Infant Predictors of Individual Differences in Working Memory During Childhood

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Abstract

This study was an attempt to integrate cognitive development (i.e., cognitive control) and emotional development (i.e., emotion regulation) in the first years of life. The construct of temperament was used to unify cognition and emotion because of its focus on attentional and regulatory behaviors. Children were seen at 8 months and 4½ years of age in a study designed to examine the correlates of working memory development. Frontal brain electrical activity and temperament predicted working memory performance at 8 months. Similarly, frontal brain electrical activity, temperament, and language predicted working memory at age 4½ years. Temperament in early childhood mediated the relation between infant temperament and early childhood working memory performance. These associated temperament characteristics highlight the value of early-learned regulatory and attentional behaviors and the impact of these early skills on later development.

Methodology

Fifty healthy 8-month-old infants and their parents were recruited from birth announcements placed in local newspapers. After the children had their fourth birthday, parents were contacted by phone. Of the original 50 participants, 43 were located and contacted. Twenty-seven were still in the area. Of these, 25 agreed to return to the research lab for a follow-up visit. This subgroup with data at both assessment periods was composed of right-handed Caucasian children whose ages ranged from 52 to 56 months.

At the 8-month assessment, infants were assessed on a oculomotor spatial working memory task (Bell, 2001, 2002; Bell & Adams, 1999) requiring the use of both working memory and inhibitory control. EEG was recorded during task performance and during a brief baseline period prior to the task. Parents completed the IBQ temperament questionnaire.

At 4.5 years the children returned to the lab and performed a series of tasks that required the cognitive skills of working memory and inhibitory control in 3.5 to 7 year old children. These were the day-night Stroop-like task (Diamond, Prevor, Callender, & Druin, 1997) and the yes-no task created in our lab (Wolfe & Bell, 2004). EEG was recorded during task performance and during a brief baseline period prior to the task. Parents completed the CBQ temperament questionnaire. At the end of the session, each child completed the Peabody Picture Vocabulary test (PPVT).

Results

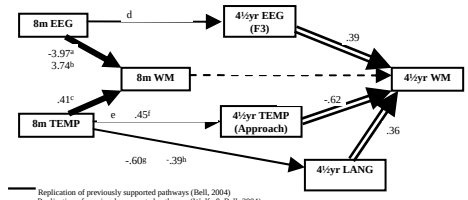

Table 1. Results of Hierarchical Regression Analysis Predicting Working Memory Performance in Early Childhood from Electrophysiology, Temperament, and Language Receptivity

	β^a	R	R^2	t	*Sig.*
Dependent variable: Working memory performance					
Predictors entered:					
Step 1: PPVT-III	.36	.59	.36	2.11	.05
Step 2: Approach (CBQ)	-.62	.73	.53	-3.35	.01
Step 3: EEG (F3)	.39	.81	.65	2.16	.05

[a]The values in the final equation, with all predictors entered.

Table 2. Results of Backward Regression Analysis Predicting Working Memory Performance in Infancy from Electrophysiology and Temperament

	β^a	R	R^2	t	*Sig.*
Dependent variable: Working memory performance					
Independent variables: EEG (F1,F2,F3,F4,F7,F8); IBQ scales (activity, orienting, limitations, approach, soothability, smiling)					
EEG (F3)	-3.97	.67	.45	-2.18	.05
EEG (F4)	3.74			2.05	.06
Distress to Limitations (IBQ)	.41			1.93	.07

[a]The values in the final equation, with all predictors entered.

Table 3: Correlations between Infant Frontal EEG and Child Frontal EEG

	Child Frontal EEG					
Infant Frontal EEG	F1	F2	F3	F4	F7	F8
F1	-.42*	-.48*	-.48*	-.48*	-.44*	-.38+
F2	-.42*	-.48*	-.52*	-.53*	-.46*	-.41*
F3	-.44*	-.49*	-.48*	-.47*	-.45*	-.39+
F4	-.46*	-.49*	-.48*	-.48*	-.42*	-.40*
F7	-.39+	-.44*	-.49*	-.44*	-.41*	-.35+
F8	-.39+	-.45*	-.43*	-.43*	-.39+	-.36+

Note: n=18, one-tailed test of significance
+p < .10
**p < .05*

Results

Table 4: Correlations between Infant IBQ and Child CBQ Maternal Temperament Ratings

	IBQ Scales					
	Activity Level	Latency to Approach	Distress to Limitations	Duration of Orienting	Smiling & Laughter	Soothability
CBQ Scales						
Activity Level	-	-	-	-	-.42*	.42*
Anger	-	-	.41*	-	-	-
Approach	.43*	-	-	.46*	-	.44*
Attentional Focusing	-	-.37+	-	-	-	-.35+
Attention Shifting	-	-	-	-	.49*	-
Falling Reactivity	-	-	-.39*	-	-	.33+
Soothability						
Fear	-	-	-	-	-	.33+
Inhibitory Control	-	-	-	-	.37+	-
Low Pleasure	-.38*	-.32+	-	.37+	.38*	-
Sadness	-	-	.34+	.34+	-	-
Smiling & Laughter	-	-.31+	-	.32+	-	-
CBQ Factors						
Surgency	-	-	-	-	-	.43*
Negative Affect	-	-	.31+	-	-	-
Effortful Control	-.37+	-	-	-	.34+	-

Note: n=20, one-tailed test of significance
+p < .10
**p < .05*

Conclusions

Approach/Anticipation at age 4½ mediated the relation between 8-month Soothability and 4½-year WMIC. In essence, an infant difficult to sooth at 8 months may be low on approach/anticipation behaviors at 4½ years and thus more likely to perform well on WMIC tasks involving controlled, inhibitory processing. This intriguing finding raises two questions. *First*, why would there be a negative association between approach/anticipation behaviors and WMIC performance in early childhood? The Approach/Anticipation scale of the CBQ includes items that attempt to capture the regulatory abilities of young children. It may be that these children who are low on Approach/Anticipation get just as enthusiastic about upcoming events, but they are able to focus their attentional and regulatory skills such that they are successful on the WMIC task (Davis et al., 2002).

Secondly, how could Approach/Anticipation mediate the relation between infant Soothability and preschool WMIC? In supporting infants during distress or fussiness, many parents attempt to soothe infants by distracting them with visual and other stimuli. This may aid in the development of attentional skills that later are key in relieving distress (Ruff & Rothbart, 1996). These attentional skills may also contribute to the attentional and regulatory abilities associated with the Anterior Attention System and later complex cognition, such as that required by WMIC tasks.

With this longitudinal investigation, we have made an initial attempt to integrate cognition and emotion using the construct of temperament. By focusing on attentional and regulatory behaviors, we have shown that it may be possible to predict early childhood cognitive abilities not from infant cognitive performance, but from infant temperament characteristics. Although the analyses were exploratory, these tentative findings suggest the value of early-learned regulatory and attentional behaviors and the impact of early skills on later development.

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