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Exploration of the relationships between retrieval-induced forgetting effects with open-ended versus closed-ended creative problem solving

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ABSTRACT

Reduced cognitive inhibition has been proposed to be a characteristic of creative individuals that allows them to attend to wide-ranging information and fosters remote associations. However, empirical findings regarding the relationship between cognitive inhibition and creativity remain inconclusive. The present study applies a selective attention paradigm on internal stimuli to assess cognitive inhibition. The study also differentiates open-ended and closed-ended creative problem solving as distinct indices to measure creative potentials. How cognitive inhibition correlates with different creativity measures is then explored. Experiment 1 recruited participants who performed well on the Chinese version of the Creative Thinking Test (an open-ended, divergent thinking test) and Wason's 2-4-6 problem (a closed-ended, creative problem-solving task) to perform the retrieval-induced-forgetting (RIF) task. Compared to controls, divergent thinkers showed no RIF effects while creative problem solvers did. Experiment 2 inspected individual performance on the three tasks. The results showed that, while participants with lower inhibition performed better on the divergent thinking test, performance on the creative problem-solving task was not related to RIF. Indices of divergent thinking significantly and negatively predicted extent of cognitive inhibition. These results suggest that reduced cognitive inhibition might not be a general mechanism for different kinds of creativity.

1. Introduction

Creative people are thought to be better at selecting wide-ranging information than non-creative people (e.g., Kasof, 1997; Martindale, 1999). For example, highly creative individuals were found to make more intrusion errors on dichotic listening tasks (Dykes & McGhie, 1976; Rawlings, 1985) and were found to respond more slowly to targets in a Flanker task when distracters were incongruent with the targets (Rowe, Hirsh, & Anderson, 2007). Researchers have proposed that the defocused attention characteristic of highly creative people can foster distant associations (e.g., Ansburg & Hill, 2003; Kasof, 1997; Martindale, 1999). This characteristic has been further suggested to result from low or reduced cognitive inhibition, deterring creative people from filtering seemingly irrelevant stimuli (e.g., Eysenck, 1995). However, when the relationship between creativity and cognitive inhibition has been tested experimentally with tasks of selective attention, which is considered to directly involve inhibitory processes on irrelevant stimuli for focusing on target information (Posner, 1987), the results have been inconclusive. Some studies have found a negative correlation between individual cognitive

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inhibition and creative performance (e.g., Carson, Peterson, & Higgins, 2003; Kéri, 2011), while others have not (e.g., Burch, Hemsley, Pavelis, & Corr, 2006; Stavridou & Furnham, 1996; Storm & Angello, 2010).

One possibility of these inconclusive results may lie in that various creativity measures were employed by previous studies with no further distinctions between different types of creativities. Open-ended (such as divergent thinking) and closed-ended creative problem-solving tasks (such as insight problem solving) have been widely adopted to calibrate individuals' creative potentials in psychometric and cognitive approaches to creativity studies (Sternberg, Lubart, Kaufman, & Pretz, 2005). Divergent thinking is one of the most representative open-ended creative problems. The concept of divergent thinking refers to the ability to generate diverse and numerous responses to a question (Guilford, 1956) and is usually measured by fluency (number of generated responses), flexibility (ability to switch categories between responses), and originality (generation of rarely seen responses according to the norm) indices. On the other hand, individuals who are undertaking closed-ended creative problem solving have to generate ideas (generation processes) and then examine these ideas (exploration processes) under specific problem constraints to reach the final correct answers (Geneplore Model; Finke, Ward, & Smith, 1992).

According to their different task demands (i.e., open- versus closed-solution problem types; Wakefield, 1989), researchers have differentiated the two measures with respect to the novelty and appropriateness properties of creativity (Lin, Hsu, Chen, & Wang, 2012). An open-ended, particularly divergent thinking question better emphasizes the novelty aspect of creativity since only the number and unusualness of the responses are scored. In contrast, a closed-ended creative problem with a specific solution goal demands ideas that are novel as well as appropriate, which are consistent with the problem constraints. Empirical evidence has revealed that individuals' performances on the two measures were not correlated (Lin, Lien, & Jen, 2005) and correlated differently with other variables such as gender, personality traits (Lin, Hsu, Chen, & Wang, 2012), and working memory capacity (Lin & Lien, 2013). It is therefore suggested that the two creativity measures involve distinct mental processes (dual-process account of creativity; Lin & Lien, 2013; Lin, Hsu, Chen, & Wang, 2012). It is possible that low cognitive inhibition also plays a different role in these two creativity measures.

To explore the possibility that reduced cognitive inhibition exhibits different relationships with open- versus closed-ended creative problem solving, three tasks were employed in the present study to measure participant performance on cognitive inhibition, divergent thinking, and closed-ended creative problem solving tasks. In the next few paragraphs, we introduce these three tasks and outline our hypotheses.

First, in contrast to most previous studies, which have measured cognitive inhibition through tasks that tap into participants' inhibition of external irrelevant stimuli, such as the negative priming paradigm (NP; Tipper, 1985) or the latent inhibition paradigm (LI; Lubow, 1989), we inspected inhibitory control on internal stimuli. As Posner (1987) pointed out, selective attention can operate on both external as well as internal stimuli (see also Anderson & Spellman, 1995). Moreover, creativity involves the generation of novel ideas from individuals' inner world, rather than from their external world.

To measure individuals' inhibitory control while they were retrieving concepts, the present study adopted the retrieval-induced-forgetting paradigm (RIF; Anderson, Bjork, & Bjork, 1994). The RIF phenomenon has proven to be robust with various stimuli and in different domains. For example, schizophrenic patients were found to exhibit a reduced RIF effect (Soriano, Jiménez, Roman, & Bajo, 2009), which is compatible with previous suggestions that schizophrenic patients are impaired by a lack of inhibitory control (e.g., Frith, 1979). In the RIF task, participants study items from different semantic categories (e.g., Fruit-*Orange*, Fruit-*Banana*, Animal-*Monkey*, Animal-*Rabbit*) and subsequently perform selective stem-completion retrieval practice on half of the items from half of the categories (e.g., Fruit-*Or*___). After a distraction task, a category-cued recall test for all previously studied items is administered. Researchers have typically observed that, while participants' recall of the practiced items (*Rp*+ items; e.g., *Orange*) improves, their recall of the unpracticed items (*Rp*− items; e.g., *Banana*) is impaired, as compared to their recall of the control items from unpracticed categories (*Nrp* items; e.g., *Monkey*, *Rabbit*). The different recall rates between the *Nrp* and *Rp*− items are considered the extent of inhibition, indicating that the *Rp*− items are inhibited to a lower activation level during retrieval attempts when competing with the practiced items from the same categories (e.g., Anderson, 2003; Aslan & Bäuml, 2011; Storm, 2011).

A Chinese version of the RIF task was developed by Huang (2004) for Mandarin speakers and was adopted in the present study. In accordance with the properties of the Chinese characters, Huang modified the stem-completion practice into "category-phonetic symbol of the first character" patterns. This procedure has proven to demonstrate robust RIF effects with Chinese characters (e.g., Huang, 2004, 2005).

Second, we used the Chinese version of the Creative Thinking Test (CVCTT; Wu, 1998) to measure open-ended, divergent thinking ability. This test was designed from subtests of the Torrance Test of Creative Thinking (TTCT; Torrance, 1974) with culturally familiar materials. A large-sample norm has been developed using Taiwanese elementary to graduate students, and stable reliability and validity results have also been established (Wu, 1998).

Third, instead of using traditional insight problems, which could only offer final correct rates as indices of closed-ended creative problem-solving abilities, we adopted a version of the 2-4-6 problem (Wason, 1960), which allows researchers to measure the degree of creativity of the hypotheses that participants generate (Lien & Lin, 2011; Lin & Lien, 2013). In the 2-4-6 problem, participants are told that 2-4-6 is a number triple that has been generated in accordance with a predetermined rule (i.e., ascending numbers). The participants must discover this predetermined rule. They are allowed to test a series of triples of their choice (e.g., 10-12-14), receive feedback from the experimenter about whether each tested triple is consistent with the correct rule, and revise their hypotheses accordingly. Previous studies have noted that the majority of participants cannot