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# INDIVIDUAL DIFFERENCES IN STRESS RESPONSES AMONG KINDERGARTENERS:

# BEHAVIOR AND CORTISOL ASSESSED IN SPEECH TASK

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## Abstract

This study examined behavior in response to a speech task (a putative social stressor) and how it related to cortisol levels in five-year-olds. Children were asked to participate in the birthday speech task, a paradigm during which they experienced a threat to their social self. It was expected that overall cortisol would increase in response to the stressor and that increases would be positively correlated with social inhibition and shyness. It was also predicted that timid children would use more regulating behaviors to control their distress. Overall there was no significant increase in cortisol during the speech task. When participants were grouped by the timidity of speech (an indicator of distress), however, there were differences in regulatory behaviors and how these related to cortisol reactivity. Attention shifting (a regulatory behavior) was associated with a decrease in cortisol reactivity in timid children. It is possible that the use of this alienating social behavior (frequent attention shifting) could result in an unhealthy cycle of peer rejection and increased social withdrawal.

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# Introduction

The ability of humans to adapt to their surroundings is essential to normal functioning; in children, this skill is necessary for healthy development. Children must develop the capability to respond to different stressful environmental conditions, whether those conditions involve social interaction, novelty, or family conflict (e.g., Perez-Edgar, Schmidt, Henderson, Schulkin, & Fox, 2008). Responses to stressors such as these involve internal (biological) and external (behavioral) components and it is believed these components are linked (Shirtcliff, Granger, Booth, & Johnson, 2005). The current study is designed to target the link between physiological stress responses and behavior. The stress hormone, cortisol, has been related to internal regulation and response to the external environment (Shirtcliff, 2005). Cortisol reactions can influence behavior in the moment, and shape the development of future social behavior (Perez-Edgar et al., 2008). Therefore, early childhood is a critical time to study this biology-behavioral link. The threshold for stimulation of the HPA system, which produces cortisol, is established early in life (Granger, Stansbury, & Henker, 1994). It is conceivable that this threshold can be influenced by several aspects of a young child's life experience, including patterns of social interactions. In addition, focusing on the preschool years allows researchers to delineate the development of adaptability traits such as self-regulation of emotion and self-control (Stansbury & Harris, 1993). The present study was designed to investigate the physiological and behavioral responses of kindergarten-age children to stressful social situations.

## Cortisol as a Physiological Factor

The specific biological component of interest in the current study is the hypothalamic-pituitary-adrenal (HPA) axis, a physiological system that responds to acute stress by producing the hormone cortisol and releasing it into the body. It is released by the adrenal glands and the basal amount of this hormone in circulation depends on time of day, the highest levels in the morning. Cortisol is also released in higher amounts in response to stress or threat. Cortisol sampling can be an effective assessment of an individual's stress response. The hormone itself can be non-invasively extracted from saliva and increases during periods of novelty, uncertainty, and negative affect. The stress felt as a result of a particular situation can be partially alleviated using certain coping mechanisms and strategies—including but not limited to fidgeting, gaze aversion, and avoidance (Buss & Goldsmith, 2007). There are two different approaches that could be employed in measuring the link between cortisol and behavior. First, one can examine cortisol *levels*, capturing the amount of hormone present at one point in time; this approach could include basal cortisol, morning cortisol, or single instances of laboratory cortisol. Alternatively, one can study cortisol *reactivity*, characterized by a change in cortisol levels over time. This study will be exploring cortisol reactivity, the change in cortisol before and after participation in a stress task.

## Cortisol and Social Behavior

Both approaches to studying cortisol have been utilized in past studies to examine the relationship between cortisol and social behavior. The study of momentary cortisol levels has illustrated that elevated mean hormonal levels are negatively correlated with social competency and positively correlated with social inhibition (Schmidt, Fox, Rubin, Sternberg, Gold, et al., 1997; Kagan, Reznick, & Snidman, 1987; Perez-Edgar et al., 2008; Granger et al., 1994). For example, children who were labeled as extremely wary when confronted with novel stimuli and when involved in social situations were found to have higher morning cortisol than others. They were also found to have overall higher laboratory cortisol, however this was not statistically significant (Schmidt et al., 1997). Behaviorally, this group of extremely wary of children scored higher on maternal reports of shyness (Schmidt et al., 1997). Similarly, higher levels of pre-stress, post-stress, and morning cortisol in five and a half year olds were positively correlated with social inhibition, which was described as exhibition of timidity and withdrawal (Kagan et al., 1987). Withdrawal was also found to correlate with high basal cortisol in boys with negative temperaments, which was measured using a composite score of negative affectivity (Perez-Edgar et al., 2008).

Cortisol reactivity, measuring changes in HPA activation in response to stress, also supports this link between cortisol and social behavior. For example, increased cortisol reactivity in response to social conflict indicated lower social competency as well as emotional behavioral problems (Granger, Weisz, McCracken, Ikeda, & Douglas, 1996). More specifically, increased reactivity has been associated with negative affect (Davis, Donzella, Krueger, & Gunnar, 1999; Gunnar, Tout, de Haan, Pierce, & Stansbury, 1997) and solitary behavior (Gunner et al., 1997). Conversely, the hormone levels of children who perceived themselves as socially competent returned to baseline more quickly than those who saw themselves as low in social competence. This suggests that the latter group is less able to regulate negative emotionality (Schmidt, Fox, Sternberg, Gold, Smith, & Schulkin, 1999).

This evidence supports a link between cortisol, in higher mean levels and greater reactivity levels, and social inhibition. However, research findings about the nature of this relationship are somewhat mixed. High levels of mean cortisol have been associated with increased popularity, frequency of social interactions initiated, and social competence as described by teacher report (Tennes & Kreye 1985). In addition, high amounts of cortisol reactivity were shown to correlate with increased social competence in boys while it was negatively correlated with shy behavior (Hart, Gunnar, & Cicchetti, 1995). Increased reactivity was also linked to extroversion in elementary school children (Davis et al, 1999). This controversy suggests that more empirical research concerning cortisol and social inhibition in children is needed.

Regardless of the manner in which these biological and behavioral elements of development are related, failure to develop healthy adaptability can result in a spectrum of maladaptive behavior, ranging from mild to severe. Reactivity registering at either extreme can result in behavioral problems. Low levels of cortisol were linked to early onset aggression in a clinically-referred male sample (McBurnett, Lahey, Rathouz, & Loeber, 2000), and are correlated with increased levels of both aggression and hostility in normal school children (Tennes & Kreye 1985). On the other hand, high cortisol associated with depression and anxiety disorders (Granger et al., 1996). It was also found that increased baseline and stress-induced cortisol were associated with hyperactivity, impulsivity, and emotion problems in boys (Hatzinger, Brand, Perren, von Wyl, von Klitzing, & Holsboer-Traschler, 2007).

**Shy Social Behavior**

It is clear that when confronted with social situations, children can react in a variety of ways. On one hand, children who are more socially competent tend to be comfortable, display focused-attention, and exhibit a willingness to interact with others in social situations (Eisenberg, Shepard, Fabes, Murphy, & Guthrie, 1998). Conversely, other children demonstrate timidity, shyness, and inhibition in the same situations. Inhibited children have been characterized as possessing a tendency to react with fear and wariness when encountering unfamiliar stimuli (Kagan et al., 1987; Schmidt et al., 1997). This display of inhibition was marked by timidity and shy behavior. Also, a study found that at 14 months, children who were wary of novel stimuli were also socially wary during peer play. The children who persisted in wary behavior during peer play were rated as more shy on maternal reports than others (Schmidt et al., 1997). As a result, it is clear that social inhibition and shyness are intertwined. Both nonsocial and social inhibition were found to function as predictors of children's social behavior, though in different ways; nonsocial behavior was shown to predict play patterns while social inhibition projected interactive techniques. In this way, social inhibition was found to be a significant predictor of shyness (Kochanska & Radke-Yarrow, 1992).

**The Role of Emotion Regulation**

Along with inhibition and timidity, emotional regulation also plays a role in social behavior. The term emotional regulation denotes certain mechanisms that function to modify the intensity of emotion—such as negative emotion evoked in response to a stressful social situation (Rubin, Coplan, Fox, & Calkins, 1995). Rubin and his colleagues (Rubin et al., 1995) conducted a study showing that children who were low in social interaction and low in capacity to emotionally regulate exhibited wary, internalizing, and anxious behavior. However, children who scored low in social interaction but did not have issues regulating emotion did not display social difficulties. This study indicates that the presence or absence of effective emotional control has implications concerning social competence (Rubin et al., 1995).

The elements of social inhibition, shyness, and emotional regulation all play roles in the development of social behavior, and are therefore interrelated. This point is successfully illustrated by a past study which measured shyness through maternal and teacher reporting. Shyness ratings were related to social behavior, emotionality, and regulation—or coping. Children who were reported as shy tended to internalize negative emotion and use insufficient coping mechanisms. Four to six-year-old children who scored high in emotional internalization on parent reporting were shown to be shy at ages 8-10. Parent reporting of inhibition was correlated with avoidant coping mechanisms and social wariness when dealing with unfamiliar people. Teacher reports of inhibition were associated with social evaluative concerns, which include the judgment of others (Eisenberg et al., 1998).

Similar to physiological dysregulation, the inability to successfully interact in social settings can have negative long-term implications for children's development. One study found that children who were consistently identified as inhibited from age four to seven had higher rates of anxiety disorder (Hirshfeld, Rosenbaum, Biederman, Bolduc, Faraone, Snidman, Reznick, & Kagan, 1992). Children with insufficient emotional regulation as toddlers were also found to maintain that poor regulating ability at five years old and exhibited increased negativity. Poor emotional regulation was further associated with negative social outcomes and these children were considered less likeable by peers (Blandon, Calkins, & Keane, 2010). Sociable children were found to be more successful in using interpersonal negotiation strategies than those who were less socially competent. Socially withdrawn children tend to shy away from interactions with peers and as a result may not acquire social skills vital to development of a positive self-image and normal social life (Rubin & Burgess, 2001). Reluctance to engage in social interaction and withdrawal are associated with negative self-image and with perceived peer rejection. These perceptions can in turn prevent the child from future social interaction, which prevents the development of necessary skills, and can perpetuate negative emotions and cognitions, potentially leading to the child's interpretation of social situations as stressors.

**Effective Paradigms to Elicit Stress**

In order to successfully study the connection between cortisol and social behavior, one must use an effective stressor paradigm that significantly raises cortisol levels and stress levels in the target population. Public speaking (e.g., taking turns speaking in front of a group of children) has been found to cause elevated hormonal activity in children, increasing cortisol 2-4 times above baseline (Kirschbaum, Pirke, & Hellhammer, 1993). A meta-analysis of over one hundred cortisol studies by Gunnar, Talge, and Herrera (2009) compared findings from paradigms involving public speaking, as well as those centered on novelty, threatening, mild pain, physical examination, and negative emotion. Paradigms most similar to the Trier Social Test for Children successfully activated the HPA axis in children over the age of seven because it incorporates the vital elements of uncontrollability, unpredictability, low availability of coping resources, threat to the social self, and self-evaluation. This paradigm includes an anticipation phase and a phase in which participants must give an impromptu speech and do mental mathematics in front of an audience. The article suggested the birthday task, which is similar to the Trier Social Test for Children, for studying children under seven. In this task, children are asked to stand before a group of their peers and give a speech about their last birthday party. Though this has not been extensively tested as of yet, the task induces sufficient levels of anxiety and will be utilized in the present study (Gunnar, Talge, & Herrera, 2009). In dealing with this anxiety, children will employ coping strategies, attempting to alleviate stress and negative feelings. The birthday task is a context in which the participants have limited control over the proceedings; however, coping techniques such as gaze aversion, fidgeting, whispered voice, and certain avoidant behaviors are available. Therefore, it is plausible that displays of these behaviors reflect the amount of stress/anxiety felt by each participant. Some behaviors, such as negative expression and partial voice, indicate the presence of distress while others, such as avoidance and shifting attention from the stressor, indicate the regulation of that distress. For example, it has been found that children who are less able to focus their attention tend to be more shy. However, this was only found to be true in teacher reports, not parent reports, leaving the area of attention regulation open for contribution (Eisenberg et al., 1998).

### The Current Study

The purpose of this study was to explore the relationship between physiology and behavior observed during a stress task. Five-year-old children came to the laboratory to participate in a peer visit. As part of this visit, they were placed with same-age, same-sex unfamiliar peers, ranging from 3 to 4 members, and asked to give a speech in front of the peer group (and experimenter) about their last birthday. Age five often marks the entrance to kindergarten and therefore also marks the intensifying of social pressures (Granger et al., 1994). It is the goal of this study to shed light on the link between laboratory cortisol reactivity and social inhibition. In past studies, inhibited five and a half years olds were found to have higher laboratory and morning cortisol (Kagan et al., 1987). It is predicted that higher levels of laboratory cortisol reactivity will be correlated with increased social inhibition and shy behavior. We predict that these children would also utilize regulatory strategies like gaze aversion and avoidance to deal with their elevated anxiety.

## Method

### Participants

A subsample of seventy-one children (38 boys) participating in a larger longitudinal study of emotion development were the focus of the present investigation. Participants were recruited from several counties in Missouri and were predominantly middle class and Caucasian (Hollingshead *M* = 47.10, *range* = 17-66; 97.2% Non-Hispanic Caucasian). As part of the larger study, children completed multiple assessments (age 2, 3, 4, and 5). A laboratory peer visit at age 5 is the focus here. In this peer visit, the participating child was grouped with three or four unfamiliar, same-sex peers. Usually these groups were composed of multiple study participants, but in some cases due to scheduling constraints, children from the surrounding community were brought in to fill in any gaps.

**Procedure**

The kindergarteners were invited to the lab to participate in a visit lasting approximately 30-40 minutes in total. During the visit, the children took part in three episodes intended to measure social inhibition. The first consisted of group free play involving age-appropriate toys and lasting for 15 minutes. Next, the group was given 10 minutes to work together in order to make packets consisting of colored cards (i.e., a card sort). The final episode of the visit was the birthday speech task, which is the episode of interest in the current study. This task, like the others, took place in an empty room containing a one-way mirror; it began with the children sitting with their backs to this mirror. The experimenter then explained the task, describing it as a game of show-and-tell, and asked participants to stand up and tell the audience about their last birthday. If the child could not remember a birthday, the experimenter stated that he/she can talk about something else. Following the explanation, the experimenter asked who would like to go first, giving the children the opportunity to volunteer. If the child did not volunteer s/he will be prompted and encouraged by the experimenter. When a child does participate, he or she should stand facing his/her peers. When the child was done, the experimenter asked if there was anything else he/she would like to add. If the child confirmed that s/he was finished, the experimenter followed up with something positive like “great job”.

**Salivary Cortisol**

Samples of salivary cortisol were taken on three occasions during the course of this visit. Sample one was collected upon arrival to the lab, sample two was taken after the card sort task, and sample three was collected by parents twenty minutes after the study and mailed back to the lab. Cortisol levels are thought to peak approximately 15-20 minutes after the onset of the stressor. Due to this lag in cortisol activation, the difference between samples two and three will serve as measures of baseline and post-task cortisol reactivity (i.e., baseline levels immediately before and post-task level 20 minutes after the speech task).

Cortisol was collected by having the children chew on braided cotton dental rolls, which could be dipped into sugar crystals to make them more appealing. Once fully saturated, the dental rolls were secured in airtight conical tubes. Samples one and two, taken at the lab, were refrigerated until the end of the visit. Sample three, taken by parents, was refrigerated until it was sent into the lab. Samples were frozen at -50°F until shipping, at which point they were sent on ice to the Behavioral Endocrinology Laboratory at Penn State University where they were frozen at -80°F until assayed (Salimetrics, State College, PA). On the day of cortisol assay, the samples were centrifuged at 3000 rpm for 15 minutes in order to remove mucins. Then samples were assayed for salivary cortisol utilizing an enzyme immunoassay US FDA (510) cleared to function as an in vitro diagnostic measure of adrenal activity (Salimetrics). The test required 25 μL of saliva and had a sensitivity range of .007 to 3.0 μg/dL. It also had an average intra-assay coefficient of variation less than 5% and an inter-assay coefficient less than 10%.

**Behavioral Coding**

The participants' performances were video-taped through the one-way mirror and both global and second-by-second coding systems were used to quantify behavior during the task. Each participant's place in the speaking order of his/her group was noted, as was whether or not the child volunteered to speak or refused altogether. Each child's overall negative affect, overall positive affect, and speech intensity were coded globally. The scale for overall affect codes ranged from 1 to 5, a 1 representing little to no positive/negative affect and a 5 representing an almost constant presence of positive/negative affect. The global code for speech intensity was an overall impression based on behavior and quality of speech. The scale for speech intensity ranged from 1 to 4: 1 exemplifying extreme timidity and low speech quality, 2 representing timidity and insufficient detail in speech, 3 representing normal speech, and 4 illustrating over-exuberance. For example, a child scoring a 3 would speak clearly and confidently, include appropriate detail, and exhibit body language free of avoidant behavior. In contrast, a child scoring a 1 would mumble or refrain from speaking, attempt to avoid the audience by turning away or looking down, and include little if any detail. The coding also included second-by-second coding of bodily freezing, bodily pleasure, whispered speech, fidgeting, disfluencies/hesitations, prompting from the experimenter, time speaking, avoidance behavior, and gaze aversion. Avoidance behavior consisted of physically attempting to avoid the audience by turning of the head or body, covering the face, or moving backwards. The gaze aversion code captured the target of the participants attention at every second of the episode (i.e., the wall, mirror, floor, audience). Latency to start speaking, latency to first fear response, and latency to fidget were also coded.

Twenty-eight percent of episodes were coded separately by two trained coders to establish coder reliability. Global coding reliability was found to be sufficient (affect: $\kappa$ ranging from 0.52 to 0.53; speech intensity: $\kappa = 0.68$). The second-by-second reliability was good (vocalization: $\kappa$ ranging from 0.80 to 0.91; gaze behaviors $\kappa = 0.84$; bodily behaviors: $\kappa$ ranging from 0.34 to 0.46; discrete behaviors: $\kappa$ ranging from 0.75 to 0.90).

## Data Transformation

Raw cortisol values were positively skewed and natural log transformed. A MCAR test of the pattern of missingness found that the data was most likely missing at random ($p = 0.28$; chi square = 8.59). Missing cortisol data was imputed using the expected maximization (EM) algorithm so that all children who participated in the speech task episode could be used in analyses.

## Variable Creation

Cortisol reactivity in response to the speech task was measured by creating a variable representing the difference between the values of sample 3 and sample 2. Composite variables were also created to represent behavior. A variable labeled "attention shifting" represented the number of looks by a participant that were not towards the audience. "Attention shifting" was calculated as the proportion of looks away from the audience (looks not to audience divided by the child's total number of looks). In this way, this variable captures a child's attempt to avoid attending to the audience.

# Results

## Preliminary Analyses

Descriptive statistics were run on all variables; means and standard deviations are presented in Table 1. The cortisol values used in this descriptive analysis are the natural log transformed variables; contrary to our expectations the overall trend was for means to decrease from the time participants arrived at the visit, sample 1, to the time capturing the cortisol associated with the speech task, sample 3. A series of independent t-tests was performed to examine gender differences in the study's variables. It was found that there were no significant differences in cortisol levels resulting from gender ($t$s $\leq 1.62$, $p$s $\geq 0.07$). In addition, a series of independent t-tests explored group differences between children who refused to participate ($n$ = 8) and those who did not refuse ($n$ = 63). No significant differences in cortisol were found between these two groups ($t$s $\leq 0.61$, $p$s $\geq 0.20$).

## Primary Analyses

We expected group level differences to be informative concerning patterns of social behavior. As a result, we created groups of participants in two different ways: first based on volunteering (i.e., whether they volunteered to speak or not) and then again based on timidity (i.e., a timid child would give a low quality speech and exhibit avoidant/wary behavior), examining both mean differences and partial correlations regarding cortisol reactivity and behaviors (i.e., negative affect and attention shifting). We expected whether a child volunteered or did not volunteer to reflect their confidence in the social situation, and therefore it would be an indicative grouping technique. Also, we chose to group participants based on timidity in order to capture social inhibition and shyness. The behavioral variables examined were overall negative affect (NA) and attention shifting. In our analyses these two variables, sample size varied across the measures. There were two cases in which the coders could not see the child's face in order to score negative affect but could see the direction in which the child was looking and could code attention shifting.

**Mean level group differences in behavior.** Additional independent t-tests were conducted to examine group differences in behavior and cortisol. However, there were no significant differences in cortisol or behavior between the group of children who did volunteer to participate and the group who did not volunteer, and were instead prompted to participate. Overall negative affect was significantly higher in the group of children who did not volunteer ($t(48) = 3.37$, $p < 0.001$), and attention shifting was used significantly more often by the group of children who volunteered ($t(49) = -2.04$, $p < 0.047$). Descriptives are in Table 2.

We were interested in comparing children who were timid to those who were not timid. This determination of timidity was based on speech intensity; children scoring a 1 or 2 on the scale were labeled as timid and those scoring a 3 or 4 were labeled as not timid. A score of 1 or 2 indicated avoidant behavior and low quality of speech, a score of 3 indicated a detailed speech and more confident behavior, and a score of 4 indicated hyperactivity or over-exuberance. Interestingly, as shown in Table 3, there were no group differences found between timid participants and participants who were not timid ($t$s $\leq -1.42$, $p$s $\geq 0.08$). Because variables such as these were predicted to be related to cortisol but did not yield the expected effects, a deeper analysis was conducted to probe the pattern of associations.

**Correlations between biological and behavioral measures.** First, a partial correlation matrix was constructed to illustrate the intercorrelations among all study variables for the complete sample of participants. This matrix is shown in Table 4. Cortisol values and behavioral measures were included, controlling for time of day that the initial lab cortisol sample was taken. As expected, cortisol time point levels were positively correlated with one another. Overall negative affect was significantly correlated with cortisol reactivity ($r = 0.26$, $p < 0.049$) and, interestingly, not correlated with the behavioral regulation (attention shifting) variable ($r = -0.12$, *n.s.*).

Next, we examined the pattern of partial correlations in separate groups of children based on whether they volunteered to give their speech or did not volunteer. The results for those who did volunteer, shown in Table 5, indicate that there was a positive correlation between negative affect and cortisol reactivity to the speech task, meaning that increased negative expression was linked to an increase in cortisol from sample 2 to sample 3 ($r = 0.43$, $p < 0.013$). In addition, attention shifting was marginally correlated with a decrease in cortisol reactivity to the speech task ($r = -0.34$, $p < 0.055$).

The results for children who did not volunteer (Table 6) and were thus prompted to participate indicate that attention shifting is negatively correlated with the cortisol reactivity variable ($r = -0.56$, $p < 0.04$). In other words, as children increasingly shifted their attention away from the audience, their cortisol decreased more steeply, indicating physiological recovery after the stressful speech task.

We also examined partial correlations separately for timid and non-timid groups of children. There were no significant correlations concerning the cortisol or behavior of those who were not timid (Table 7). On the other hand, for timid participants, attention shifting was negatively correlated with cortisol reactivity ($r = -0.40$, $p < 0.04$). Therefore, an increase in this regulatory behavior is linked with a decreased in cortisol from sample 2 to sample 3 (Table 8). This is a noteworthy finding because the pattern of correlation did not differ by volunteering group, but differed across timidity groups significant. This suggests a link between shyness and regulation of distress—a distress that is best captured through the assessment of children's ongoing behavior during a stressful task—something that should be explored further.

## Discussion

The purpose of this study was to examine the link between cortisol and social behavior. More specifically, we were interested in affective behavior related to social inhibition and shyness, such as regulatory strategies and negative affect. Five-year-olds were asked to participate in a mildly stressful task in which they gave a speech in front of their peers. Their performances were observed for social behavior, which was then analyzed in combination with their cortisol reactivity. We found that there were no overall increases in cortisol in response to the speech task. We did find that, in children who were classified as timid, attention shifting (regulatory behavior) was related to a decrease in cortisol. Next we will summarize all of the findings and discuss their implications.

### Findings Related to Cortisol Means and Reactivity

We predicted that mean cortisol levels, assessed in three samples collected throughout the visit, would be highest during the speech task. It has been suggested by past studies that tasks involving public speaking and social evaluation lead to significant cortisol increases in children (Kirschbaum et al., 1993; Gunnar et al., 2009). Stressor paradigms that were most similar to the Trier Social Stress Test (TSST) for Children were most effective in raising cortisol levels. The birthday speech task, used in the current study, involved elements of uncontrollability, self-evaluation, threat to social self, and unpredictability—all factors that have been shown to successfully activate the HPA axis (Gunnar et al., 2009). However, there were no overall increases in mean cortisol levels across the three time points in this sample. There are two possible explanations for this finding that was in contrast to my predictions. First, this could be because the paradigm that has been shown to be effective, the speech task, was preceded by one that has been shown to be ineffective at eliciting stress, card sorting. This task was unlikely to be stressful and may have therefore provided a reprieve from the distress of social interaction; thus resulting in decreased levels of cortisol. This decrease could have thrown off cortisol values for the speech task. Second, and more probably, the TSST is the paradigm that was proven lucrative; the birthday speech task differs slightly from this test. These two tasks are alike in that they both include social evaluation and speeches given before an audience. However, the TSST for Children alone involves performing mental mathematics, and the children are told their speeches will be video-taped and judged (Gunnar et al., 2009).

In spite of our specific prediction that an overall increase in cortisol would be detected, the existing research findings are mixed. For example, our results are in contrast to those found by another a study, in which cortisol increased with inhibition to unfamiliar social situations (Kagan et al., 1987). In the current study, there was no overall increase in cortisol resulting from the stressor, and this is consistent with other research that also did not find significant increases in laboratory cortisol (Schmidt et al., 1997). In our study, the highest cortisol value was that taken upon arrival to the laboratory, a sample time which was intended to capture a baseline. It is possible that the anticipation of interacting with unfamiliar peers acted as a stressor to children before the visit began, and this apprehension triggered cortisol activation. Because we did not detect an overall pattern of increasing cortisol across the three time points, we instead looked at cortisol reactivity for all participants.

Specifically, this study looked at the difference (e.g., the cortisol reactivity) between samples 2 and 3 to capture cortisol reactivity in response to the speech task. Sample 2 was taken just before the birthday speech task (thus serving as a natural baseline for stress elicited by this task), and Sample 3 was taken 20 minutes after the end of the study procedures. This reactivity variable was used in place of using the difference between sample 1 and 3 because it more precisely captured the portion of cortisol reactivity in the peer visit that was specific to the speech task. It has been found in the past that social conflict tasks have increased cortisol reactivity in children with low social competency (Granger et al., 1996). However, we did not see a trend such as this when using the birthday task. There was no overall increase or decrease in cortisol during this task when considering all participants; therefore we decided to look at groups of children, based on their behavior during the task, in order to identify differences in cortisol reactivity.

**Physiological Findings Based on Grouped Participants**

To examine whether there were differences in the relation of cortisol and affective behavior in children based on observable behavior, the children were grouped based on whether they volunteered to participate or were prompted to participate. This was because we predicted that volunteering could represent social competency, which has been associated with lower cortisol reactivity (Granger et al., 1996). However, no group differences were observed between the cortisol (mean levels or reactivity) of children who volunteered and that of children who did not. Next, participants were grouped according to timidity of their speech as a second behavioral indicator of social competency. Based on past research, it was expected that higher cortisol would be associated with social withdrawal or shyness (Perez-Edgar et al., 2008; Smider et al., 2002). However, there were no significant differences between the cortisol of timid children and the cortisol of non-timid children. Because we did not find any mean differences when splitting the participants, we then investigated how affective behavior related to cortisol reactivity using partial correlations.

## Patterns between Cortisol and Behavior

When examining the overall partial correlation (controlling for time of day of the first cortisol sample) matrix for the key variables of our study, we found that cortisol reactivity was positively correlated with negative affect. In other words, negative affect was associated with an increase in cortisol. This finding is consistent with our hypotheses (Davis et al., 1999), and it provides evidence that the birthday task was indeed stressful to the children participating in it and elicited negative affect. Interestingly, there was no correlation between attention shifting—a regulatory behavior—and reactivity for the complete sample. Because we did not find any overall associations between cortisol and attention shifting behavior, but had strong theoretical reasons to expect cortisol and affective behavior to be associated differently for children who were more or less socially competent, we then investigated the patterns of the behavior as they related to cortisol reactivity separately within the groups we created.

**Correlations Based on Volunteering.** Although the relationship between attention shifting and reactivity was not significant when comparing the complete population of participants, attention shifting was linked to a decrease in cortisol in both children who volunteered and those who did not. This discrepancy can be explained by the number of children

($n = 12$), included in the complete sample, who were not given the opportunity to volunteer due to experimenter error. The experimenter on these occasions delineated the order of speakers; it is possible that having a definite, predictable spot in the order of speakers alleviate some children's distress about waiting to speak. If this was the case and the task became less stressful, there would be a reduced need for regulatory behaviors, hence no significant relationship. However, when the variance added by this subset of children was removed (by grouping the participants by volunteering) reactivity was substantially correlated with regulation.

In addition, negative affect was correlated with reactivity in children who did volunteer, but was not correlated in children who did not volunteer. This could be because the children who volunteered were ill prepared to handle the stress of social evaluation once they were standing in front of their peers. It was not uncommon in watching the video-taped performances to see a child who had volunteered freeze up once he or she was standing in front of the audience, often exhibiting negative affect upon his or her realization of the stress associated with the speech. It is also possible that volunteering itself could be a regulatory behavior, helping the children exert some control over their situation. These children would be distressed at the thought of participating and use the action of volunteering to regulate that distress. After examining the pattern of correlations within each volunteering group, we were interested in focusing on ongoing timid behavior, because this would better indicate children's physiological and emotional distress over the course of the speech.

**Correlations Based on Timidity.** Children labeled as timid usually exhibited this behavior throughout their speech, making timidity an ongoing behavior more useful for capturing a child's distress over the course of the task. Investigating the relationship between cortisol reactivity and attention shifting regulatory behaviors in children who were timid versus children who were not timid shed some light on this pattern of behavior. Regulatory behaviors were significantly correlated with a decrease in cortisol, but only among the group of children we identified as timid; this link between regulation and shyness is supported by the literature (Rubin et al., 1995; Eisenberg et al., 1998). For example, Rubin and his colleagues (Rubin et al., 1995) suggested that dysregulation played a part in the development of maladaptive socioemotional tendencies. In addition, research by Eisenberg and colleagues found that behavioral inhibition was linked to avoidant regulation tendencies (Eisenberg et al., 1998). There is only a noteworthy difference in regulation when the sample is split by timidity, this difference did not exist when we looked at separate volunteering groups (i.e., the relation between cortisol and regulatory behavior was similar within both volunteering groups).

There were no mean differences in cortisol levels or reactivity between timidity groups, which implies that children from both groups were starting at the same point physiologically, timid children were not beginning with higher stress levels. Our findings illustrate that the regulatory behavior of attention shifting was effective in offsetting some of the children's distress (i.e., the most fearful children). It seems that the more these children, shifted their attention to look away from the stressor, the more this regulatory behavior lowered participants' physiological distress.

It has been shown before that shyness is positively related to the use of coping techniques, including avoidant coping and attention shifting (Eisenberg et al., 1998). Timid children need behaviors such as these more so than do non-timid children to deal with the distress they feel as a result of social interaction. If regulation such as this aids children in reducing some of their socially induced stress, they may begin to unconsciously rely on these behaviors for relief. If these shyer children repeatedly use socially inappropriate behaviors, such as attention shifting, that alienate themselves from other children, their peers may start to ostracize them. It has been found in prior research that children with higher cortisol reactivity engage in not only overcontrolled behavior, but also in socially inappropriate, or odd, behavior. In this way regulatory behaviors can reinforce a cycle of peer rejection and increased timidity in shy children (Nelson et al., 2005).

**Limitations and Future Directions**

Although the concurrent sampling of key study variables means that we cannot argue for the direction of causality, our findings have provided food for thought concerning cortisol reactivity, social shyness, and regulation. In future research, a larger and more diverse sample size would be beneficial for further investigation of this relationship. In some instances my predictions were not supported, and this may have been due in part to the small sample with complete behavioral and physiological data available to examine. Also, it would be interesting to conduct a similar study with a sample of children who have problems with internalizing behavior or anxiety; our current sample was a low-risk community sample. Similar studies would benefit from ensuring experimenter consistency, giving all children the opportunity to volunteer. In addition, we needed to impute some of our cortisol data due to missing values. Future studies may explore the link between cortisol and behavior in more depth by additionally analyzing basal or morning cortisol patterns; this would better encompass all aspects of the research questions posed here.

**Conclusion**

In sum, this study resulted in a variety of findings. It was predicted that cortisol levels would increase in response to a social stressor, and children would use different affective behavior in response to this increase. Instead, we found that physiological distress was alleviated through the use of regulatory attention shifting by children who were timid. Though effective stress regulation may appear to be beneficial for children, an over-reliance on avoidant regulatory strategies like attention shifting may trigger a cycle resulting in further introversion. Future study is required to better identify the connection between shy children, stress regulation, and the implications shyness can have for children in social arenas.

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Table 1

*Descriptive Statistics for Key Study Variables*

| | Minimum | Maximum | M (SD) |
|---|---|---|---|
| Cortisol (*n* = 71) | | | |
| Lab Cortisol 1 | -4.61 | -1.02 | -2.63 (0.59) |
| Lab Cortisol 2 | -5.12 | -1.39 | -2.90 (0.62) |
| Lab Cortisol 3 | -3.86 | -1.90 | -2.88 (0.42) |
| Cortisol Reactivity | -1.13 | 1.89 | 0.03 (0.59) |
| Behaviors | | | |
| Overall NA (*n* = 61) | 1.0 | 4.0 | 1.66 (0.91) |
| Attention shifting (*n* = 63) | 0.0 | 1.0 | 0.56 (0.15) |

*Note.* The cortisol values are natural log transformed. Cortisol Reactivity represents cortisol values from sample 2 minus values from sample 3. Attention shifting refers to the proportion of looks not to the audience over total number of looks.

Table 2

*Means and Standard Deviations By Volunteering Groups*

| | Did Volunteer | Did Not Volunteer |
|---|---|---|
| Cortisol | *n* = 36 | *n* = 23 |
| Lab Cortisol 1 | -2.69 (0.63) | -2.56 (0.61) |
| Lab Cortisol 2 | -3.00 (0.71) | -2.79 (0.54) |
| Lab Cortisol 3 | -2.89 (0.38) | -2.87 (0.49) |
| Cortisol Reactivity | 0.11 (0.63) | -0.09 (0.53) |
| Behaviors | *n* = 35 | *n* = 15 |
| Overall NA | 1.40 (0.78)** | 2.27 (0.96)** |
| | *n* = 36 | *n* = 15 |
| Attention Shifting | 0.59 (0.12)* | 0.51 (0.17)* |

*Note*. *$p < .05$; **$p < .01$; Group differences from t-tests are marked with asterisks. The cortisol values are natural log transformed. Cortisol Reactivity represents cortisol values from sample 2 minus values from sample 3. Attention shifting refers to the proportion of looks not to the audience over total number of looks.

Table 3

*Means and Standard Deviations By Timidity of Speech Groups*

| | Timid | Not Timid |
|---|---|---|
| Cortisol | *n* =31 | *n* = 32 |
| Lab Cortisol 1 | -2.61 (0.64) | -2.65 (0.53) |
| Lab Cortisol 2 | -2.90 (0.63) | -2.95 (0.61) |
| Lab Cortisol 3 | -2.92 (0.38) | -2.86 (0.41) |
| Cortisol Reactivity | -0.02 (0.59) | 0.10 (0.60) |
| Behaviors | *n* =31 | *n* = 32 |
| Overall NA | 1.83 (0.97) | 1.50 (0.84) |
| | *n* = 29 | *n* = 32 |
| Attention Shifting | 0.53 (0.18) | 0.59 (0.09) |

*Note*. The cortisol values are natural log transformed. Cortisol Reactivity represents cortisol values from sample 2 minus values from sample 3. Attention shifting refers to the proportion of looks not to the audience over total number of looks.

Table 4

*Partial Correlations of Key Variables for Full Sample (n = 71)*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1: Lab Cortisol 1 | | | | | |
| 2: Lab Cortisol 2 | 0.78*** | | | | |
| 3: Lab Cortisol 3 | 0.42** | 0.38** | | | |
| 4: Cortisol Reactivity | -0.55*** | -0.80*** | 0.25~ | | |
| 5: Overall NA | -0.06 | -0.21 | 0.05 | 0.26* | |
| 6: Attention Shifting | 0.56 | 0.17 | -0.07 | -0.23~ | -0.12 |

*Note.*~*p* < .10; **p* < .05; ***p* < .01; ****p* < .001. The cortisol values are natural log transformed. Cortisol Reactivity represents cortisol values from sample 2 minus values from sample 3. Attention shifting refers to the proportion of looks not to the audience over total number of looks.

Table 5

*Partial Correlations of All Variables for Participants Who Volunteered (n = 35)*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1: Lab Cortisol 1 | | | | | |
| 2: Lab Cortisol 2 | 0.88*** | | | | |
| 3: Lab Cortisol 3 | 0.58*** | 0.49** | | | |
| 4: Cortisol Reactivity | -0.67*** | -0.86*** | 0.02 | | |
| 5: Overall Negative Affect | -0.35* | -0.31 | 0.14 | 0.43* | |
| 6: Attention Shifting | 0.29 | 0.36* | 0.12 | -0.34~ | -0.07 |

*Note.*~$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$. The cortisol values are natural log transformed. Cortisol Reactivity represents cortisol values from sample 2 minus values from sample 3. Attention shifting refers to the proportion of looks not to the audience over total number of looks.

Table 6

*Partial Correlations of All Variables for Participants Who Did Not Volunteered*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1: Lab Cortisol 1 | | | | | |
| 2: Lab Cortisol 2 | 0.63* | | | | |
| 3: Lab Cortisol 3 | 0.40 | 0.32 | | | |
| 4: Cortisol Reactivity | -0.26 | -0.66* | 0.50 | | |
| 5: Overall NA | 0.27 | -0.29 | -0.07 | 0.21 | |
| 6: Attention Shifting | -0.12 | 0.23 | -0.45 | -0.56* | 0.0 |

*Note*. *$p < .05$; **$p < .01$; ***$p < .001$. The cortisol values are natural log transformed. Cortisol Reactivity represents cortisol values from sample 2 minus values from sample 3. Attention shifting refers to the proportion of looks not to the audience over total number of looks.

Table 7

*Partial Correlations of All Variables for Non-Timid Participants*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1: Lab Cortisol 1 | | | | | |
| 2: Lab Cortisol 2 | 0.73*** | | | | |
| 3: Lab Cortisol 3 | 0.37* | 0.36* | | | |
| 4: Cortisol Reactivity | -0.49 | -0.77* | 0.32 | | |
| 5: Overall NA | 0.03 | -0.15 | 0.20 | 0.28 | |
| 6: Attention Shifting | -0.07 | -0.24 | 0.20 | 0.33 | 0.42 |

*Note*. *$p < .05$; **$p < .01$; ***$p < .001$. The cortisol values are natural log transformed. Cortisol Reactivity represents cortisol values from sample 2 minus values from sample 3. Attention shifting refers to the proportion of looks not to the audience over total number of looks.

Table 8

*Partial Correlations of All Variables for Timid Participants*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1: Lab Cortisol 1 | | | | | |
| 2: Lab Cortisol 2 | 0.84*** | | | | |
| 3: Lab Cortisol 3 | 0.50** | 0.41* | | | |
| 4: Cortisol Reactivity | -0.60** | -0.83*** | 0.16 | | |
| 5: Overall NA | 0.03 | -0.15 | 0.20 | 0.28 | |
| 6: Attention Shifting | 0.10 | 0.23 | -0.25 | -0.40* | -0.13 |

*Note*. **p* < .05; ***p* < .01; ****p* < .001. The cortisol values are natural log transformed. Cortisol Reactivity represents cortisol values from sample 2 minus values from sample 3. Attention shifting refers to the proportion of looks not to the audience over total number of looks.

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