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Attentional Priming Effects on Creativity

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ABSTRACT: The authors tested the hypothesis that a broad or narrow scope of perceptual attention engenders an analogously broad or narrow focus of conceptual attention, which in turn bolsters or undermines creative generation. In the first two experiments, participants completed visual tasks that forced them to focus perceptual attention on a comparatively broad or narrow visual area. As predicted, broad, compared to narrow initial focusing of perceptual attention subsequently led to generation of more original uses for a brick (Experiment 1) and generation of more unusual category exemplars (Experiment 2). In Experiment 3, participants were merely asked to contract their frontalis versus corrugator muscles, producing rudimentary peripheral feedback associated with broad versus narrow perceptual focus. As predicted, frontalis contraction, relative to corrugator contraction, led to the production of more original uses for a pair of scissors. Together, these three experiments provided converging initial support for our attentional priming hypothesis, suggesting that situationally induced variations in the scope of perceptual attention (and simple cues associated with such variations) may correspondingly expand or constrict the focus of conceptual attention within the semantic network, thereby improving or diminishing creativity.

In his widely influential theory of individual differences in creativity, Mednick (1962) argued that the ability to produce creative solutions is substantially influenced by ideographic variation in the strength distributions of associative responses. For individuals with relatively steep associative response gradients, the most conventional responses to a given stimulus are overwhelmingly high in associative strength, ensuring that these responses will almost always be produced. For instance, within the context of a word association task, for any given word presented (e.g., "table"), individuals with more steeply graded associative distributions will typically offer only the most dominant or stereotyped responses (e.g., "chair," "cloth"). In contrast, for individuals with relatively flat response gradients, the associative strengths of responses with respect to a given stimulus are more equally distributed, increasing the likelihood that remotely associated responses (e.g., "leg," "fable") will be produced. Inasmuch as it is "among...more remote responses that the requisite elements and mediating terms for a creative solution will be lurking" (Mednick, 1962, p. 223), Mednick argued that individuals with flatter associative gradients—those more likely to generate unconventional responses to a given stimulus—should demonstrate greater creativity, on average, than those with steeper associative gradients. This prediction

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was empirically supported by Mednick's (1962) own studies revealing positive correlations between performance on the Remote Associates Test (higher scores posited to indicate flatter associative gradients) and various indices of creativity (e.g., originality of independent research).

Although couched in the language of behaviorism, according to Martindale (1981, 1995), Mednick's theory may be readily reconstrued in the language of cognitive science. Essentially, Martindale suggested that the individual differences in the slope of associative gradients, as described by Mednick (1962), may be understood in cognitive terms as individual differences in the chronic scope (i.e., breadth or narrowness) of *conceptual* attention, or attentional selection of internal, conceptual representations (as opposed to external percepts). According to this view, individuals described by Mednick as having steep associative gradients may be seen as tending to focus conceptual attention narrowly, leading to the strong activation of only a few proximal nodes (e.g., "chair," "cloth"), when primed with a given input (e.g., "table"). Correspondingly, individuals described by Mednick as having relatively flat associative gradients may be seen as inclined to focus conceptual attention broadly (or to defocus conceptual attention), engendering the weaker activation of more, and thereby more remote (e.g., "leg," "fable") nodes in memory. In Martindale's reconceptualization, it is the enhanced activation of these more remotely associated concepts that accounts for the latter individuals' superior propensity to access and creatively recombine disparate ideas.

Nomothetic Implications: An Attentional Priming Hypothesis

Although Martindale's (1995) cognitive reconceptualization of Mednick's theory was formulated to account for individual differences in creativity, his analysis has clear nomothetic implications. Specifically, if ideographic variations in the scope of conceptual attention influence the creative generation of ideas, then situational factors that transiently impact the breadth or narrowness of conceptual attention (and thereby the extensiveness of spreading activation) should analogously influence creativity. We posit that one such factor which may situationally influence the scope of conceptual attention, and thereby creativity, is the scope of *perceptual* attention.

Why and how might the breadth or narrowness of perceptual attention—attention directed to external percepts—affect the scope of conceptual attention? According to a large and burgeoning number of cognitive theorists (Anderson & Spellman, 1995; Neill & Westberry, 1987; Neumann & DeSchepper, 1992; Posner, 1987), the attentional selection mechanism utilized on a perceptual level (e.g., to visually focus upon percept X, while excluding percepts Y and Z) may be identical, or at least highly correlated, with the attentional mechanism utilized to select conceptual nodes within the semantic network (i.e., to regulate the extensiveness of spreading activation). That is, a narrowing or broadening of attention to elements of external perceptual input may be achieved by means of the same mechanism used to narrow or broaden attention to internal, conceptual representations. For example, when viewing a vase full of flowers, attention may be directed narrowly (e.g., to the vase alone, or the petals alone) or broadly (e.g., to the vase, stems, and petals together). Likewise, when the concept of "flowers" is semantically primed, conceptual attention may be directed narrowly (e.g., allocating activation to the concepts of "vase" alone or "petals" alone), or broadly (e.g., collectively allocating activation to the concepts "vase," "stems," and "petals"). According to the "identity" hypothesis, these two varieties of attentional narrowing and broadening share the same underlying mechanism: They differ in content (perceptual vs. conceptual), not process.

The Attentional Priming Hypothesis

Assuming that perceptual and conceptual selection are indeed regulated by the same basic mechanism, it is possible that broadening or narrowing the scope of perceptual attention, by directing its focus to a wider or more limited visual area, may activate or prime the attentional mechanism, so that, for at least a brief period of time, conceptual attention is correspondingly broadened or narrowed. In other words, broadening or narrowing the scope of perceptual attention may subsequently engender more or less extensive (broader or narrower) spreading activation, with respect to constructs entered into working memory. More concretely speaking, we propose that if individuals are first directed to focus their visual attention broadly or narrowly on some initial stimulus, then (on an ostensibly

unrelated second task) are presented with a given semantic construct to process, spreading activation from this construct (e.g., "bird," or "brick," or "scissors") will be more extensive when individuals initially have to focus their perceptual attention broadly, and spreading activation will be less extensive when individuals initially have to focus their perceptual attention narrowly. Concisely stated, broad or narrow perceptual attention primes broad or narrow conceptual attention.

In terms of creativity, we predict that broad situationally induced perceptual attention should momentarily widen the scope of conceptual attention, enhancing spreading activation to remote associates, and thereby transiently bolstering the generation of creative ideas. In contrast, narrow situationally induced perceptual attention should temporarily constrict the scope of conceptual attention, reducing spreading activation to remote associates, and thereby diminishing creative generation. In this study, we tested these predictions in three experiments, two manipulating the scope of perceptual attention prior to gauging the ability to produce innovative alternatives; and one manipulating facial muscular cues associated with broad versus narrow perceptual attention prior to assessing originality of generated alternatives.

Preliminary Experiment

Before attempting the aforementioned creativity experiments, we first needed to empirically address a critical, preliminary issue: If a situational manipulation of the scope of perceptual attention is to prime, that is, to have a lingering effect on the scope of conceptual attention, it should be at least potent enough to have lingering effects on another subsequent measure of perceptual attentional scope. Or, as restated, if manipulations of broad or narrow perceptual scope cannot carry over to influence perceptual attention on a subsequent task, there is no reason to believe that such manipulations can carry over to influence the breadth or narrowness of conceptual scope (and thereby creativity) on a subsequent task. To ensure that situational manipulations of perceptual attentional scope can have a significantly lingering influence, we conducted a preliminary experiment in which we manipulated the breadth or narrowness of visual attention, then gauged residual effects on the scope of perceptual attention using an ostensibly unrelated, subsequent measure.

Manipulating Scope

To experimentally vary perceptual attentional scope, we devised a visual search-based manipulation. Here, participants were provided with a series of 18 computerized displays, each containing nine digits (0–9), with each digit subtending a visual angle of approximately 1 degree. Half of these displays contained the digit "3" and half did not. Each display was presented on screen for 1 sec, after which participants were asked to respond as quickly as possible whether or not a 3 was present, using the "y" or "n" keys, respectively. There was a 2-sec intertrial interval between displays. In the broad attentional scope condition, the nine digits were randomly scattered about the periphery of a 9×13-in. CRT display (excluding the area within a 2-in. radius from the center), rendering it necessary to visually search a broad perceptual area to make the requisite presence/absence decision. Correspondingly, in the narrow attentional scope condition, the nine digits were randomly scattered about within relatively close proximity to the center of the CRT display (within a 2-in. radius), rendering it necessary to restrict search to a narrow visual area to make each presence–absence decision. We posited that the repeated requirement to broaden or narrow the scope of perceptual attention across 18 trials would prime the attentional system, so that a relative broadening or narrowing of perceptual attention could be detected on a subsequent, unrelated task.

Measuring Attentional Priming

To gauge the extent of attentional priming, we utilized a paper-and-pencil drawing task, in which participants were given 1 min to complete a cartoon picture (involving a doctor bicycling past a camel) by connecting numbered dots in ascending order. Accurate completion of this task requires narrowed perceptual attention to ensure the pencil mark actually connects with each dot. Broader attention (e.g., to wider segments of the picture or to the scene as a whole) detracts from focus on the component dots themselves and hampers performance.

Method

Participants were 28 undergraduates of the University of Maryland who were informed that they would be completing a study involving "a few separate tasks"

and were paid $5 for their participation. Upon arrival, participants were randomly assigned to complete either the broad or narrow versions of the attentional scope manipulation (the 3 task). After completing this task, participants were administered the connect-the-dots task, which, again, was meant to assess priming of perceptual attentional scope.

Results

Performance scores on the connect-the-dots task were computed by taking the difference between the order of the final dot each participant marked (out of 96) and the number of dots which they missed (i.e., which their pencil mark did not intersect). To reiterate, it was predicted that the performance of participants in the narrow perceptual attention condition should be superior to that of those in the broad condition, inasmuch as fine-grained, narrowly directed attention should enhance focus on the low-level components essential to the task (e.g., the dots) rather than on more global, albeit task-irrelevant, aspects of the picture. These predictions were supported: $M_{narrow} = 75.6$, $M_{broad} = 68.7$, $t(26) = 2.30$, $p = .03$. Theoretically speaking, this suggests that manipulating the breadth or narrowness of perceptual attention may at least briefly prime the attentional system, leading to broader or narrower perceptual attention on a physically and psychologically separate task (at least on one presented after merely a brief delay). These preliminary findings convinced us that attentional priming manipulations may indeed be potent enough to influence subsequent attentional processing. The question then remained, whether this subsequent processing includes the conceptual attentional selection involved in creative generation? Does perceptual attentional priming influence the production of innovative alternatives?

Experiment 1

Overview

As an initial test of the attentional priming hypothesis, we used the same experimental manipulation of perceptual attentional scope utilized in the preliminary experiment (the 3 presence–absence task). As dependent measures of originality (a critical component of creativity), we administered two brief tasks, the first requiring participants to generate a creative alternative use for a brick, the second asking participants to devise a creative title for a photograph. It was predicted that participants who had to search a broad visual area for the appearance of a 3 (broad perceptual attention condition) would generate more creative responses on these tasks than those who had to search a narrow visual area for the appearance of a 3 (narrow perceptual attention condition). In theoretical terms, this would suggest that compared to a narrow perceptual focus, a broad focus of perceptual attention gives rise to a broader focus of conceptual attention, increasing the accessibility of remote, atypical associations, and thereby enhancing innovation.

Method

Participants. Participants were 47 undergraduates of the University of Maryland who were recruited to complete a study involving "a few separate tasks." Participants were run individually and were paid $5 for their participation.

Procedure. Upon arrival, participants were randomly assigned to complete either the broad or narrow versions of the attentional scope manipulation (the 3 task, described in the previous section). After completing this task, participants were administered the two generation measures. In the first measure, participants were given 1 min to write down the most creative use for a brick that they could generate. They were asked to produce a use for a brick that was "neither typical nor virtually impossible" (Friedman & Förster, 2001). After time had elapsed, participants were then provided with a photograph of a Rottweiler stretched out on a plush bedspread holding a bagel in its mouth. Participants were given 1 min to generate a creative title for this photograph. Following completion of these tasks, participants were debriefed, paid, and released. No participants voiced any suspicions regarding the connection between the 3 task and the creativity measures.

Data coding. For the purposes of analysis, our dependent variable was a composite of the creativity of the brick uses and the photograph titles generated by participants. To assess the creativity of the responses tendered, nine independent scorers (all members of the psychology department at the University of Maryland) were asked to separately rate the creativity of the brick uses and the photograph titles that participants generated on a

Likert scale ("How creative is this response?") anchored at 1 (*not at all creative*) and 9 (*very creative*). These ratings (interrater reliability: $\alpha = .76$) were used to compute originality scores for each participant on each task, which were then averaged to form the composite score. An example of a relatively innovative solution on the brick task was "to grind [it] up and use [it] as makeup"; an example of a relatively mundane solution was "to throw [it] through a window." On the photograph task, an example of a relatively innovative title was "Betty the Beagle Beds a Bagel"; an example of a relatively mundane title was "Dog Who Breaks Rules."

Results

To assess the attentional priming hypothesis that broadly focused perceptual attention would enhance innovation compared to narrowly focused perceptual attention, a *t* test was conducted comparing mean creativity scores within the two attentional scope conditions (broad vs. narrow). As predicted, participants who completed the broadly focusing visual search (3) task, prior to the generation tasks, demonstrated more originality ($M = 4.19$) than those who completed the narrowly focusing visual search task, ($M = 3.57$), $t(45) = 2.31$, $p = .02$. This finding comprises the first evidence consistent with the notion that situational variations in the scope of perceptual attention may analogously influence the scope of conceptual attention, thereby affecting the generation of innovative alternatives. Theoretically speaking, these results suggest that, relative to a narrow perceptual focus, a broad focus of perceptual attention widens the focus of conceptual attention, rendering remote, unconventional associations more accessible and consequently bolstering innovation. In terms of the present tasks, broadening of perceptual attention may have expanded the scope of conceptual attention, so that more unusual features of a brick (i.e., features irrelevant to construction) or more remote associations to details of the Rottweiler photograph (e.g., the use of a bed for sex rather than sleep), became available for use in generating original responses.

Experiment 2

Overview

One question that remains from Experiment 1 concerns the nature of the manipulation of perceptual attentional scope. Here, participants were explicitly asked to perform a visual search for a piece of information (3) within either a broad or narrow perceptual space. However, the provision of these explicit search instructions raises the issue of whether active search of a broad or narrow visual area is required to produce attentional priming effects on creativity. Theoretically, we posit no such requirement: The scope of conceptual attention, with its concomitant effects on creativity, should be influenced by the initial scope of the area of perceptual focus, regardless of whether an active search was underway for an object within that perceptual area. To demonstrate this empirically, in this experiment, we devised a new manipulation of perceptual attentional scope, in which participants were merely asked to repeatedly focus their attention on broad or narrow segments of a set of visual scenes (state maps).

Another limitation of the first experiment involved the dependent measures. Although the brick-use and title-generation tasks are face-valid indexes of creativity, these measures do not clearly reveal how conceptual broadening or narrowing influence the originality of responses. Again, we have argued that broad or narrow perceptual focus should prime broader or narrower conceptual focus, facilitating or impairing the accessibility of remote, unconventional associates, and correspondingly bolstering or diminishing innovation. To provide more direct evidence for the mediating role of conceptual attentional scope, in Experiment 2, we devised a new originality measure in which participants were to generate unusual exemplars for a series of categories. Presumably, broader conceptual attention (i.e., more extensive spreading activation) should enable generation of more atypical, creative exemplars for any given category. Notably, this task is closely akin to the sort of word association task described by Mednick (1962) in conceptualizing the underlying, associative basis of creativity.

Method

Participants. Participants were 62 undergraduates of the University of Maryland, who were recruited to complete a study involving "a few separate tasks." Participants were run individually and were paid $5 for their participation.

Procedure. As discussed earlier, in this experiment, we devised a novel manipulation of perceptual

scope. Here, participants were presented with a series of seven Rand McNally U.S. state maps. One map was presented on the computer screen for 5 sec before each experimental trial (see later). Each digitized map image subtended nearly the entire area of the computer screen. For each map, participants randomly assigned to the broad perceptual scope condition were asked to attend to the entire state, rather than any particular city or region, for the entire time that the map appeared on screen. Correspondingly, participants randomly assigned to the narrow perceptual scope condition were instructed to focus their attention on a red star (marking a city within the center of each map), rather than any other area of the map, for the entire time that the map appeared on screen. The seven state maps used, along with the central cities attended to in the narrow scope condition, are as follows: Arkansas (Little Rock); Iowa (Ames); Massachusetts (Worcester); Pennsylvania (Selinsgrove); South Carolina (Columbia); Tennessee (McMinnville); and Wisconsin (Wisconsin Rapids).

Following the presentation of each state map, participants were provided on the computer with one of seven category names ("birds," "colors," "fruits," "furniture," "sports," "vegetables," and "vehicles"). For each category, participants were asked to type as quickly as possible the name of the most unusual exemplar of that category that they could think of. The computer recorded their entries and response times for use in analysis. Following completion of the computer program, participants were debriefed, paid, and released. No participants voiced any hypothesis-consistent suspicions.

Data coding. To assess the originality of the responses generated, 13 independent scorers (all members of the psychology department at the University of Maryland) were asked to rate how unusual each exemplar was for its category, on a Likert scale anchored at 1 (*very typical*) and 9 (*very atypical*). Ratings (inter-rater reliability: $\alpha = .93$) were averaged across categories to form a composite originality score for each participant.

Results

To assess the main experimental hypothesis that broadly focused perceptual attention would enhance generation of innovative exemplars, compared to narrowly focused perceptual attention, a *t* test was conducted, comparing mean atypicality scores within the broad- and narrow-scope conditions. Consistent with predictions, participants who focused broadly on the state maps, prior to response generation, produced more unusual exemplars ($M = 3.41$) than those who focused narrowly on the state maps, ($M = 3.04$), $t(60) = 1.87$, $p = .06$. Analyses of log-transformed response times revealed no reliable difference between experimental conditions whatsoever ($t > .19$), suggesting that participants in the broad perceptual scope group were not more innovative than those in the narrow group merely because they took longer to generate their responses.

Analyses of the zero-order correlations, between originality (atypicality of exemplars) and generation time, revealed substantial differences between the broad and narrow conditions. Specifically, within the broad perceptual attention condition, the correlation between atypicality of generated exemplars and response time was strong and positive, $r(29) = .46$, $p = .01$, suggesting that increased response time perpetuated spreading activation, enabling access to more remote, unusual exemplars. However, within the narrow perceptual attention condition, there was no correlation between response time and the originality of responses, $r(33) = .08$, *ns*. However, on average, participants in the narrow group took just as much time as those in the broad group to generate their responses, and their originality was not appreciably enhanced by increased rumination. This may suggest that narrow perceptual attention constricted the scope of conceptual attention, so that spreading activation to innovative exemplars was at least momentarily inhibited.

The results of Experiment 2 conceptually replicate those of the first experiment, providing further evidence that situationally induced variations in the scope of perceptual attention may influence creativity. These findings also suggest that active visual search (as in the procedure of Experiment 1) is unnecessary for attentional priming effects—prolonged attention to a broad or narrow visual area is alone sufficient to bolster or impair creative generation. Furthermore, the results of Experiment 2 more clearly suggest that altering the scope of perceptual attention analogously alters the scope of conceptual attention. Presumably, the generation of atypical exemplars of a given category requires broadening conceptual focus within the semantic network to render fringe exemplars more accessible. As such, the fact that participants in the broad

perceptual scope condition generated more atypical exemplars than those in the narrow condition implies that their scope of conceptual attention was probably wider than that of the narrowly focused group. This assumption is further supported by the finding that atypicality of generated exemplars was uncorrelated with response time in the narrow condition, suggesting that spreading activation within this group was constrained by narrowed attentional selection on a conceptual level.

Experiment 3

Overview

Experiments 1 and 2 provided evidence that the scope of perceptual attention influences that of conceptual attention and thereby affects originality—a fundamental component of creativity. In an exploratory vein, our final experiment tested the possibility that simple bodily cues associated with, but not necessarily evocative of, perceptual broadening or narrowing, may, by dint of this association, come to independently prime conceptual attention and thereby affect creative generation.

The rationale for this corollary hypothesis flows from the principles of learning theory. Over the course of a lifetime, certain bodily or environmental cues may consistently precede or co-occur with the narrowing or broadening of perceptual attention. If so, then over time, by means of conditioning, these cues may come to independently narrow or broaden the scope of conceptual attention, even when they no longer precede or co-occur with changes in perceptual attentional scope.

To provide an initial assessment of this hypothesis, we tested whether facial muscular cues associated with, but not directly evocative of, narrowed or broadened perceptual scope would themselves influence the scope of conceptual attention and thereby influence the generation of innovative alternatives. More specifically, we tested whether contraction of the eyebrow-furrowing corrugator muscles, a known concomitant of focused perceptual attention (Cohen, Davidson, Senulis, Saron, & Weisman, 1992) compared to contraction of the eyebrow-raising frontalis muscle, a concomitant of widened perceptual scope (antithetical to corrugator contraction), may diminish originality on a creative generation task.

Method

Participants. Participants were 19 undergraduates of the University of Würzburg, who were recruited to complete a battery of psychology studies. Participants were run in groups up to three (separated so they could not see one another) and received DM 10 for their participation.

Procedure. Upon arrival, participants were given a packet of paper-and-pencil surveys and instructed to complete the different tasks contained therein. As a cover story for the facial muscle manipulation, participants were told that in addition to the study they were participating in at that time, another related study was concurrently being run by the psychology department, one concerning muscle contractions involved in computer work. It was explained to participants that instead of working at a computer, they would instead serve as a control group, engaging in similar muscle contractions, yet doing so while completing paper-and-pencil, rather than computerized, tasks.

At this point, participants randomly assigned to the broad attentional cue condition were asked to contract their frontalis muscle by raising their brows; those randomly assigned to the narrow attentional cue condition were asked to contract their corrugator muscles by furrowing their brows. The experimenter did not personally demonstrate these muscle actions, but merely described them verbally. All participants were instructed to maintain these muscle contractions throughout the course of the subsequent task. In this task, which served as our dependent measure of originality, participants were instructed to generate and write down, on a preprepared blank sheet of paper, as many creative uses for a pair of scissors as they could think of. They were asked to refrain from listing typical uses or from listing uses that were virtually impossible.

Participants were interrupted after 2 min, told to stop generating uses, and to fill out a final questionnaire. This survey gauged participants' retrospective liking of the generation task ("How much did you like the task?"), anchored at 1 (*not at all*) and 9 (*very much*); their motivation to perform the task ("How motivated were you to complete the task?"), anchored at 1 (*not at all*) and 9 (*very much*); and the perceived difficulty of the task ("How difficult was the task?"), anchored at 1 (*not at all difficult*) and 9 (*very difficult*). These items were included for potential use as statistical covariates to control the possibility that frontalis

contraction, relative to corrugator contraction, enhances creativity, not by virtue of its association with broad perceptual attention, but, rather, because it somehow renders the task at hand more enjoyable and/or less effortful (cf. Amabile, 1996). Finally, participants were probed for suspicions, debriefed, sworn to secrecy, paid, and released. No suspicions regarding the connection between the muscle contraction manipulations and the creative generation task were voiced.

Data coding. The main dependent variable was the originality of the scissor uses generated by participants. To assess this, 12 independent scorers (all members of the psychology department at the University of Würzburg) were asked to rate the creativity of the different uses participants generated on a Likert scale ("How creative is this response?"), anchored at 1 (*very uncreative*) and 9 (*very creative*), with an explicit midpoint of 5 (*neither creative nor uncreative*). These ratings were used to compute a mean creativity score for each participant (summed ratings for each response offered, divided by the total number of responses). In addition, the total number of responses generated was recorded for use in analysis. An example of a relatively innovative response was to use the scissors as a hair decoration; an example of a relatively mundane response was to use the scissors to cut open a milk container.

Results

We predicted that corrugator contraction, a muscle action associated with narrowed perceptual attention, compared to frontalis contraction, a muscle action associated with broadened perceptual attention (or at least antithetical to narrowed attention), would independently prime narrowed conceptual attention, and thereby diminish originality. In terms of the scissor-use generation task, it was predicted that corrugator contraction would lead to production of fewer innovative responses than frontalis contraction. Consistent with this prediction, participants who engaged in corrugator contraction (narrow attentional cue) generated significantly fewer innovative uses for a pair of scissors ($M = 4.01$) than those who engaged in frontalis contraction (broad attentional cue), ($M = 3.57$), $t(17) = 2.14$, $p = .04$. There were no significant differences in the total number of responses tendered within the two experimental conditions ($t < 1$), suggesting that participants in the corrugator contraction group were equally able to produce uses for a pair of scissors, but that the novelty of their uses was diminished by the relative inaccessibility of remotely associated cognitive material. Finally, there were also no significant differences between conditions (all ts < 1) in self-reported task liking, motivation, or difficulty, suggesting that the obtained findings were not somehow an artifact of these states.

The results of Experiment 3 supplement those of the first two experiments, by suggesting that even simple muscular cues associated with broadened or narrowed perceptual attention may yield attentional priming effects, surreptitiously impacting the scope of conceptual attention and thereby influencing the ability to generate creative alternatives. Moreover, Experiment 3 complements Experiments 1 and 2 by suggesting that attentional priming effects on creativity do not require explicit, initial instructions to focus perceptual attention broadly or narrowly. Presumably, the mere activation of cues associated with a broadened or narrowed focus of perceptual attention may prime the attentional system, such that it momentarily expands or constricts the scope of conceptual attention and correspondingly enhances or impairs creativity.

General Discussion

These experiments tested the hypothesis that a broad or narrow scope of perceptual attention engenders an analogously broad or narrow focus of conceptual attention, which in turn bolsters or undermines innovation. In Experiment 1, participants completed a visual search task, which forced them to focus perceptual attention on a comparatively broad or narrow visual area. Here, as predicted, broad, compared to narrow focusing of perceptual attention during visual search subsequently led to generation of more original uses for a brick. In Experiment 2, in place of a visual search-based manipulation, participants were merely asked to focus their perceptual attention broadly or narrowly on a series of visual scenes (U.S. state maps). Again, consistent with predictions, those led to broaden their scope of perceptual attention subsequently generated more unusual, creative, category exemplars than those led to narrow their focus of perceptual attention. Finally, in Experiment 3, participants were merely asked to contract their frontalis versus corrugator muscles, producing rudimentary peripheral feedback associated with

broad versus narrow perceptual focus. As predicted, frontalis contraction, relative to corrugator contraction, led to the production of more original uses for a pair of scissors. Together, these three experiments provided converging initial support for our attentional priming hypothesis, suggesting that situationally induced variations in the scope of perceptual attention (and simple cues associated with such variations) may correspondingly expand or constrict the focus of conceptual attention within the semantic network, thereby improving or diminishing creativity.

Future Directions

Attentional priming and memory. If variations in the scope of perceptual attention significantly affect creativity, what other fundamental cognitive processes might they influence? Assuming that changes in the focus of perceptual attention indeed influence creative generation by altering the focus of conceptual attention, this question then becomes: What other fundamental cognitive processes might be influenced by variations in the scope of conceptual attention?

One prominent candidate is memory retrieval. According to Anderson and his colleagues (Anderson & Neely, 1996; Anderson & Spellman, 1995), retrieval of items from memory may be seen as involving a conceptual focusing of attention. The perceptual attentional mechanism used to select the image of a single object within a visual array is conceived of as identical (or closely analogous) to the conceptual selection mechanism used to retrieve a given target representation from within its subnetwork of associated representations. In this view, narrowing of conceptual attention is seen as critical for effective retrieval, inasmuch as it serves to shut out competition from related representations in memory. Given this reasoning, we might predict that narrowing perceptual attention may correspondingly constrict the scope of conceptual attention during retrieval, improving recall of recently encoded material by inhibiting the activation of competitor items. In contrast, we might speculate that broadening perceptual attention may expand the scope of conceptual attention during recall, diminishing interference from highly accessible constructs (which are in the focus of attention) and enabling retrieval of less recently encoded or more weakly associated material.

Attentional priming from motivational systems. Although the present experiments explored the influence of perceptual attentional scope on conceptual attentional focus, situationally induced variations in the scope of perceptual attention are most likely not the only means of indirectly eliciting variations in the focus of conceptual attention. For instance, according to Derryberry and Tucker (1994; see also Tucker & Williamson, 1984), there are two lateralized motivational/emotional systems in the brain, which function in part to regulate the breadth of attention on both a perceptual and conceptual level. The brain's right hemisphere is the seat of an appetitive motivational system, which regulates emotional experience on a continuum from elation to depression (cf. Higgins, 1997; Watson, Wiese, Vaidya, & Tellegen, 1999) and serves to expand the focus of attention, again, both perceptually and conceptually. In corresponding fashion, the left hemisphere is posited as the locus of an aversive motivational system, which regulates the experience of anxiety and serves to constrict both perceptual and conceptual attention.

Derryberry and Tucker's (1994) theory implies that activation of the appetitive motivational system, proposed to broaden the focus of conceptual attention, should bolster creativity, and that activation of the aversive system, posited to narrow conceptual attentional scope, should impair it. We have recently collected a great deal of evidence ostensibly consistent with this notion (Friedman & Förster, 2001, 2002). Here, participants were asked to perform arm motor actions associated with appetitive versus aversive motivation (i.e., arm flexion vs. arm extension) or were exposed to external approach versus avoidance-related cues (i.e., pictures of a mouse searching for cheese vs. escaping an owl). During, or shortly after the presentation of these internal or external appetitive and aversive motivational cues, participants were administered various measures of creative problem solving and originality (e.g., the brick-use task). Relative to avoidance-related cues, approach-related cues were found to significantly facilitated creativity across tasks. In light of Derryberry and Tucker's (1994) theory, these results may be seen as demonstrating that activation of the appetitive or aversive motivational systems, via presentation of internal and external motivational cues, broadened or narrowed conceptual attention, thereby bolstering or impairing creative cognition. We are still in the process of determining whether the

aforementioned effects may in fact be understood as reflecting attentional priming of creativity by differential motivational systems.

At best, this research can only serve as a point of departure en route to further developing the seminal theoretical propositions advanced by Mednick (1962) and refined by Martindale (1995). Wherever it leads, we hope this line of work will appreciably contribute to understanding the intriguing, yet still mostly mysterious, relationship between attentional processes and creativity.

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