36, SD = 2.84) than did participants in the rectangular-walking (M = 9.32, SD = 3.49) and sitting (M = 8.36, SD = 2.98) conditions, $F(2, 101) = 3.40$, $p = .04$, $\eta_p^2 = .06$. Again, planned contrasts revealed that the ideas of free-walking participants were significantly more original than were the ideas of rectangular-walking and sitting participants, $F(1, 101) = 5.22$, $p < .02$, $\eta_p^2 = .05$; ideas generated by rectangular-walking and sitting participants did not differ in their originality ($F < 1.63$). The fluency and flexibility scores did not differ across the three conditions (Fs < .89).

Study 3

Studies 1, 2a, and 2b focused on the embodiment of metaphors for creativity through actual bodily movement (i.e., hard embodiment). It is conceivable that embodied cognition can also be derived from the psychological representation of the body interacting with the world (i.e., soft embodiment; Leung & Cohen, 2007; Zajonc & Markus, 1984). This psychological representation of the body comes about as people form mental images of the ways in which they carry their bodies (Boroditsky & Ramscar, 2002; McGlone & Harding, 1998). We hypothesized that mentally embodying metaphors for creativity by imagining bodily motions would have effects similar to those of physically enacting such metaphors. To investigate the soft embodiment of creative metaphors, we conducted Study 3 using *Second Life* (www.secondlife.com), a popular three-dimensional virtual world.

Method

Seventy-three participants (35 females, 38 males) took part in this study in return for approximately $3.80. Participants were told that this study concerned perspective taking in virtual worlds. They were assigned an avatar of their gender and asked to imagine being that avatar in *Second Life*. After a practice trial in which they controlled the avatar to make it walk, participants completed a creativity task that required them to generate as many ideas as possible for creative gifts they might give to an acquaintance (Leung & Chiu, 2010). While participants generated ideas, they walked the avatar and imagined themselves as the avatar. The avatar walked either freely or along a fixed, rectangular path; in other words, the environmental setup was similar to that used in Study 2b, but situated in a virtual world (see Fig. 1). After virtually walking for 3 min, participants wrote down their gift ideas. Finally, they reported how easy it had been for them to control their avatar, using a scale from 1 (*extremely difficult*) to 7 (*extremely easy*).

We used the same procedure used for responses in the Lego task in Study 2b to calculate a dominance-to-rank ratio for each gift idea. Higher ratios indicated less-original gift ideas (i.e., gift ideas generated by more participants in the sample). We also obtained scores for fluency (i.e., number of gift ideas generated) and flexibility (i.e., number of categories reflected by the gift ideas; interrater $r = .82$).

Results

Participants in the two conditions did not differ in their ratings of the ease of controlling their avatars, $t(71) < 0.57$, and fluency and flexibility did not differ between conditions (Fs < .01). However, participants whose avatars walked freely generated gift ideas that were more unconventional (e.g., a magazine subscription; $M = 5.71$, $SD = 2.63$) than were the gift ideas of participants whose avatars walked along a fixed path (e.g., a CD or DVD; $M = 7.00$, $SD = 2.78$), $F(1, 71) = 4.17$, $p = .045$, $\eta_p^2 = .06$. This finding suggests that even in the absence of physical movement or changes in the way the body is situated in relation to the environment, "softly" embodying metaphors for creativity can also promote creative thinking, at least as indexed by originality.

Study 4

We had two goals in Study 4. First, we examined the effect of embodying another creativity-related metaphor: "putting two and two together." Second, we tested whether enacting this metaphor facilitated creative problem solving in the form of convergent thinking, but not in the form of divergent thinking. Specifically, we hypothesized that embodying the metaphor by putting two objects together would catalyze participants' ability to synthesize multiple ideas to produce the best solutions to problems. This ability is critical for solving convergent-thinking tasks (e.g., the RAT; Dewhurst et al., 2011; Taft & Rossiter, 1966), which require people to use conceptual recombination to recognize seemingly distant relationships between individual elements of a problem in order to approach a solution (Subramaniam et al., 2008). In fact, when S. A. Mednick (1962) developed the RAT, he theorized that more-creative individuals would excel at the task because they could generate more and broader associative links among the presented stimuli (see also Dewhurst et al., 2011; Rossmann & Fink, 2010). Therefore, it is reasonable to predict that embodying the act of recombination benefits convergent thinking by facilitating the generation of broader associative links among given stimuli. However, the same embodiment might not benefit divergent thinking—the capacity to generate multiple divergent ideas.

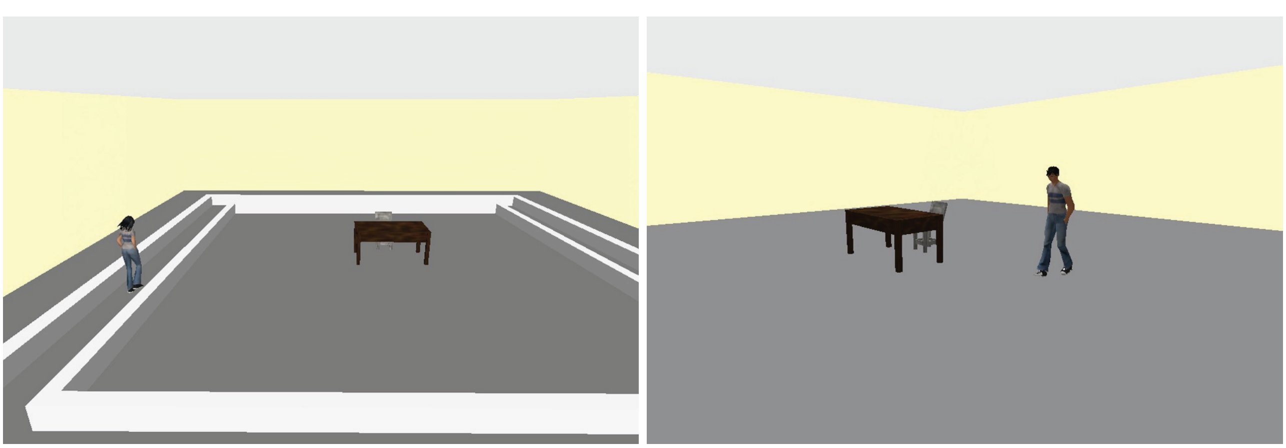

Fig. 1. Experimental setup for the two conditions of Study 3. The illustration on the left shows a *Second Life* avatar in the rectangular-walking condition. The illustration on the right shows a *Second Life* avatar in the free-walking condition.

Method

Sixty-four participants (39 females, 25 males) took part in this study in return for course credit. Participants were told that the study concerned the effects of task repetition on problem solving and were randomly assigned to one of two conditions (recombination or nonrecombination). We cut round paper coasters into halves and stacked the halves in either two stacks (recombination condition) or one stack (nonrecombination condition). Participants were informed that they would simply have to transfer pieces of coasters from the stack or stacks to the middle of the table, and that they would do this repetitively for about 2 min until they had moved all of the pieces to the middle of the table.

For the recombination condition, one stack of coaster halves was placed on the left side of the table, and the other half was placed on the right side; participants had to simultaneously pull one coaster half from the left stack, using their left hand, and another coaster half from the right stack, using their right hand, and then put the halves together (i.e., recombine them) in the middle of the table. Hence, participants in the recombination condition made gestures that involved integrating objects. In the nonrecombination condition, participants transferred the coaster halves from only one side of the table to the middle of the table for 2 min; the side of the table on which the coaster halves were placed was counterbalanced across participants.

Subsequently, we had participants complete a five-item RAT, as a measure of convergent thinking, and the same Lego task used in Study 2b, as a measure of divergent thinking. For the Lego task, our measure of fluency was the total number of ideas generated; our measure of flexibility was the average number of distinct categories reflected by the ideas (interrater r = .76); and our measure of originality was the grand dominance-to-rank ratio for those ideas.

Results

As predicted, embodiment of the act of recombination facilitated convergent, but not divergent, thinking. On the RAT, participants who enacted gestures of recombination (M = 2.78, SD = 1.19) outperformed participants who did not (M = 1.92, SD = 0.97), $F(1, 62) = 8.92$, $p = .004$, $\eta_p^2 = .13$. Scores for fluency, flexibility, and originality in the convergent-thinking Lego task did not differ between conditions (Fs < 2.98).

General Discussion

Across five experiments based on different metaphors for creativity and using different measures of creativity, we found convergent support for the creativity-enhancing effects of embodying creative metaphors. The results from our series of experiments are consistent with accounts of metaphor-enriched social cognition and provide evidence that prevalent metaphors for creativity tap an implicit wisdom about physical experience: Creativity-implicating physical acts may be conducive for creative problem solving because they activate the processes involved in overcoming mental fixedness or the processes involved in forging new connections among distinct ideas.

Thus, the acts of alternately gesturing with each hand and of putting objects together may boost performance on divergent-thinking and convergent-thinking tasks, respectively, and thinking while moving freely or without constraints (e.g., walking outdoors, pacing around a room) may inhibit unconscious mental barriers that restrict creative cognition and thereby boost performance on both convergent- and divergent-thinking tasks. Further, consistent with the notion that people's mental imagery of the way their bodies move instantiates their understanding of their place in the physical world (Cohen, Hoshino-Browne, & Leung, 2007; Cohen & Leung, 2009), our findings demonstrate that mental representations of creativity-supporting bodily movements can also enhance creative thinking. Together, these effects of hard and soft embodiments of metaphors for creativity suggest that the associations between mind and body in common metaphors are more than merely metaphorical.

One might reasonably ask whether embodying metaphors for creativity indeed facilitated creativity, or whether our various control manipulations merely hampered creativity. The results of our analyses suggest that the former is true. The control conditions in Study 1 and Study 4 were not constraining because, although we explicitly told participants in these conditions to use one hand, we did not explicitly restrict them from using their other hand; in fact, in these conditions, using one hand might have been less cognitively demanding than using both hands. Even clearer conclusions can be drawn from Studies 2a and 2b. Whereas the outside-the-box condition (Study 2a) and the free-walking condition (Study 2b) promoted creative problem solving, the baseline performance of participants in the control (no-box) and sitting conditions did not significantly differ from the performance of participants in the inside-the-box and rectangular-walking conditions, respectively. This pattern of results suggests that enacting metaphors for creativity—at least the metaphors examined in the present research—enhances creativity.

It should be noted that Studies 2b and 3 showed an effect of embodiment on originality, but not on fluency or flexibility. We offer two potential explanations for this unexpected result. First, we propose that originality is the most central component of creativity, given that it is "theoretically possible to be creative without being flexible or fluent (e.g., if one generates only one creative solution), but it is impossible to be creative without being original" (Rietzschel, De Dreu, & Nijstad, 2007, p. 857). Despite being an appropriate measure of originality, our Lego task may have imposed a ceiling effect on fluency and flexibility. In the task, we asked participants to generate up to eight ideas for what each Lego assemblage could represent, and participants in all conditions generated about five ideas (free-walking condition: M = 4.85; rectangular-walking condition: M = 5.24; sitting condition: M = 4.83) for each assemblage. Given this explicit ceiling, we hesitate to make strong inferences from the null effects that emerged. Notably, this methodological issue did not extend to our measure of originality, which was based on the statistical infrequency of ideas rather than the number of ideas generated. Second, the effects of embodying the thinking-outside-the-box metaphor in Studies 2b and 3 might in fact be consistent with the investigated embodied state, given that this metaphor emphasizes breaking conventions and may thereby facilitate the generation of normatively infrequent responses (originality) more than it facilitates the generation of many responses (fluency) or the generation of responses that reflect different categories (flexibility).

Together, results for both Studies 2b and 3 showed that enacting the thinking-outside-the-box metaphor enhanced originality in three divergent-thinking tasks: generating Droodle captions (Study 2b), generating ideas about what Lego assemblages could represent (Study 2b), and generating gift ideas (Study 3). The two-hands metaphor embodied by participants in Study 1 implicitly suggests that individuals should overcome cognitive fixedness (facilitating originality), think more (facilitating fluency), and entertain diverse perspectives (facilitating flexibility); our findings from Study 1 confirmed that this embodied state enhanced the three components of divergent thinking.

Our studies provide the first experimental evidence that enacting metaphors for creativity that implicitly discourage cognitive fixedness benefits creativity. Recent research has suggested that creative problem solving can also be achieved through focused, hard work and perseverance (Nijstad et al., 2010). Future research can extend that idea by examining whether physical acts that entail a guided, focused activity (e.g., a focused eye gaze) can similarly promote creativity (see Thomas & Lleras, 2009).

Taken together, our findings move research on embodied cognition in a new direction, and their implications extend beyond the domain of creativity. Embodiment research thus far has tended to concentrate on the role of the body's sensorimotor system in activating existing repertoires of knowledge and thereby facilitating the expression of certain thoughts and behaviors. Our findings shed new light on this perspective by demonstrating that embodiment can potentially enlarge—not just activate—repertoires of knowledge by triggering cognitive processes that are conducive to generating creative solutions. In other words, body-mind linkages influence not only processes of knowledge activation, but also processes of knowledge generation. Embodying metaphors for creativity appears to help ignite the engine of creativity.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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