

# Harsh parenting relates to increased error-related brain activity in children

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# Disclosures

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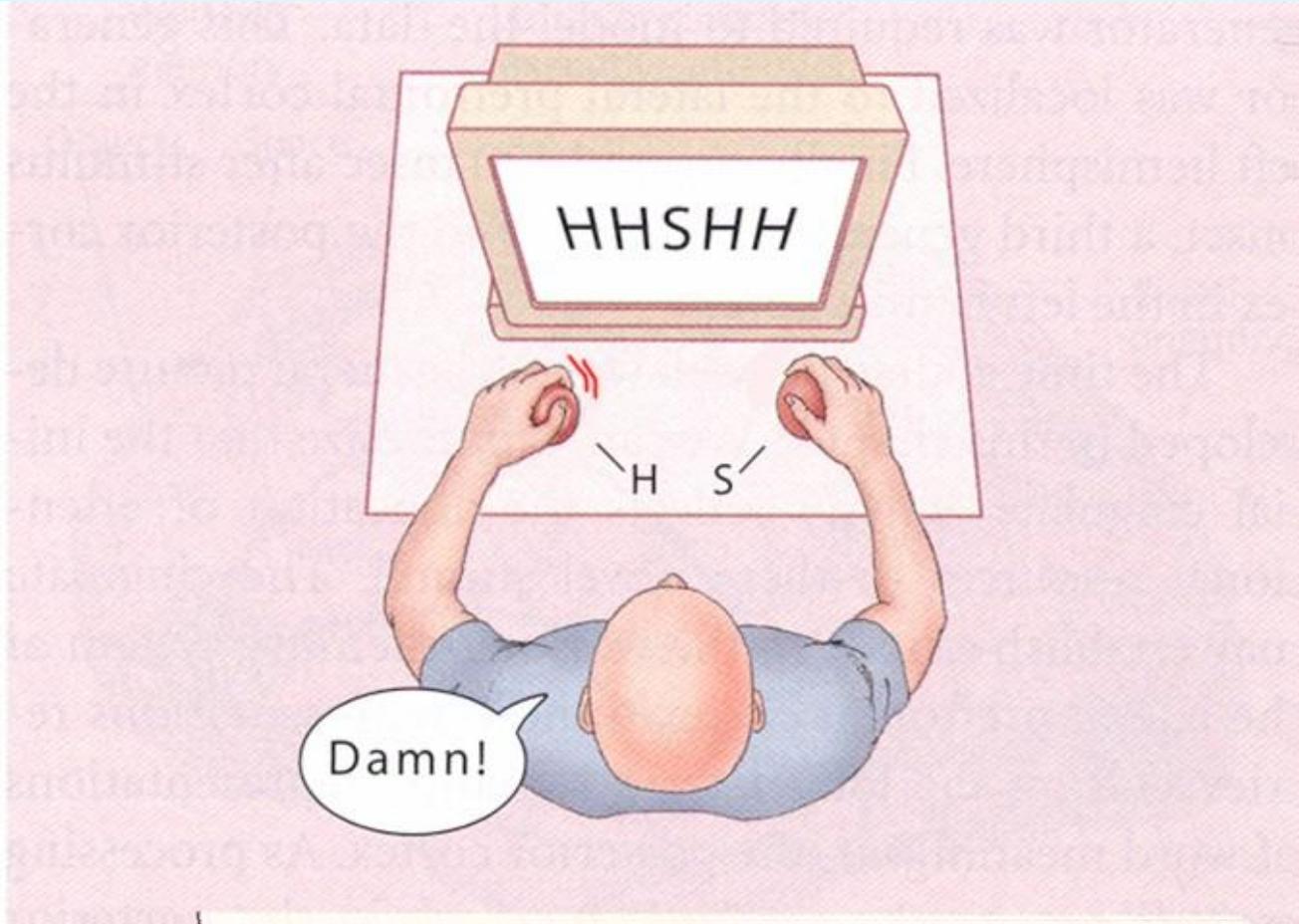
*Psychophysiology*

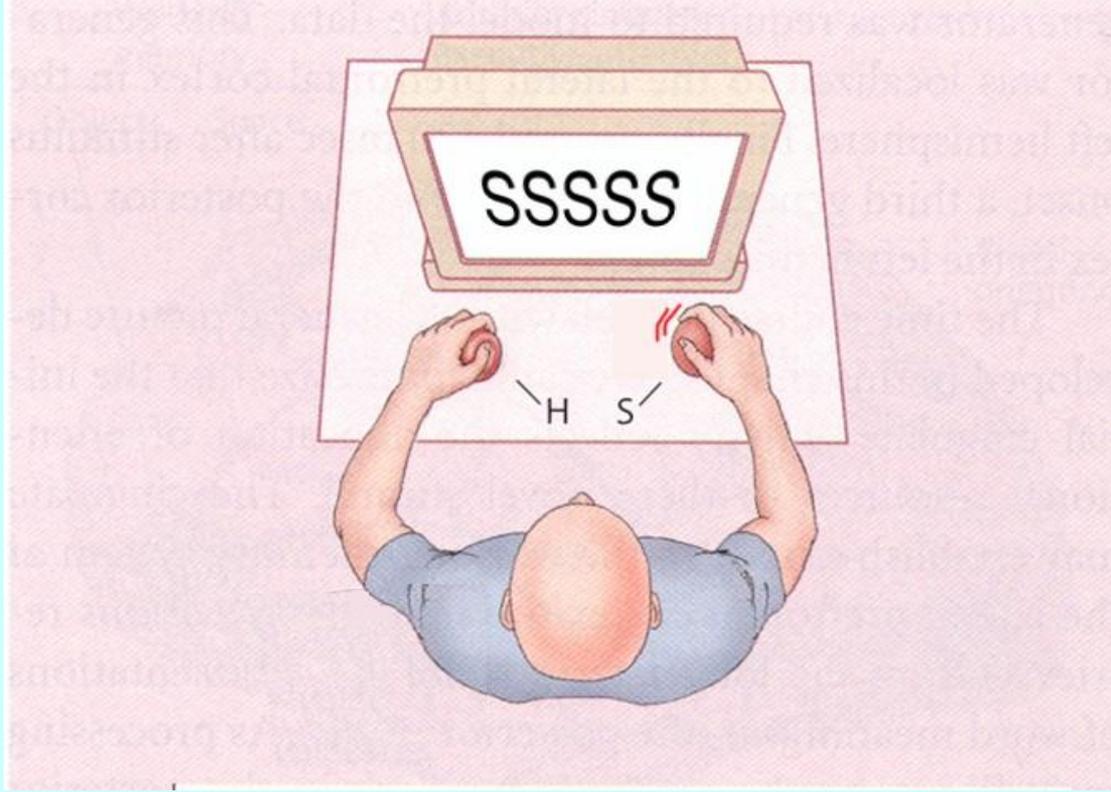
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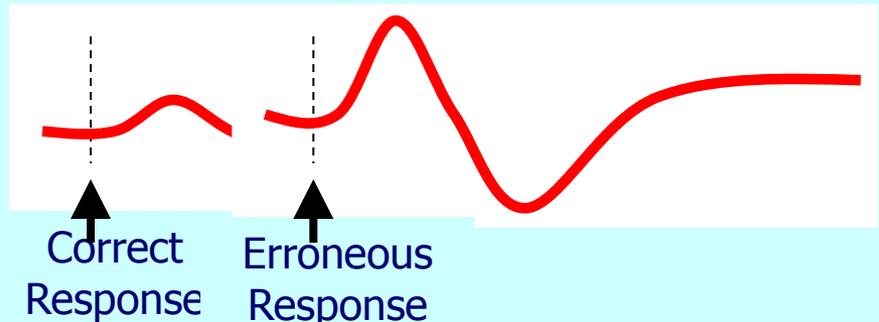
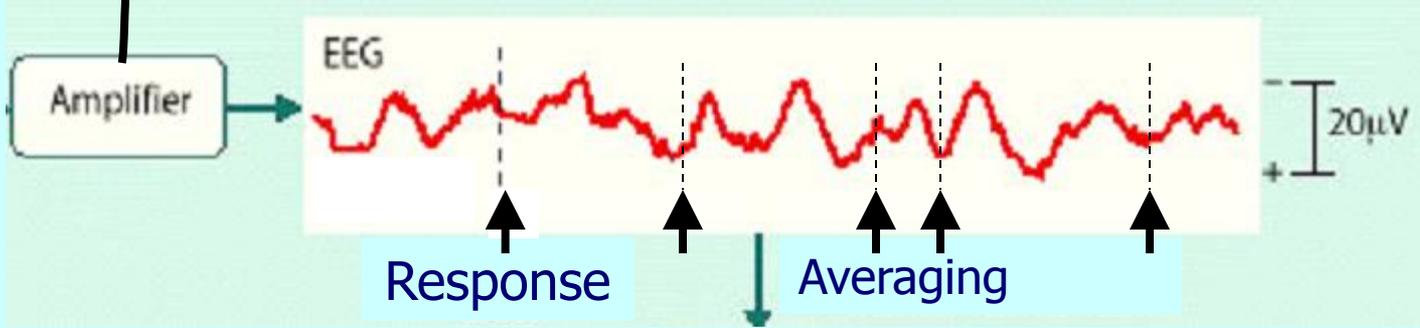
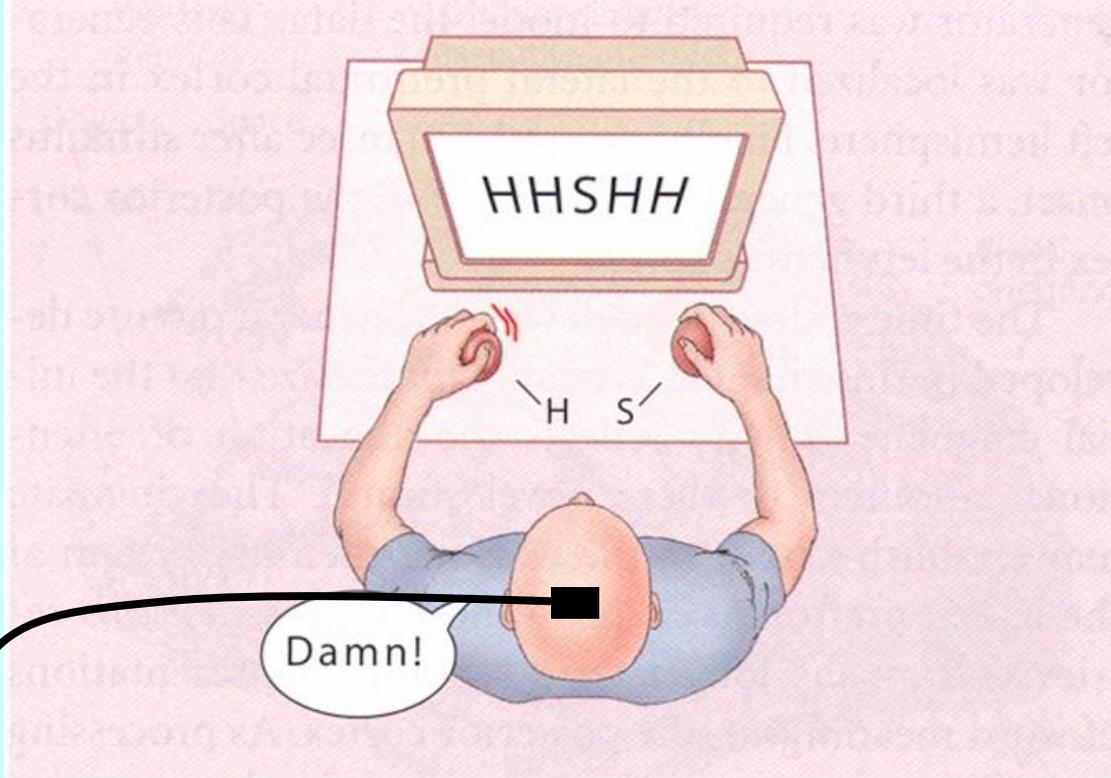
# Anxiety disorders

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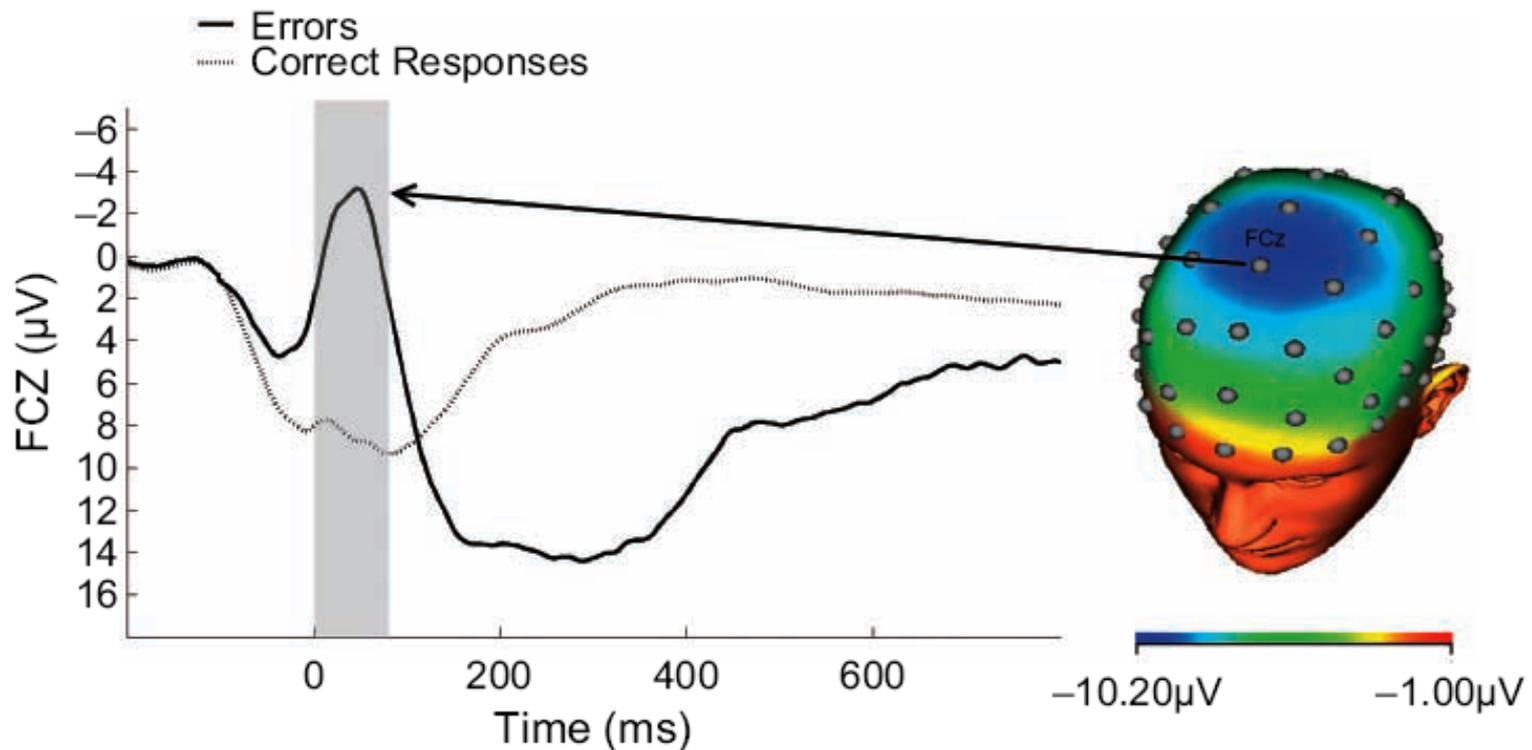
- Among children and adolescents, anxiety disorders are the most frequently diagnosed form of psychopathology (Beesdo, Knappe, & Pine, 2009)
- Anxiety disorders often continue into adulthood and result in chronic impairment (Kessler et al., 2005; Pine, 2007)
- Identifying early neural markers of pathological trajectories may aid prevention and intervention efforts
- It may be possible to identify modifiable environmental factors that modulate these neural markers of risk





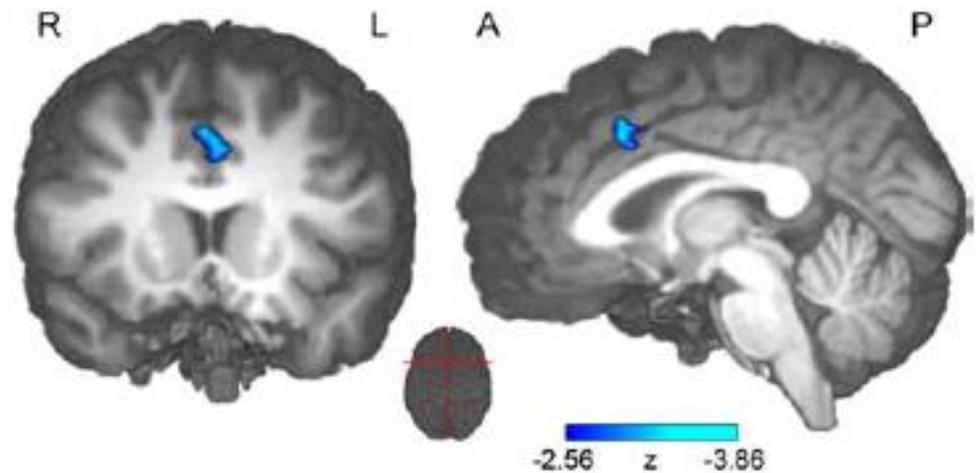


# Error-Related Negativity (ERN)



# Error-Related Negativity (ERN)

- Is evident across a variety of stimulus and response modalities (Gehring, 1993)
- Generated in the anterior cingulate cortex (vanVeen & Carter, 2002)
- ERN amplitude 40 – 60% heritable (Anokhin et al., 2008)
- Trait-like (i.e., high test-retest)
  - 2 week ( $r \sim .70$ )
    - Olvet & Hajcak, 2009
  - 2 year ( $r \sim .65$ )
    - Weinberg & Hajcak, 2011
  - 2 year in kids (8-13;  $r \sim .60$ )
    - Meyer, Bress, & Hajcak (in press)



# ERN and Individual differences

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- Increased ERN amplitude has been consistently related to trait anxiety in adults:
  - Generalized Anxiety Disorder (Weinberg, Olvet, & Hajcak, 2010; Weinberg, Klein, & Hajcak, 2012; Xiao et al., 2011)
  - Obsessive-Compulsive Disorder (Gehring et al., 2000; Endrass et al., 2008, Hajcak et al., 2008; Stern et al., 2010; Xiao et al., 2011)
  - extreme worry (Hajcak, McDonald, & Simons, 2003)
  - behavioral inhibition (Amodio, Master, Yee, & Taylor, 2008)
  - high negative affect (Hajcak, McDonald, & Simons, 2004)
  - punishment sensitivity (Boksem, Tops, Wester, Meijman, & Lorist, 2006)
  - For meta-analysis, see: (Moser, Moran, Schroder, Donnellan, & Yeung, 2013)
- ERN has been suggested as a neural biomarker of anxiety (Weinberg, Riesel, & Hajcak, 2012)

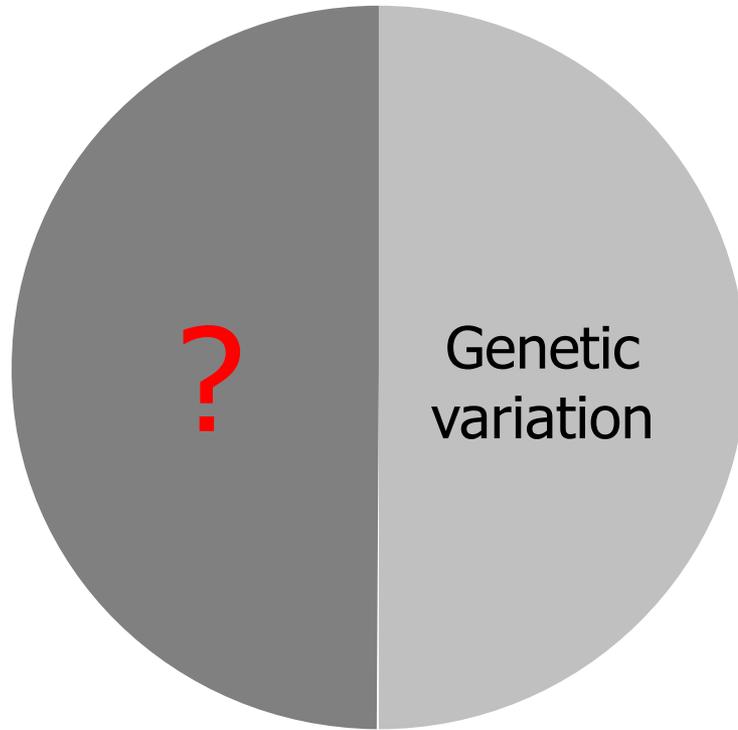
# The ERN and anxiety in children and adolescents

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- **An increased ERN has also been observed in:**
- A heterogeneous group of clinically anxious children (Ladouceur, Dahl, Birmaher, Axleson, & Ryan, 2006)
- Children with obsessive-compulsive disorder (Carrasco et al., 2013; Hajcak, Franklin, Foa, & Simons, 2008; Hanna et al., 2012)
- Six year old children with clinical anxiety (Meyer et al., 2013)
- Adolescents with non-clinical anxiety (Meyer, Weinberg, Klein, & Hajcak, 2012)

# How do individual differences in ERN come to be?

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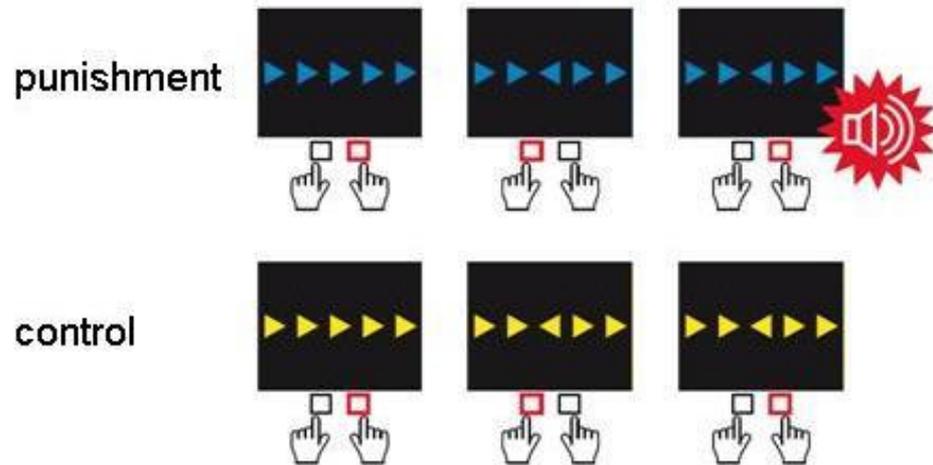
Anokhin, Golosheykin,  
& Heath (2008)

ERN?

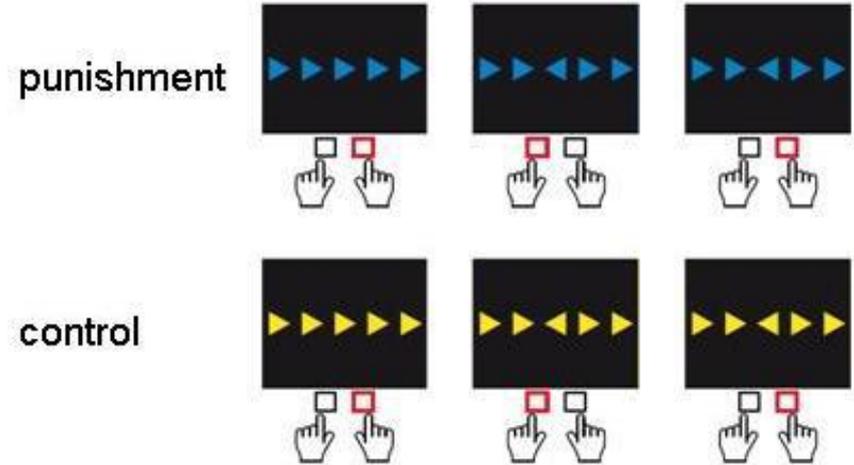
# ERN and punishment

Operant conditioning paradigm: punishment schedule switches from continuous (first five errors) to intermittent (50% of errors)

**Acquisition** (8 blocks, 4 each condition)



**Extinction** (8 blocks, 4 each condition)



# ERN and punishment

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- ERN was increased when errors were punished, and this effect persisted into extinction period
- Punishment-related modulation of the ERN was larger among more anxious individuals
- Learning-related experiences may impact the ERN and the relationship between ERN and anxiety
- Children's exposure to critical or punitive parenting may impact the magnitude of their ERN

# Parenting and anxiety

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- Parenting characterized by high control, low support, hostility, rejection, and authoritarianism have been associated with anxiety in offspring (Bogels & Brechman-Toussant, 2006; Brown & Whiteside, 2008; Erozkan, 2012; McLeod, Wood, & Weisz, 2007)
- Punitive parenting styles may similarly sensitize children to error commission, and thereby increase their ERN
- The relationship between parenting and anxiety may be mediated by increases in ERN magnitude

# ERN and harsh parenting

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- We examined the relationship between parenting styles and children's ERN in a longitudinal study.
- **The first assessment:**
- Parents and children (approximately 3 years old) completed behavioral tasks that were coded by trained observers to assess hostile and supportive parenting style.
- Parents also completed the Parenting Styles and Dimensions Questionnaire (PDSQ)
- **The second assessment (3 years later):**
- Children were approximately 6 years old
- ERPs were recorded while children performed a Go/No-Go task

# Participants

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- 326 children with adequate EEG data
  - Of these:
    - 295 had completed the teaching task battery at age 3
    - 280 had self-report data regarding parenting style from age 3
- Of these 280 children (144 female)
  - Age at first assessment:  $M = 3.52$ ,  $SD = .27$
  - Age at second assessment:  $M = 6.11$ ,  $SD = .42$
- 95% Caucasian, 1.7% Asian, 8.5% Hispanic, 1.7% African American, 5.4% other

# Observed parental hostility and support

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- 93% were mothers
- Modified version of the Teaching Task battery (Egeland et al., 1995)
- 6 standardized tasks (e.g. block-building, book-reading) designed to elicit behaviors from parents and children
- Coders rated on a 5-point scale
- Hostility = parent's expression of anger, frustration, and/or criticism towards her child,  $M = 1.19$ ,  $SD = .33$ , Range: 1.0 – 3.67
- Support = parent's provision of emotional support and expression of positive regard,  $M = 4.48$ ,  $SD = .56$ , Range: 2.17 – 5.00

# Self-reported parenting style

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- At the first assessment, the primary parent completed the PSDQ (Robinson, Mandleco, Olsen, & Hart, 2001)
- 37 items
- Scale from 1 (never) to 5 (always)
  
- Measures three parenting styles:
  - Authoritative (high control, high warmth)
  - Authoritarian (high control, low warmth)
  - Permissive (low control, high warmth)

# Diagnostic interviewing

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- Time 2 (Age 6)
- Preschool Age Psychiatric Assessment (PAPA; Egger, Ascher, & Angold, 1999)
- Anxiety disorders included: specific phobia, separation anxiety disorder, social phobia, generalized anxiety disorder, obsessive-compulsive disorder, and agoraphobia.

# Go/No-Go task & ERN

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- Time 2 (Age 6)
  - Children respond to upward-pointing triangles
  - Children withheld responses to tilted triangles



- ERN: average activity 0-100 ms at Fz on error trials
- CRN: average activity 0-100 ms at Fz on correct trials
- $\Delta$ ERN: ERN minus CRN

# Statistical analyses

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- Pearson correlations ( $r$ ) to examine associations between parenting and ERN
- A simultaneous regression analysis to examine the specificity of the relationships between self-reported and observed parenting with ERN
- A nonparametric bootstrapping method (MacKinnon, Lockwood, & Williams, 2004) to conduct mediational analysis

# Correlations

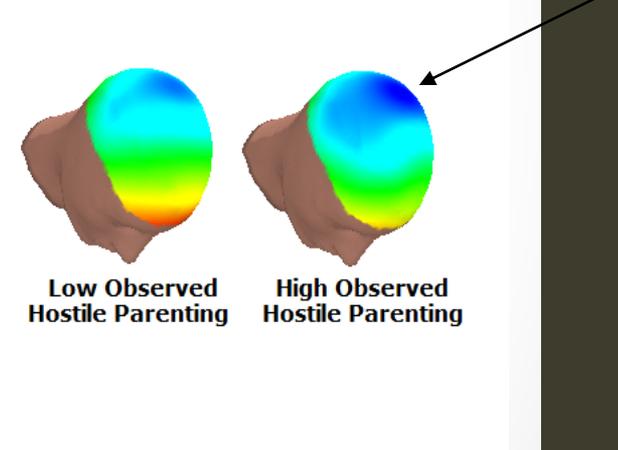
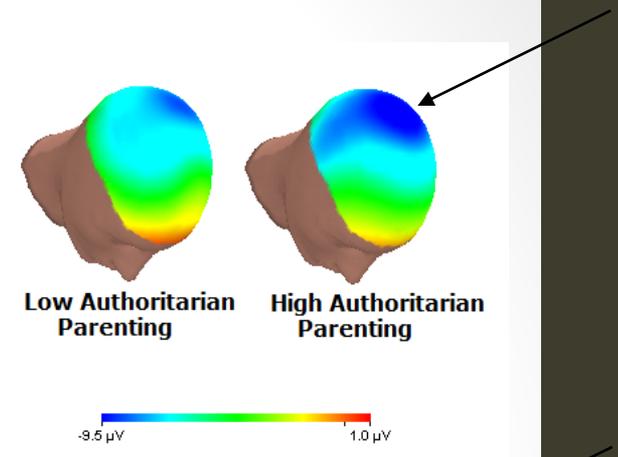
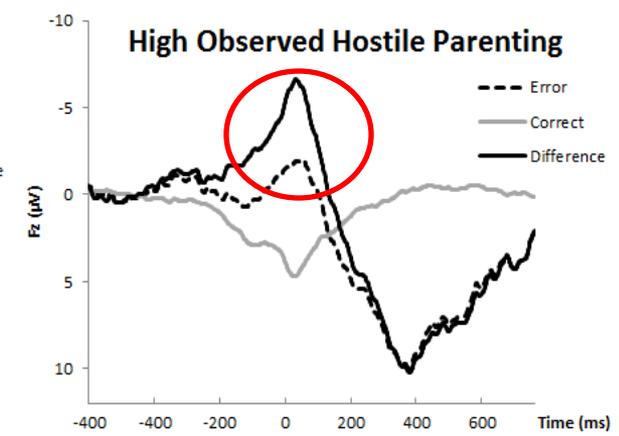
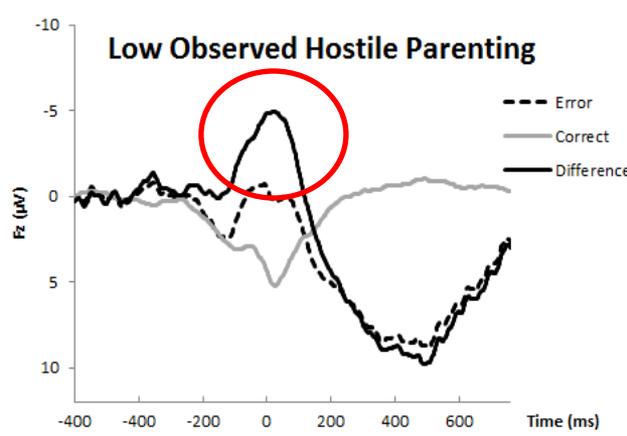
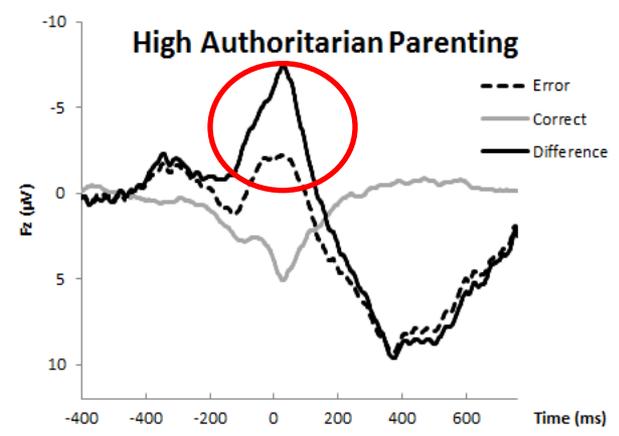
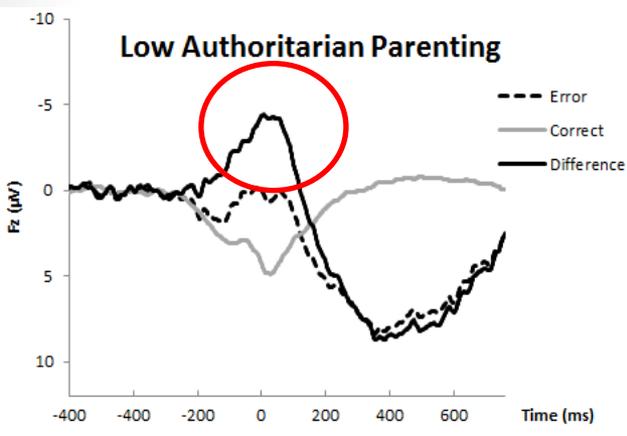
	$\Delta$ ERN	ERN	3	4	5	6	Mean	SD
<b>1. <math>\Delta</math>ERN</b>	-						-4.93	8.30
<b>2. ERN</b>	.85**	-					-.68	8.04
<b>3. PSDQ Factor 1: Authoritative</b>	-.05	-.03	-				61.44	6.68
<b>4. PSDQ Factor 2: Authoritarian</b>	-.10†	-.12*	-.23**	-			20.08	4.67
<b>5. PSDQ Factor 3: Permissive</b>	-.03	-.05	-.10†	.42**	-		10.76	3.26
<b>6. Observed Hostility</b>	-.13*	-.14*	-.03	.21**	.27**	-	1.19	.33
<b>7. Observed Support</b>	.06	.10	.05	-.21**	-.23**	-.65**	4.48	.56

† =  $p < .09$ , \* =  $p < .05$ , \*\* =  $p < .01$

# Simultaneous regression

$\Delta$ ERN			
Variables entered	<i>b</i>	Std. error	<i>t</i>
<i>N</i> = 280			
Age at ERN assessment	-1.50	1.23	-1.22
PSDQ Factor 1: Authoritative	-.11	.08	-1.44
PSDQ Factor 2: Authoritarian	-.22	.12	-1.79†
PSDQ Factor 3: Permissive	.19	.18	1.07
Observed Hostility	-3.92	2.00	-1.96*
Observed Support	-.78	1.18	-.66
Overall model: total <i>R</i> -squared		.04	

† =  $p < .09$ , \* =  $p < .05$ , \*\* =  $p < .01$



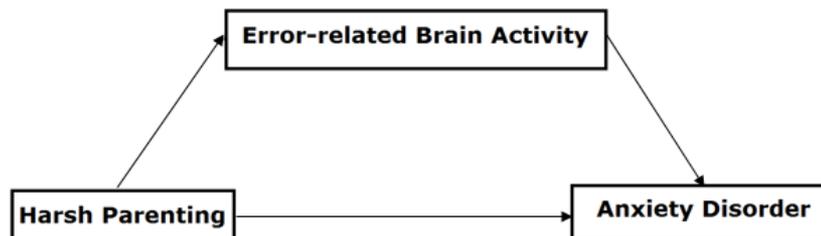
# Results: Parenting and anxiety

	Anxiety Diagnosis ( <i>N</i> = 43)	No Anxiety Diagnosis ( <i>N</i> = 260)
<b>1. ΔERN</b>	-7.74 (8.74) μV*	-4.49 (8.25) μV*
<b>2. ERN</b>	-2.07 (7.93)μV	-.46 (8.13)μV
<b>3. PSDQ Factor 1: Authoritative</b>	62.44 (6.39)	61.30 (6.72)
<b>4. PSDQ Factor 2: Authoritarian</b>	22.20 (5.25)*	19.78 (4.52)*
<b>5. PSDQ Factor 3: Permissive</b>	12.03 (3.94)†	10.57 (3.12)†
<b>6. Observed Hostility</b>	1.23 (.29)	1.18 (.33)
<b>7. Observed Support</b>	4.42 (.62)	4.49 (.55)

# Mediation analysis

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- Results indicated that the mediation model was predictive of variance in childhood anxiety, at a trend level,  $R^2 = .024$ ,  $F = 2.87$ ,  $p = .06$
- Harsh parenting significantly predicted the magnitude of the  $\Delta$ ERN,  $\beta = -.14$ ,  $t(279) = -2.23$ ,  $p < .05$
- The  $\Delta$ ERN in turn significantly predicted childhood anxiety disorders,  $\beta = .51$ ,  $t(279) = 2.37$ ,  $p < .05$
- While, harsh parenting was not directly predictive of childhood anxiety disorders,  $\beta = -.03$ ,  $t(279) = -.16$ ,  $p = .88$ , there was a significant indirect effect of harsh parenting, mediated through the  $\Delta$ ERN, on childhood anxiety disorders,  $\beta = -.08$  (95% confidence interval [CI]:  $-.19$  to  $-.02$ ).



# Discussion

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- Observed parental hostility, as well as self-reported authoritarian parenting style, both prospectively predicted an increase in ERN in children 3 years later.
  - Both measures uniquely predicted ERN (authoritarianism at a trend level)
- Observational and self-reported measures of harsh parenting were only minimally correlated ( $r = .21$ ).
  - Consistent with previous work (Bogels & Brechman-Toussaint, 2006; Greco & Morris, 2002)
- Relationships with ERN were specific to harsh parenting.
- ERN magnitude mediated the relationship between harsh parenting and child anxiety disorder status at age 6
- Harsh parenting may relate to subsequent risk for anxiety insofar as it shapes children's neural response to errors.

# Discussion

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- Previous human and animal works suggests that parenting may substantially impact brain development and stress reactivity (Belsky & de Hann, 2011; Francis, Diorio, Liu, & Meany, 1999).
- It is possible that parenting may program biological responses to threatening stimuli to allow organisms to thrive under the unique demands of their environment (Francis et al., 1999)
- Harsh parenting may “program” errors as threatening and thereby increase children’s neural response to them
- The extent to which parenting specifically impacts the ERN relative to other measures of threat sensitivity should be explored in future work

# Discussion

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- Mediation analysis suggest a pathway whereby parents confer risk of clinical anxiety to their children through the impact of harsh parenting on children's error processing.
  - Need additional longitudinal data to properly test mediation
- Parenting interventions decrease anxiety in children (Rapee, Kennedy, Ingram, Edwards, & Sweeny, 2010)
- Future work should explore whether the ERN is a mechanism through which parenting interventions work to decrease anxiety in children
  - Is the ERN a *modifiable* biomarker of risk?

# Thanks!!

- Alex Meyer
- Dan Klein
- Anja Riesel
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- The entire CAP Lab and Klein Lab

