Creativity

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shared by the three words presented (e.g., problem: cottage swiss cake; solution: cheese).
In contrast, divergent thinking is a style of thought that requires the individual to explore several different perspectives, producing an array of potential answers, situated on a gradient of utility.

manipulation, performance on the practice trials were submitted to an independent samples t-test. Due to random assignment, no differences were expected and in fact none were found for any of the four creativity subscores; fluency: (60)=.21, =.83, detail: (60)=-.01, =.99, categorical distinctiveness: (60)=.07, =.95 and appropriateness: (60)=-.07, =.94.

To test the hypotheses that induced BEMs lead to a creative advantage, that weak-handers would have higher creativity scores than strong-handers and whether there were differences pre- v. post manipulation for handedness and/or condition the dependant measure, four sub-scores of the Alternate Uses Test (fluency, detail, categorical distinctiveness and appropriateness), were submitted to a 2 (condition: control, experimental) X 2 (handedness: weak, strong) X (2) (Test: pre, post) mixed factorial MANOVA. Mixed MANOVA results indicate significant main effects of Handedness (Wilk's **Λ**=.831, (4,55)=2.81, <.05, partial η^2= .169) and Test (Wilk's **Λ** = .193, (4,55)=3.58, =.01, partial η^2=.207) on the combined dependent variables of the four creativity subscores. No main effects for Condition (Wilk's **Λ** = .972, <1) were observed. The main effect for Test suggests a practice effect, where participants show higher creativity on the test items than the practice items when the creativity subscores are linearly combined.

Univariate ANOVA results indicate that weak-handers (M=3.14, SE=.201) outperformed strong-handers (M=2.49, SE=.171) on the fluency variable, (1,58)=6.19, .016 partial η^2 =.096). Weak-handers (M=2.45, SE=.157) also outperformed strong-handers (M=1.77, SE=.134) on the categorical distinctiveness variable, (1,58)=11.11, .002 partial η^2=.161). Weak-handers (M=2.72, SE=.177) outperformed strong-handers (M=1.94, SE=.151) on the appropriateness variable, (1,58)=11.28, .001 partial η^2=.163). Weak-handers (M=2.49, SE=.141) were marginally higher than strong-handers (M=2.14, SE=.12) on the detail subscore, (1,58)=3.63, .062 partial η^2=.059). These results support the hypothesis that weak-handed individuals would have higher creativity scores.

No significant two-way interactions were observed for Condition x Handedness, Condition x Test, or Handedness x Test; the three-way Condition x Handedness x Test interaction was also not significant (all <1). Although no interactions were observed the hypotheses warranted a series of tests. Of specific interest was whether the creativity of strong-handers or weak-handers in the control and experimental groups differed for Test Items. This tests the hypothesis that the creativity of weak-handers may not be manipulated, whereas that of strong-handers may be manipulated. These tests re-affirmed the MANOVA findings, where there was no differences between control and experimental groups for strong-handers (all F's<1) or weak-handers (all F's<1).

Demographic information was also collected for age and gender. A MANOVA revealed no effect of gender (Wilk's **Λ**=.92, (4,57)=1.25, <.3) on the linearly combined subscores. However, univariate analyses indicate that males (M=2.48, SE=.232) outperformed females (M=1.96, SE=.12) on the categorical distinctiveness variable, (1,60)=4.02, .05 partial η^2=.063). Pearson product moment correlation analyses on age and the four creativity subscores revealed that age and categorical distinctiveness were strongly correlated, (59)=.25, =.05 as were age and appropriateness, (59)=.28, <.05.

Discussion

Bilateral eye movements, thought to increase state levels of interhemispheric interaction (IHI) (Charlton et al., 1989), had no effect on creative performance in this study. However, handedness, the physiological indicator of trait levels of IHI, had a significant effect on three of the four creativity scores with the fourth reaching marginal significance, such that weak-handers,

thought to exhibit higher levels of IHI, outperformed strong-handers. These results support the hypothesis greater interhemispheric interaction, such as that associated with weak-handedness, results in greater creativity. However, the attempt to manipulate interhemispheric interaction did not increase the creativity of strong- or weak- handers. Indeed, the current findings suggest no effect of bilateral eye movements on divergent thinking.

Due to the methodological limits of the current study the debate between those in favor of an IHI model of creativity (Bogen et al., 1969, 1988; Atchley et al., 1996; Kounios et al., 2006; Jung-Beeman et al., 2004 & Sviderskaia et al., 2007) and those in favor of a right hemisphere (RH) model (Abeare, 2005; Weinstein, et al., 2002; Springer, et al., 1981 and Ornstein, 1977) is unable to be resolved. The ability to tease these two models apart is beyond the methodology of the proposed study because although it may be that weak-handers are outperforming strong-handers because of their higher levels IHI, it could also be that they are superior because of increased RH activity. Future research may be able to settle the dispute by utilizing EEG coherence analysis to see if the synchronization characteristic of IHI is present during creative performance. Using EEG, researchers would be able to see if IHI is present or if primarily RH activity is, as the aforementioned research suggests.

Christman et al. (2004) and Christman et al. (2003) found significant effects of bilateral eye movements on memory such that BEM decreased false memories and increased episodic retrieval, respectively. It may be that memory is more susceptible to this IHI manipulation while creativity is not. Because Markman et al. (2007) successfully manipulated creativity with the use of mindset priming (mentioned earlier), the findings of this study do not suggest that creativity, per se can not be manipulated. Perhaps the BEM effect is not strong enough to influence the more complex construct of creativity compared to the simple spread of activation associated with memory.

The main effect for test on the linearly combined creativity subscores suggests a practice effect. This practice effect was not mediated nor influenced by any of the other variables (condition, handedness) by virtue of the fact that all interactions were non-significant. This, and additional analyses, suggest that strong- and weak-handers do not differentially benefit from the BEM task. Further, participant's increase in creativity from Practice to Test was not differentially affected by whether they were in the control or experimental group.

Demographic results indicated that, on average, men generated more categorically distinct answers than women for the objects. This finding is questionable though because of the differences in group sizes with 49 females and just 13 males, and previous research on gender differences in divergent thinking tasks is mixed, with most observing no gender differences or similar differences reported here only in children (Lee, 2002; Houtz, Jambor, & Cifone, 1989; Rejskind, Rapagna, & Gold, 1992; Morse & Morse, 1995; Chan, Cheung, & Lau, 2001). Age was also found to be significantly correlated to categorical distinctiveness and appropriateness. It may be that with age, we are exposed to more of a variety of ways to use objects whereas younger participants were relying more on expanding on the uses they already mentioned. This reliance could lead to the production of inappropriate and irrelevant ways of using the object.

The current study introduces handedness as an important variable mediating creativity, a relation warranting further research to determine more precisely the neural substrates of creativity.

Appendix A

Original Alternate Uses Items from Christensen et al. (1960):

- newspaper
- shoe
- button
- key
- wooden pencil
- automobile tire
- eyeglasses
- bar (was “cake” in original but was altered to be more easily understood) of soap
- barrel
- sock
- paper clip
- comb
- table
- paper cup
- brick

Additional five items from common word bank (Snodgrass et al., 1980):

- toothbrush
- doorknob
- hat
- belt
- book

References

Abeare, C. (2005). The hemispheric dynamics of semantic processing and creativity.

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Chamorro-Premuzic, T., (2006). Creativity Versus Conscientiousness: Which is a Better Predictor of Student Performance? : 521–531.
Chan, D.W., Cheung, P.C., & Lau, S. (2001).Assessing ideational fluency in primary students in Hong Kong.
, 359-365.
Charlton, S., Bakan, P., & Moretti, M. (1989). Conjugate lateral eye movements: A second look. , , 1±18.
Christensen, P. A., Guilford, J. P., Merrifield, P. R., & Wilson, R. C. (1960).
. Beverly Hills: Sheridan Psychological Services.
Christman, S. D., Propper, R. E. & Brown, T. J. (2006). Increased Interhemipsheric Interaction is Associated With Earlier Offset of Childhood Amnesia.
3, 336-345.
Christman, S. D., Propper, R. E. & Dion, A., (2004). Increased interhemispheric interaction is associated with decreased false memories in a verbal converging semantic associates paradigm. : 313-319.
Christman, S. D., Garvey, K. J., Propper, R. E. & Phaneuf, K. A. (2003). Bilateral eye movements enhance the retrieval of episodic memories. , , 221-229
Christman, S. D. (2001). Individual differences in Stroop and local-global processing: A possible role of interhemispheric integration. 97-118.
Christman, S.D. (1995). Independence versus integration of right and left hemispheric processing: Effects of handedness. In F.L. Kitterle (Ed.),
(pp. 231–253). Hillsdale, NJ: Lawrence Erlbaum Associates Inc.
Dallob, P. I., & Dominowski, R. L. (1993). Erroneous solutions to verbal insight problems: Effects of highlighting critical material. Paper presented at the annual meeting of the Western Psychological Association.
Damasio, A. R. (2001). Some notes on brain, imagination and creativity. In K. H. Pfenninger & V. R. Shubik (Eds.), (pp. 59-68). Oxford: Oxford University Press.
Dietrich, A. (2004). The cognitive neuroscience of creativity.
, , 1011-1026.
Duncan, J., & Owen, A. M. (2000). Common regions of the human frontal lobe recruited by diverse cognitive demands. , , 475-483.
Fink, A. & Neubauer, A. (2007). Eysenck meets Martindale: The relationship between extraversion and originality from the neuroscientific perspective.
, , 299-310.
Finke, R.A., Ward, T.B., and Smith, S.M. (1992)
. Cambridge, MA: MIT Press.
Gazzaniga, M. S., Bogen, J. E. and Sperry, R. W. (1962) Some functional effects of sectioning the cerebral commissures in man.
. , Part 2, 1765-1769.
Guilford, J. P. (1962). Potentiality for creativity. 87-90.
Guilford, J. P. (1950). Creativity. 444-454.
Hellige, J. (1993). Cambridge, MA: Harvard University Press.
Hines, D., & Martindale, C. (1974). Induced lateral eye-movements and creative and

intelletutal performance. , , 153-154.
Houtz, J.C., Jambor, S.O., & Cifone, A. (1989).Locus of evaluation control, task directions, and type of problem: Effects on creativity. , 118-125.
Ince, E., & Christman, S. (2002). Semantic representations of word meanings by the cerebral hemispheres. , 3, 393-420.
Jung-Beeman, M. J., Bowden, E. M., Haberman, J., Frymiare, J. L., Arambel-Liu, S., Greenblatt, R. E., Reber, P. J., & Kounios, J. (2004). Neural activity when people solve verbal problems with insight. PLOS BIOLOGY, (4), 500-510.
Kaplan, J. T., (2002). The neuropsychology of executive function: Hemispheric contributions to error monitoring and feedback processing. , , 1604.
Khatena, J. (1989). Intelligence and creativity to multitalent. , 93-97.
Kitterle, F. (1995). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
Kounios, J., Frymiare, J. L., Bowden, E. M., Fleck, J. I., Subramaniam, K., Parrish, T. B. & Jung-Beeman, M. (2006). The Prepared Mind: Neural Activity Prior to Problem Presentation Predicts Subsequent Solution by Sudden Insight. , 882–890.
Kray, L. J., Galinsky, A. D., & Wong, E. M. (2006). Thinking within the box: The relational/processing style elicited by counterfactual mind-sets. , , 33-48.
Kray, L. J., & Galinsky, A. D. (2003). The debiasing effect of counterfactual mind-sets: Increasing the search for disconfirmatory information in group decisions. , , 69-81.
Kwiatkowski, J. (2002). Individual differences in the neurophysiology of creativity. , , 3050.
Lee, K.H. (2002). Creative thinking in real world situations in relation to gender and education of late adolescents , 59-70.
Markman, K. D., Lindberg, M. J., Kray, L.J., & Galinski, A.D. (2007). Implications of Counterfactual Structure for Creative Generation and Analytical Problem Solving. ; 33; 312.
Martindale, C. (1999). Biological Bases of Creativity. In: R. Sternberg (Eds.) . p. 141. Cambridge University Press, 2004.
McCallum, R. S. & Glynn, Shawn M. (1979). Hemispheric specialization and creative behavior. , 1979. pp. 263-273.
Morse, L.W. & Morse, D.T. (1995).The influence of problem-solving strategies and previous training on performance of convergent and divergent thinking. , 341-348.
Niebauer, C. (2004). Handedness and the fringe of consciousness: Strong handers ruminate while mixed handers self-reflect. 730- 745.
Niebauer, C., & Garvey, K. (2004). Godel, Escher, and degree of handedness:

Differences in interhemispheric interaction predict differences in understanding self-reference. 19-34.
Niebauer, C., Aselage, J. & Schutte, C. (2002). Hemispheric interaction and consciousness: Degree of handedness predicts the intensity of a sensory illusion ; , 85–96.
Oldfield, R. C. (1971). The assessment and analysis of handedness: The Edinburgh Inventory. Neuropsychologia, , 97–113.
Ornstein, R. C. (1977). . New York: Harcourt Brace Jovanovich.
Potter, S., & Graves, R. (1988). Is interhemispheric transfer related to handedness and gender? , 319-325.
Propper, R. E., Pierce, J., Geisler, M. W., Christman, S. D. & Bellorado, N. (2007). Effect of Bilateral Eye Movements on Frontal Interhemispheric Gamma EEG Coherence: Implications for EMDR Therapy. . :785-788.
Propper, R. E. & Christman, S. D. & Phaneuf, K. A. (2005). A mixed-handed advantage in episodic memory: A possible role of interhemispheric interaction. 751-757.
Propper, R. E. & Christman, S. D. (2004). Mixed- versus strong-handedness is associated with biases toward “Remember” versus “Know” judgments in recognition memory: Role of interhemispheric interaction. 707-714.
Ramachandran, V.S. (1995). Anosognosia in parietal lobe syndrome. , , 22–51.
Rejskind, F., Rapagna, S.O., Gold, D. (1992). Gender differences in children's divergent thinking. ,165-174.
Runco, M. (2006). . Academic Press.
Runco, M. (2004). Creativity. Annual Review of Psychology, , 657–687.
Schooler, J.W., & Melcher, J. (1995). The ineffability of insight. In S. M. Smith, T. B. Ward, & R. A. Finke (Eds.), (pp. 249-268). Cambridge, MA: MIT Press.
Simonton, D. K. (2004). New York: Cambridge University Press.
Snodgrass, J. G. & Vanderwart, M. (1980). A standardized set of 260 pictures: Norms fro name agreement, image agreement, familiarity, and visual complexity. , 174-215.
Springer, S. P. & Deutsch, G. (1981). . San Franciso: Freeman.
Sternberg, R. J. (1998) . Cambridge University Press.
Sternberg, R. J., & Lubart, T. I. (1992). Buy low and sell high: An investment approach to creativity. , , 1-5.
Sviderskaia N. E., Antonov A. G., Butneva L. S. (2007). Comparative analysis of spatial EEG organization on models of non-verbal divergent and convergent thinking. I P Pavlova; :144-54.
Torrance, E. P. (1974). The Torrance Tests of Creative Thinking: Norms-technical manual. Princeton, New Jersey: Personnel Press/ Ginn & Company.