



## Creativity training enhances goal-directed attention and information processing



Nicholas Bott<sup>a,b</sup>, Eve-Marie Quintin<sup>a</sup>, Manish Saggar<sup>a</sup>, Eliza Kienitz<sup>a,b</sup>, Adam Royalty<sup>c</sup>, Daniel Wei-Chen Hong<sup>d</sup>, Ning Liu<sup>a</sup>, Yin-hsuan Chien<sup>e,f</sup>, Grace Hawthorne<sup>c</sup>, Allan L. Reiss<sup>a,\*</sup>

<sup>a</sup> Center for Interdisciplinary Brain Sciences Research Department of Psychiatry and Behavioral Sciences, Stanford University, 401 Quarry Road MC 5795, Stanford, CA 94305, United States

<sup>b</sup> Pacific Graduate School of Psychology-Stanford University, Psy.D. Consortium, 1791 Arastradero Road, Palo Alto, CA 94304, United States

<sup>c</sup> Hasso Plattner Institute of Design at Stanford, 416 Escondido Mall, Building 550, Room 169, Stanford, CA 94305, United States

<sup>d</sup> Institute of Biomedical Engineering, National Taiwan University, No. 1, Sec. 1, Jen-Ai Road, Taipei 100, Taiwan

<sup>e</sup> Department of Pediatrics, Taipei City Hospital, Zhong-Xing Branch No. 145, Zhengzhou Road, Datong District, Taipei 103, Taiwan

<sup>f</sup> Graduate Institute of Biomedical Electronics and Bioinformatics, National Taiwan University, Room 410 BL Building, No. 1, Roosevelt Road, Sec. 4, Taipei 10617, Taiwan

### ARTICLE INFO

#### Article history:

Received 6 September 2013

Received in revised form 27 February 2014

Accepted 31 March 2014

Available online 12 April 2014

#### Keywords:

Creativity

Goal-directed attention

Information processing

Intervention

### ABSTRACT

Studies suggest that individuals with greater creative potential have enhanced executive function. Here we tested the hypothesis that a creativity training intervention would increase both low and high-level executive functions. Fifteen participants completed a 5-week creative capacity building program (CCBP) and 15 participants completed a control intervention consisting of a parallel 5-week language capacity building training program (LCBP). Goal-directed attention and processing speed were measured with the Delis–Kaplan Executive Function System (D-KEFS) color–word interference test. Results revealed higher scores post-training associated with CCBP compared to LCBP on the primary D-KEFS measure of combined completion time for color-naming and word-reading conditions, and the primary contrast measure of combined completion time for color-naming and word-reading compared to completion time for inhibition switching. Relative to LCBP, CCBP leads to improvement performance on measures reflecting lower-level executive functions (goal-directed attention and information processing) as opposed to higher-level executive functions, which showed no between-group differences.

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## 1. Introduction

Creativity has been associated with general intelligence, divergent thinking, dimensions of personality, and increasingly, executive functions (Batey & Furnham, 2006; Benedek, Franz, Heene, & Neubauer, 2012; Furnham & Bachtar, 2008; Guilford, 1988; Hocevar, 1980; Kaufman, Kaufman, & Lichtenberger, 2011; Kettner, Guilford, & Christensen, 1959; Kim, 2008;

\* Corresponding author. Tel.: +1 650 498 4538.

E-mail address: [areiss1@stanford.edu](mailto:areiss1@stanford.edu) (A.L. Reiss).

Silvia, 2008). Broadly defined, “lower-level” executive functions include attention and processing speed, while “higher-level” executive functions include inhibition, cognitive flexibility, fluency, working memory, and organization of thoughts and behaviors (Dempster & Corkill, 1999). To date, the relationship between executive functions and creativity has been studied cross-sectionally (i.e., at one specific point in time). In this paper, we examine the longitudinal changes in executive functioning associated with targeted creativity training designed to enhance creative capacity in healthy adults.

While research has examined whether an individual's creative capacity can be augmented with training (Scott, Leritz, & Mumford, 2004; Torrance, 1979; Torrance & Safter, 1999), these attempts to stimulate or increase creativity have mostly been done in children and adolescents in scholastic settings (Baer, 1996; Clapham, 1997; Glover & Gary, 1976; Scott et al., 2004). Scott et al. (2004) review of seventy creativity-training based intervention studies found training-related changes in younger participants with moderate to large effect sizes across modality, setting, and population. Although a large set of studies show efficacy of targeted training to enhance creative capacity in children, some work has also shown that gains accrued from such training do not transfer well across domains (Baer, 1988, 1996, 2009) and, thus, provide contrasting evidence for domain general constructs of creative capacity enhancement (Baer, 2012). Few studies have investigated the efficacy of domain-specific creativity training in adults (Solomon, 1990), and no such interventions have included measures of executive functioning in adults. We utilized a design-thinking based creativity-training intervention to examine potential changes in lower- and higher-level executive functioning. Investigating whether creative potential is associated with cognitive change will deepen our understanding of brain plasticity and holds potential for unraveling alternative interventions to treat executive dysfunctions associated with neurological and psychiatric conditions.

Creativity has been previously defined as a behavior or product that is both novel and appropriately useful (Sternberg & Lubart, 1996). More specifically, creativity has been described as, “the process of becoming sensitive to problems, deficiencies or gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results” (Torrance, 1965). Recently, domain-specific constructs of creativity have also been posited (Baer, 2011, 2012), with various categories of creative domains being offered (Agars, Baer, & Kaufman, 2005; Baer & Kaufman, 2005; Ivcevic & Mayer, 2009). For the purpose of this study, we define creativity as “a state of being and adaptation of personal skill sets that enables an individual to synthesize novel connections and express meaningful outcomes” (Hawthorne et al., 2013).

People who obtain higher scores on measures of creativity (henceforth referred to as “creative people” for brevity) exhibit strengths in both lower- and higher-level executive functions. Specifically, creative people show enhanced goal-directed attention skills, an example of low-level executive functioning (Ansburg & Hill, 2003; Zabelina & Beeman, 2013). Creative people have shorter reaction times on tasks with little cognitive interference and longer reaction times on tasks with greater cognitive interference, indicating enhanced differential lower- and higher-level executive functioning, depending upon task demands (Dorfman, Martindale, Gassimova, & Vartanian, 2008; Kwiatkowski, Vartanian, & Martindale, 1999; Vartanian, Martindale, & Kwiatkowski, 2007). On the other hand, one study found wider breadth of attention correlated with creative performance, exposure to attention narrowing stimuli diminished creative performance (Kasof, 1997). Creative people also show greater cognitive control on the Stroop task (Groborz & Necka, 2003). Gilhooly, Fioratou, Anthony, and Wynn (2007) demonstrated that greater executive capacity of strategy switching, a higher-level executive function skill, was associated with increased creativity. They found that performance on the letter fluency “executive loading task” predicted fluent production of new uses on the alternate uses task, a measure of creativity (Guilford, 1967). Production of familiar uses from long-term memory, which requires less involvement of higher-level executive function than the letter fluency task, was not associated with performance on the alternate uses task. Similarly, Nusbaum and Silvia (2011) found that increased executive switching on a divergent thinking task mediated the effect of fluid intelligence measures of creativity. Creative people also show enhanced performance on the specific conditions of the Stroop color word test assessing inhibition and cognitive flexibility, which are higher-level executive functions (Golden, 1975; Groborz & Necka, 2003; Zabelina & Robinson, 2010).

Thus, there is evidence from cross-sectional data that creativity is related to executive functioning skills or ability. The question of central interest to the present study was whether a creativity training intervention would increase lower- and higher-level executive functioning. We sought to address this question with a 5-week, random assignment, parallel-group design where participants received either creativity training or a control language training. The creativity training was domain-general and was built upon several theories ranging from problem solving skills, affective processing, motivational aspects, and creative confidence building, and was part of a larger project investigating the neural correlates of creativity (Hawthorne et al., 2013). In a companion paper in the same Journal, we have provided more details about the training (Kienitz et al., 2014). Using the Torrance Test of Creativity, figural version (TTCT-F) (Torrance, 1981), a standardized divergent thinking measure of creativity, we found moderate to large effect size increases in TTCT-F average, elaboration, and resistance to closure scores, pointing to a wider synthesis of ideas after training. We thus predicted that this creativity training would also be associated with enhancement in lower-level executive abilities, specifically of goal-directed attention and processing speed, as well as higher-level executive abilities, specifically with respect to fluency, inhibition, and flexibility.

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