

Prefrontal Functioning and Predictive Validity in Infancy and Early Childhood

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This review compares experimentally derived measures of prefrontal functioning and tests used in early infancy to predict cognitive capacity at a later age. It is suggested that the predictive power of the early developmental scales depends on their ability to assess prefrontal functioning.

There is evidence indicating that the development of prefrontal functions is a multi-stage process (Passler, Isaac, & Hynd, 1985; Welsh, Pennington, & Groisser, 1991), reflected behaviorally already in the first year of life (Goldman-Rakic, 1987; Welsh & Pennington, 1988).

Prefrontal functioning appears to be of primary importance for behaviors such as goal directed problem solving, initiative, and impulse control (Fuster, 1980; Luria, 1980; Stuss & Benson, 1984).

Using two classical Piagetian paradigms of "object search" and "object retrieval", Diamond and Goldman-Rakic (Diamond, 1993; Goldman-Rakic, 1987) showed that correct solution of the tasks depended upon intact dorsolateral prefrontal functioning in the monkey. Human subjects could solve these tasks already at an age of 11-12 months. More specifically, Goldman-Rakic (1987) theorized that goal directed behavior in infancy and early childhood is based on the developing capacity for representational memory or the ability to hold information "on line" in working memory, what she considered the "building block" or "cornerstone" of cognitive development. Assuming this to be the case, it may be argued that early assessment of prefrontal functioning would be of predictive value with regard to the cognitive development of the infant or young child.

It is well known that traditional infant developmental tests such as the Bayley Scales of Infant Development have quite limited predictive validity regarding later intelligence test scores for healthy infants younger than 18 months of age (Anastasi, 1982; Bayley, 1969; Fagan & Montie, 1988). However, recent research indicates that certain tasks or tests may have considerable predictive validity for later developmental quotients or IQs in healthy infants even though the testing is performed in the first year of life.

Adopting the classical "object search" and "object retrieval" paradigms, Messer et al. (1986) found significant correlation ($r \geq .40$) between persistence in solving tasks at 12 months of age and scores on the McCarthy Scales at age 30 months. On the other hand, scores on the Bayley Scales of Infant Development at 12 months did not correlate significantly ($r < .30$) with McCarthy scores at 30 months of age. By implication, therefore, functions related to the dorsolateral prefrontal cortex (and representational memory) had greater predictive power than abilities assessed by the predominantly sensori-motor tasks of the Bayley Scales at 12 months of age.

Other infant tests, reported to have good predictive validity with regard to later cognitive development, have focused on behavioral characteristics of the infant such as initiative, curiosity, attention, and organized goal directed problem solving (Als and Duffy, 1989; Aylward, Verhulst, & Bell, 1988a, 1988b; Fagan & Montie, 1988; Hrcir, Speller, and West, 1985). These are all behavioral characteristics associated with prefrontal functioning (Fuster, 1980; Luria, 1980; Stuss & Benson, 1984).

It is suggested, therefore, that the predictive power of the early developmental scales is essentially dependent on their validity in assessing prefrontal functioning. In addition to its implications for the construction of scales of better predictive validity, this hypothesis would also lead one to expect developmental consequences of early prefrontal brain damage. The consequences of early prefrontal damage for later functioning will be tested in a prospective study in progress in Iceland.

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