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The relationship between analytical and creative cognitive skills from middle childhood to adolescence: Testing the threshold theory in the Kingdom of Saudi Arabia☆

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ABSTRACT

Guilford's seminal studies (Guilford, 1967) propose that an average level of intelligence is required to demonstrate a creative skill. However, according to the threshold theory, in individuals with high levels of intelligence (IQ ≥ 120) creativity is no longer related to intelligence. Studies that have explored this phenomenon have shown inconsistent results. Most of the available literature has originated from Western countries and used a correlation approach to find a threshold for the association between different measures of IQ and creativity. The goal of this study was to find a threshold using novel tasks of analytical skills (verbal, scientific and mechanical reasoning) and creativity (fluency, flexibility, originality and elaboration) by conducting segmented regression analysis in a representative sample of Saudi Arabian students. The sample of 4368 3rd to 11th grade students (53.1% girls) was divided into three grade-groups (3rd–5th, 6th–8th, and 9th–11th). A threshold was found only for 6th–8th graders at a level of analytical skills of 108.8, and at 108.4 for 9th–11th graders. The analysis of gender differences showed that the threshold was significantly higher for boys than girls in the group of 9th–11th graders (105.6 for boys, 81.46 for girls). These thresholds were generally lower than those reported in other studies. Contrary to the threshold theory, for both grade-groups the relationship between creativity and analytical skills was positive and significant only above the thresholds. Potential factors accounting for these findings may be the type of analytical skills tasks, more related with crystallized intelligence and the culture-specific educational experiences of Saudi children.

The relationship between intelligence[1] and creativity has been explored for several decades, yet interpretations of research findings have defied consensus. Is one construct dependent upon the other? Are they independent but overlapping, completely disjointed, or perhaps associated in some way that has not yet been revealed (Getzels & Jackson, 1962; Sternberg & O'Hara, 1999)? Further, when students are differentiated by level of IQ, the correlations between intelligence and creativity have been found to vary, with weak and non-significant correlations at high levels of IQ, but positive and linear correlations in the lower to average IQ range (Guilford, 1967; Yamamoto, 1964). Guilford's (1967) proposal that high creativity requires high or at least above-average intelligence led to a specification that at IQ levels above 120 (a so-called "threshold"), creativity is no longer limited by intelligence (Jauk, Benedek, Dunst, & Neubauer, 2013). That is, a moderate level of intelligence is necessary to be creative, so that a person can select and integrate relevant information, or can identify a problem and subsequently generate an original solution or several solutions for that problem (Runco, 1991). The relationship between intelligence and creativity has indeed been found in many studies to be weak above a specific threshold of analytical ability. As long as certain analytical skills are present, it seems, creativity may diverge from intelligence.

Studies that have systematically investigated this theory have produced inconsistent results. There is a group of studies that has established support for the threshold theory. For example Fuchs-Beauchamp, Karnes, and Johnson (1993) found moderate correlations between intelligence and creative potential in preschool children with IQ below 120 ($r = .49$ to $r = .09$ depending of the dimension of creativity) and a lower correlation ($r = .12$ to $r = .05$) in children with IQ above 120. Another study demonstrated the threshold effect using

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[1] In this study, we use the term intelligence interchangeably with such terms as IQ, aptitude, intelligence test scores and performance on other analytically-based assessments.

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measures of verbal and figural creative potential in a sample of adolescents and adults; correlations between intelligence and creative potential of up to $r = .40$ were observed in the average IQ sample, while correlations in the higher IQ (>120) sample were close to zero (Cho, Nijenhuis, Van Vianen, Kim, & Lee, 2010).

In contrast to these supportive results, though, other studies have registered only negligible differences between IQ–creativity correlations in different ability groups. Mednick and Andrews (1967) detected no differences in the correlations between students' scores on the Remote Associated Test (RAT) and the SAT-V and SAT-M when the sample was broken in quintiles of performance (the SAT here is a proxy for IQ). Similarly, Runco and Albert (1986) using a correlation approach and correction for range restriction found no significant correlations between intelligence (using the WISC-R or Stanford-Binet) and divergent thinking within four IQ levels (98–120, 121–130, 131–145, 146–165)—with the exception of a positive relationship between intelligence and verbal fluency ($r = .25$) and verbal flexibility ($r = .27$) within the 131–145 IQ group. When they used scores from the California Achievement Test (CAT) to divide the student sample into subgroups, the correlations between CAT scores and creativity remained insignificant for most groups but were lower than those obtained with the WISC; the largest and the only significant CAT-creativity coefficients were for the subgroups above the 4th quartile in CAT performance.

Finally, a meta-analysis by Kim (2005) ultimately rejected the threshold theory by compiling and analyzing data from 21 quantitative studies of creativity, intelligence and the correlation between them. Estimated mean correlations below and above an IQ of 120 were $r = .20$ and $r = .23$, respectively, clearly contradicting the threshold theory as the correlations across the studies above and below the threshold were both statistically significant and statistically undistinguishable from each other. In the same meta-analysis Kim (2005) examined the variations in the correlations between creativity and intelligence. These variations appeared to be due to 1) the nature of the tests used to measure analytical skills and creativity (e.g., verbal vs. non-verbal); 2) the dimensions of creativity being tested (e.g., fluency, flexibility, originality, and elaboration); and 3) the age and gender in the samples selected for the meta-analysis. Some examples of these variations are provided in the next section.

1. Type of tests used to measure analytical skills and creativity

Regarding the use of different IQ measures, three studies exemplified the variability of results. The first study, conducted by Runco and Albert (1986) showed that the correlations between analytical skills and creativity differed when the CAT and IQ scores from the Stanford Binet or WISC-R were correlated with creativity measured by the Wallach and Kogan (1965) test of creativity. They found that, using the thresholds of 145 for IQ and the 4th quartile for the CAT, IQ correlations with creativity were higher in both groups above the threshold, although the CAT-creativity correlations were lower than the IQ–creativity correlations for each of the different dimensions of creativity (e.g., fluency, flexibility, originality and elaboration) as well as for the verbal and figurative tasks.

Sligh, Conners, and Roks-Ewoldsen (2005) reported correlations between creativity measured by the Finke Creative Invention Task (FCIT: Finke, 1990) and IQ measured with the Kaufman Adolescent and Adult Intelligence Scale (KAIT; Kaufman, 1993) (assessing fluid, crystallized and composite intelligence) as well as the Raven's Advanced Progressive Matrices Set I (Raven & John, 1985). The participants were classified into two groups based on their composite KAIT scores (average and high IQ). The correlations with crystallized IQ, as indicated by KAIT scores, were significant in the average IQ group, but non-significant in the high IQ group ($r = .34$, $p < .05$ and $r = .19$, $p =$ ns respectively). However, the opposite pattern was found when using fluid IQ, as measured by the Raven's matrices: the correlations with creativity measures were non-significant in the average IQ group, but significant in the high IQ group ($r = .12$ and $r = .39$, $ps < .05$, respectively). Different results were obtained by Cho et al. (2010). Korean students were classified as average IQ or high IQ (IQ < 120) based on the WAIS test. They were then administered the Raven's Advanced Progressive Matrices (RPM) as a measure of fluid intelligence. The average IQ group showed significant and positive correlations between the figural and verbal tasks of the TTCT with WAIS ($r = .44$ and $r = .42$ respectively) but no correlations were found with RPM. The high IQ group showed no significant correlations with either the WAIS or RPM.

In the Kim (2005) meta-analysis when the type of creativity test was taken into account as a moderator, IQ–creativity correlations varied, indicating that the type of test and the dimension of creativity being assessed may influence the correlations between analytical skills and creativity, as well as the IQ level of the threshold. Specifically, different correlations between IQ and creativity were found between studies that used the Torrance Tests of Creative Thinking (TTCT; $r = .22$) and those using the Wallach–Kogan divergent thinking measures ($r = .12$). In addition, verbal and figural task correlations with IQ were different depending on whether verbal tests ($r = .16$) or figural (i.e., nonverbal) tests ($r = .23$) of creativity were used.

2. Dimensions of creativity

Kim's meta-analysis (Kim, 2005) also showed that the correlation between IQ and creativity tended to change depending on the dimension of creativity being measured. For example, low IQ–creativity correlations were found for originality ($r = .13$) and fluency ($r = .17$), whereas slightly higher correlations were observed for flexibility ($r = .23$) and figural redefinition ($r = .36$). Significant differences between the dimensions were found using chi-square comparisons. These variations in the correlation coefficients by dimension suggest the possibility of different thresholds for each dimension. In fact, Jauk et al. (2013) did establish different thresholds for different dimensions of creativity. When analytical skills were measured using the Intelligence Structure Battery (Intelligenz-Struktur-Batterie, INSBAT; Arendasy et al., 2005), and creativity with the Inventory of Creative Activities and Achievements (ICAA), the correlation between IQ and ideational fluency changed at IQ = 86.09, with the correlation below the threshold at $r = .56$ and above, $r = .09$. For originality, the threshold was detected at an IQ of 119.60; the correlation below was $r = .38$ and above $r = .14$.

3. Thresholds as a function of gender and age

In two meta-analyses, Kim (2005, 2008) did not find statistically significant differences between males and females for the correlation between IQ and creativity. However, differences in IQ–creativity correlations for different age groups were found (Kim, 2005). These correlations were lowest for students in elementary school ($r = .09$), but higher and of similar magnitude among students in middle school ($r = .21$), high school ($r = .26$), and for adults ($r = .21$). All of the correlations between and within the groups were significantly different (Kim, 2005).

However, studies that explore specifically the variation of the threshold by gender are non-existent to our knowledge. An early study of Yamamoto (1964) found no support for a threshold in elementary school students, but found a threshold in secondary school students (IQ < 120). In this study, the threshold was explored through an analysis of variance between three groups of IQ performance (below 120, between 120 and 135, above 135).

4. Methods used to explore the threshold theory

Early studies exploring the threshold theory segmented their samples into groups by IQ performance, then creativity scores between groups were compared using analyses of variance. The assumption was that creativity scores of the high IQ group would be greater than

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