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Proceedings of the Annual Meeting of the Cognitive Science Society

Title

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Permalink

<https://escholarship.org/uc/item/5658n8zc>

Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 24(24)

ISSN

1069-7977

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Publication Date

2002

Peer reviewed

Dynamic Interrelations Among Processing Efficiency, Working Memory, and Problem Solving: A Longitudinal Study

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A study is presented aiming to contribute to the integration of the information processing, the differential, and the developmental modelling of the mind into a comprehensive theory. This is a longitudinal study which investigated the relations between processing efficiency, working memory and problem solving from the age of 8 to 16 years. This study involved 113 participants, almost equally drawn among 8-, 10-, 12-, and 14-year olds at the first testing: these participants were tested for two more times spaced one year apart. These participants were tested individually with a large array of tasks addressed to processing efficiency (that is, speed of processing and inhibition), working memory (that is, phonological storage, visual storage, and the central executive of working memory), and thinking (that is, quantitative, spatial, and verbal reasoning).

Confirmatory factor analysis validated the presence of all of the above dimensions and indicated that they are organized in a three-stratum hierarchy. The first stratum included all of the individual dimensions mentioned above. These dimensions are organized, at the second stratum, in three constructs, namely processing efficiency, working memory, and problem solving. Finally, all second-order constructs are strongly related to a third-order general factor. This structure is stable in time.

Structural equation modelling indicated that the various dimensions are interrelated in a cascade fashion so that more fundamental dimensions are part of more complex dimensions. That is, speed of processing proved to be the most important aspect of processing efficiency and it is strongly related to the condition of inhibition, indicating that the more efficient one is in stimulus encoding and identification, the more efficient one is in inhibition. In turn, processing efficiency is strongly related to the condition of executive processes in working memory, which, in turn, are related to the condition of the two modality-specific stores (phonological and visual). Finally, thinking was related to both processing efficiency and working memory, the central executive in particular.

These findings provide only partial support to the basic positions in psychometric theorizing

concerning the role of the components of processing capacity in the functioning of thinking. Specifically, none of these components alone is the crucial factor in the functioning of thinking. Rather, they additively contribute to its functioning. Moreover, a considerable amount of variance in different domains of thinking remains unexplained by these general factors. Therefore, any theory of intelligence must be able to account for the organization and functioning of these domains.

All dimensions appeared to change systematically with time. Growth modelling suggested that there were significant individual differences in attainment in each of these dimensions. Moreover, development affected differently each of them as well as their interrelation. Mixture growth modelling suggested that there were four types of developing persons, each being defined by a different combination of performance along these dimensions. Some types were more efficient and stable developers than others. These analyses indicated that processing efficiency is a factor that explains developmental differences in problem solving whereas working memory explains individual differences. Modeling by logistic equations uncovered the rates and form of change in the various dimensions and their reciprocal interactions during development. A developmental model is proposed to account for these findings.

References

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