Creative thinking & insight tests measure the same processes: Is creative thinking simply insight?

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Abstract
Creativity is a multidimensional concept that has been studied extensively over the last few decades (Kilgour, 2006). Two central aspects of creativity are the product and the process; the product refers to an item or an idea produced by an individual, while the process refers to the cognitive steps during creative thinking that give rise to the product. Insight is another well-studied phenomenon that results from a combination of cognitive processes such as divergent thinking, convergent thinking, and attention redirection (Ansburg, 2000; DeYoung, Flanders, & Peterson, 2008). This paper examines the various definitions of creativity and compares the creative process to the processes underlying insight. Furthermore, the cognitive processes measured in various tests of creative thinking, such as the Remote Associates Test (RAT) and the Torrance Test of Creative Thinking (TTCT), are examined and argued to also underlie insight. Creative thinking and insight are essentially the same phenomena, and creativity is simply the product of insight.

Introduction
The definition of creativity has eluded people for decades, largely because its multifaceted nature makes it seemingly impossible to settle on one, all-encompassing explanation (Piffer, 2012). Rhodes’ (1961) definition seems to encapsulate most elements of creativity, such as the creative person, the process, the product, and the press, of which the process refers to the cognitive mechanisms underlying creativity. Likewise, one of the most intensively studied phenomena in the cognitive psychology of problem solving is insight, commonly understood as the ‘aha!’ feeling when one unexpectedly stumbles upon a solution to a problem (Burns & Ellis, 1970; Davidson & Sternberg, 1995; Weisberg, 2010). Insight constitutes a set of cognitive processes for solving a problem that requires an individual to shift perspective. Insight problems require restructuring of the way the problem is perceived and attended to, such that when the restructuring occurs, the solution becomes immediately apparent and evokes the ‘aha!’ feeling. Creative thinking and the processes underlying insight are remarkably alike, as they both involve redirecting or restructuring attention and they both require increasing awareness of the relationships between elements of a problem. Creativity and insight tests measure the same underlying cognitive processes of divergent thinking (DT), convergent thinking (CT), and restructuring via attention redirection, which suggests that creative thinking is simply an example of insight.

Creativity
Prior to explaining creative thinking, it is important to understand the concept of creativity. In attempting to define creativity, many end up segregating the creative process and the creative product (Gardner, 1988; Hanson, 2013; Ivcevic, 2009; Zeng, Proctor, & Salvendy, 2011), but rarely do they include both aspects. Piffer (2012) focuses on the product in defining creativity in terms of the usefulness and originality of the product. Conversely, Mumford and Whetzel (1996) outline the various mental processes of creativity, such as how one organizes and attends to the problem, and how one can reach the solution. In trying to find a balance between the two definitions, Zeng and colleagues (2011) defined creativity as the cognitive processes employed to create a novel and useful product. Although the cognitive process is mentioned, the product and its commerciality are emphasized as the defining factors of creativity (Zeng et al., 2011), even though creative products do not always have commercial value.

Despite the vast range of definitions available for creativity, most definitions converge on four main defining characteristics of creativity as they relate to the product: originality, novelty, appropriateness, and value (Kilgour, 2006). Although these characteristics do not allude to the creative process, they are often evaluated in creativity tests. This suggests that unlike studying insight, creative thinking can hardly be studied in isolation from the sociocultural factors attached to it.
The creative process is not expected to be novel, original, or useful; rather, the outcome of the process is what earns the label of being creative. Accordingly, if one instance were more novel, original, or functional than another, it would be considered more creative. A strength of product-oriented creativity tests is that ideas or products from any field, from science to art, can be an instance of creativity due to the breadth of the criteria. Unfortunately, the breadth becomes vague in attempts to determine definitive, standardized criteria for an idea or product to be labelled novel. The continuum of creativity does not have clear boundaries that allow us to distinguish between what is minimally creative and what is not creative. The problem with settling on a definition of a creative product is that the criteria used to label the product creative are subjective. For example, does art have to be aesthetically pleasing in order to be creative? If so, opinions of what is aesthetically pleasing may differ between people. Creative products reflect the sociocultural views of a society at any given point in time. When examining creative thinking in isolation from sociocultural variables, such as the originality or the novelty of a product, there is overlap between the tests used to examine insight and those used to examine creative thinking. For instance, the Remote Associates Task (RAT), which measures processes such as convergent thinking and divergent thinking, is used as a measure of both creativity and insight. Thus, the process-oriented definition of creativity is most relevant to creative thinking, as it outlines the mental processes that result in a creative product and can be compared to those underlying insight.

**Insight**

Insight, much like the creative process, constitutes the set of mental processes that leads to a realization, or the ‘aha!’ moment. Insight results from a dynamical and self-organizing process of shifting attention and restructuring the salient and relevant aspects of a problem. At a specific moment during the process of solving an insight problem, an individual becomes aware of the associations between critical elements of the problem, which allows them to restructure their problem formulation and subsequently arrive upon a solution (Brock, 2015; Dominowski & Dallob, 1995; Metcalfe & Wiebe, 1987; Mumford & Whetzel, 1996; Necka, 2011). To break out of the initially incorrect problem formulation, the problem solver must first scale down or focus their attention on the different aspects of a problem by breaking the problem down, and then scale up their attention by looking at the big picture in order to make the relevant associations clear and achieve the correct problem reformulation. This requires consciously adjusting the opponent processes of scaling up and down at appropriate times during the task in order to facilitate insight.

The main characteristics of insight include restructuring (Bowden & Jung-Beeman, 2003; Duch, 2007; Luo & Knoblich, 2007; Necka, 2011) and overcoming fixation on the incorrect problem formulation (Mumford & Whetzel, 1996; Necka, 2011), as mentioned above, as well as cognitive leaping (Baker-Sennett & Ceci, 1996; Necka, 2011). Cognitive leaping, which is a subset of pattern completion (Baker-Sennett & Ceci, 1996), involves leaping from not knowing to knowing the solution. In this context, pattern completion refers to identifying a pattern as informative cues become more apparent. An example of a visual pattern completion task is when, upon seeing a blurred out picture of a couch, it is difficult to determine what it is. As the picture becomes less blurry and more information is provided, even if it is not completely clear, it becomes easier to identify it as a couch. Likewise, with insight problems, as relevant cues to solve the problem become more apparent, it results in a sudden insight to the solution. Often, relevant cues in the environment can trigger restructuring of the problem during the time spent away from the problem, which can lead to an insight (Dodds, Smith, & Ward, 2002; Necka, 2011; Seifert, Meyer, Davidson, Patalano, & Yaniv, 1995; Sio & Ormerod, 2014). Many of the characteristics of insight are apparent in the nine-dot insight problem (NDP), as illustrated in Figure 1. The task is to draw four straight lines that pass through each dot without lifting the pen off the paper. This is an insight problem because it requires reformulation of the problem. Specifically, the solver must break out of the incorrect representation of the dots forming a square. Restructuring the representation of dots results in the sudden insight that the NDP is not a connect-the-dots problem but rather, the solution requires a non-dot turn. The solver must surpass the perceived square frame created by the dots to solve the problem.
Due to fixation on the incorrect problem representation, in two separate experiments, none of the participants were able to solve this problem without external help (Chi & Snyder, 2012; Weisberg & Alba, 1981). In Weisberg and Alba’s (1981) study of 15 participants who were not given any clues or help, none of them was able to solve the NDP. Similarly, Chi and Snyder (2012) found that none of the 22 participants were able to solve the NDP prior to brain stimulation, and those who received sham stimulation could not solve it during or after stimulation. In this case, only those participants with excitatory transcranial direct stimulation of the right anterior temporal lobe (ATL) and inhibition of the left ATL solved the problem. However, the rate of success for solving the NDP increases if appropriate clues or training are provided (Casselman & Maier, 1970; Kershaw & Ohlsson, 2004). As the low success rate indicates, people nearly always reach an impasse when trying to solve the nine-dot problem; clues can help them overcome fixation and help them restructure the problem appropriately.

Aside from brain stimulation, training people to scale up or down can also facilitate insight. McCaffrey (2012) gave participants various insight problems like the Duncker candle problem. In this problem, using only a matchbox, a box of thumbtacks, and a candle, the objective is to attach the candle to the wall while ensuring that the wax does not drip down to the floor. The solution is taking the thumbtacks out of the box, setting the candle into the box and attaching the box to the wall using the thumbtacks, and using the matchsticks to light the candle. The problem’s difficulty arises because people fixate on the conventional use of the objects, whereas the key is to realize that the box can be used to hold the candle. Half of the participants were taught the generic-parts technique, in which they were given an object and asked to break it down into its parts by scaling down their attention, such as a bell, and to think about whether the parts could be useful in any way. After training, all participants were given the insight problems. Those trained on the generic-parts technique solved many more insight problems than those in the control group, largely because the technique helped them overcome fixation.

Another example of an insight problem is the multiple marriages problem, which requires making remote associations, and in turn requires divergent thinking and convergent thinking in order to reach the solution (Sowden, Pringle, & Gabora, 2015). Remote associations are relations between items that are not salient or immediately apparent. Convergent or analytical thinking occurs from scaling down attention, while DT occurs from scaling up attention. The multiple marriages problem is:

“A man who lived in a small town married twenty different women of the same town. All are still living and he never divorced a single one of them. Yet, he broke no law. Can you explain?”

(Lockhart, Lamon, & Gick, 1988, p.36)

People are quick to reach an impasse because they fixate on the predominant meaning of the word “married” (Lockhart et al., 1988, p.36), which is to be wed to someone. However, to solve this problem successfully, people must overcome this fixation and shift their attention to the less common meaning of marry, which is to make two people into spouses. Once they restructure their formulation of the problem and make this remote association, usually with the help of clues, they realize that the man in question is in fact a clergyman (Lockhart et al., 1988; Perfetto, Bransford, & Franks, 1983). It is evident from this problem that making remote associations between aspects of insight problems is critical to solving them, and often requires training or additional clues (Gick & Holyoak, 1980). Insight problems measure the processes of overcoming fixation via DT, restructuring via attention redirection, and making remote associations via DT and evaluating them using CT (DeYoung et al., 2008). These processes are also present in creativity, and are measured by tests of creative thinking.
Tests of Creative Thinking

Similar to insight, the creative process consists of restructuring, problem reformulation, and a combination of DT and CT (Okuda, Runco, & Berger, 1991; Sowden et al., 2015; Sternberg, 2001). The idea that creative thinking and insight potentially use the same cognitive processes is not new (Duch, 2007; Necka, 2011). Creativity requires dynamical opponent processing, such as shifting attention from a defocused to a concentrated state, and a combination of DT and CT (Chand & Runco, 1992; Gilhooly, Ball, & Macchi, 2015; Kilgour, 2006; Simonton, 2012; Sowden et al., 2015; Tasman, 1976), which occur in a recursive, dynamic manner (Zeng et al., 2011). Creative thinking is not simply a matter of applying a process to a problem, but rather, it is the ability to shift between different cognitive processes depending on the context of the task. This opponent processing also occurs in insight following de-automatization of cognitive processes. For instance, if DT is used to solve an insight problem, de-automatization of cognitive processes facilitates a shift to CT, which often results in insight. Alternatively, if CT is used ineffectively, the individual must also be able to switch to DT. Creative thinking tests that measure DT and CT via the ability to form remote associations and problem restructuring following attention redirection lend support to the fact that the cognitive processes occurring in creativity and insight are the same.

Traditional tests of creative thinking largely measure DT, and DT tests measure the extent to which people can think in unusual ways. The most common DT task is the Alternate Uses task, in which participants have to generate alternative uses for an object. It is present in the Torrance Tests of Creative Thinking (TTCT) and the Wallach and Kogan Creativity Battery (WKCB), which are widely used tests to evaluate DT and CT (Crockenberg, 1972). The tasks in the TTCT and WKCB involve visual and verbal content, allowing for an estimation of creative thinking across domains. The TTCT is mostly composed of DT tasks, while the WKCB is mostly composed of tasks that involve CT in the form of making remote associations. The TTCT is scored on fluency, flexibility, originality, and elaboration (Crockenberg, 1972). Fluency is the number of responses given by the participant; flexibility is the diversity of the responses and it implicitly measures the number of remote associations the participant makes; originality is the uniqueness of the responses when compared to other participants; and elaboration is the amount of detail in a response (Crockenberg, 1972). As these tests measure DT comprehensively through different tasks like the Alternate Uses task, and as these tests moderately predict creative potential (Crockenberg, 1972; Piffer, 2012; Runco, 2004; Yoruk & Runco, 2014; Zeng et al., 2011), it is clear that DT is an important part of creative thinking.

Although the TTCT and WKCB suggest DT has a role in creativity, the role of CT cannot be overlooked. Some aspects of a task require DT and widespread attention (Kounios et al., 2008), while others entail CT and focused attention (Sowden et al., 2015). A DT task such as the Alternate Uses task requires multiple solutions, whereas a CT task would require analytical thinking resulting in one correct solution. CT tasks can be mental arithmetic or logical thinking tasks. However, most insight and creative thinking tasks, such as the nine-dot problem, employ both CT and DT. Attention redirection has been shown to facilitate the de-automatization of cognitive processes, which results in a shift from convergent to divergent thinking and vice versa (Gilhooly et al., 2015). Cropley (2006) argues that convergent thinking is necessarily required in creative thinking because when ideas are generated, they must be further analyzed before they are accepted as a feasible solution or idea to further build on. CT is also involved in creative thinking, and the use of an appropriate task is particularly important. That is, a straightforward CT task that measures simple addition is not likely to be correlated with creativity, whereas a task that measures CT in the context of complex problem-solving requiring restructuring and appropriate attentional focus, such as a Remote Associates Task (RAT), is more highly correlated with creativity (Taft & Rossiter, 1966). This is consistent with the importance of the appropriate scaling of attention to insight. Moreover, even in DT and insight tasks, CT is used because analytical thinking is required to determine whether potential solutions are correct (Sowden et al., 2015). However, creative thinking tasks that measure CT, such as the RAT, typically also measure DT, rather than measuring CT independently of DT. This is one of the problems with measuring creative thinking, as the disproportion-
ate focus on DT results in other cognitive processes being overlooked.

The Remote Associates Task (RAT) is an insight and a creative thinking test based on both DT and CT. In the RAT, words are presented to the participant, and they are asked to identify one word that is related to each of the presented words. For example, given the words home, stomach, and sea, the expected answer is sick, as it relates to all three given words. In this task, recognizing associations requires DT while reaching the correct solution requires convergence (Benedek & Konen, 2012). It was initially considered a convergent thinking task because it was most highly correlated with measures of convergent thinking, such as verbal IQ and total IQ (Taft & Rossiter, 1966). However, newer research indicates that the RAT validly captures the machinery of both DT and CT, which are involved in both insight and creativity (Kilgour, 2006; Morais, Almeida, Azevedo, & Necka, 2009; Yoruk & Runco, 2014; Zeng et al., 2011). Forming associations may require scaling up of attention to seek out potentially distant relationships, while convergent thinking is used to analyze potential solutions to determine the correct one (Cropley, 2006). Making easy associations on the RAT requires focused and narrowed attention, and not much DT, because the relationship between the words is salient, allowing one to reach the solution easily. On the other hand, difficult associations require widespread attention to all word meanings, because the relationship between the words is not immediately evident (Sio & Ormerod, 2014). More DT is needed to make those associations. Thus, the scaling up and down of attention, as well as knowing when to do so, is equally important in both creative thinking and insight, as are CT and DT.

Despite the widespread use of DT and CT tasks as measures of creative thinking, they come with several criticisms. For instance, there is evidence against the use of TTCT tasks as measures of creative thinking. The lack of score consistency between the TTCT tasks is interpreted as evidence against their importance in the creative process, though restructuring and problem reformulation that occur in insight are important for creativity (Almeida, Prieto, Ferrando, Oliveira, & Ferrandiz, 2008). This is a valid concern, but this task inconsistency could occur because DT is measured in different domains (Kilgour, 2006). That is, measuring DT in the verbal Alternate Uses task is not the same as measuring it in the visual Picture Construction task, because the participants’ capabilities in each domain reflect individual differences. This is not sufficient to conclude that DT and CT are not essential to the creative process. Creativity is also associated with DT rather than CT, because the novelty associated with a creative product is the result of combining information in a novel and unusual way (Almeida et al., 2008). However, as creative thinking tasks like the RAT measure both DT and CT, and Almeida and colleagues (2008) only looked at the TTCT, this assertion is not supported. Though both DT and CT are implicated in creative thinking, DT may play a larger role. However, this is difficult to conclude as most tests of creative thinking, such as the TTCT, are biased towards measuring DT, and rarely measure CT as well.

Additionally, the RAT scores are not related to other product-oriented measures of creativity, in that the inconsistency is a result of association between presented information rather than an individual’s own associative production (Kilgour, 2006). While this is a strong criticism of creativity per se, it is not relevant when comparing the RAT to insight problems, which also require the formation of novel associations amongst the presented information. DT tests receive criticisms because they measure cognitive strategy selection rather than inherent associative ability (Kilgour, 2006). However, this is based on the assumption that creative thinking abilities are different from general cognitive processes such as attention and working memory. Yet if creative thinking is viewed as a set of cognitive processes that result in insight, the cognitive processing strategy becomes synonymous with creative thinking because creative thinking is neither automatic nor unique from other cognitive processes (Dietrich & Kanso, 2010; Morais et al., 2009; de Sousa, 2008). Hence, in the absence of these potentially weak assumptions, creative thinking and insight can employ the same cognitive processes.

In addition to traditional creativity tests, insight problems themselves are often used as measures of creative thinking based on the premise that solving an insight problem itself is a form of creativity (Cosmelli & Preiss, 2014; Dietrich & Kanso, 2010; Kounios et al., 2008; Kounios & Beeman, 2009; Runco, 2004). In assuming that solving insight problems is a form of
creativity, insight problems provide strong evidence regarding the relationship between insight and creative thinking. The cognitive aspect of creativity therefore appears to be reliant on or simply a series of insights. The most commonly used tasks are the RAT and the compound remote associates (CRA) tasks, which have been used to study insight in the past (Ansberg & Hill, 2003; Bowden et al., 2005; Bowden & Jung-Beeman, 2003; Dodds et al., 2002). The CRA task is a version of the RAT in which the answer forms a compound word when joined to the presented words, rather than just being related to them. For example, if the presented words were magic, board, and hole, the answer black would yield a compound word when combined with the presented words, such as black magic. Performance on different insight tasks was correlated with the RAT, indicating that making associations between aspects of a problem is crucial in both creativity and insight (Ansburg, 2000). Moreover, when insight and divergent thinking tasks are used as measures of individual differences in creativity, success on various verbal insight problems is a distinguishing factor in the degree to which participants’ products are considered creative (Morais et al., 2009). There is an important relationship between insight problem solving and DT, and DT is central to creativity. Although insight is related to creative thinking, the majority of these experiments use the same type of task to measure this relationship – the RAT – which is not representative of all aspects of creative thinking. In particular, the RAT demonstrates how CT and DT are used to form remote associations, but the RAT fails to account for appropriate restructuring processes seen in problems such as the NDP that are also essential for creative thinking and insight. Creativity and insight use various cognitive processes, not all of which are studied within the same experiment. As such, the processes underlying how creativity and insight are reported and conceptualized is inconsistent, with a disproportionate focus on DT. This creates an avenue for future research for exploring and comparing the concepts of creativity and insight in detail. Even though they both use the same cognitive processes, they are not the same phenomenon. Insight is a cognitive phenomenon, whereas creativity involves sociocultural factors in addition to the cognitive processes of creative thinking. Given the overlap between the processes involved in creative thinking and insight, they appear to be largely the same, albeit with varying outcomes. That is, insight seems to be a precursor to creativity, as it may be needed to generate a creative product. However, not every insight results in creativity or a creative product. Creative thinking may be an instance of insight, with the outcome of generating a creative product. It is unclear whether DT or CT contribute more to creative thinking, as DT has been studied more extensively in this context. Next, researchers could develop tasks that measure CT in the context of creative thinking, to determine whether CT significantly contributes to creative thinking independently of DT.

Conclusion

Creative thinking tests such as the TTCT and RAT, as well as insight problems like the NDP, the multiple marriages problem, and the RAT measure the same cognitive processes; namely divergent thinking, convergent thinking, and attentional focus. Currently, researchers believe both insight and creative thinking use the same cognitive processes (Gilhooly et al., 2015), and insight can be facilitated (Chi & Snyder, 2012; McCaffrey, 2012). However, most studies have not investigated the similarities between creative thinking and insight processes directly. They have not examined all of these processes in one study; most studies focus on divergent thinking exclusively. While divergent thinking is required to solve insight problems, other processes such as CT and attentional focus should be studied further, as these tests do not fully measure these other processes. When evaluating an individual’s performance during an insight or during a creative thinking task, it is important to specify which cognitive processes are being studied. This will determine whether the same processes underlie both creative thinking and insight. Future research could measure all the processes underlying insight and creative thinking, and an increased understanding of these processes could allow us to train creativity by facilitating insight.

References
