



## Drinking tea improves the performance of divergent creativity

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theanine does (Parnell, Owen, & Rycroft, 2006). Drinking tea that contains both L-theanine (97 mg) and caffeine (40 mg) leads to higher accuracy in the attention-switching task than drinking a placebo that includes neither L-theanine nor caffeine (Giesbrecht, Rycroft, Rowson, & De Bruin, 2010).

On the other hand, attention is the cognitive process that plays an important role in many other high-order cognitive processes (Peterson & Naveh-Benjamin, 2017; Varao-Sousa, Solman, & Kingstone, 2017), especially in creativity (Vartanian, Martindale, & Kwiatkowski, 2007; Kasof, 1997; Kharkhurin, 2011). Vartanian (2009) suggested that creative people perform well in creative problem solving tasks, adjusting their attention adaptively to the tasks's level of ambiguity.

Above researches about tea's effect on attention and the relationship between attention and creativity arose scientists' curiosity into the effect of tea on creativity. The current study is mainly focusing on tea's relationship with creativity.

## 1.2. Tea and creativity

Creativity is generally considered the human capacity to create original and useful ideas to solve problems (Runco & Jaeger, 2012). Creativity can be classified into two detailed and testable components: convergent and divergent thinking (Guilford, 1967). Convergent thinking is a cognitive process involved in solving a certain problem with only a single solution (Zmigrod, Colzato, & Hommel, 2015). Divergent thinking is the ability to offer unlimited solutions to a single problem and is the key component of creativity (Vincent, Decker, & Mumford, 2002).

The Remote Associates Test (Mednick, 1962) is the typical measurement of convergent thinking creativity. In this test, participants are given three words, such as "blue", "cake", and "cottage", and are required to give the solution word that is associated with these three words ("cheese"). The Alternative Uses Task (Guilford, 1967) is the typical measurement of divergent thinking creativity. In this task, participants must generate as many ideas as possible about the usages of a certain object, such as "brick" or "pen".

According to Hommel (2012), convergent creativity and divergent creativity requires different cognitive control either. Convergent creativity needs strong top-down control which focuses on the search for one idea with well-defined search criteria, whereas divergent creativity needs weak top-down control such that one can switch from one idea to another idea within broad search span with less defined search criteria. Applying this strong/weak top-down cognitive control, one would expect that tea's effect on attention brings strong degree of top-down cognitive control, and in turns improve convergent creativity performance. Actually, Isen, Labroo, and Durlach (2004) tested the relationship between iced tea and convergent creativity. They used the Remote Associates Test (Mednick, 1962) to measure convergent creativity. They found that participants who drank iced tea gave more correct answers in the Remote Associates Test than those who drank water. Einöther et al. (2015) also examined tea's positive effect on convergent creativity with RAT, showing that those who prepared and drank tea performed significantly better than those who drank water in high difficult level of RAT.

Researchers have also begun to investigate the effect of tea on divergent creativity. To date, only one study has tested this association. Einöther et al. (2015) used the alien drawing task (Ward, Patterson, & Sifonis, 2004) as the measure of divergent creativity and recruited regular tea consumers as participants. However, they did not find a significant effect of tea on divergent creativity performance. The purpose of the current paper is to uncover the relationship between tea and divergent thinking creativity.

Our belief in the relationship between tea and divergent thinking creativity is based on several inferences and evidences. Colzato, Ozturk, and Hommel (2012) investigated the improvement of creativity task performance through meditation and found that meditation based on

open monitoring helped to enhance divergent creativity performance. During open-monitoring meditation, one is open to perceive and observe any sensation or thought without focusing on a concept in the mind or a fixed item (Colzato et al., 2012, p1). The essence of meditation is relaxation, and the essence of open-monitoring meditation is "open", "accepting myself as I am", which is much similar to tea's recovery effect from stress (Steptoe et al., 2007). Therefore, one would expect that tea would promote divergent creativity because of its function of promoting relaxation (Dietz & Dekker, 2017) just as meditation does.

A possible mechanism of tea's effect on divergent creativity can be traced to Einöther et al. (2015)'s work, which suggested that preparing and drinking tea can promote positive affect, increasing valence of mood during and immediately after tea consumption (within 10 min from preparing stage). Positive affect is beneficial for creativity (Baas, Dreu, Carsten, & Nijstad, 2008). Therefore, these authors hypothesized that the mechanism of tea's effect on improving creativity is through increased mood valence. In other words, tea consumption is predictive of improved creativity through increased valence of mood.

However, Einöther et al. (2015) did not find empirical support for their assumption for divergent creativity. Although we agree with their reasoning, we believe that their failure to find an effect of tea on divergent thinking creativity is due to the experimental paradigm. Testing the effect of tea on divergent thinking requires a selection of suitable cognitive tasks that encourage and allow multiple solutions rather than a unique solution. Moreover, the performance of the selected cognitive task should not be restrained by other skills that are not related to divergent thinking. Although an alien drawing task may test divergent thinking (Ward et al., 2004), it requires drawing skills that are unrelated to creativity.

## 1.3. Overview of the present research

The current study tested the hypothesis that drinking tea promotes creativity with divergent thinking by adopting two tasks that measure spatial cognitive creativity and semantic innovative creativity. In experiment 1, we used a block-building task to measure divergent thinking. Playing blocks may be associated with the improvement of spatial reasoning (Jirout & Newcombe, 2015). Casey et al. (2008) used a block-building task as their spatial measure to investigate whether block-building activities enhance children's spatial skills. Moreover, Jirout and Newcombe (2015) found that playing with blocks is positively associated with spatial skills. In experiment 2, we used a creativity measurement task, similar to the pasta-naming task (Steffens, Gocłowska, Cruwys, & Galinsky, 2016), as a measure of divergent thinking. The pasta-naming task measures ideational fluency, which is an essential element of creativity (Steffens et al., 2016). Both tasks meet the requirements of being related to divergent creativity without being restrained by other skills unrelated to divergent thinking.

Additionally, we adopted the implicit priming experimental paradigm such that participants were unaware of the independent variable manipulation (Hong, Morris, Chiu, & Benet-Martinez, 2000). Tea consumption was manipulated implicitly by serving tea and water during the greeting stage of the experiment, so the participants did not realize that drinking was the crucial part of our study. This research design helped us exclude the potential compound effect of the experience induced by making tea themselves during tea preparation.

To sum, current research aims to examine the hypothesis that tea consumption promotes divergent creativity, the main effect hypothesis (H1). We also hypothesize that this improvement is due to that tea drinking can lead to a positive mood which is beneficial for divergent creativity, the mediation hypothesis (H2). We ran experiment 1 to test the main hypothesis, and experiment 2 to retest the main effect and to investigate mood's mediation effect. Particularly, we are mainly focusing on acute effect of tea on creativity, and creativity is measured within 10–25 min after tea drinking. In other words, we are mainly

interested in the psychological function on creativity that may happen in very short period of time after drinking.

## **2. Experiment 1**

### **2.1. Method**

#### **2.1.1. Participants**

Fifty university students (22 males) were recruited from the campus Bulletin Board System (BBS). Their mean age was 23.73 years (SD = 2.11). We paid \$6 to each participant for his or her involvement.

#### **2.1.2. Design**

There is a newly opened ramen (noodle) shop, and we are recruiting shop names for it. Please write as many names as possible that you think are cool and attractive within 20 min. There are some judges in the next room who are responsible for evaluating and selecting the appropriate shop names. We will give your final name list to them to rate. Your scores will determine how much extra money you can earn.

Similar to experiment 1, we used the words “cool and attractive” rather than “creative” because we believed that the former is more understandable and meaningful to participants. The name must be attractive to be considered creative, and a creative name draws the attention of the judges by standing out.

After 20 min, experimenter B notified the participants that the trial time was up and asked them to wait in place. Then, experimenter A entered and removed the paper with the participant’s ramen shop names.

In the last step, the participants were asked to complete the tea consuming habit questionnaire, which was the same as in experiment 1 with two additional questions about the participant’s perceived degrees of mental involvement and body involvement (Einöther et al., 2015).

### 3.1.2. Design

The participants underwent the same 3-min warm-up stage as in experiment 1. The participants were randomly allocated into two groups, resulting in 20 participants in the tea group and 20 in the water group. However, in our final data analysis, we excluded one participant who drank nothing, and this participant came from the water group. As a result, we had 19 participants in the water group and 20 in the tea group.

### 3.1.3. Procedure

We retained every procedure in the warm-up stage, including the tea and water treatments, as in experiment 1. We changed only the task that measured creativity to examine our hypothesis. Given that several studies have found an association between tea drinking and positive mood and a relationship between positive mood and creativity (Einöther et al., 2015; Einöther, Rowson, Ramaekers, & Giesbrecht, 2016), it has been suggested that positive mood may explain the mechanism of the relationship between tea drinking and creativity. Therefore, we added a measure of the participants’ mood using the Affect Grid (Russell et al., 1989) at the end of the warm-up stage. According to Russell et al. (1989), the Affect Grid assesses the degree of valence and arousal. The participants were asked to mark how they felt on a  $19 \times 19$  grid with valence on the horizontal axis, ranging from unpleasant to pleasant, and arousal on the vertical axis, ranging from sleepy to active.

After the warm-up stage, the participants were led to room B. Experimenter B in room B (who did not know whether the participant consumed tea or water) explained the instructions of the ramen restaurant-naming task and gave them the task paper, which was a form with 50 blanks.

The instructions for the naming task were as follows:

names remained. We excluded two judges' ratings to reach a coefficient of internal consistency of 0.733 (the two judges' ratings had low correlations with others).

Using a MANOVA that controlled for gender, the volume the par-

effect.

Moreover, we contribute to the literature in the methodological aspect by using adapted experimental paradigms and identifying more

- mood-creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin*, 134(6), 779–806. <http://dx.doi.org/10.1037/a0012815>.
- Bateson, P., & Nettle, D. (2014). Playfulness, ideas, and creativity: A survey. *Creativity Research Journal*, 26(2), 219–222. <http://dx.doi.org/10.1080/10400419.2014.901091>.
- Benedek, M., Jauk, E., Sommer, M., Arendasy, M., & Neubauer, A. (2014). Intelligence, creativity, and cognitive control: The common and differential involvement of executive functions in intelligence and creativity. *Intelligence*, 46, 73–83. <http://dx.doi.org/10.1016/j.intell.2014.05.007>.
- Bryan, J. (2008). Psychological effects of dietary components of tea: Caffeine and L-theanine. *Nutrition Reviews*, 66(2), 82–90.
- Casey, B. M., Andrews, N., Schindler, H., Kersh, J. E., Samper, A., & Copley, J. (2008). The development of spatial skills through interventions involving block building activities. *Cognition and Instruction*, 26(3), 269–309. <http://dx.doi.org/10.1080/07370000802177177>.
- Colzato, L., Ozturk, A., & Hommel, B. (2012). Meditate to create: The impact of focused-attention and open-monitoring training on convergent and divergent thinking. *Frontiers in Psychology*, 3, 116. <http://dx.doi.org/10.3389/fpsyg.2012.00116>.
- De Bruin, E. A., Rowson, M. J., Van Buren, L., Rycroft, J. A., & Owen, G. N. (2011). Black tea improves attention and self-reported alertness. *Appetite*, 56(2), 235–240. <http://dx.doi.org/10.1016/j.appet.2010.12.011>.
- Dietz, C., & Dekker, M. (2017). Effect of green tea phytochemicals on mood and cognition. *Current Pharmaceutical Design*, 23(19), 2876–2905. <http://dx.doi.org/10.2174/1381612823666170105151800>.
- Einöther, S. J. L., Baas, M., Rowson, M., & Giesbrecht, T. (2015). Investigating the effects of tea, water and a positive affect induction on mood and creativity. *Food Quality and Preference*, 39, 56–61. <http://dx.doi.org/10.1016/j.foodqual.2014.06.016>.
- Einöther, S. J. L., & Giesbrecht, T. (2013). Caffeine as an attention enhancer: Reviewing existing assumptions. *Psychopharmacology (Berl)*, 225(2), 251–274. <http://dx.doi.org/10.1007/s00213-012-2917-4>.
- Einöther, S., & Martens, V. (2013). Acute effects of tea consumption on attention and mood. *American Journal of Clinical Nutrition*, 98(6), 1700S–1708S. <http://dx.doi.org/10.3945/ajcn.113.058248>.
- Einöther, S. J. L., Rowson, M., Ramaekers, J. G., & Giesbrecht, T. (2016). Infusing pleasure: Mood effects of the consumption of a single cup of tea. *Appetite*, 103, 302–308. <http://dx.doi.org/10.1016/j.appet.2016.04.003>.
- Giesbrecht, T., Rycroft, J., Rowson, M., & De Bruin, E. (2010). The combination of L-theanine and caffeine improves cognitive performance and increases subjective alertness. *Nutritional Neuroscience*, 13(6), 283–290. <http://dx.doi.org/10.1179/147683010X12611460764840>.
- Goldstein, E. B. (2010). *Cognitive psychology: Connecting mind, research and everyday experience*. Research and Everyday Experience: Wadsworth Publishing.
- Gomez-Ramirez, M., Kelly, S., Montesi, J., & Foxe, J. (2009). The effects of L-theanine on alpha-band oscillatory brain activity during a visuo-spatial attention task. *Brain Topography*, 22(1), 44–51. <http://dx.doi.org/10.1007/s10548-008-0068-z>.
- Guilford, J. P. (1967). *The nature of human intelligence*. New York: McGraw-Hill.
- Hayat, K., Iqbal, H., Malik, U., Bilal, U., & Mushtaq, S. (2015). Tea and its consumption: Benefits and risks. *Critical Reviews in Food Science and Nutrition*, 55(7), 939–954. <http://dx.doi.org/10.1080/10408398.2012.678949>.
- Hill, G. (2001). A level psychology thorough diagrams.