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How does the strength of the relationships between cognitive abilities evolve over the life span for low-IQ vs high-IQ adults? ☆

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Abstract

The present study was designed to examine how the correlations between cognitive abilities evolve during adulthood. Data from 1104 participants on the French version of the Wechsler Adult Intelligence Scale-Third Edition were analyzed. The entire sample was divided into four age groups (16–24 years; 25–44 years; 45–69 years and 70–89 years), which were themselves split into two IQ-levels using the mean standard score on Vocabulary and Block Design. For every age group, the mean correlation between subtest scores of low-IQ participants was higher than that of high-IQ participants. There was also no interaction between age and IQ for the strength of subtest relationships. Indeed, the effect sizes of correlation differences between low- and high-IQ participants appeared to be relatively constant across age. A general developmental schema of how the strength of correlations between cognitive abilities of low- and high-IQ individuals evolves during the entire life span is sketched in the discussion.

Keywords: Intelligence; Adulthood; Diminishing returns, Wechsler Adult Intelligence Scale; Spearman law; Differentiation; Cognitive abilities

The law of diminishing returns (Spearman, 1927), that is, the inverse relationship between IQ and the strength of correlations of cognitive abilities, has been the subject of numerous studies in recent decades (e.g., Abad, Colom, Juan-Espinosa, & García, 2003; Carlstedt, 2001; Deary et al., 1996; Detterman, 1993; Detterman & Daniel, 1989; Evans, 1999; Facon, 2002, 2003a, 2003b; Hartmann & Reuter, 2006; Hunt, 1997; Jensen, 2003; Legree, Pifer, & Grafton, 1996; Lynn, 1990; te Nijenhuis & Hartmann, 2006; Reynolds & Keith, 2007). The bulk of this research was conducted with the implicit idea that this inverse relationship does not develop with age. Stated otherwise, individuals with low-IQ would have less differentiated cognitive profiles than individuals with high-IQ from the outset of their development. However, recent investigations have challenged this "fixist" view of the law of diminishing returns. For example, in the Facon (2004) study, the mean correlations between cognitive abilities of children of low and high-IQ aged from 6 to 9 years were nearly equal, suggesting that the inverse relationship does not appear during childhood, and Arden and Plomin (2007) have now reported similar results for 7–10 year old children. Moreover, in a study of children

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and young adolescents of high and low intellectual functioning ages 7–9, 10–12 and 13–15 years, Facon (2006) showed that median correlations between intellectual scores did not change with age for high-IQ participants (.13, .15 and .14 for the three age groups), whereas an increase was observed for low-IQ participants (.15, .16 and .25, respectively). Thus, it seems that only at the end of childhood (13–15 years) does the phenomenon described by Spearman begin to appear.

The idea of bringing a developmental perspective to the study of the law of diminishing returns is justified in at least two respects. First, there is a great deal of evidence, in psychology, of developmental variations in the relationships between cognitive, demographic and background variables. For example, the correlation between parents' education or socioeconomic status and intelligence test scores of their offspring is negative or close to zero during early childhood but increases to .40–.60 in the following years (e. g., Bayley & Jones, 1937; Bayley, 1954, 1970; Honzik, 1957, 1963, 1967). Also, the IQ variance explained by genotype increases with age whereas the effect of shared environmental influences tends to diminish between childhood and adolescence (Plomin, 2003; Plomin, DeFries, McClearn, & McGuffin, 2001; Plomin & Petrill, 1997; Plomin & Spinath, 2004). In another area of research, an age-related stabilization of composite intelligence test scores during childhood was early demonstrated. Indeed, age to age correlations are very low before 18 months, increase rapidly up to 5 or 6 years and then become both high and stable even when the psychometric examinations are conducted several years apart (Bayley, 1949; Bayley & Schaefer, 1964; Lewis & McGurk, 1972; McCall, 1976; McCall, Hogarty, & Hurlburt, 1972). In the same way, although this point is still much debated (Anstey, Hofer, & Luszcz, 2003; Facon, 2007; Juan-Espinosa, García, Colom, & Abad, 2000; Juan-Espinosa et al., 2002; Zelinski & Lewis, 2003), some results indicate the existence of an age-related differentiation–dedifferentiation of cognitive abilities over the life span (Li et al., 2004; Hertzog & Bleckley, 2001; Tideman & Gustafsson, 2004). Finally, the relationship between intelligence test scores and learning or job performance often changes markedly with practice (Ackerman, 1987, 1988, 2005; Ackerman & Cianciolo, 2000, 2002; Fleishman, 1972; Fleishman & Mumford, 1989; Fleishman & Quaintance, 1984; Hulin, Henry, & Noon, 1990; Kennedy, Dunlap, Turnage, & Wilkes, 1993). In view of these few examples of macro or micro developmental trends, one may ask why the relationship between IQ and correlations between cognitive abilities might not also evolve with age. Indeed, one of the most prime lessons of developmental psychology in general and of the above-mentioned examples in particular, is that psychological phenomena have a genesis. The law of diminishing returns is probably not an exception to this rule, and thus it is important to study *when* the IQ-related process of differentiation appears and *how* the correlations evolve in low- and high-IQ groups over the course of development.

Second, a developmental approach to studying the law of diminishing returns could help to resolve some inconsistencies in the literature. Indeed, the inverse relationship between IQ and the strength of correlations among cognitive abilities is not always confirmed (e.g., Fogarty & Stankov, 1995; Hartmann & Teasdale, 2004; Hartmann & Reuter, 2006; Nesselroade & Thompson, 1995). These negative results have been attributed to several explanatory variables such as the type of measure and the cutoff point used to constitute IQ groups, the content, number, and complexity of ability tests, and the location of groups along the IQ continuum (Abad et al., 2003 [study 1]; Deary et al., 1996; Fogarty & Stankov, 1995; Hartmann & Teasdale, 2004, 2005; Nesselroade & Thompson, 1995; Pagliari, 1998). But it is also possible, beyond these variables, that the age of participants moderates the effect of IQ on the degree of differentiation of abilities and thus makes the phenomenon more difficult to discern when, as is frequently the case, several age levels are present but not controlled for. From this standpoint, it seems clearly necessary to study the law of diminishing returns by taking age into account. In some respects, this approach combines the ability-related differentiation hypothesis with another well-known hypothesis, that of a change in the structure of cognitive abilities with age. This latter was probably originated in 1919 with Burt (see Burt, 1954) and, under the influence of Garrett (1946), gave rise to numerous works in which, surprisingly, age and ability level were never actually studied simultaneously. Nonetheless, at least two studies had already been done on the differentiation of cognitive abilities as a function of both age *and* IQ. Lienert and Faber (1963), for example, simultaneously tested the IQ-related differentiation hypothesis (called, after Wewetzer, the *divergence hypothesis*) and the age-differentiation hypothesis. However, the age differences between their groups were, on the average, only 3 years (8–10 years vs 11–13 years). Deary et al. (1996) have also crossed these two variables in a methodologically sound study conducted with a sample of impressive size, but again with a too small age range (14–17 years). In addition, beyond this age span problem, neither of these two