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ROLES OF INDIVIDUAL DIFFERENCES AND NEURAL CORRELATES IN THE RESPONSE TO PEER FEEDBACK IN EARLY CHILDHOOD

JEONG HA CHOI
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Reviewed and approved* by the following:

Koraly Pérez-Edgar
Associate Professor of Psychology
Thesis Supervisor

Richard Carlson
Associate Head
Professor of Psychology
Honors Adviser

* Signatures are on file in the Schreyer Honors College.

ABSTRACT

Although peer rejection has broad negative consequences for children's psychological and social adjustment (Nesdale & Lambert, 2007), specific children may be more sensitive to the long-term effects of social rejection. The goal of this preliminary study was to examine how temperament and rejection sensitivity may shape a young child's initial emotional and neural response to positive and negative peer feedback by using Event Related Potentials (ERPs). Results show that there was a significant difference in Behavioral Inhibition Questionnaire (BIQ) levels for high and low Rejection Sensitive (RS) groups. When children reported to be unhappier with their peer feedback, they showed smaller C1 mean amplitudes. Also, children with high anxious expectations showed faster N1 latency when rejected. Lastly, children with high BIQ showed faster N1 latency when accepted, and faster C1 latency when rejected. Findings inform our understanding of variations in children's response to social feedback. Continued data collection will allow us to see if these patterns remain over time.

TABLE OF CONTENTS

LIST OF TABLES

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Chapter 1

Introduction

According to the social information processing model (Crick & Dodge, 1994), children process their environment, and the social relationships within it, by (1) encoding cues, (2) interpreting these cues, (3) clarifying a goal, (4) generating goal-directed responses, (5) deciding on a response, and lastly, (6) enacting the chosen response. This process is informed by the child's prior knowledge and experiences, which are updated by ongoing events. Thus, social relationships, which are marked by constant feedback from peers in response to individual behavior, feed this cycle of social information processing. How a child understands his or her relationships with peers is an important component of his or her social development. Peer relationships differ from relationships with parents or siblings in that they are based on active selection, reciprocity, and fairly equal social status. Once outside of the boundary of family, the child has the power to select whom he or she wants to befriend Peers, in turn, also have the power to accept and reject individual social bids. Thus, peer relationships provide for the child a unique information stream for judging their position within the larger social group.

Negative peer experiences (e.g. rejection) can be stressful for children and are associated with both internalizing (e.g. worries) and externalizing (e.g. fighting) problems (Sandstrom, Cillessen, & Eisenhower, 2003; Coie, Lochman, Terry, & Hyman, 1992). In addition, Vitaro et al (2012) found that peer rejection has a negative influence on academic achievement. In particular, peer-rejected children were more likely to experience negative peer treatment and show less participation in class, as well as have poor academic results (Buhs & Ladd, 2001).

Although peer rejection has broad negative consequences for children's psychological and social adjustment (Nesdale & Lambert, 2007), specific children may be more sensitive to the long-term effects of social rejection. Within the information processing model, children may differ at the stage of encoding cues, varying in how they interpret negative social feedback. For example, some children may attribute the feedback to the specific social context while others may take it as an indication of their inherent social standing.

Behavioral Inhibition, Rejection Sensitivity, and Peer Feedback

There are clear individual differences in how children interpret peer feedback. One factor that influences how children respond to peer evaluation is temperament. Temperament is “a biologically based predisposition toward specific patterns of behavioral and emotional reactivity to environmental stimuli” (Howarth, Guyer, & Pérez-Edgar, 2013). Temperament-based individual differences in emotion and social behavior are evident as early as 4-months of age (Fox et al., 2015). Due to its early appearance, temperament affects social relationships early on in a child’s development. Behavioral inhibition (BI), temperamental shyness, is assessed via a child’s initial response to novel situations or people and is characterized by social withdrawal. Temperamental shyness is marked by heightened reactivity to novelty and social encounters (Fox, Henderson, Marshall, Nichols, & Ghera, 2005).

Studies show that extreme temperamentally shy children have difficult peer interactions. Burgess, Wojslawowicz, Rubin, Rose-Krasnor, & Booth-LaForce (2006) found that temperamentally shy children are more likely to blame themselves for negative interactions with unfamiliar peers, which may lead them to expect rejection. Temperamentally shy children are more prone to peer rejection (as cited in Howarth, Guyer, & Perez-Edgar, 2013), which in turn leads to poorer social relationships than less shy children. Howarth et al. (2013) also found that temperamental shyness shapes how children respond to peer feedback during a computer-based peer feedback task. Specifically, compared to non-shy boys, shy boys expressed higher level of sadness when peers with whom they were interested in playing rejected them. Interestingly, they showed lower level of sadness when rejected by peers for whom the boys showed no interest. Presumably, shy boys may be attentive to not only the fact they are rejected, but also by whom they are rejected, implying that they tend to process more contextual information than non-shy boys.

Another factor associated with interpreting peer evaluation is rejection sensitivity. Rejection sensitivity is the defensive expectation of rejection (Downey, Lebolt, Rincón, & Freitas, 1998). As such, rejection-sensitive children often expect rejection prior to a social encounter, will readily perceive rejection, even in an ambiguous situation, and will subsequently overreact to rejection. Downey et al. (1998) found that children with high rejection sensitivity (as measured with the Children's Rejection Sensitivity Questionnaire; CRSQ) showed greater distress than children with low rejection sensitivity only in rejections with ambiguous intentions. In addition, the researchers found that based on self-reports, teacher reports, and official reports (i.e. academic performance scores), rejection sensitive children have more relationship problems with peers than low rejection sensitive children. Adolescents with high rejection sensitivity are more anxious and depressed (Sandstrom et al., 2003), possibly because they tend to attribute rejection to the self, both in hypothetical and in real life situations (Downey & Feldman, 1998; Mor & Inbar, 2009).

Given these findings on temperamental shyness and rejection sensitivity (RS), we can expect to see differences in affective self-report to peer rejection across children varying in levels of shyness and RS. While temperamental shyness considers a wider range of social situations, rejection sensitivity is comparatively narrower in that it focuses on rejection. However, no study has examined these factors together. We could, therefore, predict a correlation or interaction between rejection sensitivity and temperamental shyness, particularly in instances that involve peer rejection versus instances of peer acceptance.

In addition, peer research has mainly relied on traditional measures such as self-report and behavioral observation. These measures of children's responses to peer feedback have high ecological validity and can yield high participation rates. However, not only do these measures require large samples of children to provide sociometric ratings and self-report, but they may also involve in-depth observation and behavioral coding. Such complexity and cost may limit their application to multimethod, multilevel examinations of children's responses to peer feedback that can incorporate behavior, cognition, and biology. Therefore, there is a need for an additional approach in understanding the underlying process of peer feedback.

Playdate Task and Event Related Potentials

Event-related brain potentials (ERPs) are noninvasive means of evaluating brain functioning by measuring electrocortical brain responses to sensory or cognitive stimuli. ERPs reflect the psychological process involved in task performance and can supplement information provided by self-report. The real-time temporal resolution of ERPs helps answer the question of 'when' feedback events are processed at the level of neural activity. ERP can help elucidate the temporality of neural processes toward peer feedback, which is more fine-grained compared to other, relatively slow, neurological measures such as functional magnetic resonance imaging (fMRI). Therefore, ERP can help us better understand individual differences in response to peer evaluation from a neurological perspective.

ERP waveforms consist of a series of positive (P) and negative (N) voltage deflections. While C1, P1 and N1 represent early, automatic visuospatial orienting of attention (Hillyard & Anllo-Vento, 1998; Luck et al., 1990), P2, N2, and P3 components reflect top-down, higher-level cognitive processing of information. In particular, emotion evaluation has been linked with the P2 component of the ERP (Carretie et al., 2001; Huang & Luo, 2006). Components associated with initial, automatic attention (C1, N1, and P1) were found to show larger amplitudes to negative stimuli than positive or neutral stimuli (Carretie et al., 2004). P2 was also found to demonstrate larger amplitudes to negative stimuli (Huang & Luo, 2006). ERP latency is associated with attention and information processing. Bar-Haim et al (2005) found that high-anxious individuals display faster P1 and N1 latency to emotional face stimuli. Carretie et al. (2001) found faster P2 latency in response to negative versus positive-arousing pictures. Studies also suggest that the latency of the P3 component depends on stimulus evaluation (McCarthy & Donchin, 1981) and response selection (Verleger, 1997).

Previous research on ERP and social interaction has mainly focused on young adults. Using a task similar to the playdate task, Van der Veen et al. (2014) found that the P3 amplitude is related to expected peer acceptance. Sun & Yu (2014) found that the feedback-related negativity (FRN), which is identified as a marker of reward prediction error, is sensitive to social rejection. However, there is lack of research examining social interaction among young children when the social world becomes more expansive and salient to these children's development. By observing children's neural processes at an early stage of social development, we can understand how children vary in their interpretation of negative social feedback, ultimately influencing their social interaction.

In order to collect ERP data, the study utilized a peer evaluation task previously used in Howarth et al. (2013). The playdate task is a computer-based peer evaluation task in which a child is initially presented with pictures of same-age peers and is asked to select whether they are interested, or not interested, in playing with the potential playmate. They are later given feedback from the same hypothetical children. In half the trials the hypothetical peers wish to play with the child and in the other half of trials they do not. As a result, the task crosses the child's social preferences (Interested/Not Interested) with peer feedback (Acceptance/Rejection). Following the feedback, the child is asked how they feel in response ("How sad are you?"). The playdate task is helpful for the study because of its simplicity, allowing Event Related Potential (ERPs) to be collected while the task is being performed.

While there is a lack of ERP research on individual differences in relation to social feedback, fMRI studies have found that neural reactivity does vary to peer feedback depending on level of BI or rejection sensitivity. For example, anxious adolescents showed greater amygdala activation compared to healthy adolescents when anticipating peer feedback (Guyer et al., 2008). BI adolescents were also found to show high striatal responses when selected, but non-BI adolescents showed high striatal responses when not selected (Guyer et al., 2015). The striatum is associated with novelty-related decision-making behaviors (Wittmann et al., 2008). There has also been research on neural activation and rejection sensitivity (RS). Kross and colleagues (2007) found that the left inferior frontal gyrus and right dorsal superior frontal gyrus were more active among low RS adolescents when viewing images of social rejection than those with high RS. One downside of utilizing fMRI with young children is that it requires them to lie down still for an extensive period of time. ERP, however, does not require such intense lack of movement during the completion of a task, making it a better measure when working with young children. Based on these studies, we can expect to find individual differences in ERP responses as well. In the study, ERPs will be used to compare responses to peer rejection versus peer acceptance.

Current Study

The goal of my research is to examine individual differences, specifically temperament and rejection sensitivity, which may shape a young child's initial emotional and neural response to positive and negative peer feedback. Based on the literature review, we predict a positive correlation between rejection sensitivity and temperamental shyness. Also, we predict greater amplitudes in C1, P1, N1, P2, and P3 components of the ERP when children are socially rejected versus when they are accepted. We also predict that rejection-sensitive children will show more negative self-report responses to peer feedback (rejected/accepted), larger ERP amplitudes, and faster ERP latency in neural responses than low rejection-sensitive children when rejected versus accepted. Lastly, we hypothesize that children with high BI will have more negative self-report responses to peer feedback (rejected/accepted), larger ERP amplitudes, and faster ERP latency than children with low BI when rejected versus accepted.

Chapter 2

Methods

Participants

Participants between the ages of 5 to 6 were recruited through the FIRST family database from the Pennsylvania State University. 35 participants completed the BI and rejection sensitivity questionnaires (14 females, M_{age}= 5.25, SD_{age} = 0.51). A total of 16 children participated for ERP collection. Two children rejected EEG net placement, and data from one child was lost due to computer problems.

Questionnaires

After children and their parents were greeted and consent for participation was obtained, the children were seated at a table in a developmentally appropriate testing room. Children were then trained on the emotion scale (Sad, A little sad, A little happy, Happy) along with the faces associated with each emotion. This was done to assure that children understood the differences between each emotion and what emotion to select during the response phase of the task. Then, the children completed Section I of the Children’s Rejection Sensitivity Questionnaire (CRSQ; Downey & al., 1998). This questionnaire is used to measure rejection sensitivity among children. This section presents children with six peer- and six teacher-related vignettes in which the possibility of rejection exists. For each vignette, children first indicate the degree of anxious anticipatory affect they would experience in that situation (e.g., "How NERVOUS would you feel about whether or not the teacher will let you take the video game home this time?"), using a 6-point scale ranging from 1 *(not nervous)* to 6 *(very, very nervous).* Then, children indicate the likelihood that the other person would respond with acceptance or rejection (e.g., "Do you think the teacher is going to let you take the video game home this time?") on a scale ranging from 1 *(YES)* to 6 *(NO).* The CRSQ was completed with the researcher asking the questions to the child. The scale was modified to fit the age of the participants, by using a smaller range from 1 (*not nervous*) to 4 (*really nervous*).

The Behavior Inhibition Questionnaire (BIQ; Bishop, Spence, & McDonald, 2003) was used to measure temperamental shyness. The BIQ is a 30-item measure that rates children's behavior in response to novelty on a 7-point Likert scale ranging from 1 (Hardly Ever) to 7 (Almost Always). The BIQ provides scores across three domains--Social Novelty, Situational Novelty, and Physical Risk. The parent completed this questionnaire while the task was in progress.

Playdate Task

After the children finished the questionnaire, they were told that other children all over the country were taking part in a study examining how children choose friends. The children were then told that they would be shown pictures of other similar-aged children and could select children with whom they would like to play with now or later.

A research assistant took the participants' picture with a digital camera. Participants were told that his or her picture would be emailed to the other children, and that they would later 'find out if the children you saw want to play with you'. Participants sat 40 cm in front of a 16-in computer monitor to sort the 60 hypothetical children into those he or she wanted to play with now versus those they wished to play with later. Pictures were selected from the Child Affective Facial Expression Set (LoBue & Thrasher, 2014). The CAFÉ set presents a standardized group of photographs of smiling children who are roughly in the same age range as our sample. We selected a diverse set of child faces, making sure we had an equal number of male and female. E-Prime (Psychology Software Tools, Pittsburgh, PA) was used for the computerized sorting task. Participants used a mouse to click on the child's picture, where they would left-click if they wanted to play with the child now, or right-click if they wanted to play with the child later. Due to our concern that free sorting could skew the number of trials per condition across participants, the computer task was automated to force 30 children to be selected for each group. This phase of the task lasted no more than 10 minutes.

Following the sorting procedure, EEG nets were placed on the participants, and then participants were brought back to the same computer monitor. Participants were reminded of the earlier sorting procedure. They were then told that the pictured children had also made their playdate choices and that the computer would show whether each pictured child had selected the participant to play with. In reality, E-Prime automatically and randomly assigned interested and not interested pictures to an equal number of acceptance and rejection feedback trials.

Trials began with a fixation cross at the center of the screen. The research assistant advanced the trial by a keyboard press once the child was focused on the screen. Each fixation was followed by a 10 cm by 15 cm picture of a previously sorted child for 3000 ms. The participant's sorting decision was noted by the boundary of the picture: if the participant was interested in the pictured child, the boundary was green, and if the participant was not interested, it was red. The research assistant also verbally reminded the participant of their choices, saying 'You wanted (or did not want) to play with this child'. The background color then reflected the pictured child's 'choice' for 3000 ms. If the pictured child accepted the participant, the background was green. If the pictured child rejected the participant, the background was red. The research assistant also told the participant of the pictured child's decision with the statement 'This child did (or did not) want to play with you'. The task was programmed to counterbalance the participant's sorting of the pictures with the simulated social feedback to ensure equal numbers of trials within each of four conditions: acceptance from children with whom they wished to play (interested/accepted; marked as green/green), rejection from children with whom they wished to play (interested/rejected; green/red), acceptance from children with whom they did not wish to play (not interested/accepted; red/green), and rejection from children with whom they did not wish to play (not interested/rejected; red/red). At the end of the study, participants were debriefed and told that the feedback they received from other children were not the actual answers from the pictured children, but rather the result of a random computer sorting.

Electroencephalogram (EEG) Recording

EEG recordings were acquired using a 128-channel EGI Electrode Net. Electrodes placed below the left eye were used to capture vertical eye movements (VEOG), and electrodes placed on the external canthi of each eye will be used to capture horizontal eye movements (HEOG). All electrode impedances were kept below 50k ohms. The EEG data was digitalized at a 250 Hz sampling rate (Low pass 40 Hz) and any unreliable signals were discarded manually. The data were then re-referenced to produce an average mastoid configuration. EEG signal contaminated with eye movement and motor artifact was removed from all channels using predetermined parameters (e.g. signal ±100μV). The signal was then submitted to a discrete Fourier transform using 1-s Hanning window with 50% overlap between consecutive windows.

ERP calculations

ERPs were collected from the presentation of feedback from interested/not interested peers, referenced to a 100 msec baseline. ERPs generated by acceptance and rejection trials were separated out into two individual files. These trials were then averaged together to create mean ERPs for each child for each trial type. Children that did not meet the threshold of 20 or more trials per condition were excluded from analysis. This resulted in a total of ten participants for the overall and peer rejection conditions respectively, and seven participants for the peer acceptance condition. The data from the mean ERPs were used in the data analyses. ERP components were chosen for analysis based on a review of the grand average ERPs. The grand average ERPs were created by averaging together the ERPs from all of the participating children. ERPs to the two different feedback conditions were compared for the following components: frontal electrodes C1 (40-120 ms), N1 (100-180 ms), P3 (200-340 ms) and occipital electrodes P1 (80-200 ms), N2 (180-300 ms), OP3 (240-400 ms). Data were analyzed separately for each of the EEG collection channels.

Data Analysis

For preliminary exploration, descriptive analyses were first carried out to characterize low and high rejection sensitive children, as well as low and high BI children. In addition, a descriptive analysis and a paired-samples t-test analysis was employed to compare self-report responses for acceptance and rejection. For the first hypothesis, an independent-samples t-test was conducted to compare BIQ in low and high anxious expectation participants. For the second hypothesis, descriptive analysis and a paired-samples t-test was utilized to compare mean amplitudes of ERP components in rejection and acceptance conditions. For the third and fourth hypotheses, bivariate correlations were employed to assess the inter-relations between the following variables: emotion self-report responses, anxious expectations, BIQ, and ERP components.

Chapter 3

Results

A descriptive analysis was employed to ensure that there was no skewness in participants' report (*N* = 29) of Behavioral Inhibition and Rejection Sensitivity and to compare the mean self-report scores for the four conditions (Table 1). There were differences between the four conditions when comparing the mean self-report scores. Children reported below 2.00 ("a little sad") when rejected, and above 3.00 ("a little happy)" when accepted. A paired-samples t-test found a significant difference between rejection and acceptance, $t(29)=12.89$, $p<.001$. In addition, there was also a significant difference between when rejected by interested versus not interested peers, $t(29)=-2.69$, $p=.012$. Significance was also found when comparing acceptance between interested versus not interested, $t(29)=3.16$, p=004. self-report scores were more polarized when receiving feedback from peers with whom the participants expressed interest in playing. The significant difference in self-report shows that the participants clearly understood the task and are incorporating both the selection and feedback into their responses.

Table 1 Descriptive Analysis on Behavioral Inhibition and Anxious Expectation

	Mean	Median	SD
Behavioral Inhibition	94.82	96.00	20.6
Anxious Expectation	2.55	2.42	0.94
Emotion Self-Report - Interested/Accepted	3.86	4.00	0.25
Emotion Self-Report - Interested/Rejected	1.47	1.33	0.43
Emotion Self-Report – Not Interested/Accepted	3.43	3.83	0.72
Emotion Self-Report – Not Interested/Rejected	1.94	1.87	0.99

To compare low and high anxious expectation groups, high and low groups were created using median split (M_{RSAnx} = 2.46). First, we looked at BIQ levels for high and low RS groups. There was a marginally significant difference in the scores for low anxious expectations (*M*=86.2, *SD*=19.54) and high anxious expectations (*M*=101.2, *SD*=20.8); *t*(28)=2.04, *p*=.051. However, there was no significant difference in anxious expectation levels for low and high BIQ groups, *t*(28)=0.72, *p*=.479.

For the second hypothesis, a descriptive analysis was initially applied to compare the mean amplitudes of each ERP components from rejection and acceptance conditions. Just comparing the means alone, mean amplitudes were larger for P1, N1, N2, and P3 components when rejected than accepted (Table 2). However, none of the components reached significance, *p's* > .50, due to the small sample size and relatively large standard deviations.

Table 2 Descriptive Analysis on Mean Amplitudes of ERP components when Rejected versus Accepted

	N	Mean	SD
C1 Mean Amplitude - Rejected	10	0.73	2.72
C1 Mean Amplitude - Accepted	7	0.80	2.98
P1 Mean Amplitude - Rejected	10	11.01	6.32
P1 Mean Amplitude - Accepted	7	10.04	5.39
N1 Mean Amplitude - Rejected	10	-5.16	4.96
N1 Mean Amplitude - Accepted	7	-4.65	2.97
N2 Mean Amplitude - Rejected	10	9.08	4.51
N2 Mean Amplitude - Accepted	7	7.28	5.25
P3 Mean Amplitude - Rejected	10	-2.37	9.01
P3 Mean Amplitude - Accepted	7	-0.19	6.06

We then ran bivariate correlations to see if the mean amplitudes of the ERP components were related to the self-report response. There was a negative correlation between emotion self-report responses and C1 mean amplitudes in the rejection condition, *r*(10) = -.696, *p* = .025. When rejected, more unhappy responses were associated with smaller C1 mean amplitudes (Table 3). There was no significant correlation between the remaining ERP components and self-report responses.

Table 3 Correlation between ERP Mean Amplitudes and Emotion Self-Report Responses

	Self-Report - Accepted	Self-Report - Rejected
C1 Mean Amplitude - Rejected		-.696*
C1 Mean Amplitude - Accepted	-.330	
P1 Mean Amplitude - Rejected		-.092
P1 Mean Amplitude - Accepted	.401	
N1 Mean Amplitude - Rejected		-.136
N1 Mean Amplitude - Accepted	-.227	
N2 Mean Amplitude - Rejected		-.255
N2 Mean Amplitude - Accepted	-.096	
P3 Mean Amplitude - Rejected		.135
P3 Mean Amplitude - Accepted	-.103	

Note: *p<.05, **p<.01

Bivariate correlations were then used to test the third hypothesis. Results show that there were no significant correlations between anxious expectations and emotion self-report, and anxious expectations and ERP mean amplitudes. There was a correlation only between anxious expectations and N1 latency in rejection conditions, $r(10) = -.644$, $p = .045$ (Table 4). Despite the lack of significance, which can be linked to the small sample size, anxious expectations and N1 latency in acceptance conditions also showed a correlational trend, $r(7) = -.721$, $p = .068$.

For the final hypothesis, there were no significant relations between the BIQ and emotion self-report scores, but there were two significant correlations between BIQ and ERP components. There was a correlation between BIQ and N1 latency in acceptance conditions, $r(6) = -.915$, $p = .011$. There was also a correlation between BIQ and C1 latency in rejection conditions, $r(9) = .799$, $p = .01$ (Table 4). These analyses are limited by the same sample size problems noted in the third hypothesis.

Table 4 Bivariate Correlation between Individual Differences and ERP Latency in Rejection and Acceptance Conditions

	Anxious Expectations	Behavioral Inhibition
Self-Report – Rejected	-.024	.101
Self-Report – Accepted	-.259	-.161
C1 Latency – Rejected	.229	.799**
C1 Latency – Accepted	.286	-.024
P1 Latency – Rejected	-.456	-.223
P1 Latency – Accepted	-.149	-.152
N1 Latency – Rejected	-.644*	-.461
N1 Latency – Accepted	-.721+	-.915*
N2 Latency – Rejected	.044	-.212
N2 Latency – Accepted	-.525	-.107
P3 Latency – Rejected	.297	-.490
P3 Latency – Accepted	-.223	-.503

Note: +p<.10, *p<.05, **p<.01

Chapter 4

Discussion and Conclusions

The current preliminary study examined temperament and rejection sensitivity, which may shape a young child's initial emotional and neural response to positive and negative peer feedback. Despite the small sample size we found several preliminary findings through our data analysis that inform our understanding of variations in children's response to social feedback. Continued data collection will allow us to see if these patterns remain over time. In the current analysis, there was a significant difference in BIQ levels for high and low RS groups. When children reported to be unhappier with their peer feedback, they showed smaller C1 mean amplitudes. Also, children with high anxious expectations showed faster N1 latency when rejected. Lastly, children with high BIQ showed faster N1 latency when accepted, and faster C1 latency when rejected. These findings were supplemented with relations that fell below traditional statistical cutoffs, but can still help inform our interpretation of the task.

The initial analysis of the children's self-report shows that the participants clearly understood the task and incorporated both the selection and feedback into their responses. We then noted a relation between rejection sensitivity and temperamental shyness, supporting my first hypothesis. We found that the high RS group was higher in BI than the low RS group; however there was no significant difference in RS levels for high and low BI groups. Based on this finding, we can say that children who anxiously expect rejection may be more likely to be temperamentally shy and withdraw from social interactions. While overlapping, the two constructs differ in the scope of behaviors encompassed; rejection sensitivity is comparatively narrower in that it focuses on rejection, while temperamental shyness considers a wider range of social situations. This may explain the relatively asymmetrical relation we found.

We also hypothesized that the C1, P1, N1, P2, and P3 components of the ERP would have greater amplitudes when children are socially rejected versus when they are accepted. Only emotion self-report responses and C1 mean amplitudes were negatively correlated in the rejection condition. This suggests that children with a greater initial impact by rejection are likely to have a more negative response. C1 is generated in the primary visual cortex (Luck, 2005), which is the first to receive visual information from the retina. When we start the task, we initially prime children with the information that a red background means “rejection” and a green background means “acceptance.” This brief exposure may influence children with the information that they are processing because the background color is what initially catches their vision. The visual feedback children receive is processed, which is reflected in the ERP, and then is translated into the self-report. Therefore, the intensity of the feedback that the children receive at the very beginning influences how much children interpret that information and ultimately respond to it.

My third and fourth set of predictions involved rejection-sensitive and temperamentally shy children. These children, respectively, were expected to show more negative self-report responses to peer feedback (rejected/accepted), larger ERP amplitudes, and faster ERP latency in neural responses than low rejection-sensitive children. Children with high anxious expectations showed faster latency in N1 when rejected. Although not significant, children with high anxious expectations also tended to show a faster N1 latency when accepted. In addition children with higher BI show faster N1 latency in acceptance conditions and a faster C1 latency in the rejection condition.

The first three findings align with Bar-Haim et al. (2005)’s finding of high-anxious people being associated with faster N1 latency overall when we take into consideration that rejection sensitive children and temperamentally shy children both have anxiety traits. Here we can assume that trait anxious children can be anxious about different things: the novelty of the situation, or the fact that they might get rejected. For temperamentally shy children, situational novelty may be central to their anxiety. Once they are accepted, that barrier is broken, which may be the reason they are quicker to catch acceptance cues. For rejection sensitive children, they tend to expect rejection even in ambiguous situations (Downey et al., 1998), therefore being quicker to detect rejection cues.

Children with higher BI show faster N1 latency in acceptance conditions and a faster C1 latency in the rejection condition. This suggests that high BI children are also faster to catch both rejection and acceptance than low BI children, across different neural stages. While both C1 and N1 components involve initial, automatic attention, C1 is earlier in temporal processing. From this we can assume that, if we are to compare between the two feedback cues, temperamentally shy children are quicker at detecting rejection but not acceptance. There is a clear tendency for both anxious expectations and BI in demonstrating a faster latency early on in accepting both negative and positive feedback. However, we could not find significance for anxious expectations and N1 latency in acceptance conditions, and BI and N1 latency in rejection conditions, due to the small sample size. With a larger sample, we may expect to see significant correlation between anxious expectations, BI, and N1 latency in both the acceptance and rejection conditions.

A core limitation of this study is the small sample group that prevented us from noting stronger results. The small number of participants also limited our ability to directly compare different levels of individual differences. In particular, the need for strong, clear ERP data from children was a major impediment to generating the needed sample for the study. It is hard for children to sit in one setting for an extensive period of time, but this is required for the Playdate task. This resulted in a large amount of noisy data, even when we required only one-third of the total number of trial segments for inclusion in the analyses. Therefore, more data collection, as well as cleaner data, is needed to achieve a better understanding of the neural processes involving social feedback.

This study opens up many questions for future research. This study was the first to examine the relation between behavioral inhibition and rejection sensitivity, but we do not know which children, who are high in BI, are likely to develop rejection sensitivity. For future research, we can look specifically into children with high BI and observe their behavioral differences as well as neural responses to rejection. In addition, the preliminary findings indicate that children do not respond to rejection and acceptance in the same manner. There are also individual differences in how quickly they interpret the feedback or how intense the feedback is depending on rejection or acceptance. These data can help us begin to understand children's responses to social feedback at a neural level from their earliest stages of social development, further expanding our understanding of how children interpret peer responses.

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Academic Vita

Jeong Ha (Stephanie) Choi

219 S Sparks Street Apt 21, State College, PA 16801
Email: amebasong@gmail.com

Education

May 2015 (expected) **Psychology, B.A.**
Schreyer Honors College
Pennsylvania State University

Honors Thesis: Roles of individual differences and neural correlates in the response to peer feedback in early childhood (under development)
Advisor: Dr. Perez-Edgar
Phi Beta Kappa

Honors & Scholarships

Fall 2011 – Present Dean's List, College of Liberal Arts
Fall 2011 Undergraduate Scholastic Awards - President's Freshman Award

Research skills

- Analyze and manage data using Excel
- Transcribe narrative speech with CLAN CHAT program
- Develop templates, code, and calculate kappa with Interact program
- Process EEG/ERP data utilizing Brain Vision Analysis (BVA)
- Process psychophysiological data using MindWare
- Utilize SPSS for data analyses

Posters and Presentations

Choi, J., Cho, S., Soto, J. *Practice Makes Perfect? The Effects of Habitual Emotional Suppression on Physiological Response to Disgust Films.* Poster presentation at the 2015 Emotion Pre-conference for the Society of Personality and Social Psychology.

Choi, J., Fu, X., Galinsky, P., & Perez-Edgar, K. *The Roles of Expressive and Receptive Language Abilities in Moderating the Link between Behavioral Inhibition and Social Phobia*. Poster presentation at the 2015 Society for Research on Child Development Biennial Meeting.

Choi, J. H., Thai, N., & Pérez-Edgar, K. (2015, April). *Roles of individual differences and neural correlates in the response to peer feedback in early childhood*. Poster presentation at the annual meeting of Psi Chi Research Conference, University Park, PA.

Research Experience

Penn State Culture, Health and Emotion Lab — *Lab Director: Dr. Jose Soto*
Department of Psychology, Pennsylvania State University — June 2014 - Present
Research Assistant

- Assisted with study design and eventual IRB submission for study examining cultural factors in the regulation of anxiety
- Analyzed archival data examining cultural identity and emotional experience and regulation for eventual poster presentation
- Ran study participants through psychophysiological protocols for study examining emotion regulation (suppression/amplification) to disgust
- Cleaned psychophysiological data (heart rate, heart rate variability, cardiac impedance, skin conductance) utilizing MindWare software

Cognition, Affect, and Temperament Lab — *Lab Director: Dr. Koraly Perez-Edgar*
Department of Psychology, Pennsylvania State University — August 2013 – Present
Research Assistant

- Run study visits (EEG net placement, RSA placement) with children of 5 – 6 years old for social decision making project
- Clean ERP data using BVA
- Transcribed and analyzed speech in 9 – 12 year old children using CLAN CHAT program
- Developed protocols for social decision making task relating to affective responses in 5 – 6 year old children
- Edited behavioral coding manual for social behavior in 9 – 12 year old children
- Coded social interaction, speech, and cooperation in 9 – 12 year old children based on behavioral dues i.e. direction of gaze, facial expression, and quality of voice using Interact
- Analyzed coding discrepancies in behavioral coding in 9 – 12 year old children between coders using Interact and Excel
- Organized questionnaires for parents with children of 5 – 6 years old for social decision making project

Nelson Language Lab — *Lab Director: Dr. Keith Nelson*
Department of Psychology, Pennsylvania State University — January 2013 – May 2013
Research Assistant

- Transcribed and coded story telling narrative in 5 – 7 year old children
- Entered data from story comprehension task in 5 – 7 year old children

Leadership

Vice President May 2013 – May 2014
Raw Aesthetic Movements (RAM Squad)
Pennsylvania State University

- Recruited judges, schedules and annual hip hop dance competition
- Directed largest annual performance for Penn State IFC/Panhellenic Dance Marathon
- Overlook and announce important performance times and events through social media
- Plan weekly schedules for practice time
- Teach hip hop dance to members