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On the relationship between general fluid intelligence and psychophysical indicators of temporal resolution in the brain ☆

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Abstract

One possible cause for the higher speed of information processing of more intelligent individuals may be that higher-intelligence scores are associated with higher temporal resolution capacity of the brain. Therefore, the present study was designed to investigate the potential relationship between timing performance and general fluid intelligence. For this purpose, a sample of 100 participants was divided into a lower-IQ and a higher-IQ group according to below and above median scores on Cattel's Culture Fair Intelligence Test Scale 3. Experimental tasks were duration discrimination of auditory intervals in the range of milliseconds and seconds, temporal-order judgments (TOJ), and auditory flutter fusion (AFF). Performance on duration discrimination of both filled and empty intervals in the range of milliseconds was significantly better for the high-IQ than for the low-IQ group. No IQ-related differences could be shown for temporal discrimination of intervals in the range of seconds, TOJ, and AFF. Furthermore, stepwise multiple regression analysis revealed that combining performance on duration discrimination with filled and empty intervals in the range of milliseconds accounted for 22% of the total variance of general

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fluid intelligence. Findings suggest that brain mechanisms specifically involved in discriminations of extremely brief intervals represent a sensitive indicator of general fluid intelligence.

Keywords: Duration discrimination; Temporal order judgment; Auditory fusion threshold; Intelligence; Internal clock

1. Introduction

Early experimental approaches to intelligence already put forward the notion of intelligence as a biological quality reflected in elementary and physiological measures such as reaction times or sensory discriminations (e.g., Cattell, 1890; Cattell & Farrand, 1896; Galton, 1883, 1908). Similarly, more recent information processing approaches consider intelligence a characteristic of the central nervous system to process information quickly and correctly. Within this general framework, the relationship between intelligence and processing speed has been explained, for example, by neuronal refractory periods (Jensen, 1982), reliability of neuronal transmission (Hendrickson, 1982; Hendrickson & Hendrickson, 1980), or specific cortical activation (Haier, 1993; Neubauer, Freudenthaler, & Pfurtscheller, 1995). On the whole, all these accounts refer to neural efficiency in the brain as a basic determinant of individual differences in cognitive abilities. From this perspective, neural efficiency has been hypothesized to constitute the biological substrate of a general mental ability, usually referred to as general intelligence *g*, present in all cognitive tasks (Bates, Stough, Mangan, & Pellett, 1995; Jensen, 1998).

Various measures of speed of information processing, such as reaction time (e.g., Eysenck, 1987; Jensen, 1987a), inspection time (Brand & Deary, 1982; Vickers, Nettelbeck, & Wilson, 1972), short-term memory scanning (Sternberg, 1969), or speed of access to long-term memory stores (Posner, Boies, Eichelman, & Taylor, 1969), have been assumed to be valid indicators of neural efficiency. Although correlations between these measures and psychometric estimates of *g* appear to be fairly well established, the correlations are not always consistent and may depend on the methodology employed (Bowling & Mackenzie, 1996; Jensen, 1987b; Kranzler & Jensen, 1991; McGarry-Roberts, Stelmack, & Campbell, 1992; Neubauer, Riemann, Mayer, & Angleitner, 1997; Olsson, Björkman, Haag, & Juslin, 1998; Roberts & Stankov, 1999; Vernon & Weese, 1993).

One possible cause for the higher speed of information processing of more intelligent individuals may be that an internal master clock operates at a faster rate with increased intelligence. The notion of such an hypothetical master clock has been put forward by Surwillo (1968) to account for age-related cognitive impairment and general slowing. He proceeded on