Associations between Temperament and Cognitive Processing during Infancy

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Introduction

Within a normal infant population there is the potential for individual differences in temperament and the brain activation associated with a particular temperamental style to interact with cognitive processing (Ruff & Rothbart, 1996). The brain/behavior system that has the capacity to tie together temperament and cognition is Posner's anterior attention system (Bush, Luu, & Posner, 2000), which begins to show some developmental changes in the 2nd six months of life (Rothbart, Derryberry, & Posner, 1994). This system focuses on the emotion (I.e., temperament)-attention and cognitive-attention functions of the anterior cingulate gyrus, which has many projections to the frontal cortex. In the developmental literature, EEG from frontal scalp locations is associated with individual differences in cognitive processing (e.g., Bell, 2001; Bell & Fox, 1992, 1997), as well as individual differences in temperament reactivity and regulation (e.g., Fox, Calkins, & Bell, 1994; Fox, Henderson, Rubin, Calkins, & Schmidt, 2001).

According to Rothbart's temperament model (Rothbart, Derryberry, & Posner, 1994), this anterior attention system begins to mature during the last half of the first year of life and is manifested in the infant's display of effortful control of behavior. Although there is much speculation in the infant literature that some relation exists between temperamental reactivity and cognitive processing (e.g., Fox, 1994; Rothbart, Posner, & Boylan, 1990; Ruff & Rothbart, 1996), few studies have been designed to explore these associations. The purpose of this study was to investigate the interrelations among temperament, cognition, and brain electrical activity during infancy.

Participants

Participants were 50 healthy, full-term, 8-month-old infants (28 male, 22 female) born to middle- and upper-middle-class parents. Infants were recruited from birth announcements parents placed in local newspapers. Complete data for all variables were available for 44 of the infants.

Methods

Infants were assessed on a spatial working memory (WM) task that also required the cognitive skill of inhibitory control. The anterior attention system is involved when there is a resolution of conflict between two forms of stored information. The choice of hiding locations in the infant WM task may represent this type of conflict (Posner & Rothbart, 1998). The variable of interest was % correct trials. K-means cluster analysis was used to place infants into high and low cognitive performance groups based on % correct trials.

	"original" correct	"reversal" correct
High cognitive (n=13)	59%	64%
Low cognitive (n=31)	37%	6%

EEG was recorded during baseline and during the WM task from 16 scalp locations equally distributed between anterior and posterior locations.

Temperament assessments included both maternal report (IBQ) and laboratory behavior (maternal separation).

EEG & WM Performance

Predicting Percentage of Correct Trials on WM Task from EEG Power Values (Stepwise Regression)

		R	B	R^2	R^2 change	sig. of R^2 change
1.	T6	.30	-.03	.09	.09	.05
2.	T6	.55	-.26	.30	.21	.001
	F4		.24			
3.	T6	.65	-.41	.43	.12	.006
	F4		.19			
	T4		.20			
4.	T6	.71	-.42	.51	.08	.018
	F4		.36			
	T4		.25			
	F3		-.20			

WM Performance & Temperament

Correlations---WM Performance and IBQ Scales

	Activity	Distress	Approach	Orient	Smile	Soothe
% Correct Trials (WM task)	.31 p=.04	.32 p=.04		.35 p=.02		.28 p=.07

	Activity	Distress	Approach	Orient	Smile	Soothe
Cry at Separation (latency)		-.33 p=.03				

Cognitive Performance Group Differences on IBQ Scales and Cry Latency at Maternal Separation (ANOVA results)

	High cognitive group (n=13)	Low cognitive group (n=31)	
Activity	5.10 (.16)	4.49 (.14)	p=.01
Distress	3.81 (.17)	3.31 (.12)	p=.03
Approach	3.11 (.21)	2.91 (.12)	*ns*
Orient	3.77 (.27)	3.27 (.15)	p=.10
Smile	5.19 (.25)	4.86 (.10)	*ns*
Soothe	5.11 (.24)	4.77 (.15)	*ns*
Cry latency	41.77 (7.2)	36.84 (4.4)	*ns*

Conclusions

Enhanced cognitive performance was linked not only with greater reported attention behaviors but also with higher distress and activity levels. Infants with high distress/activity may require more maternal interaction than infants with lower distress/activity. This may mean that these infants require more maternal support in the development of their attention skills, a result that could lead to enhanced cognitive skills as the infants get older. The addition of sustained attention tasks and temperament reactivity tasks, as well as multiple data collection points, would allow more systematic examination of these speculations.

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