



# The role of (dis)inhibition in creativity: Decreased inhibition improves idea generation



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## ABSTRACT

There is now a large body of evidence showing that many different conditions related to impaired fronto-executive functioning are associated with the enhancement of some types of creativity. In this paper, we pursue the possibility that the central mechanism associated with this effect might be a reduced capacity to exert inhibition. We tested this hypothesis by exhausting the inhibition efficiency through prolonged and intensive practice of either the Simon or the Eriksen Flanker task. Performance on another inhibition task indicated that only the cognitive resources for inhibition of participants facing high inhibition demands were impaired. Subsequent creativity tests revealed that exposure to high inhibition demands led to enhanced fluency in a divergent thinking task (Alternate Uses Task), but no such changes occurred in a convergent task (Remote Associate Task; studies 1a and 1b). The same manipulation also led to a hyper-priming effect for weakly related primes in a Lexical Decision Task (Study 2). Together, these findings suggest that inhibition selectively affects some types of creative processes and that, when resources for inhibition are lacking, the frequency and the originality of ideas was facilitated.

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## 1. Introduction

The ability most frequently said to reflect human uniqueness is creativity. Human beings are able to create and this ability is expressed in a variety of different domains such as art, technology, or science. At the same time, our uniqueness is also characterized by higher cognitive functions which have emerged with the growth of the human prefrontal cortex (PFC) (Deacon, 1997; Ruff, Trinkaus, & Holliday, 1997). These executive functions are composed of three main components: mental-set

shifting, inhibitory control, and updating working memory (Miyake et al., 2000).

From this, one might infer that creativity comes from our ability for executive functioning. However, one of the most intriguing finding in psychology and psychiatry is that many kinds of mental states that are associated with impaired executive functioning can lead to positive consequences in terms of creative performance (Dietrich, 2004). For example, White and Shah (2006) showed that ADHD individuals outperformed non-ADHD individuals on a divergent creativity task which requires participants to find multiple ideas. Interestingly, Healey and Rucklidge (2006) noted that 40% of highly creative children met criteria for ADHD. Keri (2009) indicated that a specific gene (i.e., neuregulin 1; T/T), which has been previously associated with fronto-executive disfunctioning and schizophrenia (Hall et al., 2006), is positively associated with real-life

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creative achievements. In a neurological study, [Reverberi, Toraldo, D'Agostini, and Skrap \(2005\)](#) showed that patients with lateral frontal lesions were better than normal participants at solving hard insight problems. Similarly, a recent study showed that a decrease in cortical excitability of the lateral frontal cortex, induced by transcranial magnetic stimulation, improved performance on a divergent creativity task ([Chrysikou et al., 2013](#)). A psycho-pharmacological study by [Morgan, Rothwell, Atkinson, Mason, and Curran \(2010\)](#) showed that cannabis intoxication elicited a hyper semantic priming effect. Under marijuana, the perception of a stimulus generated the activation of a greater network of distantly related concepts, which is considered an important aspect of creativity ([Martindale, 1995](#)). Also, enhanced problem solving was found when individuals worked at a non optimal time of the day compared to an optimal time of the day ([Wieth & Zachs, 2011](#)). This raises the question of why all these different conditions lead to the same positive effect. In the present research, we propose that they might all in fact be linked to the same process. That is, we do not assume that a reduced executive functioning in general is at work but rather a reduced capacity to exert inhibition. Indeed, it is known that the capacity to exert the inhibition function is impaired by cannabis use ([Skosnik, Spatz-Glenn, & Park, 2001](#)) and tends to be affected by the circadian rhythm ([May, 1999](#)). Impaired inhibition is also a suspected symptom in ADHD ([Barkley, 1997](#)) and schizophrenia patients ([Beech, Powell, McWilliam, & Claridge, 1989](#)). In addition, dysfunction of the lateral frontal cortex is typically related to reduced inhibition as this function is mainly located in this region, especially the inferior frontal cortex (e.g., [Aron, Robbins, & Poldrack, 2004](#)). Given that impaired inhibition is the common denominator of all these various conditions, we suggest that this dysfunction can have a paradoxical effect, favoring some types of creativity while being detrimental to others.

### 1.1. Inhibitory control

The function of inhibition, also called inhibitory control, is the ability to suppress the processing or expression of information that would disrupt the efficient completion of the goal at hand ([Dempster, 1992](#)). As such, inhibition provides a resistance to interference from irrelevant action. Inhibition also plays a key role in cognitive processing by limiting the content of consciousness to goal-relevant information. In other words, inhibition is thought to be the mechanisms behind selective attention, narrowing the focus of attention around one limited source of information ([Hasher, Lustig, & Zacks, 2007](#)). When inhibitory control is inefficient, a broader range of information will penetrate working memory causing the apparition of less relevant thoughts (e.g., [May & Hasher, 1998](#)).

Response inhibition can be assessed using well-known tasks such as the [Eriksen and Eriksen \(1974\)](#), [Simon \(1990\)](#), or [Stroop \(1935\)](#) tasks. In such conflict tasks, participants are required to respond, as quickly and accurately as possible, by selecting the relevant feature of the stimulus and inhibiting the irrelevant feature which is associated with the incorrect response. Reaction time (RT) and accuracy performances are usually reported to be worse when

relevant and irrelevant information are mapped to different responses (incongruent trials, IN), than when they correspond to the same response (congruent trials, CO). This phenomenon is known as the interference effect (RT on incongruent trials minus RT on congruent trials) and is interpreted as resulting from a conflict between alternative responses. The conflict paradigm provides reliable indicator of the cognitive control efficiency (see [van den Wildenberg et al., 2010](#)).

### 1.2. Types of creativity

Creativity can be described as the production of an innovative, appropriate, and surprising solution to a complex problem. In spite of this simple definition, creativity is a complex concept with many different processes involved ([Dietrich, 2007](#); [Ward, Smith, & Finke, 1999](#)). Recent models ([Allen & Thomas, 2011](#); [Dietrich, 2004](#); [Helie & Sun, 2010](#)) indicate that while some of these processes require heavy executive processing (e.g., learning the context of the problem, analytic strategy of search, checking the correctness of a solution), others would rather rely on automatic associative processing (e.g., imagination, generation of ideas). Depending on the type of creative task, not all of these aspects are equally important. For example, while aspects requiring executive processing could be quite important in convergent creativity tasks, it might be not so important in divergent creativity tasks. Divergent creativity refers to the generation of multiple ideas or solutions to a problem. Convergent creativity requires finding a unique solution to a closed ended problem. Divergent thinking is typically assessed using the Alternate Use Task (AUT, [Guilford, 1967](#)) that requires finding alternative uses for an object. As for convergent creativity, the Remote Associate Task (RAT, [Mednick, 1962](#)) is the most frequently used task. This task consists of numerous problems that require finding one unique word that can be associated to three other words. Given that many criteria must be met for a convergent creativity problem, it should require more executive processing. Inhibitory control would be specifically needed to prevent all irrelevant ideas (e.g., words that are semantically related to only one or two of the words of a RAT problem) to enter working memory. The resolution of these interferences may be crucial to stay focused on identifying a solution that meets all criteria. However, selective attention would not be as useful if the goal is to come up with many ideas. If the task does not require many constraints, the apparition of a broad range of unfiltered information in working memory might in fact be an advantage to generating a number of original ideas.

### 1.3. The present research

The present study aims to examine how inhibition contributes to creativity. While [Carson, Peterson, and DM \(2003\)](#) suggested that low inhibition is associated with high levels of creativity, we assume that low inhibition would not favor creativity as a whole but rather serves the more specific process of idea generation. In addition, unlike previous work on the role of inhibition in creativity ([Carson et al., 2003](#); [White & Shah, 2006](#)), the present

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