Creativity in the 21st Century: the added benefit of training and cooperation

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0. Abstract

Creativity is an important construct driving society and innovation forward. Many organizations have adopted team-based work in order to increase innovation and creativity under the assumption that groups of people tend to produce more creative ideas than individuals. Research has so far shown mixed results with some finding enhanced creativity in teams while others showing the opposite effect. A short literature review of team creativity and how it relates to possible neural networks is presented. In addition, we will integrate key findings from our current research implementing a group training protocol to enhance creative capacity. Participants in our creativity study underwent a distilled version of Creative Gym, a course that has been taught at the d.school for the past eight years that is purely focused on individual creativity skill building in a group environment. Students enhance their creative confidence and sharpen their individual design thinking skills through hands-on experiences that are comprised of unconventional hands-on exercises organized around nine core themes that engage our human abilities in intersecting ways. Training was performed in a group environment while improving perspective taking, empathy, synthesizing ideas and developing improvisational skills. Creativity was measured, before and after participant training (Time 1 and Time 2), using standardized assessments of creativity. In addition to neuroimaging markers, other cognitive faculties (e.g. executive functioning) and personality were also assessed before and after training (Hawthorne, et al., 2014). We will review the literature on team creativity and present key findings from our current research, using group based creativity skill training.

1. Introduction

Creativity is an important facet both for individuals as well as organizations, as it can allow for innovation to occur. While traditionally creativity has been regarded and researched as an individualistic trait, today there is a growing interest in the ability of groups to think creatively and produce creative ideas or products (Baruah and Paulus 2009). Many organizations have been implementing team-based thinking styles in an attempt to boost creativity and innovation. This is despite a growing body of knowledge suggesting that groups tend to be less creative than individuals and produce less creative and original ideas (Michael Diehl & Stroebe, 1987).

// CREATIVITY - Defined

Creativity can be defined in several ways. In everyday folklore, creativity is seen as related to a variety of concepts including innovation, imagination, and inventiveness. In the academic world, creativity has been traditionally defined as the process that gives rise to novel and useful or appropriate ideas. Other definitions focus on different aspects of creativity and can be derived from the famous "four P's" of this concept. The four P's include: process (refers to the thoughtful and critical activity of producing new solutions or ideas); person (individual characteristics of the person producing the ideas); product (the concept or idea that is proposed); and press (the environment) (Rhodes, 1961). Recently, Hawthorne et al., (2014) proposed a definition of creativity that addresses the person, process, and product aspects of creativity. They defined 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., p67). While traditional definitions focus on the process and product, this definition puts the person in the center. Focusing on the individual allows for better understanding of individual creative capacity and the effects of collaboration.

// CREATIVITY - Measured

Creativity is a multifaceted concept, which can be measured using different approaches. These approaches typically include fluency, flexibility, and originality (E Paul Torrance, 1988). Fluency refers to the number of non-redundant ideas, solutions or products and is a measure of creative production. Flexibility refers to the use of different cognitive categories and the use of broad and inclusive cognitive categories (Mednick, 1962). Originality is one of the defining characteristics of creativity and refers to the uniqueness or infrequency of the ideas, solutions or products generated (Sternberg & Lubart, 1999). Traditionally, creativity can be measured using problem-solving tasks that require creative innovation or insight problem solving, or through the process of divergent thinking. Divergent thinking refers to the process of generating many alternate ideas or solutions to an open-ended problem. One example of an extensively used divergent thinking task is the Torrance Tasks for Creative Thinking (TTCT, (Ellis Paul Torrance, 1968)). The TTCT involve different tasks both figural and verbal requiring a person to generate many alternate solutions to problems such as completing an incomplete drawing or creating interesting and meaningful illustrations from different shapes. In addition to the TTCT, researchers have expanded the choice of tasks that measure creativity (Kowatari, et al., 2009; Saggar, et al., 2016). These tasks cover several aspects of creative thinking and range from originality-centered tasks such as designing a pen (Kowatari, et al., 2009) to improvisation-centered tasks such as playing Pictionary™ (Saggar, et al., 2016; Saggar, Quintin, et al., 2015).

2. Team creativity – A literature review

There has been much research in the field of team creativity. The results of this research shows that while brainstorming in groups is reported to be more enjoyable (Nijstad & Stroebe, 2006), groups are not very conducive to the generation of unique novel ideas (Simonton, 1988; Walton, 2016).

// Wait…what was I going to say?

Several reasons have been postulated to explain this effect, the most prominent being the notion of "production blocking" (Michael Diehl & Stroebe, 1987). Production blocking refers to the inhibitory effects of groups and can include factors such as turn taking when expressing ideas in the group setting. In particular, research has shown that turn taking can cause people to forget their ideas or decide not to share them (Michael Diehl & Stroebe, 1987). Another factor of "production blocking" that can inhibit creative ideation is the added cognitive load of thinking or remembering your idea while at the same time paying attention to others' ideas (Baruah & Paulus, 2009; Coskun, Paulus, Brown, & Sherwood, 2000). Production blocking is exacerbated in larger groups as more individuals share their ideas, and is less pronounced in smaller groups (Nijstad & Stroebe, 2006).

// Your idea made me think of...

Despite the existence of factors that may inhibit creativity in groups, one of the reasons that groups are thought to be conducive to creativity is that group members can be exposed and stimulated by multiple ideas (Nijstad & Stroebe, 2006; Paulus & Brown, 2007). Several studies over the years have indeed shown this to be the case, that exposing individuals to others' ideas can stimulate and enhance the creativity of generated ideas (Dugosh & Paulus, 2005; Dugosh, Paulus, Roland, & Yang, 2000).

// Larger groups can generate more ideas disproportionately

Furthermore, while the potential of this stimulating effect can be masked by the inhibiting factors discussed above (such as "production blocking"), studies have demonstrated that electronic brainstorming, sharing ideas by computers, for instance, can lead to enhanced idea generation compared to nominal groups, especially for larger groups which provide greater numbers of ideas (DeRosa, Smith, & Hantula, 2007; Paulus, Kohn, Arditti, & Korde, 2013). In an interesting study looking at cognitive stimulation and its effect on creativity, Fink et al., (2010) found that exposing individuals to others' ideas not only resulted in more original idea production, but was associated with brain activations (less deactivations compared to free ideation without exposure to ideas) in regions involved in semantic information processing (Binder, Desai, Graves, & Conant, 2009).

While large groups can be detrimental to creativity by introducing production-blocking factors, the stimulating effect of being exposed to new ideas from other team members can be an enhancing factor in creative production. This enhancing effect is more prominent when using team environments such as electronic brainstorming where team members interact through electronic devices.

// Free-riders and the Sucker-effect

Social factors can have both a hindering and facilitating effect on individual creativity in a group setting. Several social comparison factors have been suggested to account for the reduced ideation of individuals in groups. These factors include “free-riders” and the “sucker effect” (Thompson, 2000; Walton, 2016). Free-riding describes a situation where an individual reduces effort to avoid the possibility of working harder than fellow group members, while the sucker effect describes a situation in which people think other team members claim credit for ideas, yet leave them to do all the work. These inhibitory effects have been reported to increase as group size increases (Baruah & Paulus, 2009; Nijstad & Stroebe, 2006). In contrast, facilitating factors can include a cooperative climate and group diversity.

// Diversity is good

The use of teams for creative tasks is often based on the notion that teams can increase the range of knowledge and bring new perspectives to the discussion (Hoever, Van Knippenberg, van Ginkel, & Barkema, 2012). For example, Paulus and Brown (2007) suggested that a diverse group composed of individuals with varying areas of knowledge could produce more creative ideas than a group composed of people with overlapping expertise. Diehl (1992) and Stroebe and Diehl (1994) manipulated group diversity in brainstorming sessions and found that groups with higher diversity exhibited higher group creativity, which was evident by the flexibility of ideas as measured by the number of categories of ideas produced.

// Does gender matter?

Though diversity has been argued to increase group creativity, the gender composition of teams seems not to affect the overall creativity of ideas produced unless the task itself is gender activating, such as designing a specific product for men (or women) (Pearsall, Ellis, & Evans, 2008). Despite this finding, specific instruction to take the others perspective (perspective taking) has been shown to increase creativity in teams (Hoever, et al., 2012).

// Fight it out?

There has been considerable research in the field of team and task conflict and its effect on team performance and team creativity (De Dreu & Weingart, 2003; Fairchild & Hunter, 2014; Farh, Lee, & Farh, 2010). Researchers have suggested that conflict can be beneficial to creativity in certain conditions that include the degree to which team members feel comfortable voicing their opinions and disagreements (De Dreu, 2008; Lovelace, Shapiro, & Weingart, 2001). Edmondson (2002) emphasized this by stating that task conflict can enhance creativity if it occurs in a safe climate of discussion and productivity.

As opposed to task conflict, team conflict can be detrimental to creativity and innovation (Amason, Thompson, Hochwarter, & Harrison, 1995; De Dreu & Weingart, 2003; Jehn, 1997). In a meta-analysis covering 30 published and unpublished reports, De Drew and Weingart (2003) found that team conflict negatively related to team effectiveness and team member satisfaction. It is important that conflict is kept at the task level and that positive affect be maintained between group members (Isen, Daubman, & Nowicki, 1987).

Oxytocin (a hormone and brain neurotransmitter) has been reported to be involved in cooperative exchange within groups (De Dreu, et al., 2010). Therefore it has been suggested that collaborative settings may facilitate the release of oxytocin that, in turn, may increase creativity (De Dreu, Baas, & Boot, 2015). In agreement with this hypothesis, oxytocin has recently been reported to be related to creative production using both intranasal oxytocin and oxytocin related genes (De Dreu, et al., 2013).

Collectively, the literature reviewed here suggests that in order for a group to produce creative, innovative ideas, it is not only necessary for individuals to be able to produce many ideas but the environment must be supportive in order to allow for evaluations that do not promote conflict and reduce negative elements of social comparison. In what follows we will present a summary of our group training protocol, which among others, was set to improve perspective taking, empathy, synthesizing ideas and developing improvisational skills that can lead to higher scores on a standardized test of creativity.

3. Creativity Training - our results

Creativity is not a fixed ability; it can be nurtured both through environments that stimulate individual creative potential as well as with training that can promote creative capacity.

Creativity is considered the driving force behind innovation and human progress and has benefits to mental health and wellbeing. As such, it is important to examine ways to enhance creativity and investigate the brain networks associated with both natural creativity and the effects of targeted training.

We have previously examined the effect of a targeted design-thinking training in group settings to enhance creative capacity (Bott, et al., 2014; Hawthorne, et al., 2014; Kienitz, et al., 2014; Saggar, Hawthorne, et al., 2015). We used a 5-week Creative Capacity Building Program (CCBP) to train healthy adults in creative thinking. The CCBP was an abbreviated version of a highly popular class offered at the Stanford Hasso Plattner Institute of Design called ME266 Creative Gym (http:// dschool.stanford.edu/classes/#creative-gym-a-design-thinking-skills-studio).

We designed CCBP as an interactive studio where students can build their creative confidence and sharpen their individual design thinking skills through hands-on experiences, rapid prototyping, and other improvisational exercises (See Saggar et al., 2014, p 31).

Activities in the training program were centered on hands-on projects that varied in constraints of time, materials, objectives, and intention. All projects yielded a constructed or drawn physical artifact. CCBP training was done in group setting focused on improving perspective taking, empathy, synthesizing ideas and improving improvisational skills.

We were particularly interested in determining the effect of CCBP training relative to a (non-creativity targeted) "control" training to see if creativity can be enhanced in just 5 weeks. Using a longitudinal analysis of scores on a standardized test of creativity (TTCT), we showed that with just 5-weeks of targeted training, creative capacity can be enhanced in adults as compared to control (language) training (Kienitz, et al., 2014). Furthermore, we also observed enhancements in lower-level executive functioning (i.e., information processing) associated with targeted creativity training (Bott et al., 2014; Thinking Skills and Creativity).

The results of these studies provide evidence that group training, conducted outside of the workplace or scholastic settings, could provide creative capacity enhancement in an adult population. Moreover, improvement in low-level executive functioning suggests that creative training can affect performance on attention tasks that require little cognitive interference, which is related to creativity (Martindale, 1999). In summary, these results suggest that creativity and information processing, as measured with standardized, well-accepted measures, can be enhanced through a focused training program.

We were interested in studying the underlying brain mechanism responsible for this boost in creative capacity; therefore we used fMRI (functional magnetic resonance imaging) to look the effects of training on brain mechanisms. A novel game-like fMRI paradigm was designed based on the word-guessing game of Pictionary™ to measure spontaneous improvisation and figural creativity (Saggar, Hawthorne, et al., 2015). This game-like task was designed to engage participants in spontaneous creativity that would help them reach their creative potential in a non-test-like environment.

At baseline, before training, spontaneous improvisation and creativity were associated with reduced engagement of executive functioning and volitional control, while at the same time associated with increased involvement of implicit processing (via cerebellar–cerebral connectivity).

We also examined the effects of training on brain activations in order to reveal the brain correlates of creative capacity *enhancement*. Our results suggest reduced engagement of prefrontal regions related to cognitive monitoring and volitional control as well as reduced parietal cortex activation related to the number of hours in the training program. These results suggest that training was able to reduce monitoring, evaluating or selecting ideas and help focus more on generating and synthesizing ideas. Furthermore, and similar to results of the baseline analysis, higher cerebellar–cerebral connectivity was associated with improvisation-based creativity training (Saggar, et al., 2016). Greater cerebellar-cerebral connectivity has been previously hypothesized to facilitate implicit processing during creative thinking (Ito, 2008; Vandervert, Schimpf, & Liu, 2007).

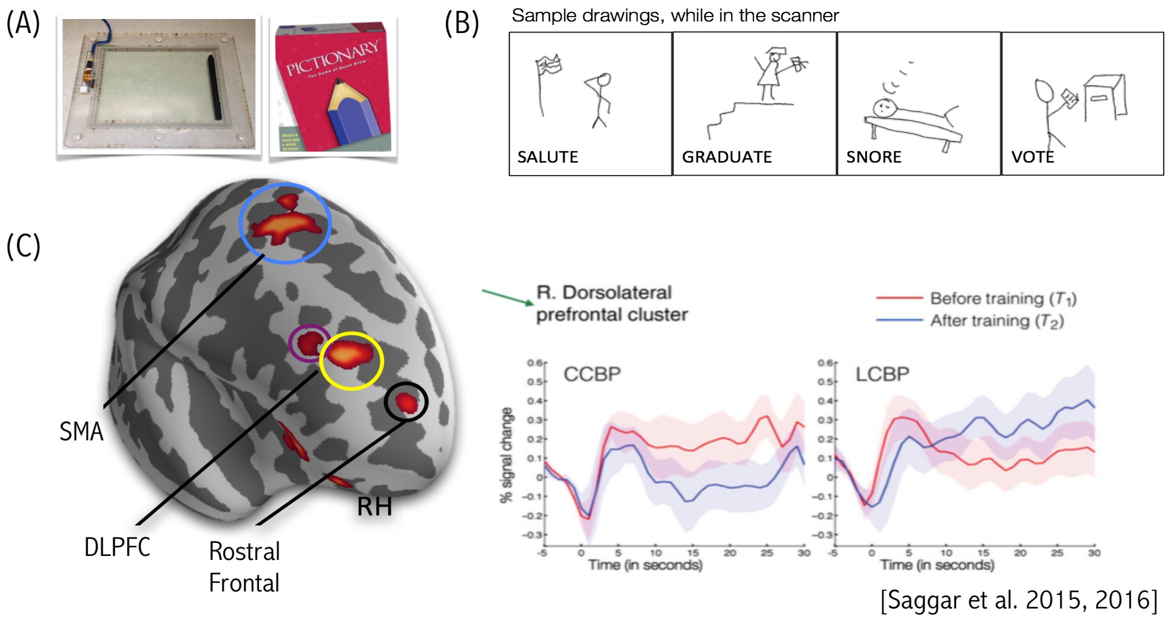

Figure depicts (A) MR-safe table and the game of Pictionary[TM] (B) Sample drawings from participants, while performing the task. (C) Neural correlates of creative capacity enhancement. After training reduced activity was observed in prefrontal regions in the group that received creativity training as opposed to language training.

Taken together, our results demonstrate the benefit of a short-term, improvisational group-based training program on creativity. In a 5-week training program, healthy adults were able to boost their creative capacity, improve their lower-level executive functioning and exhibit marked changes in brain activation related to improvements in creative capacity.

Conclusion

Taken together, teams and groups can be a nurturing environment for creativity when groups are set in a supportive environment which, on the one hand, allows for evaluation of ideas to take place but on the other hand limits the negative component of social comparison and conflict. Our own study found that training individuals in a group setting to improve perspective taking, empathy, synthesizing ideas and developing improvisational skills can lead to higher scores on a standardized test of creativity (Kienitz, et al., 2014) as well as have marked effects on creativity-related neural networks (Saggar, et al., 2016).

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