

A Biopsychosocial Perspective on Infant Cognition and Emotion

(infancy as the foundation for later development)

Martha Ann Bell, PhD
Department of Psychology
Virginia Tech



Washington State University
Oct 18, 2018



2018-19 Lab Group:

Leslie Patton

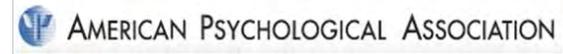
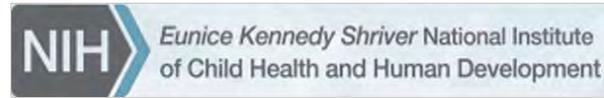
Tatiana Garcia-Meza

Alleyne Broomell (& Dominic!)

Ran Liu

*****Comment about research photos*****

Funding:



R01 HD049878

R03 HD043057

R03 HD057319

Former lab members:

Kimberly Cuevas – UConn

Tashauna Blankenship – Boston Univ

Anjolie Diaz – Ball State

Christy Wolfe – Bellarmine Univ

Collaborators:

Cindy Smith – VT

Jungmeen Kim-Spoon – VT

Kirby Deater-Deckard – UMass Amherst

Susan Calkins – UNC Greensboro

Masha Gartstein – WSU

Daniela Corbetta – Univ of Tennessee

Sherryl Goodman – Emory

Annie Bernier – Montreal



2018-19 Lab Group:

Leslie Patton

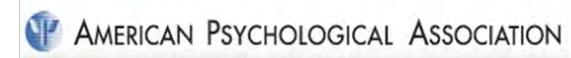
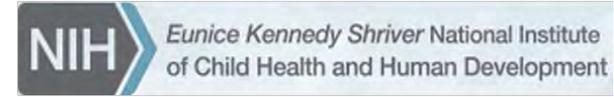
Tatiana Garcia-Meza

Alleyne Broomell (& Dominic!)

Ran Liu



Funding:



Former lab members:

Kimberly Cuevas – UConn

Tashauna Blankenship – Boston Univ

Anjolie Diaz – Ball State

Christy Wolfe – Bellarmine Univ

Collaborators:

Cindy Smith – VT

Jungmeen Kim-Spoon – VT

Kirby Deater-Deckard – UMass Amherst

Susan Calkins – UNC Greensboro

Masha Gartstein – WSU

Daniela Corbetta – Univ of Tennessee

Sherryl Goodman – Emory

Annie Bernier – Montreal

We focus on typical development

- global, representative patterns of change
- knowledge of typical development informs our understanding of atypical development
- wide ranging individual differences
- more than just describing behavior
- understand mechanisms that contribute to development
- how we think about development...



Biopsychosocial Perspective



1) Although we see some patterns.....cognition, emotion, and attention (behaviors, physiology) are complex, dynamic processes that are difficult to disentangle.

(Bell, 2015; adapted from the writings of Calkins, Lewkowicz, Lickliter, Michel & Moore)



8 mo



4 yr



8 yr

2) Attention, cognition, emotion, and temperament are connected and interrelated, but also part of a multilevel process of regulation. Each aspect of self-regulation has a different developmental pattern and each depends on different yet overlapping neural systems.



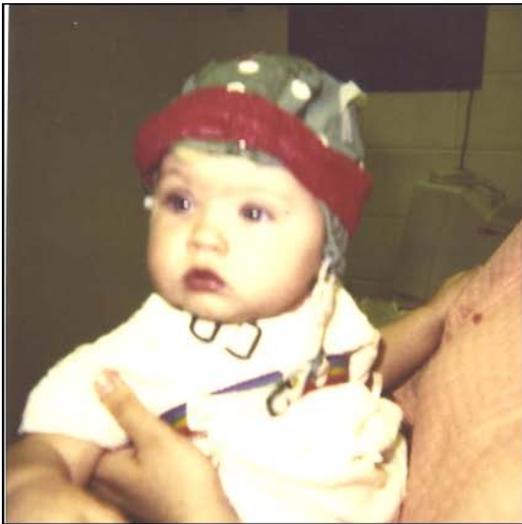
8 mo



4 yr



8 yr





3) Early development occurs in context. Early development is dyadic, so considering mother-infant interactions is critical for an informed view of early development.

Our measures

- child **behavior** → memory, attention, emotion
- mother-child interaction
- parent report



Neuroscience --- brain electrophysiology (EEG)

- efficient & relatively inexpensive
- can be recorded with little to no distress to the child
- signal is spontaneous but context-related
- temporal resolution on the order of milliseconds
- EEG power → excitability of groups of neurons
- EEG coherence → strength & number of synaptic connections



(Bell & Cuevas, 2012)

Longitudinal study with 7 data points:

- 5 & 10 months (healthy, full-term)
- 2, 3, & 4 years
- 6 & 9 years (during 2019 --- ages 13-16!)

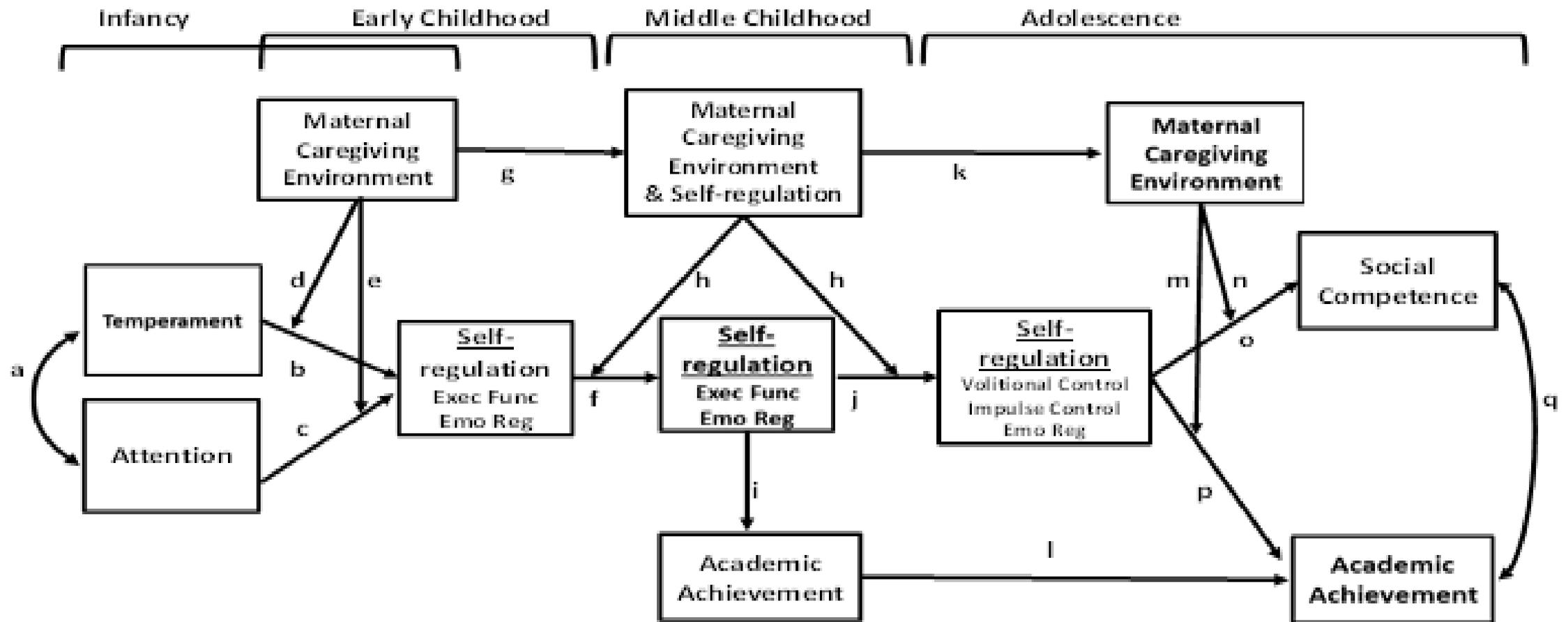
Began at 5 mo with $n = 410$; 2-site study

By age 4 we had $n = 318$

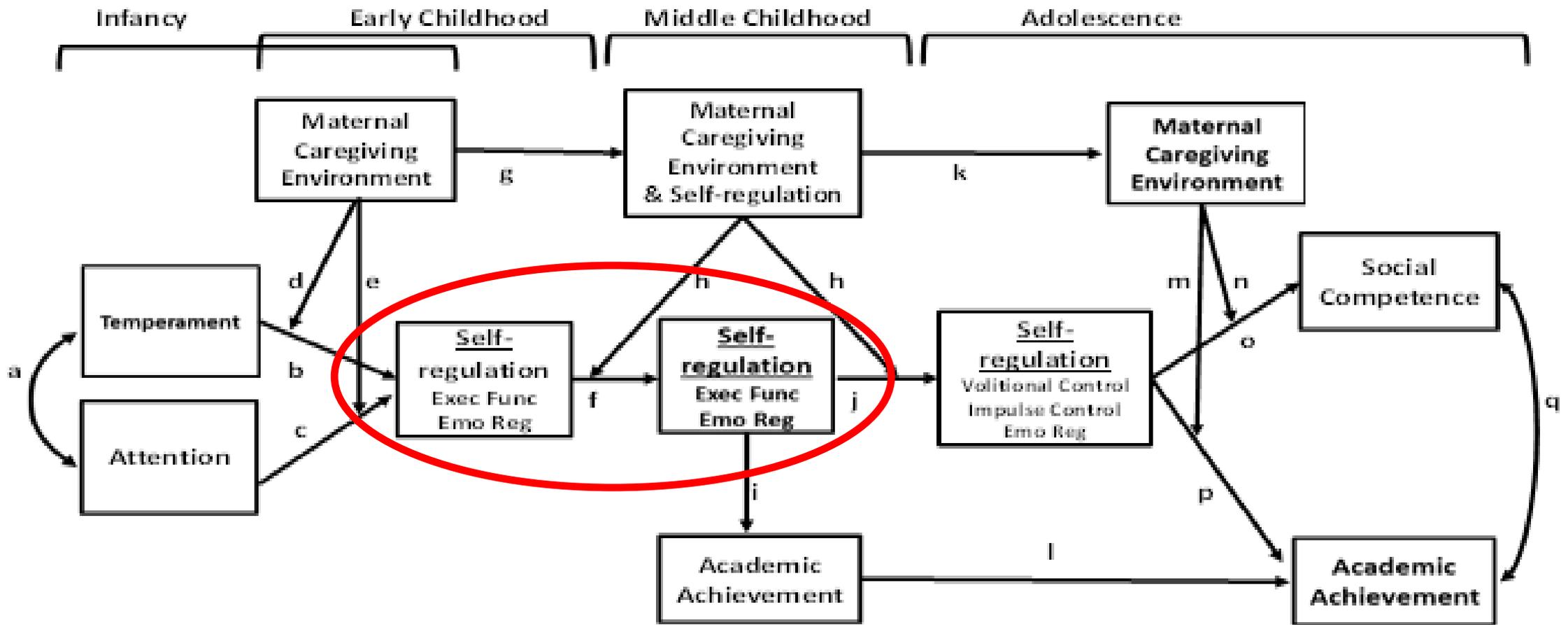
Recruited at age 6 to get back up to $n = 372$; age 9 we had $n = 341$

Diversity with respect to parent education level and parent/child race





The C.A.P. Study – “Psychobiology of Cognitive Development”



Examples of questions we pursue in our program of research

- 1) Is infant EEG related to concurrent cognitive development?
Later cognitive development?

Cognitive neuroscience perspective based on brain maturation and genetic blueprint (Diamond, 1990, 2013)

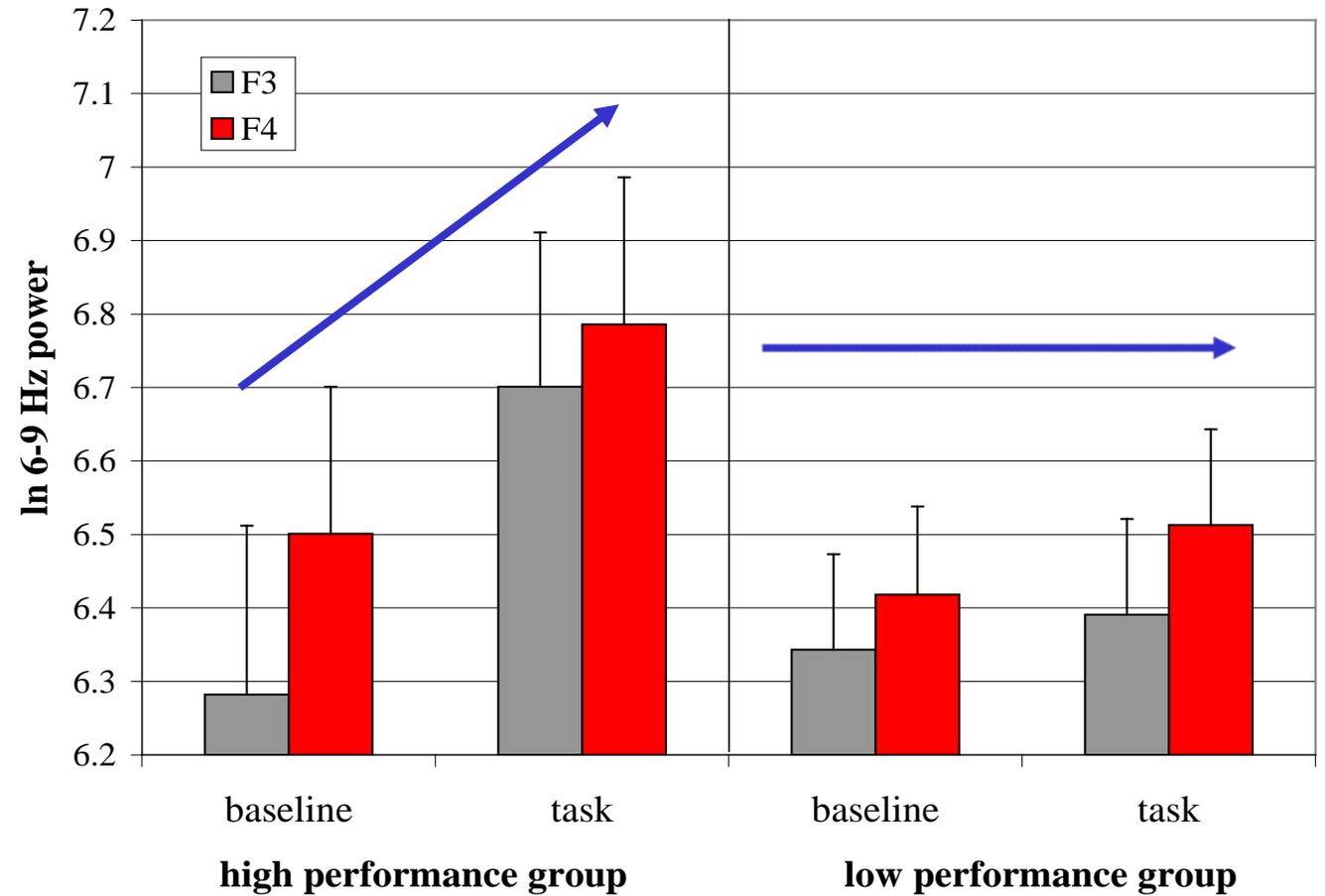
Roots in animal lesion studies (Diamond & Goldman-Rakic, 1989)

Roots in adult human brain damage studies (Posner's early work)



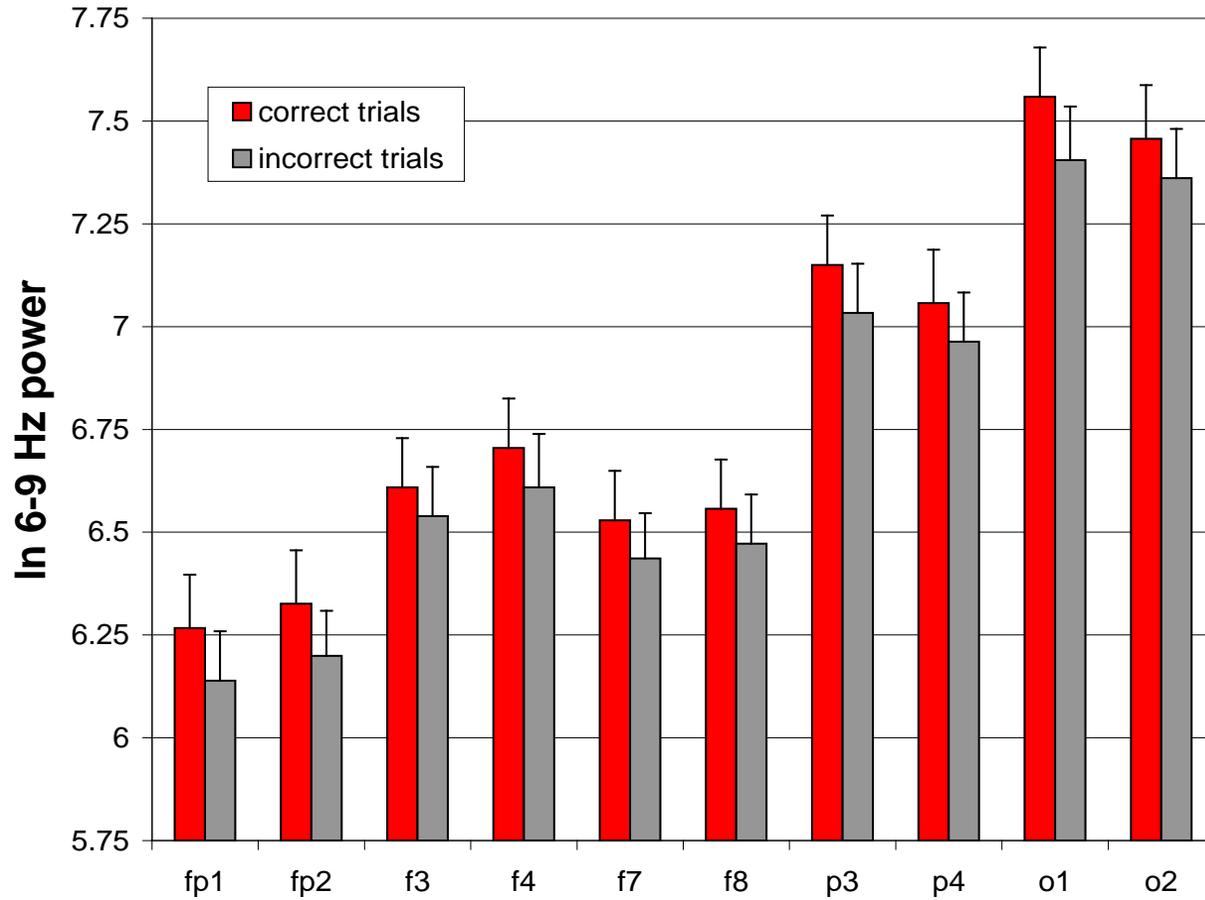
Margaret Whedon, MS
UNCG - HDFFS Grad Student

Are individual differences in task performance associated with different EEG patterns?



(Bell, 2001, *Infancy*)

Does the EEG distinguish between correct and incorrect responses?



(Bell, 2002, *Psychophysiology*)

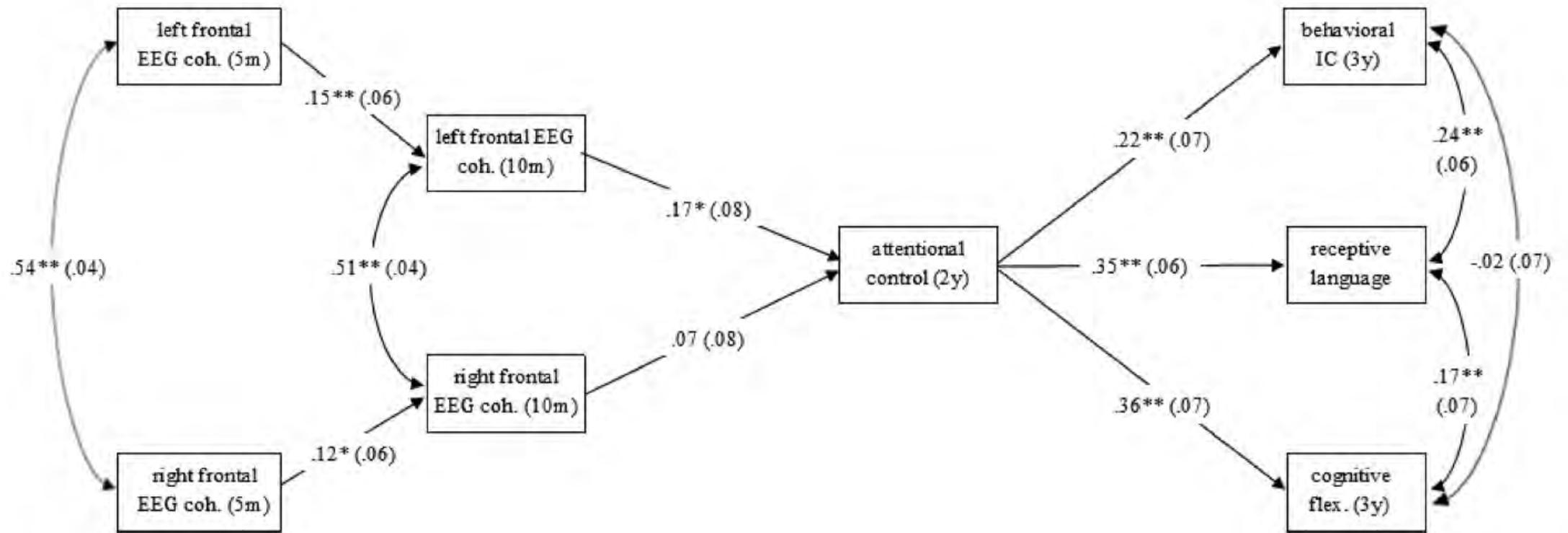
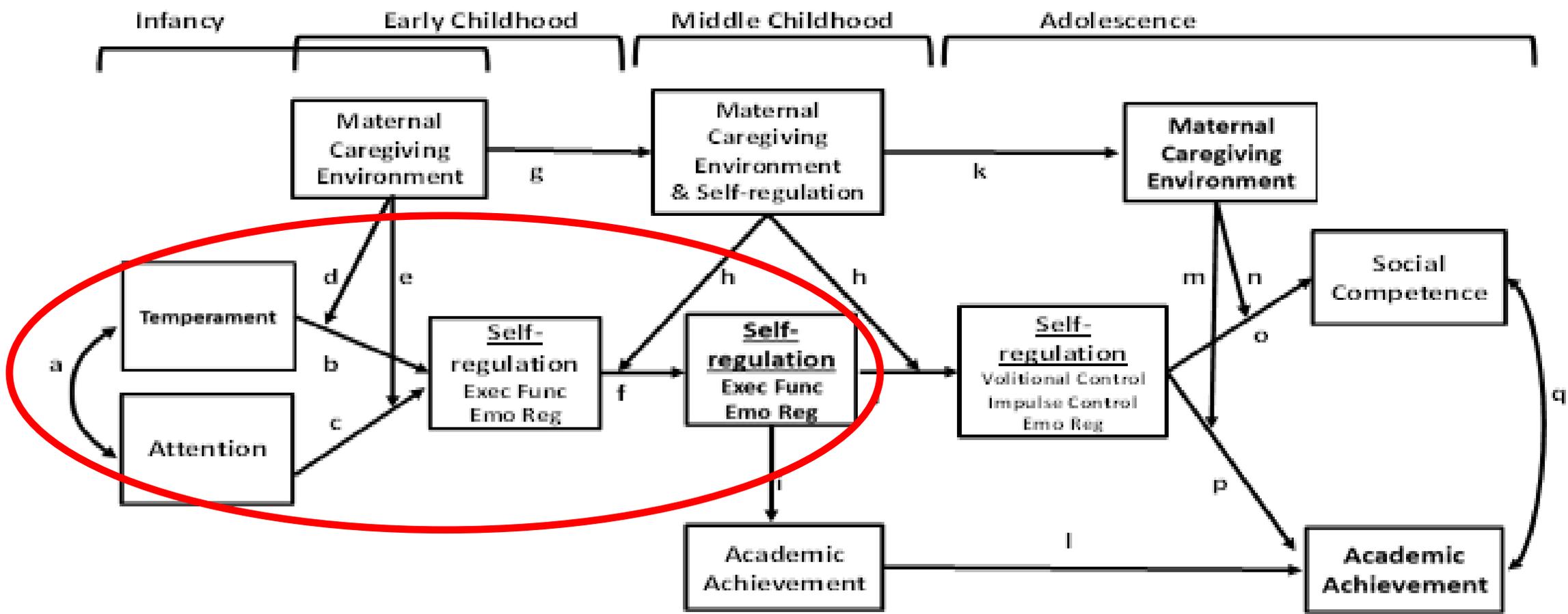


Figure 2. Standardized estimates for the model predicting 2-year attentional control (AC) and 3-year cognitive flexibility, receptive language, and behavioral inhibitory control (IC). * $p < .05$; ** $p \leq .01$.

(Whedon, Calkins, Perry, & Bell, 2016, *Dev Psyc*)



2a) Is EEG recorded during infancy related to varying levels of behavior problems in toddlerhood?

Rothbart (1989; Rothbart, Derryberry, & Posner, 1994; Rothbart & Bates 2006)) model of temperament based reactivity and regulation

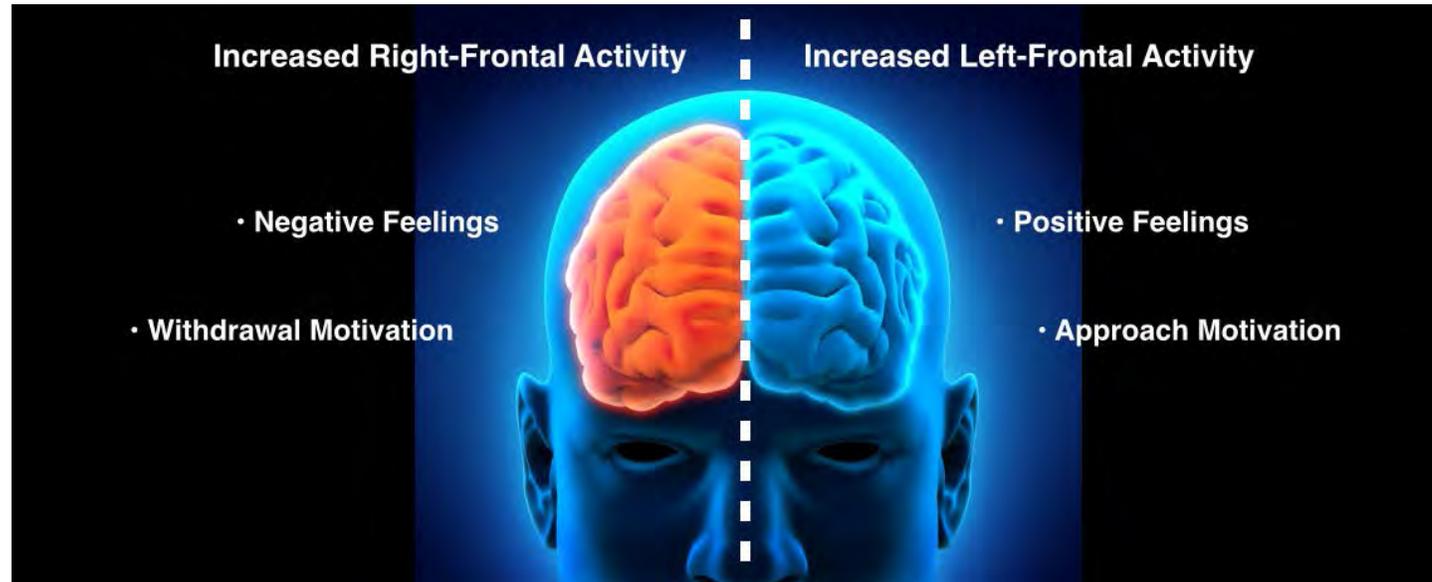
Fox (1991, 1994) model of frontal asymmetry of emotion regulation (approach / withdrawal); early marker for later regulation skills



Cindy Smith, PhD
VT - HDFS

Frontal EEG Asymmetry

Amount of EEG activity (i.e., power) in one hemisphere relative to the other hemisphere ($EEG\ power\ right\ hemi - EEG\ power\ left\ hemi = asymmetry$)



Baseline frontal EEG asymmetry - trait measure

Task-related frontal EEG asymmetry - state measure

10 mo & 24 mo frontal EEG asymmetry → 30 mo CBCL

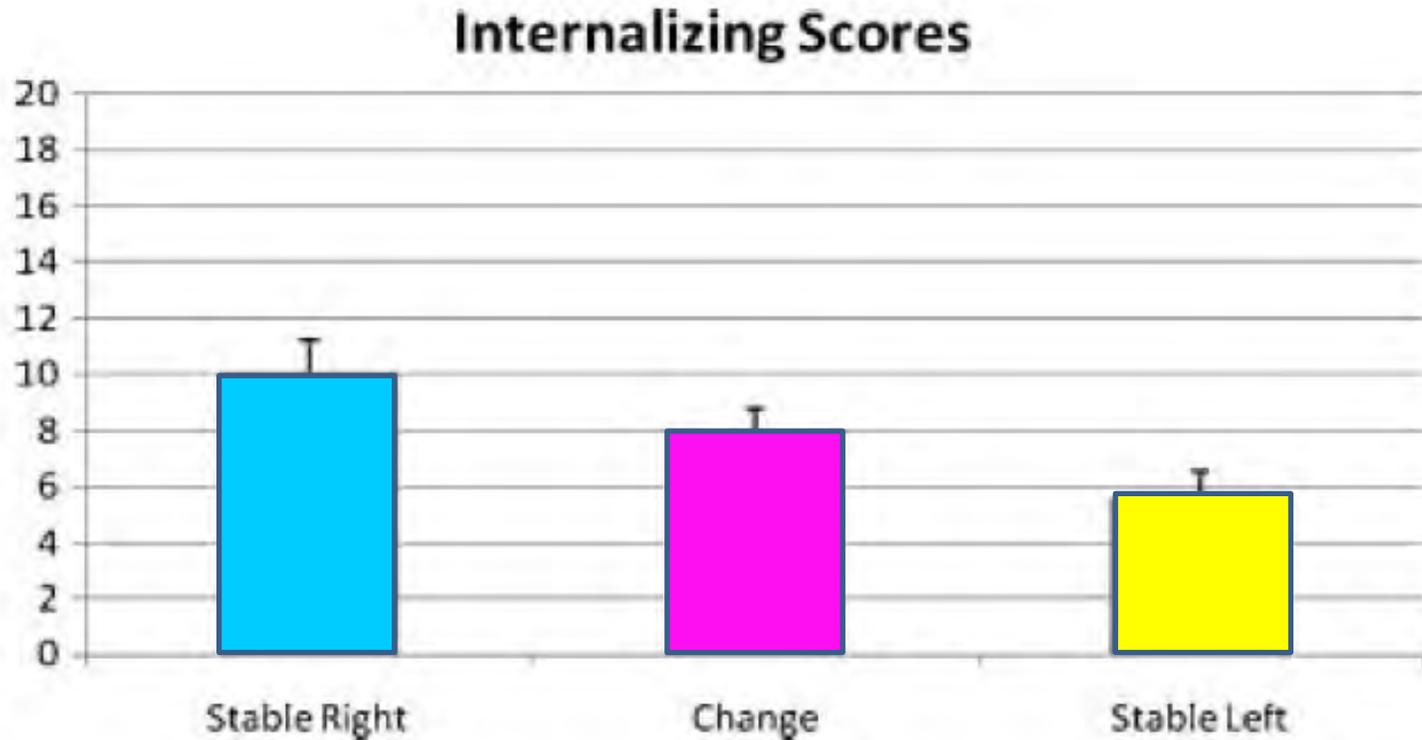


FIGURE 2 Mean differences in internalizing scores for the three frontal asymmetry groups, controlling for externalizing scores, child age, and child sex.

(Smith & Bell, 2010, *Dev Psychobio*)

10 mo & 24 mo frontal EEG asymmetry → 30 mo CBCL

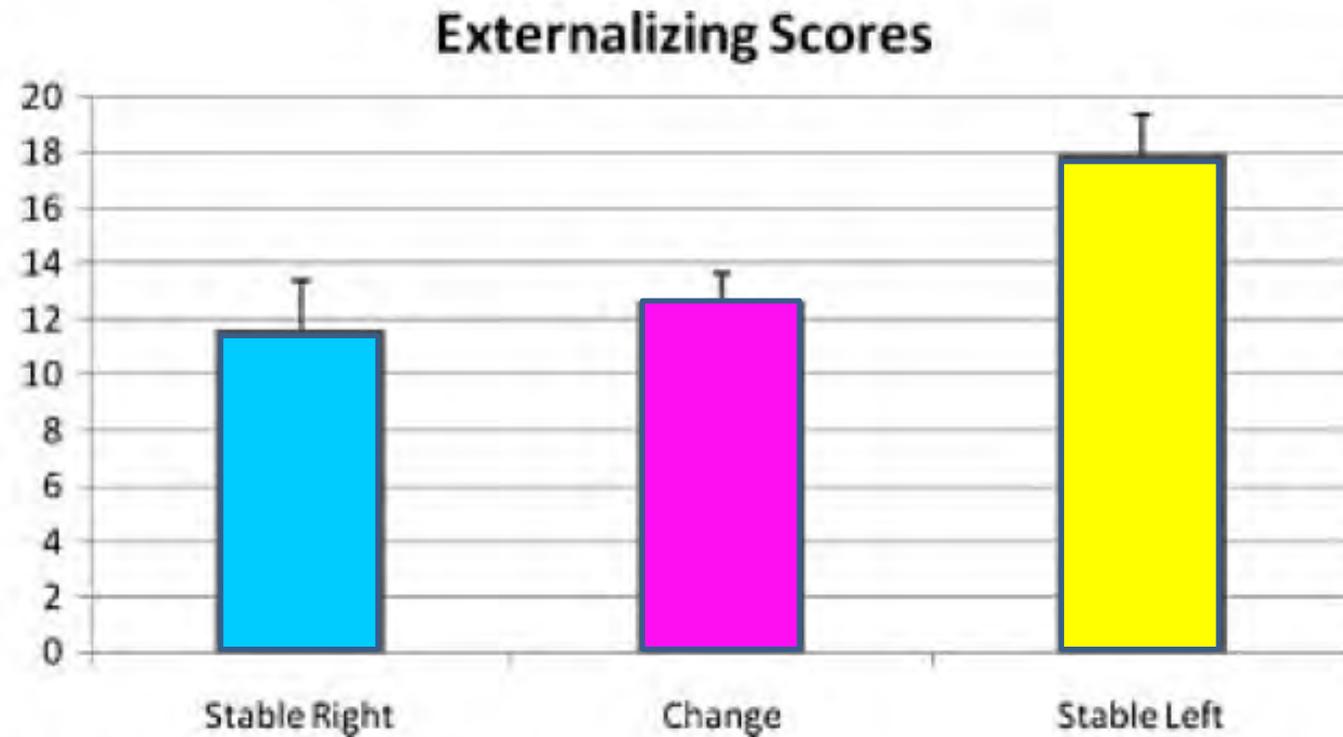


FIGURE 3 Mean differences in externalizing scores for the three frontal asymmetry groups, controlling for internalizing scores, child age, and child sex.

2b) Does task-related frontal EEG asymmetry vary by infant temperament and sex?

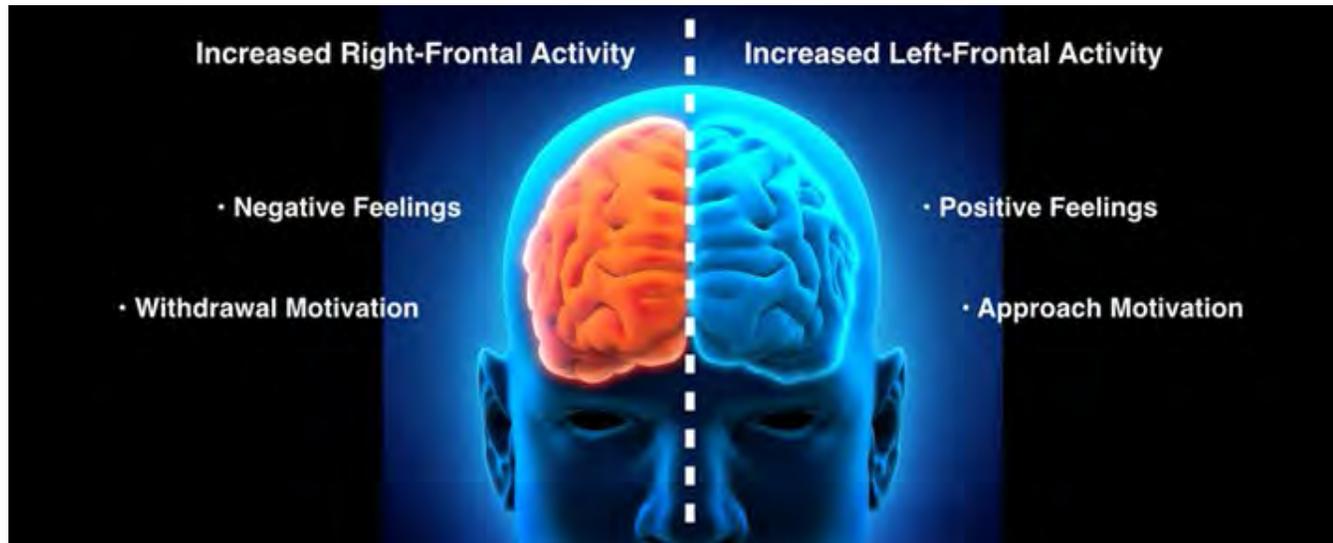
Fox (1994) approach / withdrawal model

Rothbart (2011; Gartstein & Rothbart, 2003) model of temperament reactivity and self-regulation

Sex as potential marker for sex-linked distinctions in physiological processes; and thus mechanism for early vulnerability boys for externalizing behavior Problems (Crick & Zahn-Waxler, 2003; Martel et al., 2009)



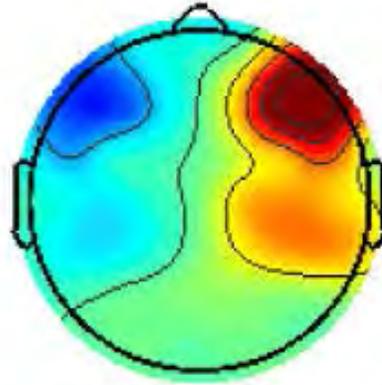
Masha Gartstein, PhD
WSU - Psyc



Method

5 mo IBQ-r – NE, PAS, ORC

10 mo frontal EEG asymmetry – baseline, arm restraint (mothers)



J.J.B. Allen website
Univ of Arizona

Results

Boys --- higher PAS at 5 mo → greater right frontal asymmetry during arm restraint at 10 mo

Girls --- higher ORC at 5 mo → greater right frontal asymmetry during arm restraint at 10 mo

Early indicator of gender differences in symptoms/behavior problems observed in childhood?

(Gartstein, Bell, & Calkins, 2014, *Dev Psychobio*)

3a) Could we potentially use infant EEG as a biomarker of later developing ADHD?

(or infant behavior as a predictor of later developing ADHD?)

Johnson, Gliga, Jones, & Charman. (2015).
Annual research review: Infant development
Autism, and ADHD – early pathways to
emerging disorders. *JCPP*.



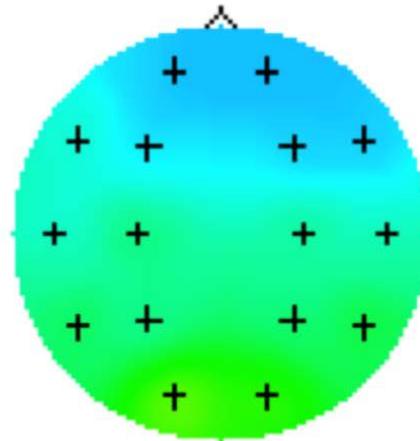
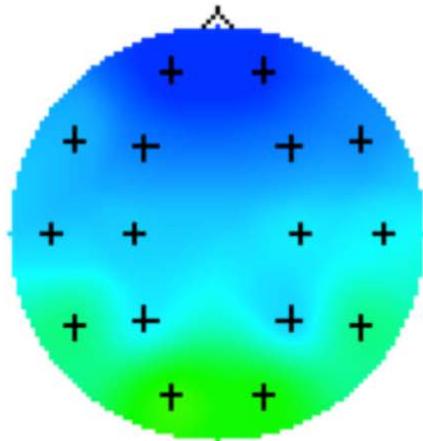
Cassondra Eng
Carnegie Mellon – Psyc grad student

EEG Power

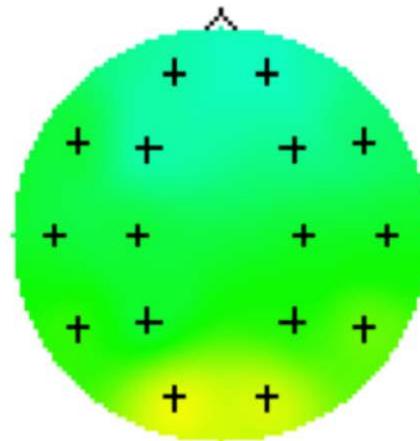
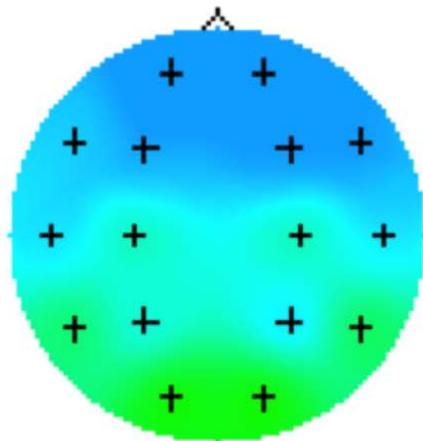
AD/HD

No AD/HD

A



B



4.02 μv



1.5 μv

A = baseline
B = task

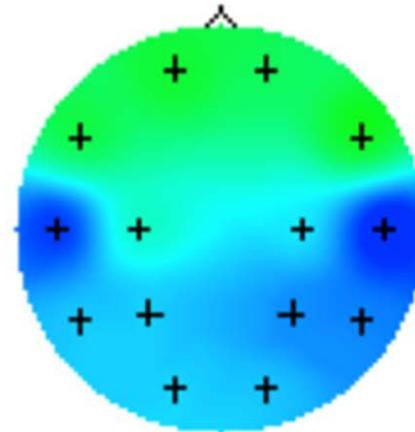
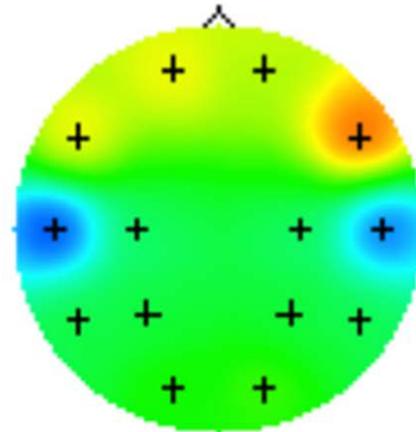
(Eng, Patton, Calkins, & Bell, in prep)

EEG Coherence

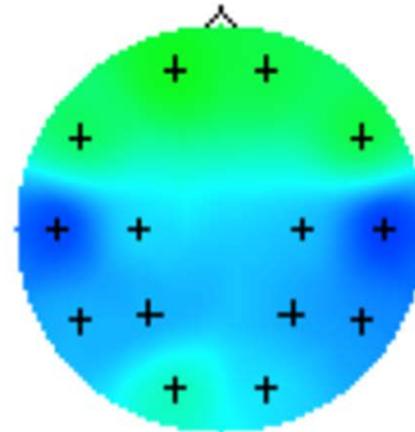
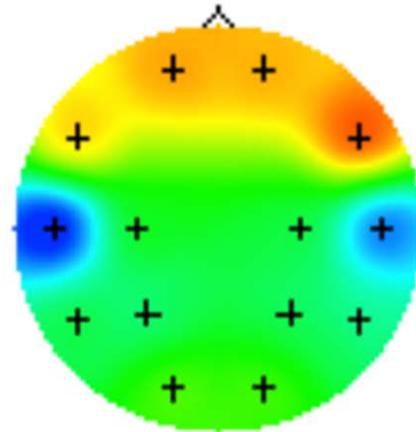
AD/HD

No AD/HD

A



B



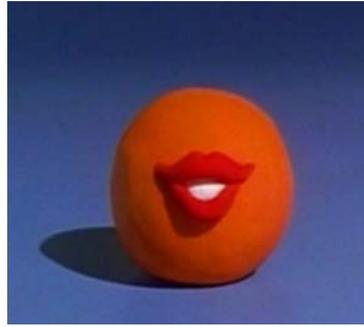
0.735 coh



0.095 coh

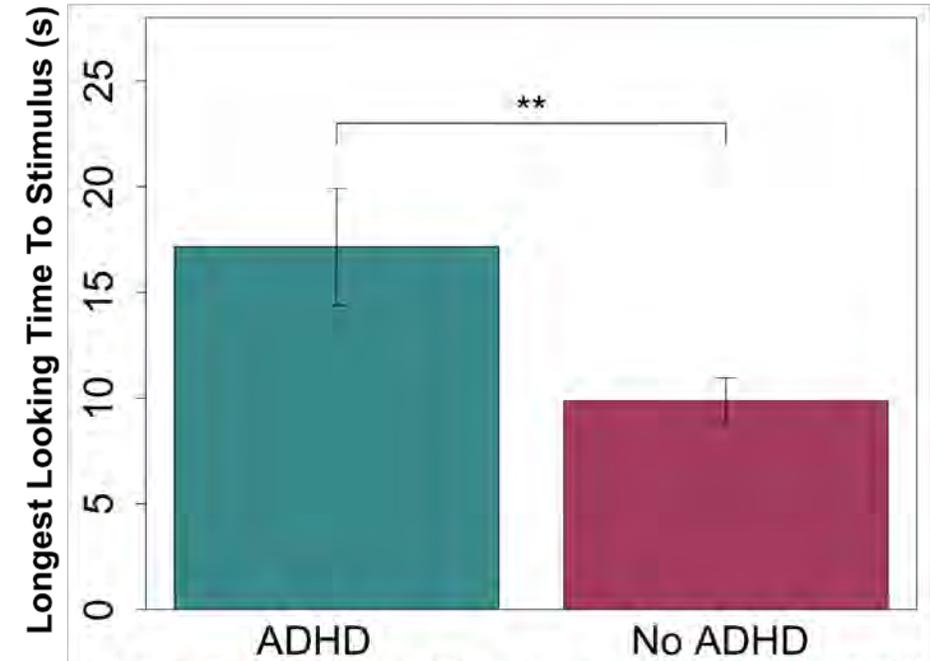
A = baseline

B = task



Results

Behavioral Differences in Attention



The later diagnosed AD/HD group at 5-months exhibited longer looking times compared to the control group.

3b) Could we potentially use infant EEG as a biomarker of difficulties with social responsiveness?

Neuroconnectivity as a biomarker, but what is the mechanism?

Fronto-temporal connectivity & the “mentalizing” network
(Happé & Frith, 2014)

Inhibition, self-regulation, and later social outcomes
(Diamond, 2013)



Alleyne Broomell, MS
Graduate Student

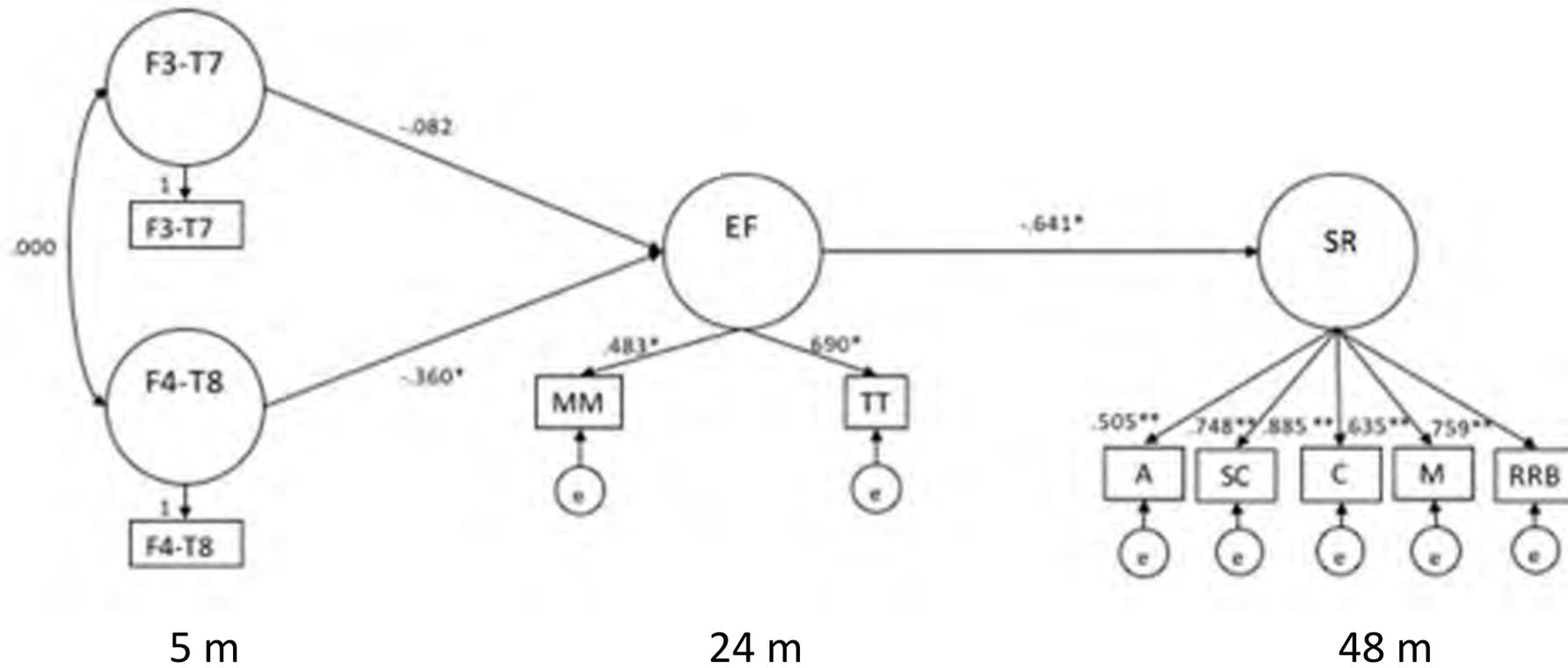
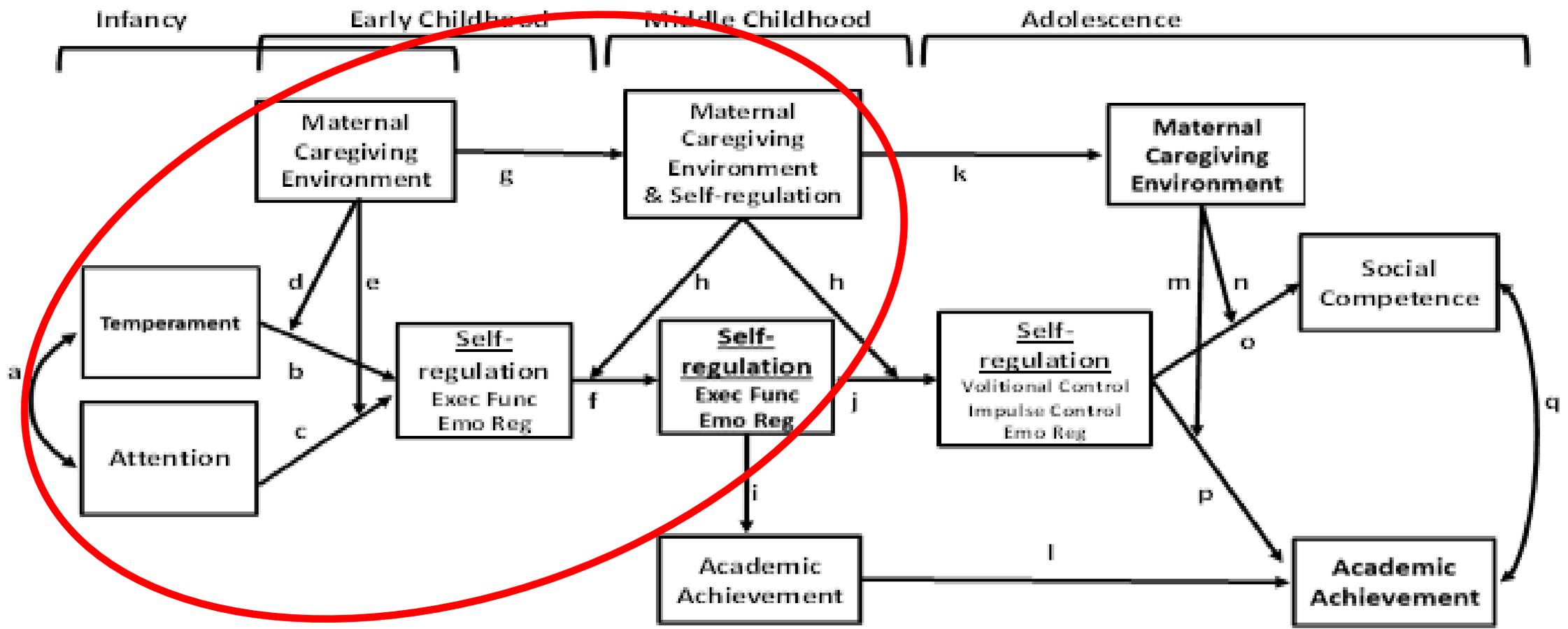


Figure 1. *Full Structural Model with Standardized Values*

For SRS, lower scores indicate greater social responsiveness

(Broomell, Savla, & Bell, in press, *Infancy*)



4) Do maternal caregiving and maternal cognition predict child cognitive development?

Much research on maladaptive parenting and risk for poor child cognitive outcomes (Hughes, 2011)

Supportive, nurturing maternal behaviors predict positive socio-emotional outcomes (Thompson, 1998)

Maternal scaffolding linked with better child cognition (Bernier et al., 2010)

Maternal EF linked with better maternal parenting (Deater-Deckard et al., 2012)



Kimberly Cuevas, PhD
UConn- Psyc

Table 7.

Results of Hierarchical Regression Analysis Predicting Child EF (A Composite of 24, 36, and 48-Month Assessments) From Maternal Education, Maternal EF, and Maternal Caregiving.

	<i>R</i>	<i>R</i> ²	<i>R</i> ² Δ	<i>F</i> Δ	<i>F</i>	β	<i>t</i>	<i>sr</i>	<i>sr</i> ²
<i>Dependent variable: Child EF Composite (24, 36, 48 months; controlling for verbal ability at each age)</i>									
<i>Step 1</i>	.25	.06			3.86				
Maternal Education						.25	1.96*	.25	.06
<i>Step 2</i>	.53	.29	.23	9.12***	7.72***				
Maternal Education						.16	1.38	.15	.02
Maternal EF						.38	3.35***	.37	.14
Maternal Caregiving Composite (10, 24 months)						-.24	-2.01*	-.22	.05

Note: One-tailed *p*-values for *t*-tests and two-tailed *p*-values for *F*-tests. ****p* ≤ .001; **p* ≤ .05. *n* = 62.

Note: “caregiving” = composite of intrusiveness, negative affect, physical stimulation, lack of sensitivity

(Cuevas, Deater-Deckard, Km-Spoon, Watson, Morasch, & Bell, 2014, *Dev Sci*)

5) If maternal caregiving is related to child cognitive development, is maternal caregiving also related to child EEG development?
(Is that the mechanism?)

Experience-dependent influences on brain development in rats (Greenough, Black & Wallace, 1987)

Maltreatment literature and detrimental effects on brain development (Curtis & Cicchetti, 2007)

“Enrichment” for institutionalized children (BEIP: Marshall, Reeb, Fox, Nelson, & Zeanah, 2008)



Margaret Swingler, PhD
Univ of North Carolina – FPG CDI



Annie Bernier, PhD
Univ of Montreal – Psyc

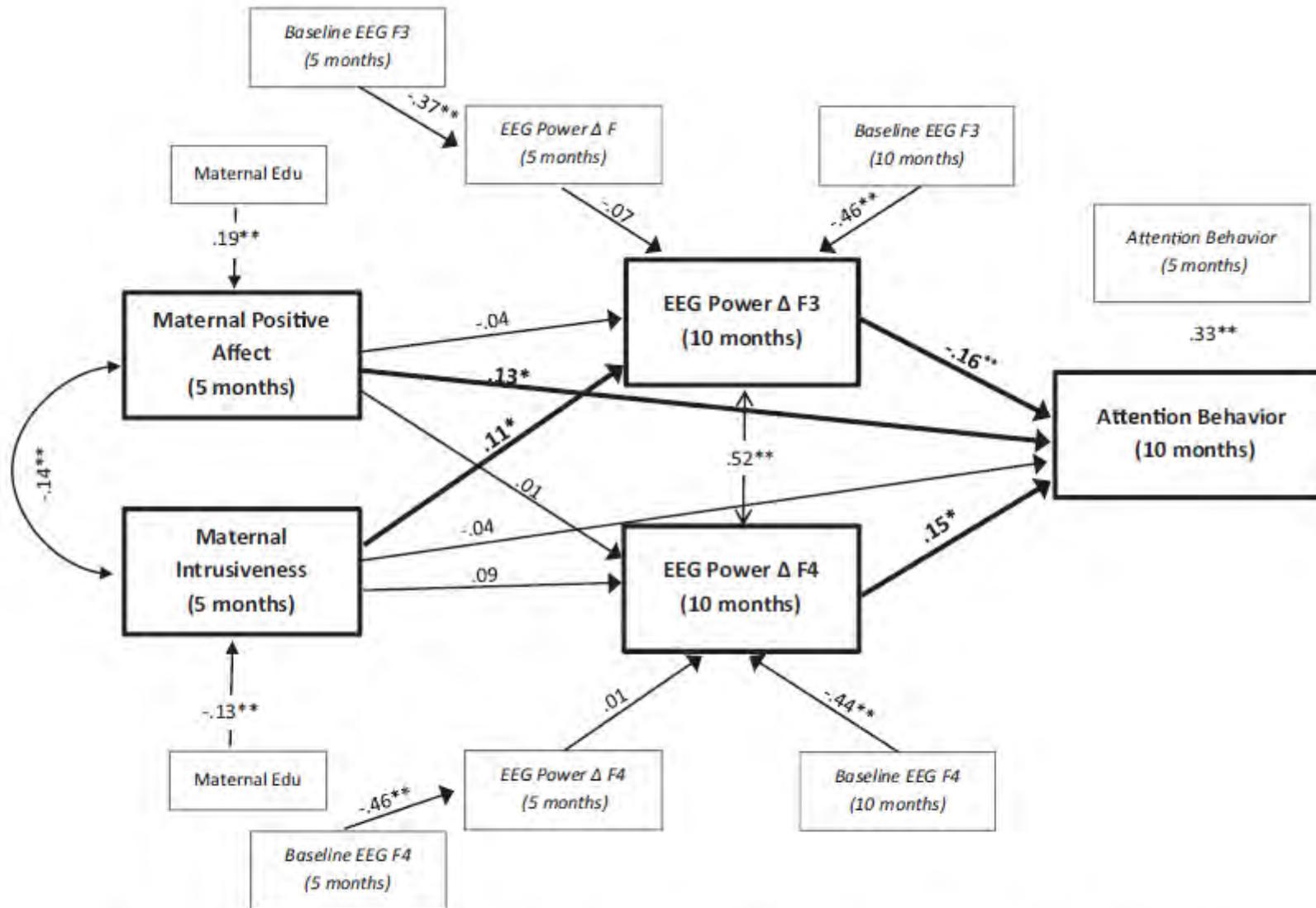


Figure 1. Standardized estimates for the indirect effects model predicting 10-month attention behavior. Italicized wording delineates variables included for the purposes of controlling for previous levels. Bold pathway delineates significant associations among primary variables of interest. * $p < .05$. ** $p \leq .01$.

(Swingler, Perry, Calkins, & Bell, 2016, *Dev Psyc*)

Table 4

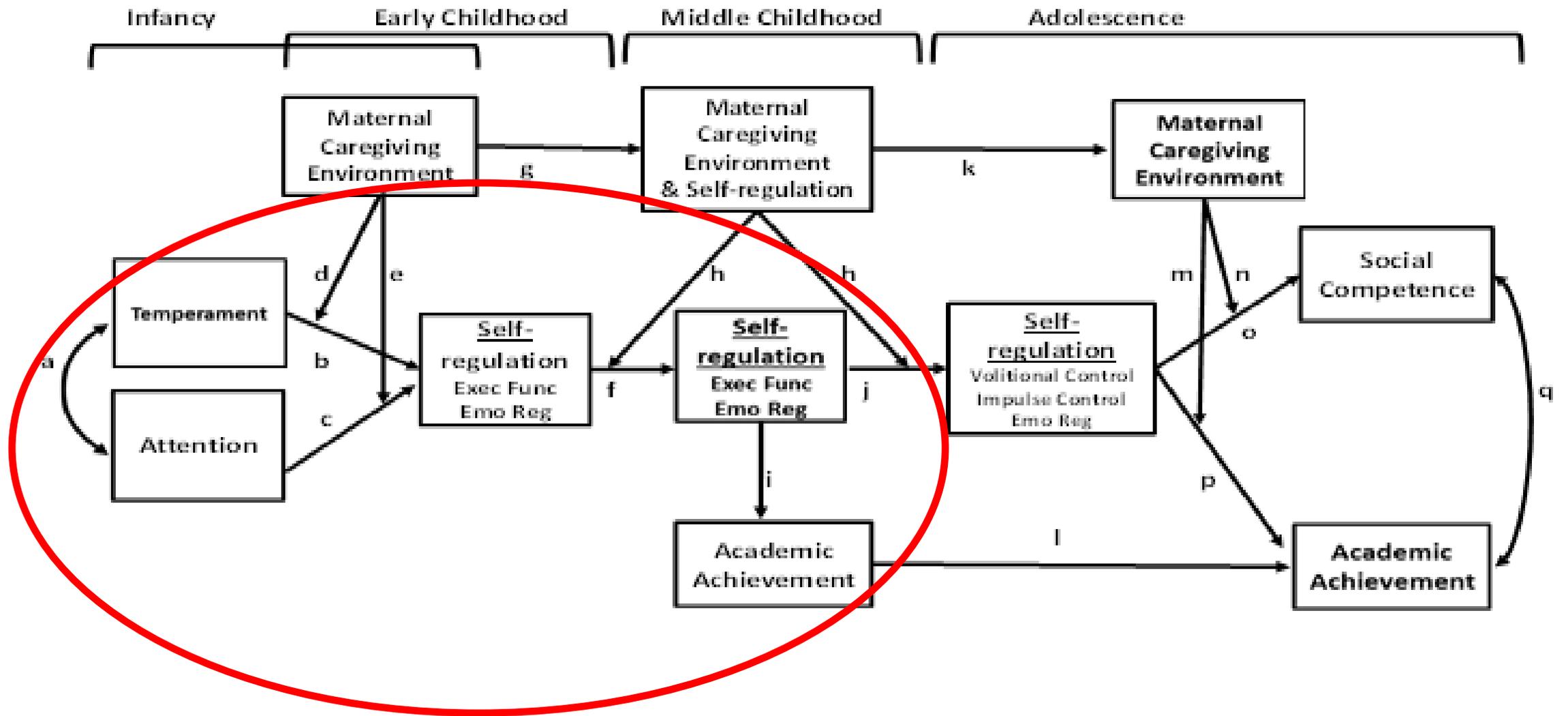
Summary of regression analyses predicting 24-month alpha (6-9 Hz) EEG power

Block	R ²	ΔR ²	F change	β when first entered	β in final model
<u>Predicting F3/F4 resting power</u>					
1. Covariates	.012	---	0.83		
Maternal age				.02	.01
Maternal education				.09	.10
Infant sex				.05	-.02
2. 10-month F3/F4 power	.099	.087	19.23***	.30***	.28***
3. Maternal behavior	.131	.032	7.40**	.18**	.18**
<u>Predicting F7/F8 resting power</u>					
1. Covariates	.026	---	1.76		
Maternal age				-.02	.01
Maternal education				.15 ^t	.11
Infant sex				.07	-.03
2. 10-month F7/F8 power	.179	.153	37.16***	.40***	.35**
3. Maternal behavior	.214	.035	8.71**	.20**	.20**

Note. $N = 197$

^t $p < .10$; ** $p < .01$; *** $p < .001$

(Bernier, Calkins, & Bell, 2016, *Child Dev*)



6a) What about academic achievement? infant/toddler temperament

Temperament influences outcomes by affecting within-individual cognitive and personality characteristics and thus shaping individual experiences (Rothbart, Ahadi & Evans, 2000)

Thus, children with different temperaments will have distinct school experiences and academic outcomes (Rothbart & Jones, 1998)

Negative affect may adversely affect academic performance (Valiente, Lemery-Chalfant, & Swanson, 2010; Zhou, Main, & Wang, 2010)

Reported effects vary from direct to indirect; thus best to use longitudinal methods and mediational models; consideration of executive function (Christianson, 2014)



Ran Liu, MS
Graduate Student

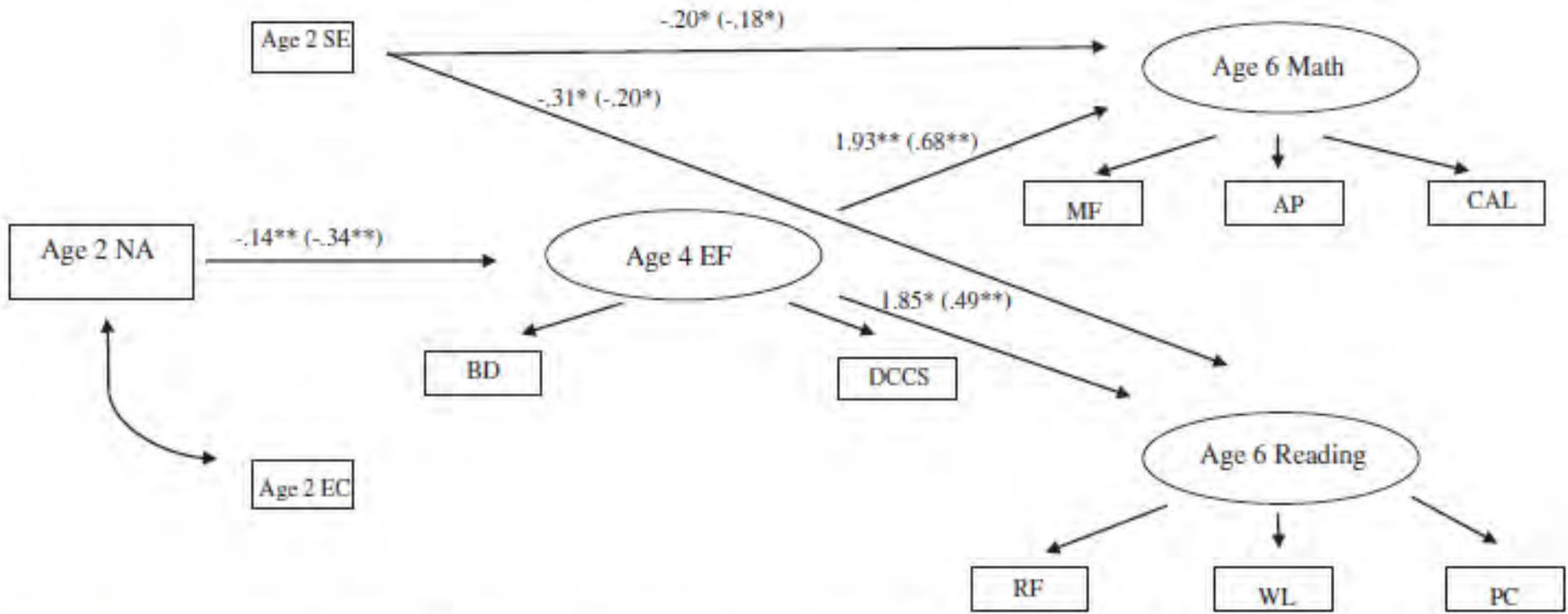


Figure 2. Structural equation model describing that age 2 NA indirectly predicts age 6 math and reading achievement through age 4 EF, controlling for age 2 SE and EC. Only significant paths are shown. Numbers represent unstandardized path coefficients (inside parentheses are standardized path coefficients). NA = negative affectivity; SE = surgency/extroversion; EC = effortful control; EF = executive function; BD = Bear/Dragon Task; DCCS = Dimensional Change Card Sort; MF = math fluency; AP = applied problems; CAL = calculation; RF = reading fluency; WL = word-letter identification; PC = passage comprehension.

* $p < .05$. ** $p < .01$.

(Liu, Blankenship, Broomell, Garcia-Meza, Calkins, & Bell, 2018, *EE&D*)

6b) What about academic achievement? infant cognitive foundations

Infancy as a foundation for later development (Bornstein, 2014)

Infant attention predicts later executive functioning (Colombo & Cheatham, 2006; Cuevas & Bell, 2014; Rose, Feldman, & Jankowski, 2012)

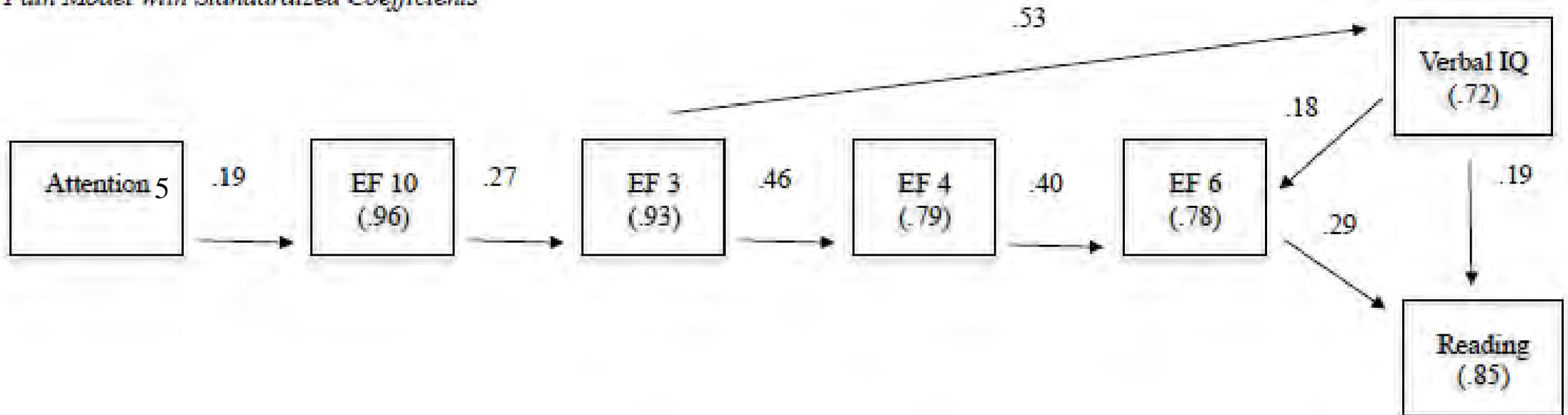
Early infant attention as foundation of self-regulation (Posner & Rothbart, 2007)

Early childhood executive function predicts academic performance in reading (Arrington et al., 2014)

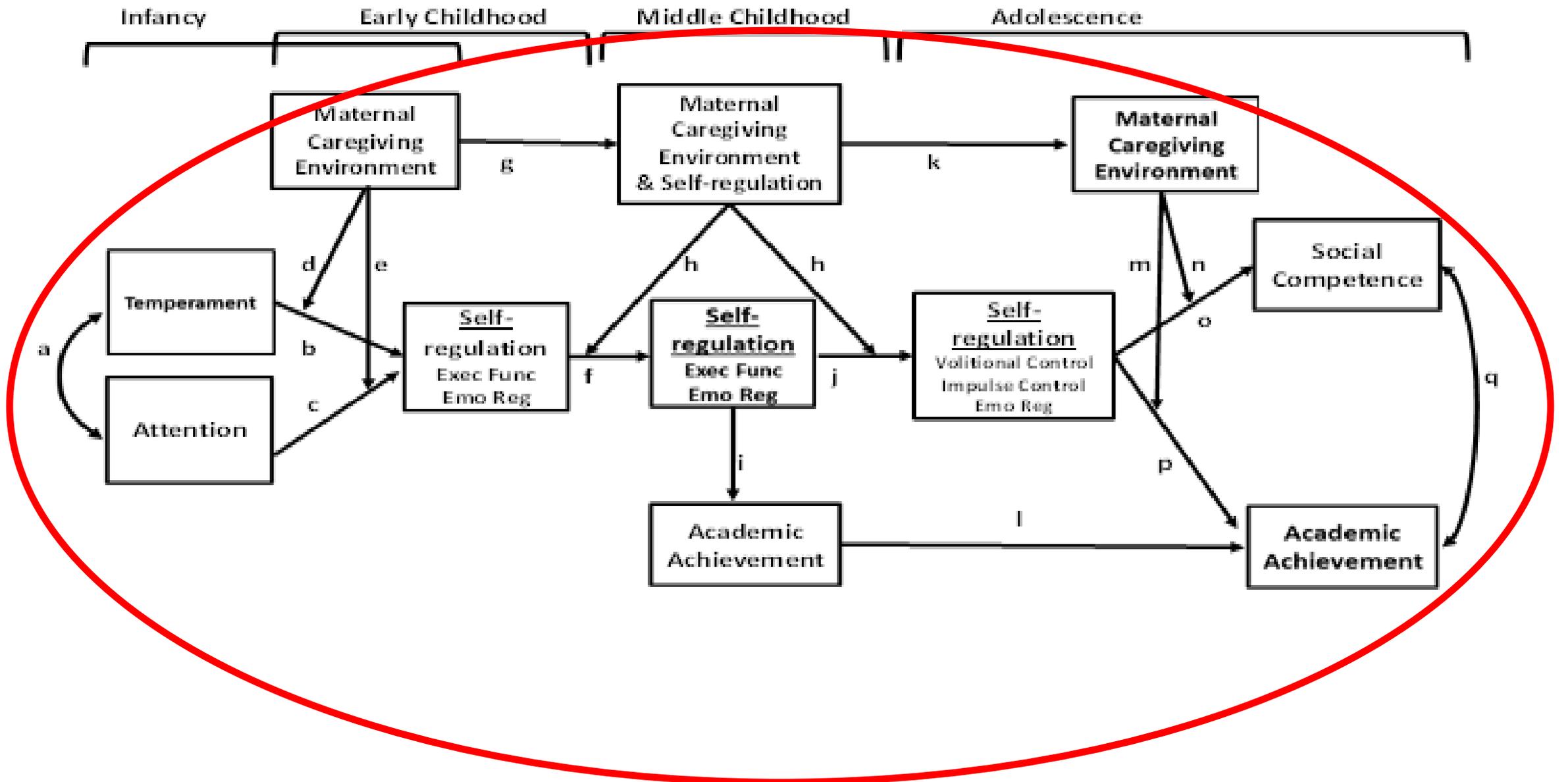


Tashauna Blankenship, PhD
Boston University – Psyc, Postdoc

Figure 2.
Path Model with Standardized Coefficients



(Blankenship, Slough, Calkins, Deater-Deckard, & Bell, revise/resubmit, *Dev Science*)



Development is:

- complex and dynamic
- connected and multilevel
- context

The study of developmental issues requires:

- multi method approach
- appreciation of what each method can and cannot tell us

Research on human behavior leads to:

- the potential to indirectly affect the lives of children and families by adding to our basic science knowledge about children's development