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The relationship between intelligence and creativity: New support for the threshold hypothesis by means of empirical breakpoint detection

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ABSTRACT

The relationship between intelligence and creativity has been subject to empirical research for decades. Nevertheless, there is yet no consensus on how these constructs are related. One of the most prominent notions concerning the interplay between intelligence and creativity is the threshold hypothesis, which assumes that above-average intelligence represents a necessary condition for high-level creativity. While earlier research mostly supported the threshold hypothesis, it has come under fire in recent investigations. The threshold hypothesis is commonly investigated by splitting a sample at a given threshold (e.g., at 120 IQ points) and estimating separate correlations for lower and upper IQ ranges. However, there is no compelling reason why the threshold should be fixed at an IQ of 120, and to date, no attempts have been made to detect the threshold empirically. Therefore, this study examined the relationship between intelligence and different indicators of creative potential and of creative achievement by means of segmented regression analysis in a sample of 297 participants. Segmented regression allows for the detection of a threshold in continuous data by means of iterative computational algorithms. We found thresholds only for measures of creative potential but not for creative achievement. For the former the thresholds varied as a function of criteria: When investigating a liberal criterion of ideational originality (i.e., two original ideas), a threshold was detected at around 100 IQ points. In contrast, a threshold of 120 IQ points emerged when the criterion was more demanding (i.e., many original ideas). Moreover, an IQ of around 85 IQ points was found to form the threshold for a purely quantitative measure of creative potential (i.e., ideational fluency). These results confirm the threshold hypothesis for qualitative indicators of creative potential and may explain some of the observed discrepancies in previous research. In addition, we obtained evidence that once the intelligence threshold is met, personality factors become more predictive for creativity. On the contrary, no threshold was found for creative achievement, i.e. creative achievement benefits from higher intelligence even at fairly high levels of intellectual ability.

1. Introduction

1.1. The relationship between intelligence and creativity

Although empirical creativity research can meanwhile look back on a scientific tradition of over 60 years of investigation, it is still unclear how the concepts of creativity and intelligence relate to each other (Kaufman & Plucker, 2011). Sternberg and O'Hara (1999) provide a general framework for researchers encompassing five possible relationships: Intelligence and

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creativity can either be seen as a subset of each other, they may be viewed as coincident sets, they can be seen as independent but overlapping sets, and lastly as completely disjoint sets.

Though there exists evidence in favor of each of these perspectives (Kaufman & Plucker, 2011), several influential models of intelligence treat creativity as a lower order factor of intelligence (e.g., divergent production in Guilford's structure-of-intellect model; Guilford, 1967), retrieval ability in Carrol's three-stratum model (Carrol, 1993), or imaginativeness in the Berlin model of intelligence structure (Bucik & Neubauer, 1996; Jäger, 1982). These models thus assume a substantial correlation between creativity and intelligence. Guilford (1967) was one of the first to discover that this correlation may vary at different levels of cognitive ability: He found a positive linear relationship in the lower to average IQ range while there was no correlation at above-average levels of intelligence. Guilford concluded that "the pattern of bivariate distribution of the cases suggests that although high IQ is not a sufficient condition for high DP [divergent production] ability, it is almost a necessary condition" (p. 168). The notion that high intellectual ability is a necessary condition for high creativity has become popular as "threshold hypothesis".

1.2. Creativity

Creativity is a concept of individual differences which is intended to explain why some people have higher potential to provide new solutions to old problems than others. It leads us to change the way we think about things and is conceived as the driving force that moves civilization forward (Hennessey & Amabile, 2010). Creativity is usually examined at different conceptual levels. One of the most general distinctions to be made is the one between creative potential as opposed to creative achievement (Eysenck, 1995). Creative potential refers to the individual's ability to generate something novel and useful (Sternberg & Lubart, 1999) and reflects a normally distributed trait (Eysenck, 1995). In turn, creative achievement refers to the actual realization of this potential in terms of real-life accomplishments (such as having made a scientific discovery, written a novel etc.; cf., Carson, Peterson, & Higgins, 2005). Although different authors use different terminologies such as Little-C vs. Big-C (cf., Kaufman & Beghetto, 2009) to describe this dichotomy, it seems that the underlying taxonomy is the same.

Creative potential is usually assessed by means of tests that measure divergent thinking ability (Runco, 2010) such as the Torrance Test of Creative Thinking (TTCT; Torrance, 1966), the Guilford tests (Wilson, Guilford, & Christensen, 1953), or the Wallach and Kogan tests (Wallach & Kogan, 1965). Divergent thinking (DT) is hereby defined as "the kind that goes off in different directions" (Guilford, 1959, p. 381). Accordingly, divergent thinking tests involve open problems for which a variety of possible solutions can be found. A widely used DT task is the alternate uses task in which participants are instructed to find creative uses for everyday objects (for example: brick — "use for karate demonstration" etc.) (Kaufman, Plucker, & Baer, 2008). DT tests can be scored with respect to different criteria usually involving ideational fluency, i.e. the quantity of ideas produced, and/or originality, i.e. the quality of ideas. However, these scores are commonly found to be correlated to an extent that their discriminative validity has been questioned (Hocevar, 1979; Michael & Wright, 1989; Silvia et al., 2008). This is especially true when a summative originality scoring is employed where originality may directly increase with the number of ideas (i.e., ideational fluency). However, alternative scorings of ideational originality, which control for fluency by either dividing originality by fluency or by considering a constant number of ideas, no longer show this problem (Benedek, Mühlmann, Jauk, & Neubauer, 2013; Hocevar, 1979; Silvia et al., 2008).

Creative achievement is commonly assessed by means of self-reports such as biographical questionnaires in which participants indicate their achievements across diverse domains (e.g., literature, music, or theatre). A popular example is the Creative Achievement Questionnaire (CAQ; Carson et al., 2005). The CAQ and related measures were found to have good psychometric properties (Silvia, Wigert, Reiter-Palmon, & Kaufman, 2012) and successfully discriminate between more and less creative persons (Vellante et al., 2011). Moreover, intelligence significantly predicts CAQ scores (Carson, Peterson, & Higgins, 2003; Kéri, 2011).

Meta-analytic findings suggest that the correlation between creative potential and intelligence generally is around $r = .20$ (Kim, 2005). Besides its relationship to intelligence, personality correlates of creative potential have been extensively studied. The most consistent and significant finding is that creative potential is positively related to openness to experiences (cf., Batey & Furnham, 2006; Feist, 2010). Openness is thought to reflect an "investment trait" relevant to creative potential (Chamorro-Premuzic & Furnham, 2005). Moreover, openness can be associated with actual creative achievement (King, Walker, & Broyles, 1996). Open people are imaginative and curious, which forms a good basis for creative endeavors across all domains. On the contrary, the relationship to other personality traits such as conscientiousness or neuroticism strongly depends on the investigated domain. While conscientiousness may be promotive of scientific creativity, artistic creativity is related to emotional instability (Batey & Furnham, 2006).

1.3. The threshold hypothesis

The basic idea behind the threshold hypothesis is that high creativity requires high or at least above-average intelligence. At this, above-average intelligence is thought to form a necessary but not a sufficient condition for high creativity (Guilford, 1967). More specifically, it is assumed that there exists a threshold in intelligence which is usually set to an IQ of 120. While creativity should be limited by intelligence below this threshold, differences in intelligence should be no longer relevant to creativity above it. Accordingly, the threshold hypothesis predicts a correlation between measures of creativity and IQ only in low to average IQ samples, whereas there should be no correlation in groups of higher IQ.

Studies investigating the threshold hypothesis focused predominantly on the relationship between intelligence and creative potential rather than creative achievement (for reviews see Kaufman & Plucker, 2011; Kim, 2005). Early studies investigating the relationship between intelligence and creativity showed that highly creative individuals are also of higher intelligence (Barron, 1963, 1969; Getzels & Jackson, 1962). Fuchs-Beauchamp, Karnes, and Johnson (1993) investigated the threshold hypothesis in preschoolers and found correlations