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EFFECTS OF EYE TRACKING DURING INFANCY ON SOCIAL AMBIGUITY AND EMOTIONAL DISTRESS

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EFFECTS OF EYE TRACKING DURING INFANCY ON SOCIAL AMBIGUITY AND
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By

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By

Gabriela Hernandez

DEDICATION

This dissertation is dedicated to Lynn Beck Brallier. Lynn, I will be eternally grateful for your friendship, mentorship, for the laughs, and the unwavering support. You encompass all that I aspire to become. Thank you for the shared wisdom and our many walks.

"When words are both true and kind they can change the world" (Buddha).

ACKNOWLEDGMENTS

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Abstract

By Gabriela Hernandez

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2020

The purpose of this study was to investigate the relationship between early eye tracking

and later non-suicidal self-injury, and whether this relationship was negatively impacted by

distress and impulsivity, and conversely alleviated by emotional regulation and problem solving

abilities. Briggs-Gowan et al. (2001) found that young children with recurrent and comorbid

externalizing and internalizing problems have the most impairment; they exhibit greater

difficulty with emotional stability, and require greater utilization of mental health services. Little

research has focused on the relationship between eye tracking in early infancy and suicidal self-

injurious (NSSI) behavior in early childhood. Multiple regression analysis was used to

determine if eye-tracking in early infancy and later self-injurious behavior is mediated by

impulsivity, distress, problem solving, and emotion regulation; for which child's gender and

income-to- needs as the control variables. Data from the National Institute of Child Health and

Development (NICHD) Study of Early Child Care and Youth Development (SECCYD).

When examining the mediating influence of early eye tracking at 15 months in the

relationship between self-injurious behavior at 15 years of age, distress at 54 months, impulsivity

at 54 months, emotion regulation in the 5th grade, and problem solving in the 6th grade, it was

found that these variables did not have a significant mediating effect. Although the hypothesized

path model was the most parsimonious, the results suggested that impulsivity acts as a mediator

in the relationship between SES and problem solving. As such, impulsivity may be directly

associated with the functions of problem solving. The significance of this study is that it adds to

the research that emphasizes the importance of understanding early markers (e.g., eye tracking in

early infancy) for social outcomes and should be utilized by educators, parents, and early

intervention programs to ensure social success for children. However, the results in this study

should not be considered for the use of policymaking, given the limitations presented.

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CHAPTER 1: INTRODUCTION

According to Bagner et al. (2012), behavioral and emotional problems are highly

prevalent in early childhood and represent an important focus of practice for clinicians and

psychologists. Research has found that psychopathology rates in preschoolers may be as

prevalent as those in school-age children (Bufferd et al., 2012), which suggests that the etiology

begins in early childhood. While psychological or psychiatric disorders are not typically

diagnosed in children under the age of 2 years, research supports assessing behavioral and

emotional problems during the first 2 years of life (Bagner et al., 2012). Bufferd et al. (2012)

found that preschool psychiatric disorders are moderately stable over time. The researchers

found that three-month rates of disorders were relatively stable from age 3 to age 6. In other

words, children who met the criteria for any diagnosis at age 3 were nearly five times as likely as

others to meet the criteria for a diagnosis at age 6 (2012). Briggs-Gowan et al. (2001) found that

young children with recurrent and comorbid externalizing and internalizing problems have the

most impairment; they exhibit greater difficulty with stability, and require greater utilization of

mental health services.

Gleason et al. (2016) found that at least 8% to 10% of children younger than 5 years of

age experience clinically significant and impairing mental health problems, which included

emotional, behavioral, and social relationship problems. Gleason et al. also mentioned that many

children demonstrate impairment across multiple domains including social interactions,

problematic parent-child relationships, physical safety, an inability to participate in childcare

without expulsion, delayed school readiness, school problems, and physical health problems in

adulthood. According to the Center for Disease Control and Prevention (CDC), during 2009-

2012, 7.6% of Americans ages 12 and over had depression (2014). Comparably, the estimate of people living with anxiety disorders in the world is 3.6% (a 14.9% increase since 2005). According to the World Health Organization (WHO) report, in 2015 an estimated 78,800 people died due to suicide. It is estimated that many more than this number attempted but did not die by suicide (2017). The researchers found that persons living below the poverty level were nearly 2 ½ times more likely to have depression compared to those who were at or above the poverty level. Of those with severe symptoms, only 35% reported having contact with a mental health professional in the past year (Pratt & Brody, 2014). Globally, the World Health Organization (WHO) found that depression is the single largest contributor to global disability (4.4% of the world's population suffers from depression) and is the major contributor to suicide deaths (close to 800,000 per year).

Loades and Mastroyannopoulou's (2010) research assessed teachers' ability to recognize common mental health problems in their students. Consistent with previous research, the results showed that help-seeking referrals done by teachers tend to be higher for children with behavioral disorders as compared to emotional disorders. In fact, the Mental Health Foundation (as cited in Loades & Mastroyannopoulou, 2010) found that emotional problems such as anxiety and depression are often dismissed or neglected in part, because students with these disorders were perceived to be less burdensome by parents and teachers than children with behavioral disorders.

Briggs-Gowan et al. (2006) found that 55% of 12 to 23-month-old infants with elevated behavioral or emotional problems continue to have elevated scores one year later. While it is recognized by researchers that identifying early emotional and behavioral problems can be challenging (i.e., it is difficult to identify what behaviors are within the developmental spectrum,

or the belief that the behavior will subside with time), early intervention of behavioral and emotional problems has proven beneficial to both children and parents. According to Gleason et al. (2016), "emotional, behavioral, and relationship disorders rarely are transient, often have lasting effects, including measurable differences in brain functioning" (2016, p. 2). Identifying early markers for children who may be at risk, and advocating for treatment that addresses early clinical concerns may assist to determine if the students' needs warrant further action including a mental health assessment or assessment for special education services and appropriate treatment. Some preschool treatments have been found to be effective for years after the treatment has ended, a finding not matched in longitudinal pharmacologic studies (2016).

According to research, when faced with stressful life events, individuals with a non-suicidal self-injurious (NSSI) history may be less equipped to cope with unpleasant emotions in an adaptive manner and resort to using NSSI as a coping mechanism (Schatten, 2015). Matson and Tureck (2012) state that the acquisition of social skills can be broken down into stages that build upon each other, with earlier skills necessary for the development of later skills. The ability to pick up relevant visual information allows people to understand, react, and anticipate the behavior of other people (Pavlova, 2013). According to Posner and Rothbart (2007), many social skills of daily life rely on the direction and duration of gaze. Conty and colleagues (2016) found that direct gaze first captures the beholder's attention and then triggers self-referential processing, which modulates incoming information and leads to the enhancement of self-awareness, memory effects, activation of prosocial behavior, and positive appraisal of others. Research suggests that the way infants visually explore faces predicts social learning. Previous findings indicate that infants as young as three months have the ability to discriminate between

happy and surprised, and sad and surprised faces (Young-Boune, et al., 1977). Thus, it seems reasonable that early gaze ability may be foundational to later socio-emotional function.

According to Allen and Hooley (2014), self-injury is often motivated by the desire to reduce the intensity of negative affect, suggesting that people who self-injure may have difficulty suppressing negative emotions. Study results found that people who self-injure show poorer inhibitory control than healthy individuals when the groups are shown images depicting negative emotional content. Johansson and colleagues (2015) found that attentional processes such as sustained attention constitute a developmental foundation for self-regulatory functions such as effortful control. The researchers asserted that "sustained attention promotes the development of goal-directed and self-regulatory behavior by allowing the child to be in control over what information is being processed" (p. 2). Their findings were consistent with previous studies hypothesizing that sustained attention is an underlying factor in the development of more advanced self-regulatory functions. However, the infant's ability to meet developmental milestones is to some extent dependent on the strategies that the infant uses to regulate uncomfortable emotions.

Bialeka-Pikul et al. (2018) found that infants who employ strategies during a delay gratification task, such as redirection of attention (e.g., looking around, looking at other objects, glancing, or glancing at the treats) is correlated strongly and positively with wait time. These behaviors of redirection of attention were the behaviors most frequently recorded in both 18 and 24-month-old children as a strategy of effortful control. Bialeka-Pikul et al.'s study supports previous findings that examine attentional pre-strategies used by infants to self-regulate their behavior during the delay of gratification task. In contrast, children who did not employ effortful strategies had shorter wait times and demonstrated difficulty resisting the impulse to take the

immediate reward. Infants' ability to direct attention has been positively associated with the

development of both executive functioning and effortful control. Delayed gratification is

considered to be an early expression of self-regulation. Thus, maladaptive strategies may begin

to emerge as the infant employs coping behavior automatically, inflexibly, and indiscriminately

as a result of repeated unsuccessful efforts to repair the mismatch, and self-regulation becomes

the predominant goal (Tronick, 2007). According to Chapman et al. (2006), research supports

the presence of avoidance tendencies among individuals who self-harm. Additionally,

researchers found higher levels of impulsivity or novelty seeking may be associated with a

greater likelihood of experiential avoidance. Additionally, Schatten et al. (2015) found that

individuals with an NSSI history describe themselves as more emotionally reactive on self-report

measures than those with no history of NSSI. A common thread among the theories reviewed is

that the act of self-injury provides the individual with emotional relief or as a way to regulate

emotions. Secondly, while maladaptive in nature, self-injury can be an effective way for the

individual to escape from unwanted internal experiences or those external conditions that elicit

them (Chapman, 2006). Schatten et al. (2015) found that NSSI appears to serve as a way of

escaping interpersonal task demands or getting a response from others. In line with previous

research, study results indicated that individuals with NSSI do not have difficulty in generating

alternative solutions to social problems; rather, they choose a more negative solution, which

suggests a deficit in decision-making when the individual is problem solving. Study results also

found that as NSSI individuals engage in decision-making, their ability to make decisions

becomes impaired in the presence of negative emotions.

Fielder & Glöckner (2012) examined attentional bias over the course of decision making

in risky choices using eye-tracking analysis. The researchers showed that attention bias and

gaze-cascade effect (e.g., the tendency that over the course of decision-making attention shifts to the chosen option) in risky choices, support the idea of systematic information distortions, particularly the accentuation of initial advantages of one option over the other. "In many every day decisions individuals choose between options with different outcomes, each of which realizes with a certain probability" (p. 13).

Generally, eye movement (tracking) is used to construct representations of the world. At any point attentional processes can be diverted by externally driven factors or stimuli (i.e. the infant's name is called, lights flashing, or a loud noise). If the information is perceived to be salient, it will demand attentional resources to be allocated independently of the infant's goal. However, as these representations are fine-tuned, the perception of unsafe situations can cause disruptions in the process. Porges' (2011) research indicates that social behaviors, social communication, and visceral homeostasis are incompatible with the neuropsychological states that support defense strategies. This may result in limitations on where the infant can selectively direct its attention and possibly result in the infant selecting a more maladaptive option of allocating attentional resources to the current physiological state. The infant's ability to reach homeostasis is dependent on attending to cues that begin the self-regulatory process to soothe when support from their caregiver is not readily available.

The present study aimed to explore the relationship of early eye tracking and later non-suicidal self-injury, and whether this relationship was negatively impacted by distress and impulsivity, and conversely alleviated by emotional regulation and problem solving abilities. Information from this study may be helpful in providing information to educators and those who work with identifying students who are at risk.

Statement of the Problem

Individuals who engage in NSSI often have a diagnosis of depression and anxiety disorder. While considerable amounts of research have been conducted on NSSI, less work has focused on early indicators in children younger than 2 years old. According to Doll and Cummings (2008), within a population-based model, delivery of mental health services requires individuals other than those solely at the highest level of risk to receive attention. Students who experience internalizing behaviors present a different profile from those with externalizing behaviors (i.e., disruptive behaviors) who tend to dominate the attention of parents and educators. Internalizing behaviors may go unnoticed as the behaviors are associated with problematic internal feelings (i.e., withdrawal), making it difficult for others to recognize, and the behaviors often co-exist with other internalizing difficulties. Internalizing behaviors have been associated with low academic performance, difficulties with future psychological adjustment, and poor physical health (Merrell & Walker, 2004).

Despite considerable amounts of research conducted on NSSI, less work has focused on early indicators in the general school age population, specifically during early infancy. Research has found that psychopathology rates in preschoolers may be as prevalent as those in school-age children (Buffer et al., 2012). While it is recognized that students may go untreated if they do not report, identifying early precursors that may be exhibited by those individuals who later engage in NSSI may assist in developing intervention efforts for children and their families.

Purpose of the Study

The purpose of this study was to investigate whether early infancy eye-tracking influenced later non-suicidal self-injury through the mediating variables of distress, impulsivity, emotion regulation, and problem solving while controlling for parental income and child sex.

This relationship was explored by way of secondary data analyses using the National Institute of Child Health and Human Development's Study of Early Child Care and Youth Development (NICHD SECCYD) longitudinal data.

Research Question

The following research question was used to guide this study's methodology: Does early infancy eye-tracking influence later non-suicidal self-injury through the mediating variables of distress, impulsivity, emotion regulation, and problem solving while controlling for parental income and child sex?

CHAPTER 2: REVIEW OF THE LITERATURE

Emotional Distress in childhood as manifested in non-suicidal self-injury, a phenomenon associated with impulsivity, emotion regulation, and impaired problem solving.

In early childhood, cognitive and emotional problems are often considered unstable and viewed simply as a snapshot of the child's current level of functioning. As a result, the diagnosis of psychological and psychiatric disorders is not typical in children under two years of age (Bagner et al., 2012). However, research has found that preschool psychiatric disorders are moderately stable over time (Bufferd et al., 2012). In addition to emotional problems being present in early childhood, disposition to distress has been positively related to maladaptive strategies and negatively related to adaptive strategies (Grynberg & López-Pérez, 2017). As noted in Chapter 1, research has shown that mental health problems that manifest early in life are linked to impairments across multiple domains including school readiness, attainment of developmental milestones, differences in brain functioning and the use of healthy or maladaptive coping behavior (2001). Non-suicidal self-injurious behavior (NSSI) is one such maladaptive response. Underlying functions associated with NSSI include impulsivity, attention deficit, emotional distress (unbearable emotions), and emotional self-regulation as they serve to modify rather than abolish the state of consciousness (Grandclerc et al., 2016).

How is it that some children become sad, withdrawn, and lacking in self-esteem, whereas others become angry, self-assertive, curious, affectionate, and self-confident? According to Tronick and Beeghly (2011), infants have the biopsychosocial competencies to react to the meaning of others' intentions and emotions. Infant mental health problems emerge when the meaning that the infant makes of an interaction selectively limits their subsequent engagement. These early interactions scaffold the infant's engagement with the world. In line with previous

research findings, the nature of these interactions can influence how infants master age-appropriate developmental tasks (e.g., self-regulation, forming attachments, or establishing autonomy). According to Bagner et al. (2012), behavioral and emotional problems are highly prevalent in early childhood and represent an important focus of practice for clinicians and psychologists. Research has found that psychopathology rates in preschoolers may be as prevalent as those in school-age children (Bufferd et al., 2012), which suggests that the etiology begins in early childhood.

Allen et al., (2014) found that self-injury is often motivated by the desire to reduce the intensity of negative affect; suggesting that people who self-injure have difficulty suppressing negative emotions. Studies have demonstrated a decrease in negative affect following the administration of painful stimulus, suggesting that there may be a biologically reinforcing mechanism. Laboratory studies have found that pain is an important emotion regulation feature of NSSI (Grynberg & López-Pérez, 2017). According to Andover and Morris (2014), deficits in emotion regulation have been associated with non-suicidal self-injury (NSSI) by both theory and research. "The way in which people regulate their own emotional experience may play a significant role in an individual's vicarious emotional response" (Eisenberg, 2000 as cited in Grynberg & López-Pérez, 2017). Grynberg and López-Pérez also found that personal distress is negatively associated with various adaptive strategies of reappraisal, acceptance, positive refocusing, and putting things into perspective. Previous research supports the notion that "emotion regulation strategies may have beneficial or detrimental effects on individual's functioning, in terms of affect, behavior and cognition, and their relationship to mental and physical health" (p. 2). Additionally, the frequent use of adaptive strategies like emotion

regulation and planning (i.e., thinking about how to handle the negative event) were found to reduce personal distress.

"Consistent with the emotion regulation hypothesis, people who self-injure show deficits in inhibition control over behavioral response to unpleasant emotional stimuli" (Allen and Hooley, 2014). Allen and Hooley's findings showed that self-injuring participants found behavioral responses to NSSI images easier to inhibit than did healthy individuals, meaning that NSSI individuals responded similarly when presented with positive emotional images or images of cutting. Research suggests that deficits in inhibitory control over negative emotion processing are characteristics of NSSI (Allen and Hooley, 2014). Schatten et al. (2015) found that NSSI individuals do not have difficulty generating alternatives to social problems, but rather select more negative solutions. According to research, when faced with stressful life events, individuals with an NSSI history may be less equipped to cope with unpleasant emotions in an adaptive manner and resort to use NSSI as a coping mechanism (Schatten, 2015). As stated earlier, the extent that the infant successfully copes is the extent that the infant will experience positive emotions and establish a positive effective core (Tronick, 2007).

Claes et al. (2009) found that patients with NSSI and no suicide attempts, reported less active problem solving and more avoidant behavior and less social support seeking than patients without NSSI. Interestingly, Seymour et al. (2015) found adolescent inpatients "engaged in NSSI showed greater deficits in emotional face recognition (a critical social communication skill) than their typically developing peers, but not inpatient adolescents who attempted suicide" (p. 247). Yates' (2004) developmental pathway from early traumatic experiences to self-injury behavior (SIB) posits that these traumatic experiences compromise the individual's competence level of adaptation. "In turn, these vulnerabilities in adaptive functioning contribute to SIB,

which acts as a compensatory regulatory and relational strategy to facilitate the individual's

negotiation of developmental challenges despite prior adaptational vulnerabilities" (Yates, 2004,

p. 54). Early identification of individuals who are likely to repeat self-harm could improve

outcomes and reduce suicide risk (de Cates et al., 2016). While vast research exists on potential

risk factors associated with NSSI, surprisingly research is lacking in identifying the emergence

of concerns in infancy.

According to Conty and colleagues (2016), direct gaze first captures the beholder's

attention and then triggers self-referential processing, which modulates incoming information

and leads to the enhancement of self-awareness, memory effects, activation of prosocial

behavior, and positive appraisal of others. Developmental shifts in the neural regulation of the

autonomic nervous system result in adaptive behavior that, depending on context, either limit or

expand the expression of social behavior (Porges, 2011). These representations (i.e., of expected

behavioral outcomes) can go awry and lead the infant down abnormal developmental pathways

when aberrant or atypical forms of meaning-making persist. "Altered meanings can interfere

with the infants' successful development and heighten their vulnerability to pathological

outcomes" (Tronick & Beeghly, 2011, p. 107). The next section examines, in some detail,

research on the role of vision in neuroanatomical systems that influence psychosocial

development.

Vision as an important part of neuroanatomical and neurophysiological systems that
contribute to healthy emotional development.

Emerging research suggests that vision plays a critical role in social-emotional and

cognitive development. According to Posner and Rothbart (2007), many social skills of daily

life rely on the direction and duration of gaze. Research supports the notion that gaze following

is a foundational skill for human social behavior and cognition. Rosati et al. (2016) examined changes in gaze following across the lifespan in human and non-human animals. Researchers found that, consistent with characteristics such as "extended juvenile periods that allow for the acquisition and refinement of cognitive skills" (Rosati, 2016, p. 2), early gaze following abilities during infancy have been found to assist in the development of joint-attention skills, language, and Theory of Mind. Johansson et al. (2015) found that effortful control measured by sustained attention using eye tracking in infancy seemed to constitute a developmental step toward meta-cognitive skills such as executive functioning. As, "better sustained attention should promote the development of goal-directed and self-regulatory behavior, by allowing the child to be in control over what information is being processed" (Garon et al., 2008, p. 2, as cited in Johansson et al., 2015).

From infancy onward, our eyes take in the world around us. In fact, eye contact motivates 9-month-old infants to devote memory resources to the encoding of the identity (rather than location) of a novel object, signaling the importance of direct eye gaze and ability to sustain the gaze long enough for the infant to gather information. As indicated earlier, infants have the biopsychosocial abilities to react to others' intentions and emotions (Tronick and Beeghly, 2011). Attentional resources allocated via direct gaze initiate the information process of gathering information. As external information becomes available, the infant's brain shapes how it perceives the information based on attention allocation. Visual stimuli captured via gaze will elicit activation across the brain ranging from early feature analysis and lead to increasing integration of information and decision-making (Meyers et al. 2008; Harvey et al. 2012, as cited in Vidaurre et al., 2019).

In fact, Lim et al. (2018) found that retinal neurons activate based on the type of information perceived. Perceived information is organized into clusters as it moves to the visual cortex, suggesting that the same information that two infants are being exposed to may not be processed the same way and are to some extent dependent on the individual's ability to perceive the information. Infants' "visual exploration strategies are important agents of change in infants' capacity to learn about emotion expression" (Amso et al, 2010, p. 1). In a sequence of events, the initial decoding of information will serve to inform subsequent information coming in. As these representations are fine-tuned, the perception of unsafe situations can cause disruptions in the process. Once detected, the information is routed and ends in the pulvinar and the amygdala. The amygdala plays a central role in directing attention, and assists in the processing and regulation of emotions. In fact, Oda and colleagues (2011) found that direct gaze perception, where individuals directed their gaze, as compared to averted gaze or simple fixation, increases self-awareness regarding one's own physiological state. In other words, infants who engage in targeted gaze use that information to comprehend irregularities in their environment and direct their attention to understand and adapt to the situation. However, the process is not always seamless. "Different stages of information processing may start and finish at different time points, depending on different levels of arousal or selective attention at the time of the stimulus onset, or as a result of learning and plasticity" (Vidaurre et al., 2019, p. 864).

Functionally, when the environment is perceived as safe, the bodily state is regulated in an efficient manner to promote growth and restoration (inhibits flight-or-fight mechanisms), and the muscles that control the face and head are regulated enough to allow information to enter (Porges, 2011). Neuroanatomical and neurophysiological linkages allow for the integration of social engagement systems that control eye gaze, facial expression, listening, and prosody

(Porges, 2011). Research indicates that this link results in the bidirectional coupling between spontaneous social engagement behaviors and bodily states. "Neural processing of a stimulus and its use in guiding behavior are highly dynamic" (Vidaurre et al., 2019, p. 864). In other words, "if the person being engaged is in a state in which the social engagement system is easily accessible, the reciprocal prosocial interactions are likely to occur. When the infant engages in sustained attention, it helps facilitate how information is processed, coded, reactivated, and the generalization of representations is made for later recall. However, if the individual is in a state of mobilization, the same engaging response might be responded to with the asocial features of withdrawal or aggression. For example, the disruption can impact the capacity to modulate arousal for sustained attention; in turn, it may negatively influence the infant's ability to tolerate changes in the environment, engage in self-consoling, and purposeful action. In such a state, it might be very difficult to dampen the mobilization circuits and enable the social engagement system to come back on line" (Porges, 2011, p.1357). Bang et al. (2018) found that visual brain areas are excitable following visual memory reactivation. As poor regulation of arousal persists over time, these memories serve as a reference, and repeated unsuccessful outcomes influence behavioral regulation and sensorimotor organization. The type of visual practice the infant engages in can be viewed as a series of reactivations that increases plasticity and mastery with each subsequent reactivation (Bang et al., 2018). Johansson et al. (2015) used fMRI activity to understand how information is properly encoded analyzing neural activity. Patterns of brain activity provided insight about mental representations by using visual orientation to analyze how mental representations changed, tuned, or suppressed information according to the subjects' goals. Imaging results suggested that as information enters neural activity during a goal-directed trajectory, the unfolding of a trajectory anticipates, at an accelerated pace, the subsequent

behavior that a person will choose to enact. Similarly, the reverse order can recur to reflect a form of goal-based problem solved by means-ends analysis.

Porges' research indicates that neuropsychological states that support defense strategies are incompatible with those that maintain a stable state of equilibrium. Highlighting the importance of self-regulation in order to foster the development of social behaviors and social communication. Individuals who are chronically traumatized tend to become overwhelmed and triggered by their unmanageable visceral feedback system (Porges, 2011). Consequently, the infant tries to inhibit sensory feedback from its body; this leads to viewing the world around it as bland and meaningless. "Faulty neuroception (that is, an inaccurate assessment of the safety or danger of a situation) might contribute to the maladaptive physiological reactivity and expression of defensive behaviors associated with specific psychiatric disorders" (p. 392). "The resultant changes in automatic state support a range of adaptive defensive behaviors" (Porges, p. 4024). Furthermore, the compromised social engagement system is associated neurophysiologically, with a change in automatic regulation. This results in a reduction in the influence of the regulatory system, resulting in neural systems that foster behaviors of flight/fight response via the sympathetic nervous system "indicating that the perception of safety is the turning point in the development of relationships and will determine whether the behavior will be prosocial (i.e., social engagement) or defensive" (p. 4033). For example, dysfunction in the limbic system will have an effect on the brain's capacity to process information, focus attention, and regulate mood and affect. As stated earlier, brain regions implicated in processing risk and fear (amygdala and pulvinar subcortical pathways) play a role in the inhibition of emotional responses and aid in the process of decision-making and self-control.

As stated earlier, attentional processes such as sustained attention constitute a developmental foundation for the self-regulatory functions such as effortful control (Johansson et al., 2015). Researchers state that self-regulatory mechanisms are present in the first few months of life and can be observed in behaviors such as the infant's hesitation before approaching a novel stimulus, expressing distress, and attentional behavior. Other research supports findings indicating that, "sustained attention promotes the development of goal-directed and self-regulatory behavior by allowing the child to be in control over what information is being processed" (Rothbart et al., 2015). Rothbart and colleagues findings were consistent with previous studies hypothesizing that sustained attention is an underlying factor in the development of more advanced self-regulatory functions. While both self-regulation and executive function forms can be seen during the first year of life, more complex and higher forms emerge in preschool and school-aged children.

Infants' "visual exploration strategies are important agents of change in infants' capacity to learn about emotion expression" (Amso et al, 2010, p. 1). The type of visual practice the infant engages in can be viewed as a series of reactivations that increases plasticity and mastery with each subsequent reactivation (Bang et al., 2018). For example, as the infant engages in interactions, relevant stages of the interaction will help to inform the infant about intentional signaling, representations of shared meaning, symbolic differentiation of affective-thematic experiences, gestural levels and communication. Porges states that before the infant can master complex behavioral interactions with the environment, the infant must completely regulate autonomic processes. This requires the infant to learn self-regulation skills, i.e., to adapt emotions and behaviors to conform to situational and social standards" (Bialecka-Pikul et al., 2018, p. 12). Self-regulatory physiological strategies involve feedback between the brain and the

careful visual surveillance of the newborn (p. 1822). These strategies promote the development

of global levels of motor and social behavior that are dependent on physiological systems. In

part, what appears to underlie the infant's ability to continue to build on social schemas points to

the importance of direct eye gaze that may cue information to help regulate the system and the

ability to sustain the gaze long enough for the infant to gather information as the event evolves.

Delayed gratification is considered an early expression of self-regulation. Research

findings have indicated that looking around, looking at other objects, glancing, or glancing at the

treat were the behaviors (usually considered as redirecting of attention) most frequently recorded

in both 18 and 24-month-old children and correlated strongly and positively with wait time. This

supports previous findings using similar methods of the delay task with children. The authors

concluded that the ability to delay gratification was a result of an increased ability to overcome

temptation by the use of an active strategy mainly based on attention. The extent that the infant

successfully copes is the extent that the infant will experience positive emotions and establish a

positive effective core (Tronick, 2007). As stated earlier, infant mental health problems emerge

when the meaning the infant makes of the interaction (while it may be adaptive in the short run)

selectively limits their subsequent engagement. Consequently, researchers found that when the

infant uses these coping skills in normal interactions, they distort those interactions as well,

generating an inward focus style of coping which may become pathological. Interestingly, the

pathway to normalcy or psychopathology appears as part of the same developmental process

(Tronick, 2007). Thus, pathology may begin to emerge as the infant employs coping behavior

automatically, inflexibly, and indiscriminately as a result of repeated unsuccessful efforts to

repair the mismatch, and self-regulation becomes the predominant goal (Tronick, 2007). For

example, these children tend to tune in to their own thoughts, play on their own rather than

engaging in reciprocal interactions, appear withdrawn, lack insight of their own behavior, and cannot sustain interactions in meaningful ways.

Vision and its relationship to impulsivity, emotion regulation, and problem solving.

Human eye-gaze direction processing has been implicated in various studies including, but not limited to, atypical neural responses of eye-gaze direction in infants at risk for autism (ASD); gaze processing abnormalities in individuals with attention deficit hyperactive disorder (ADHD); and abnormal brain activation of spontaneous gaze processing during face encoding tasks in individuals with borderline personality disorder (BPD). As stated earlier, a compromised social engagement system is associated neurophysiologically with a change in automatic regulation that results in a reduction in the influence of the regulatory system, in turn resulting in neural systems that foster behaviors of flight/fight response via the sympathetic nervous system. Healthy regulatory systems are thought to follow a steady rhythm that provides windows of information to the nervous system rather than a process that requires the rhythmic system constantly adjusting and responding to information which causes the system to deviate from a specific state (Porges, 2011).

Data suggest an association between face processing and infants' visual behavior. "Fearful faces may require more online information gathering resources" (p. 5). Thus, "successful processing of facial emotion expression is dependent in part on an infant's ability to gather the appropriate information about the object" (p. 6). According to Shaw et al. (2014), rapid and accurate recognition of emotions in human faces or voices is essential to well-regulated behavior. Emotional misperception has been linked with aberrant emotional responses, and misperception can result from emotion dysregulation. For example, children who struggle with the capacity to self-sooth, modulating their emotions, using coping skills, impulsivity, and lack

self-control as the child grows older it will struggle with developing a sense of self-efficacy.

Research supports findings indicating individuals who engage in self-injury exhibit impaired

inhibitory control over behavioral expressions of negative emotions (Allen and Hooley, 2014).

Impulsivity has been one of the most widely studied psychological characteristics not only in

suicidal populations, but also linked to personality and developmental disorders. According to

Chapman et al. (2006), individuals high in impulsivity may resort to quick, easily executable

strategies as impulsivity may heighten the tendency to choose maladaptive coping strategies

rather than functional coping strategies that may take time to relive stress. Cognition and

information abilities tend to narrow under conditions of intense emotional arousal and result in

difficulties with problem solving (2006).

According to Linehan (1993), a defining feature of individuals who engage in self-

injurious behavior is emotion dysregulation that includes an unwillingness to tolerate emotional

distress. Interestingly, research also indicates that this population also experiences difficulty

regulating positive emotions (Andover and Morris, 2014). According to Chapman et al. (2006),

"individuals with high levels of emotional intensity must regulate greater levels of arousal, and

greater arousal is associated with greater difficulty regulating emotions" (p. 377). Emotion

regulation requires the ability to experience and label emotions as well as the ability to reduce

emotionally relevant stimuli that activate or reactivate negative or positive emotions and that

result in a secondary emotional response (Andover and Morris, 2014). Chapman et al.'s (2004)

research suggests that people who self-injure lack the instrumental competence to process and

respond to another's mental state in an appropriate manner and use the body as a way to

symbolize affective experiences. Additionally, when faced with stressful life events, individuals

with an NSSI history resort to self-injury as a coping mechanism as they may be less equipped to

cope with unpleasant emotions in an adaptive manner (Schatten, 2015). According to Tronick (2007), the infant who utilizes coping strategies unsuccessfully and repeatedly fails to repair the mismatch between the infant and mother, for example, commences to feel helpless. Eventually, the infant will give up attempting to repair mismatches and focus coping behavior on self-regulation in order to control the negative emotion generated. "As this pattern continues, the infant develops a pattern of coping that limits engagement with the social environment and establishes a negative effective core" (p. 156). Thus, "affect regulation influences the quality of the individual's behavioral self-regulation and impulse control, which, in turn, contributes to her/his capacity to negotiate developmental challenges. In this way, affect is both regulated and regulating" (Chapman et al., 2004, p. 56). Furthermore, adverse states of *self-awareness* characterized by disruption behavior and confusion in thought result in a shift toward the narrowing of attention to a proximal goal (i.e., relief from emotional pain) and difficulty processing information (2004).

In *The Process Model of Emotion Regulation* proposed by James Gross (1988), emotions may be regulated at five points in the emotion generative process: (a) selection of the situation; (b) modification of the situation; (c) deployment of attention; (d) changes of cognitions; and (e) modulation of responses. As indicated by Porges (2011), within this "hierarchy of adaptive responses, the newest circuit is used first; if that circuit fails to provide safety, the older circuits are recruited subsequently" (Porges, 2011, p. 1309). Under conditions of intense emotional arousal, the individual can experience a breakdown in their cognitive or information processing system, and the individual may resort to using easy strategies that can be executed quickly rather than resorting to more adaptive skills that take longer to alleviate distress

(Chapman et al., 2006). "Pathological development is often associated with problems in brain development and dysfunctional physiological systems" (Porges, 2011, p. 1868).

Research indicates that self-regulatory functions foster the infant's attainment of developmental milestones. Additionally, research indicates that the age of reaching developmental milestones is associated with intellectual performance at ages 8, 26, and 53 years (Murray et al., 2007). "Therefore, there has been a growing interest in identifying problems as early as possible to develop effective preventive interventions to minimize current distress and enhance competence, which are the building blocks to facilitate acquisition of later competencies" (Bagner et al., 2014, p. 2). In order for emotion to be regulated, posterior attention systems must both detect salient stimuli and signal that control is needed. Evidence suggests anomalies in early orienting to emotional stimuli in ADHD" (Shaw et al., 2014, p. 5). Problem solving abilities are often thought of as a critical cognitive skill which involve planning, implementing strategies, evaluating effectiveness, and the continued monitoring of a goal. According to Keenan (2011), preschoolers appear to inherently enjoy problem solving and are sensitive to whether their actions produce ambiguous or unambiguous results. Yoon and Narayanan's (2004) study found that, compared to individuals who used mental imagery during casual problem solving, those whose eye movements reflected their problem solving strategies were more successful problem solvers, in correctly identified salient information, and spent more time attending to critical components to solving the problems that were posed. Yoon and Narayana suggest that, "if these internal processes are externally manifested in the form of eye movements, such tasks present situations in which the trajectory of a user's visual attention is systematic and predictable, and which can provide clues regarding his or her informational needs" (p.1). Insight to individuals' approach to problem solving as it manifests in visual

attention can be beneficial in allocating resources in the development of specific skills in the problem solving process. Washburn et al. (2012) found that in addition to the use of cognitive behavior therapies (CBT), the use of Problem-Solving Therapy (i.e., defining and formulating the problem, generating alternative solutions, making a decision, and solution verification) with adolescents (15-17 years old) who engaged in deliberate self-harm was beneficial in reducing depression and hopelessness and in improving problem solving.

The Present Study

While there is prominent literature regarding the NSSI and the wide variety of externalizing (i.e., impulsivity, emotion regulation, and problem solving) and internalizing (i.e., emotional distress) conditions it is associated with, there is a lack of research regarding NSSI and early indicators specifically during early infancy. As argued in this literature review, difficulties in early infant eye-tracking may be a precursor to the later development of NSSI behavior as a means of emotion regulation. To help address the gaps in the research, the following research question was presented.

Does early infancy eye-tracking influence later non-suicidal self-injury through the mediating variables of distress, impulsivity, emotion regulation, and problem solving while controlling for parental income and child sex?

CHAPTER 3: METHODOLOGY

Participants and Procedures

In 1991, the NICHD Study of Early Child and Youth Development (SECCYD) embarked on an in-depth and comprehensive longitudinal study. The study's focus was to explore how differences in intellectual, emotional, and social growth, as well as their language development and overall well-being. A diverse set of families and their newborns were recruited at hospitals across ten sites that were associated with the following U.S universities: Temple University; University of Arkansas at Little Rock; Harvard University and Wellesley College; University of California, Irvine; University of Kansas; University of North Carolina, Chapel Hill; University of Pittsburgh; University of Virginia; University of Washington, Seattle; and the University of Wisconsin, Madison. Families and children were followed beginning at 1 month of age.

The study began with a sample of 1,364 children (ages 0 to 3) in Phase I, which took place from 1991-1994. Phase II occurred between 1995-1999 and included children up to 1st grade. From 2000-2005, Phase III children up to 6th grade were incorporated. Phase IV, which took place from 2005-2007, included children through 9th grade. Across the 16 year span, the sample size decreased from phase to phase due to family withdrawal. Phase IV had a total of 1,009 children participate. Data from families, children, and schools were collected using many instruments such as interviews, questionnaires, standardized assessments, and observations.

For the current study, participants from Phase I, Phase II, and Phase III were analyzed. More specifically, early eye tracking information was collected during the first phase of the study regarding developmental status from when children were 15 months of age. From Phase II, distress and impulsivity were analyzed from when children were 54 months of age. From

Phase III, emotional regulation levels and problem solving abilities were analyzed from when

children were in the 6th grade. Finally, children's engagement in NSSI behavior was analyzed

from when children were 15 years old from Phase IV. The NICHD Study of Early Child and

Youth Development (SECCYD) data collection timelines, instrumentation and control variable

statistics are summarized in Table 1 and 2.

Table 1
NICHD Study of Early Child and Youth Development (SECCYD) Data Collection Timelines,
Measure, and Participant Statistics

Phase	Year	Child's Age/Grade	Instrumentation	Measures
I	1991-1994	15 months	Bayley Scales of Infant Development	Eye-tracking behavior
II	1995-1999	54 months	Child Behavior Check List	Level of distress
II	1995-1999	54 months	Delay of Gratification	Impulsivity
III	2000-2004	6th grade	Emotion Regulation (Teacher Report)	Emotion Regulation
III	2000-2004	6th grade	Social Information Processing	Problem Solving
IV	2005- 2007	15 years of age	Children's Depressive Inventory (CDI)	Non-suicidal self-injury (NSSI)

Table 2
Control Variable Statistics

Variable Name	Range	M	SD
Gender	1	1.48	.500
Income-to-Needs (SES)	25.08	2.7626	2.66368

Instruments

Data was collected using the following measures: The Bayley Scales of Infant

Development (Mental Development Index), which was administered individually within the

laboratory setting during Phase I at 15 months of age to provide an evaluation of a child's current

developmental status, including sensory-perceptual acuities and discriminations; the Child

Behavior Checklist, which was performed individually in the home, laboratory, and child's

daycare setting with an interviewer during Phase II when the child was 54 months of age to track

the emergence of behavior problems; the Delay of Gratification, individually administered within

the laboratory setting during Phase II at 54 months of age as a measure of a child's self-

regulatory abilities; the Emotion Regulation (Teacher Report), administered by the teacher

during the child's 6th grade year in Phase III as a measure of how the child expresses emotion in

response to events; the Social Information Processing, administered individually to each child

during Phase III of the study while the child was in the 5th grade within the home environment to

assess the child's conflict management strategies; the child's engagement in non-suicidal self-

injury was measured using the Children's Depressive Inventory (CDI). The CDI is a

questionnaire which was individually administered within the laboratory setting during Phase IV

to the child at 15 years of age.

Sex and Social Economic Status (SES)

The child's sex and a family poverty-income-to-needs ratio (used as a measure of socio-economic status [SES]) were chosen as control variables in this model, because they are generally considered common causes of achievement and behavior. The poverty-income-to-needs ratio is a standard measure of a family's economic situation that is computed by dividing the family income, exclusive of federal aid, by the federal poverty threshold for that family.

Bayley Scales of Infant Development (Mental Development Index)

The Bayley Scale of Infant Development was selected to measure the child's current developmental status. It is one of the most widely used developmental assessment tools for assessing outcomes among high-risk infants and young children. The Bayley Scale is considered to be an integrative developmental assessment that borrows from different areas of child development research, including Gesell scale (Lowe et al., 2013). The Mental Developmental Index (MDI) of the Bayley (DMI) was designed to assess cognition through the evaluation of sensory-perceptual acuities and discrimination; memory, learning, and problem-solving; early verbal communication; and the ability to form generalizations and classifications, which is one of the reasons it was selected as a measure of developmental status by the NICHD's SECCYD (1999). The full battery indexes were administered to children at 15 months of age and the revised version at 24 months during the laboratory visit. This study utilized the 15-month age test results. Split-half reliability coefficients were above .80 for all ages in the standardized sample. Correlation with Stanford-Binet IQ at 24, 27, and 30 months is reported at .57. Specific to this study, eye tracking behavior at 15 months was measured using the Sustained Inspection of Ring task. The Sustained Inspection of Ring is regarded as a measure of early information processing.

Child Behavior Checklist (CBCL)

The Child Behavior Checklist (CBCL) was used to measure distress at 54 months of age. The CBCL is a measure used to assess the social competence and problem behaviors of children 4-18 years. The questionnaire was completed by mothers in the lab setting, by fathers in the home setting, and by caregivers in the Child Care setting when the child was 54 months of age in Phase II to track the emergence of behavior problems across settings and reporters. The participants answered a total of about 100 items per version. Children's behaviors were rated on a 3-point scale from 0 (*not true*), 1 (*somewhat true*), to 2 (*very true*). Broad band scales of Internalizing and Externalizing problems, and narrow band scales of social problems, aggression, attention problems, and depression (among others) were derived from a computerized scoring program. Norms exist to determine whether children's behavior falls into the normal range, to suggest that the child is at risk for problems, or to indicate that the child's behavior is more akin to those with clinically diagnosed problems (NICHD SECC, 1999). The overall interclass correlation coefficient (ICC) was .927 for the 20 competence items and .959 for the 118 specific problem items (both $p < .001$). This indicated a very high inter-interviewer reliability in scores obtained for each item relative to scores obtained for each other item. According to Achenbach (1991), construct validity is supported by numerous correlates of CBCL scales, including significant associations with analogous scales on the Conners (1973) Parent Questionnaire and the Quay-Peterson (1983) Revised Behavior Problem Checklist. Criterion-related validity is supported by the ability of the CBCL's quantitative scale scores to discriminate between referred and nonreferred children after demographic effects were partialled out. Specific to this study, the Caregiver (CARGIV) Fears Total Score (TRF) variable was used as a measure of the child's level of distress (or personal distress).

Delay of Gratification

The Delay of Gratification was selected to measure delay of gratification. Mischel's (1974, 1981) self-imposed waiting task was employed to children at 54 months of age during the laboratory visit in Phase II of the SECCYD. Delay of gratification has been related to the capacity to manage one's impulses and has been related to children's rearing circumstances and to be predictive of their later functioning. After identifying which three types of foods a child liked most (M&Ms, animal crackers, or pretzels), the child was offered a choice between (a) waiting (for 7 minutes) until the experimenter returns to the lab room on her own and (b) receiving a larger amount of food. It was noted that both the larger and smaller quantities of food were placed in front of the child while he/she waited. In addition to scoring the length of time the child could wait all by him/herself with both quantities of food placed directly in front of him/her on a paper plate (i.e., delay gratification), videotapes of the procedure were coded to determine the amount of time the child spent attending to the food reward (e.g., "hot" cognition: looking at it, touching it, talking about it) and the amount of time the child spent not attending to the food reward (i.e., "cold" cognition: looking away, talking about other things). No strategies for coping were suggested by the experimenter (e.g., think of something else, do not look at the food). For the purpose of this study, Total Time Waited score was used to measure the child's capacity to manage impulses. Waiting time proved most predictive of later self-regulatory abilities when children were left to fend for themselves (Shoda et al., 1990). In a longitudinal study (Mischel and Peake, 1990), variations of the self-imposed delay-of-gratification situation assessed during preschools were compared to predict aspects of cognitive and self-regulatory competence and coping in adolescence. Condition analysis of variance (ANOVA) revealed no significant main effects on sex, $F (1, 174) = 0.45$, $p > .50$. Results with the delay time as the

dependent variable, a Sex X Condition ANOVA revealed a significant main effect of condition, $F (3, 174) = 4.3$, *p* < .01, as expected. Indicating that when no cognitive and attentional strategies were suggested, delay was more difficult when the reward was exposed. "The mean interrater agreement (correlations computer across the 100 CCQ items) was .42, and the Spearman-Brown estimate, based on this mean correlation, for the reliability of the composite of 7 raters was .83" (p. 981). Assessment of competencies in adolescence predicted by preschool wait time after controlling for both verbal and quantitative SAT scores found, "the following remained significantly correlated with delay time (*p* <. 05, *df* = 29): uses and responds to reason (r= .40); i*s planful, thinks ahead* (r= .38); and *tends to go to pieces under stress*, *becomes rattled and disorganized* (r= --.33). Additionally, how long a preschool child will wait was significantly correlated with the child's current delay time in an exposed-rewards condition (r= .32, N= 59, *p* < .05) but not in an obscured-rewards condition (r= --.13, N= 29, *p* > .10). A significant correlation of preschool delay of gratification behavior (with academic competence, r= .73, N= 13, *p* < .01) was obtained in the exposed-rewards-spontaneous-ideation condition.

Emotion Regulation (Teacher Report) - Teacher Report of Children's Reactions

The Emotion Regulation (Teacher Report) was selected to measure the teacher's perception of how the child expresses emotions in response to events in the school setting during the child's 6th grade year in Phase III of the SECCYD. Teachers were asked to rate the child's frequency of display of emotions on a 5 point scale: 1= *Never*, 2= *Occasionally*, 3= *About Half the Time*, 4= *Usually*, and 5= *Always*. This questionnaire is identical to "Parent Report of Children's Reactions" completed by mothers and fathers/other adults in 3rd- 6th grade, and "Parent Report of Children's Reactions" completed in 4th and 6th grade. Child Emotional Reactivity Score was computed as the sum of responses to items 1 to 10 after reflecting items 4,

5, 6, 8 and 10. Possible scores ranged from 10 to 50, with higher values indicating a higher

perceived emotional reactivity of the child. For teacher the reliability for this measure is .83 for

Fourth, Fifth, and Sixth grades, respectively (NICHD: ECCRN, 1999).

Social Information Processing Application

The Social Information Processing Application was selected to assess social information

processing skills in 3rd to 5th grades. Children were asked to complete a questionnaire designed

to assess the child's pattern of social information processing. Six stories representing situations

were presented. Three of the stories (1, 2, 4) depict instrumental conflict (e.g., a peer cuts in line

in front of the child), and three stories (3, 5, 6) depict relational conflict in which the child is

socially excluded or rejected by peers (e.g., being gossiped about). Different components of

social information processing have been measured in Crick's various studies including decisions,

instrumental and relational outcome expectations, feelings of self-efficacy, and response

evaluations. For the NICHD's SECCYD, two social information processing components were

assessed. For each hypothetical situation, the child indicated (1) which of four possible conflict

management strategies (overt aggression, relational aggression, assertive friendliness, and

avoidance) he/she most likely would engage in, and (2) his/her instrumental outcome expectation

for the selected response. The Total Overt Aggression Endorsement Score- (Child) was

computed as the mean of the three intermediate overt aggression endorsement instrument

provocation items and the three intermediate overt aggression endorsement relational

provocation items. This score was imputed by proportional weighting. Cronbach's alpha for the

scales ranged for the 3rd grade= 0.75 and 0.56 respectively. This study utilized the 5th grade test

results.

Children's Depression Inventory (CDI)-Short Form

The child's engagement in non-suicidal self-injury was measured using the Children's Depression Inventory (CDI). The CDI is a 10-item questionnaire that was individually completed by the child when they were 15 years of age during Phase IV. The CDI is the most widely used questionnaire for assessing depression symptoms (Kovacs, 1992). Ten sets of three statements were presented and the child selected the one that best described the way he/she felt over the last two weeks. The items measured dysphoric mood, lack of pleasure, and low self-esteem. The Child Depression Score is the sum of items 1-10, after recoding responses to a 0 to 2 scale, and the score reflects items 2, 4, 5, 6 and 10. Higher scores are indicative of more child depression. Scores above 8 for girls and above 10 for boys are considered "well above average." The Child Depression score reliability has moderate reliability (10 items, Cronbach's alpha =0.81).

Variables

There were a total of eight variables in the model. The variables consisted of Income (control), Gender (control), Eye-tracking (predictor), Distress (moderator), Impulsivity (moderator), Emotion Regulation (moderator), Problem Solving (moderator), and NSSI (dependent).

Procedure

Data from Phases I, II, III, and IV of the National Institute of Children Health and Development's Study of Early Child Care and Youth Development (NICHD SECCYD) were obtained. The NICHD, affiliated research institutions permitted, and researchers who analyzed the data, have focused on housing the data at a secure site to protect the privacy and

confidentiality of participants. As previously mentioned, data was analyzed using SPPS

software, and AMOS version 23.0.0 was utilized.

<div align="center">**Data Analysis**</div>

In order to determine if early eye-tracking influences later non-suicidal self-injury and if

it is facilitated by distress, impulsivity, emotional regulation, and problem solving abilities while

controlling for sex and parental income, the statistical software, S*tatistical Package for Social*

Sciences (SPSS), was used to conduct the moderator analysis. First, the data had to meet the

following key assumptions prior to analysis: linearity, independence of errors, homoscedasticity,

and normality (Keith, 2015). Keith (2015) recommends several steps involved in path analysis,

all of which were utilized when formulating, revising, analyzing, and interpreting the results in

this study:

1. Review relevant theory and research related to the topic.

2. Construct a tentative model based on previous research findings, theory, and logic.

3. Collect a sample and measure the variables in the model, or utilize a data set in which the variables are already measured (i.e. NICHD). Use reliable and valid instruments.

4. Check the identification status of the model.

5. Estimate the model.

6. Examine model estimates, paths, and disturbances along with the fit statistics.

7. If necessary, delete statistically insignificant paths and re-estimate the model.

8. Analyze and interpret results (p. 252).

All model estimations were calculated using path analysis in AMOS 23.0.0. Then, path

constraints were systematically removed to test for nonlinearity and invariance. Paths were

estimated from background variables to the dependent variables.

Structural equation models typically are utilized or rejected based on the consistency between the proposed model and the data set. Fit statistics were used to determine whether the model could reasonably explain the data. When using AMOS, competing theoretical models and their embedded hypotheses were compared through fit statistics (Keith, 2015). The Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean-Square Error of Approximation (RMSEA) fit statistics were utilized to determine whether the model should remain the same or if modifications were required. The CFI provided a population estimate of the improvement in fit for the null model and the TLI provided an adjustment for parsimony to the model. Determining the fit for the model to the data utilizing these fit statistics, Keith (2015) suggests values approaching 1.0 demonstrate a better fit with values over .95 demonstrating a good fit. RMSEA was used to explore the fit of the model as it related to the degrees of freedom. Values below .05 suggest a good fit (Keith, 2015). Baron and Kenny (1986) showed that mediation can be assumed to exist under the following conditions:

1. In a regression of Outcome on Influence, the effect of Influence on Outcome is statistically significant. This regression does not include the mediating variable.

2. The regression of the Outcome on the Mediator results in a statistically significant effect.

3. The regression of Outcome on both Influence and the Mediator results in a reduction in the effect of Influence from step 1.

In order to determine whether complete mediation exists when the addition of the Mediator to the regression reduces the coefficient c to zero; partial mediation exists when the effect is simply reduced. To determine whether the mediation is statistically significant, we need to calculate the statistical significance of the indirect effect (Keith, 2015). First, we need to

regress outcome on influence and mediator. Next, regress mediator on influence and calculate

the indirect effect by multiplying the coefficient and its standard error. In order to analyze the

indirect effect, multiplying the coefficient associated with eye-tracking times the association with

the self-injury behavior. Lastly, error variances for similar raters were allowed to correlate to

account for any common variance shared by similar raters. Family income-to-needs ratio, the 15

month eye-tracking behavior, and self-injury at 16 years of age were allowed to covary. Paths

were estimated from the background and independent variables to the dependent variable. The

change in chi-square was used to test for mediation. Maximum likelihood procedures was used

to estimate any missing data. The comparative fit index (CFI) Tucker-Lewis index (TLI) with

values above .95, and the root mean-square error of approximation (RMSEA) with values below

.05 indicated good model fit. AMOS version 23.0.0 was used to analyze the data.

The proposed model, as shown in Figure 1, was used to address the research question.

This model is a recursive, just-identified model consisting of three exogenous variables (i.e.,

SES, eye-tracking behavior, and gender) and five endogenous variables (i.e., distress,

impulsivity, emotion regulation, problem solving, and NSSI). Five disturbances were also

included to account for all other unmeasured influences on the endogenous variables that are not

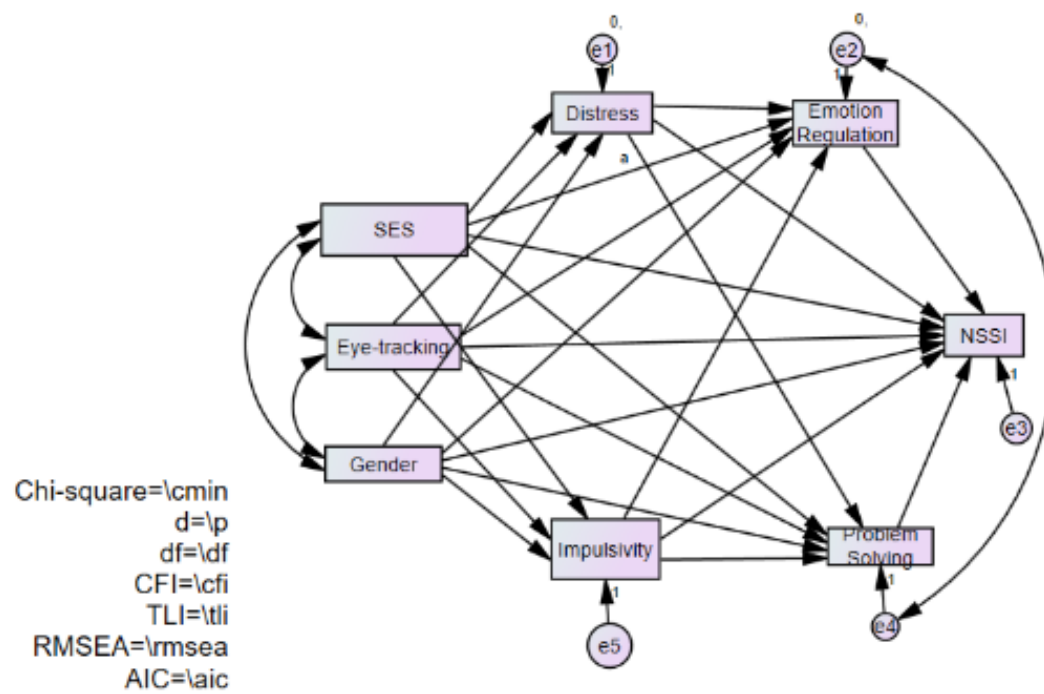accounted for in this model, symbolized as e1 through e5 (Keith, 2015).

Figure 1. Hypothesized Eye-tracking in Early Infancy Mediator Model (figure created in AMOS version 23.0.0)

CHAPTER 4: RESULTS

The purpose of the present study was to determine whether the effect of early eye tracking influenced later non-suicidal self-injury and if it was mediated by distress, impulsivity, emotion regulation, and problem solving abilities after controlling for gender and parental income. The analysis consisted of simultaneous regression. This chapter will provide: (a) descriptive statistics for variables used in the model; (b) a summary of statistical assumptions underlying regression analyses; (c) statistical significance of the mediated effect using structural equation modeling; (d) path model for the regression coefficients that provide estimates of effects; and (e) a summary of findings for the research question. The research question that guided the analysis is as follows:

Does early infancy eye-tracking influence later non-suicidal self-injury through the mediating variables of distress, impulsivity, emotion regulation, and problem solving while controlling for parental income and child sex?

Descriptive Statistics

The data was obtained from the NICHD Study of Early Child Care and Youth Development (SECCYD) from Phases I, II, III, and IV. The analyses utilized eight different variables, two of which were control variables, one predictor variable, four moderator variables, and one dependent variable. The control variables were Parental Income and the Child's gender. Eye tracking behavior measured at 15 months was used as the predictor variable; adolescent's engagement in self-injury as self-reported at 15 years of age was used as the dependent variable.

Table 3 summarizes the means, standard deviation, minimum values, and maximum values for each variable. The values all fall within the minimum and maximum range. In the sample obtained, there were 1,364 participants.

Table 3
Descriptive Statistics for Variables Used in the Present Study (N= 1,364).

Variable	Description	N	Minimum	Maximum	Mean	SD
Sample		1,364				
Eye-tracking	behavior at 15 months	658	1	4	2.4625	.54647
Income-to-Needs (SES)	Poverty-Income-to Needs Ratio	1274	0	25.08	2.7626	2.66368
Gender Male=1 Female =2	Reported at entry to study	1364	1	2	1.48	.500
Distress	Child's response to distress at 54 months	776	0	9	.90	1.337
Impulsivity	Child's wait time at 54 months	961	0	7	4.4767	3.00685
Emotion Regulation	Teacher's report of the child's expression of emotion to events in the 5th grade	930	10.00	50.00	28.4276	6.83686
Problem Solving	Child's total score of overt impulsive response during problem solving in the 6th grade	1023	0	1	.0428	.12669
NSSI	Composite of internalizing behaviors at 15 years of age	957	0	18.00	2.0051	2.63612

Bivariate Correlations

Prior to regression analysis, the correlation between the independent variable (i.e., eye tracking) and the dependent variable (i.e., NSSI) was examined. The correlation between the predictor variable and the dependent variable was not statistically significant (F [1. 507] = .194, $p < .659$). This analysis addressed the first step of a mediation analysis and indicated that the relationship between the predictor and outcome variable was not statistically significant at the .05 level (see Table 4).

Table 4
Coefficients Dependent Variable: NSSI.

Model	Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for β	
	β	Std. Error				Lower Bound	Upper Bound
Eye-tracking	.096	.217	.020	.441	.659	-.331	.522

To examine associations among study variables and NSSI, bivariate correlations were run on the gender, SES, eye tracking, distress, impulsivity, emotion regulation, problem solving, and NSSI. Gender and eye tracking (.081) were positively related, suggesting that females (as compared to males) engaged in longer ability to sustain attention. Consistent with prior research, impulsivity significantly correlated with SES (r= .210) and problem solving (r= .128), and negatively related to emotion regulation (r= -.090). Suggesting that higher social economic status may be related to longer wait time on delay of gratification task and lower socioeconomic status may be related to student's increase response to distress. Finally, consistent with models of NSSI, gender was positively related to NSSI (r= .196) and negatively correlated with problem

solving (r= -.202), suggesting that more females (as compared to males) reported engaging in

NSSI and more males (as compared to females) selected more overt aggressive solutions in

resolving conflict during social situations.

In order to determine the extent of the influence of eye tracking, distress, impulsivity,

emotion regulation, and problem solving on NSSI, while controlling for SES and gender,

simultaneous regression was analyzed. The results of the regression analysis (see Table 5) found

that only gender was statistically significant.

Table 5
Full Regression Model

		Unstandardized Coefficients		Standardized Coefficients		
					t	p
Model		β	Std. Error	Beta		
1	Constant	-.420	1.240		-3.339	.735
	Gender (male= 1, female=2)	1.082	.362	.211	2.986	.003*
	SES	.032	.068	.033	.472	.637
	Eye-tracking	-.319	.308	-.071	-1.035	.302
	Impulsivity	.051	.062	.059	.823	.412
	Distress	.349	.151	.158	2.315	.022
	Emotion Regulation	.027	.028	.067	.974	.331
	Problem Solving	.801	1.367	.041	.586	.559
	X Influence or IV	.096	.217	.020	.441	.659

* p < .05, ** p <.01, *** p <.001

Path Models in Structural Equation Modeling

The current study used path analysis and structural equation modeling (SEM) to examine

the fit of a model examining the associations among distress, impulsivity, emotion regulation,

and problem solving skills as mediators. Figure 1 represents the initial path model.

Furthermore, path analysis is an effective method for analyzing and interpreting non-experimental data (Keith, 2015). AMOS (23.0.0) was used to complete statistical analyses.
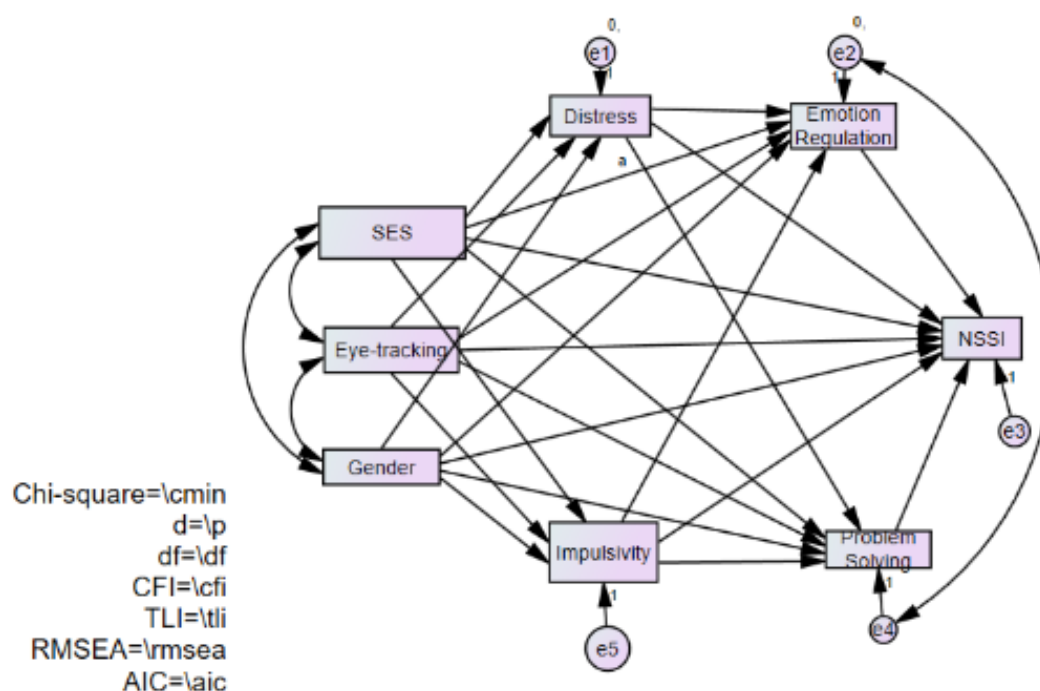

Figure 1. Hypothesized Eye-tracking in Early Infancy Mediator Model (figure created in AMOS version 23.0.0)

Simultaneous Regression

Analysis fit indices indicated that the model fit the data well (CFI=1.00; TLI=1.222; RMSEA=.000, AIC= 86.267). The largest standardized residual was -.210, indicating that the model variables adequately explained the observed correlation.

Table 6
Path Analysis Results

		Standardized Coefficients	Unstandardized Coefficients	Standard Error	*p*
Distress	< - - - SES	-.001	.000	.019	.986
Impulsivity	< - - - SES	.212	.239	.036	<.001
Impulsivity	< - - - Gender	.054	.323	.190	.090
Distress	< - - - Eye-tracking	-.023	-.056	.124	.655
Impulsivity	< - - - Eye-tracking	-.018	-.098	.239	.680
Distress	< - - - Gender	.035	.094	.096	.332
Problem Solving	< - - - Gender	-.198	-.050	.008	<.001
Emotion Regulation	< - - - Gender	.003	.036	.452	.937
Emotion Regulation	< - - - Eye-tracking	.004	.048	.591	.935
Problem Solving	< - - - Eye-tracking	.004	.001	.010	.923
Problem Solving	< - - - Impulsivity	-.108	-.005	.001	.001
Emotion Regulation	< - - - SES	-.028	-.071	.090	.427
Emotion Regulation	< - - - Impulsivity	-.079	-.197	.091	.049
Emotion Regulation	< - - - Distress	-.020	-.102	.196	.603
Problem Solving	< - - - Distress	.041	.004	.004	.302
Problem Solving	< - - - SES	-.027	-.001	.002	.397
NSSI	< - - - Gender	.202	1.065	.172	<.001
NSSI	< - - - Eye-tracking	.009	.043	.210	.840
NSSI	< - - - Impulsivity	-.005	-.004	.031	.896
NSSI	< - - - SES	-.006	-.006	.033	.868
NSSI	< - - - Emotion Regulation	-.014	-.006	.015	.705
NSSI	< - - - Distress	.053	.105	.082	.202
NSSI	< - - - Problem Solving	.041	.854	.689	.215

Note. This table demonstrates the standardized, unstandardized, standard error, and significance levels for model in Figure 1 (N= 1,364).

* p < .05, ** p <.01, *** p <.001

All pathways were investigated for this model to determine statistically significant

pathways. The pathway from SES to impulsivity was statistically significant (standardized

coefficient for SES= .212, p <.001), but not from impulsivity to NSSI (standardized coefficient for impulsivity = -.005, p .896), suggesting increase in SES was related to longer wait times on delay of gratification tasks. Impulsivity was significantly associated with problem solving (standardized coefficient for impulsivity= -.108, p <.05), suggesting increase wait times in delay of gratification task was associated with a decrease in the use of over aggression in problem solving. The pathway from gender to problem solving was statistically significant (standardized coefficient for gender -.198, p <.001), suggesting that being female (as compared to male) was associated with a decrease in the use of over aggression in problem solving. The pathway from gender to NSSI was statistically significant (standardized coefficient for gender = .202, p <.001), suggesting that being female (as compared to male) was associated with use of NSSI.

Indirect Effects

In order to test mediation in the hypothesized mode, the indirect paths from gender to problem solving and problem solving to NSSI had to be tested. The indirect path from SES to impulsivity (unstandardized coefficient SES= .239, p <.001) and impulsivity to problem solving (unstandardized coefficient impulsivity= -.005, p <.05) were tested. The path from impulsivity to NSSI (unstandardized coefficient impulsivity= -.004, *ns*) was not significant. In order to investigate if problem solving (fully or partially) mediated the effect on NSSI, the Sobel Test was used to calculate the indirect effects of the mediating variables on NSSI. The website http://quantpsy.org/sobel/sobel.htm has a calculator that was utilized to perform the calculations for the test.

With respect to the indirect effects, results indicated that the relationship between gender and NSSI was not mediated by problem solving (Sobel's Z = -1.2158, *p* < 0.224).

The direct effects from SES to impulsivity and impulsivity to problem solving were statistically significant; accordingly, an analysis was conducted to determine if there was an indirect effect from SES through impulsivity to problem solving. The results suggested that impulsivity acts as a mediator in the relationship between SES and problem solving (Sobel's $Z=$ -3.9939, $p < .001$).

Statistical Assumptions Regarding Multiple Regression

Prior to analyses, the data were evaluated to determine whether the following key assumptions were met: linearity, regression diagnostics, independence of errors, homoscedasticity, and normality (Keith, 2015). *SPSS* was used to analyze the data and check the following key assumptions.

Multicollinearity

This occurs when two or more variables are too closely related to each other. Keith (2015) suggests that a variance inflation factor (VIF) of greater than or equal to 6 is a conservative indication of multicollinearity problems. The highest VIF in the model was 1.113, so we did not appear to have an issue with multicollinearity.

Linearity

The assumption of linearity is met when the dependent variable is a linear function of the predictor variable. For the present study, a child's engagement in self-injury was a linear function of eye tracking. Keith (2015) recommends that linearity can be investigated by plotting the unstandardized residuals against the independent variable(s) and examining the lowess fit line along the mean of the residuals. If the assumption of linearity is not violated, then the lowess line should approximate the regression line and approximate a straight line (p. 188). This

was observed for the present study; thus, the assumption of linearity was not violated
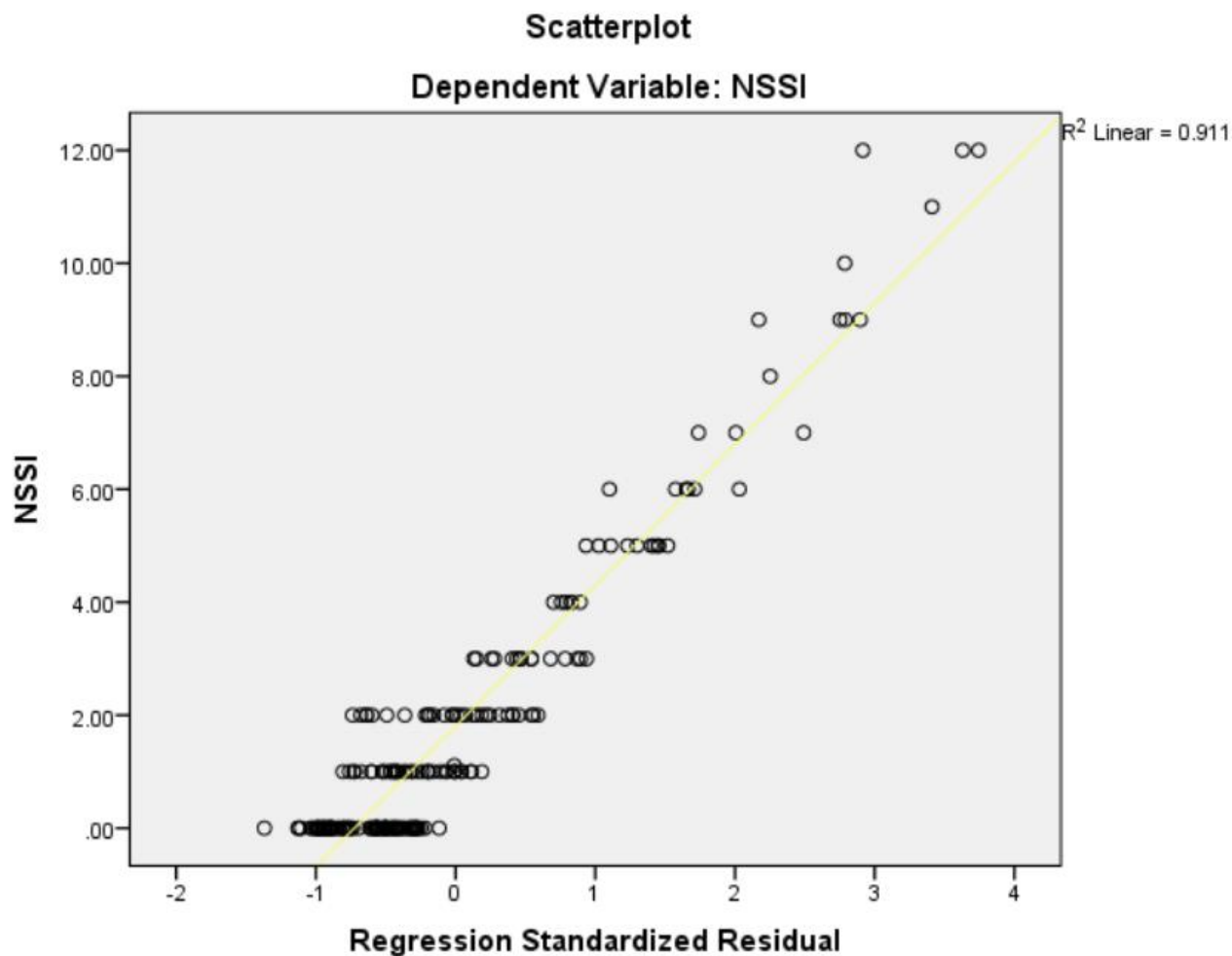
(see Figure 2).

Figure 2. Assumption of Linearity

Independence of Errors

The assumption of independence of errors is met if the data show that the errors are

independent of one another (Keith, 2015). The Durbin-Watson statistic was used to examine

whether the data met this assumption. The Durbin-Watson statistic ranges in value from zero to

four. It is recommended that the value should approximate a value of two. The *D* value for the

data was 2.340, which is within the recommended value. It is recommended that a data set with

a *D* value below 1.6 should be examined more closely before proceeding with analyses

(Montgomery, Peck, and Vining, 2001).

Normality

The assumption of normality was examined by generating a histogram of the residuals for

the dependent variable. The assumption is met if the residuals approximate a normal distribution

(Keith, 2015). When plotted along a normal curve, the histogram approximated a normal

distribution with a slight positive skew (see Figure 3). This assumption appears to have been
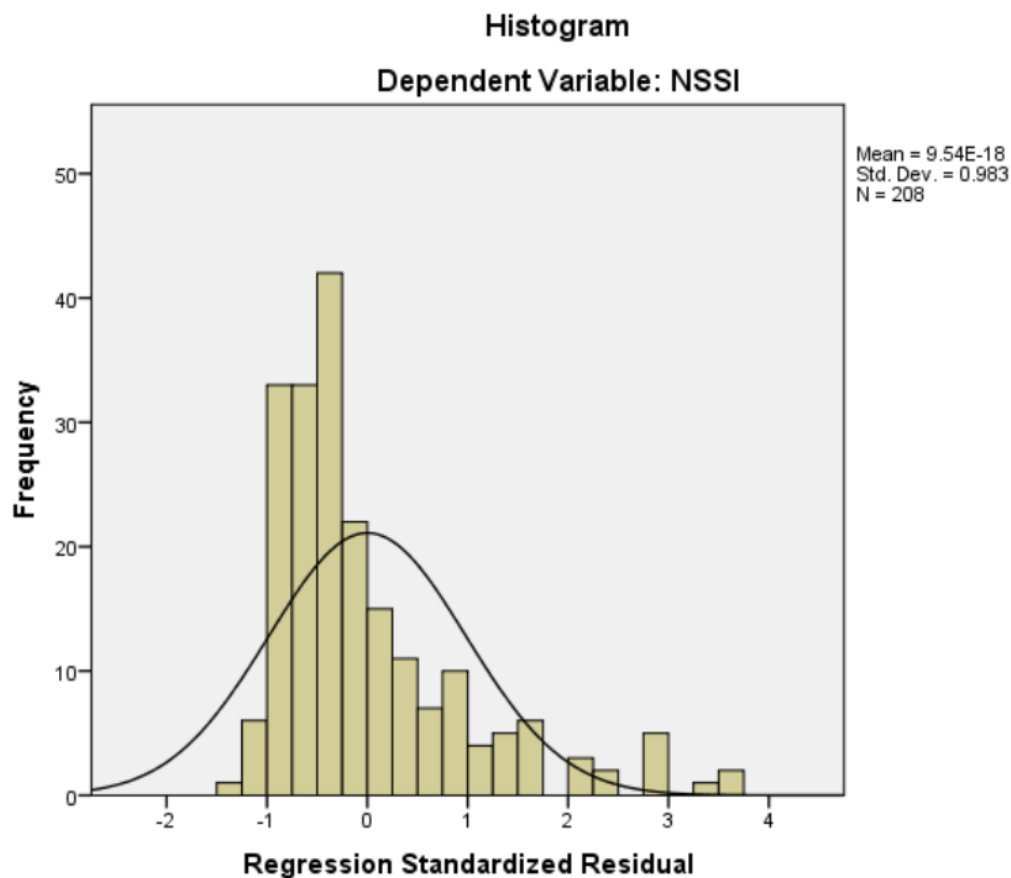
met.

Figure 3. Assumption of Normality Histogram

CHAPTER 5: DISCUSSION

This study investigated impulsivity, distress, emotion regulation, and problem solving as mediators of the relationship between eye tracking and NSSI, while controlling for SES and gender. The measures used in this study were rating scales and direct assessments that are commonly used by many school psychologists across the nation. Descriptive and bivariate analyses were conducted with a sample obtained from the National Institute of Child Health and Development (NICHD) Study of Early Child Care (SEEC). The overall findings tend to suggest that the initial hypothesized model provided the best fit for the data. Meaning that the model variables adequately explain the observed correlation. The differences between the observed values and the model's predicted values are small and unbiased (Keith, 2015).

When examining the mediating influence of early eye tracking at 15 months in the relationship between self-injurious behavior at 15 years of age, distress at 54 months, impulsivity at 54 months, emotion regulation in the 5th grade, and problem solving in the 6th grade, it was found that these variables did not have a significant mediating effect. Although the hypothesized path model was the most parsimonious, the results suggested that impulsivity acts as a mediator in the relationship between SES and problem solving. As such, impulsivity may be directly associated with the functions of problem solving.

Findings

There are several implications for these findings. First, the results suggested that gender is more strongly associated with NSSI than eye tracking, given that eye tracking was never directly associated with NSSI in the hypothesized model. Previous research has found gender

differences in NSSI prevalence. These findings were consistent with research which indicates

that while NSSI is common in both males and females, "males report lower severity levels for

most NSSI correlates (e.g., psychopathology, suicidality), highlighting the need to screen males

for NSSI even when reporting comparatively less impairment" (Victor et al. 2018, p. 1).

Historically, the majority of clinical samples have been female. Consistent with previous

studies, the results of this study indicated that females engaged in NSSI most frequently. Despite

these rates, much has yet to be learned about the purpose that NSSI serves. Secondly, the results

found that early eye tracking was not directly associated with NSSI, which highlights the need

for additional research related to infant visual exploration related to early indicators of NSSI.

Previous research (Posner and Rothbart, 2007) findings offer support that early gaze ability may

be foundational to later socio-emotional function. As previously indicated, the ability to pick up

relevant visual information allows people to understand, react, and anticipate the behavior of

other people (Pavlova, 2013). While early gaze ability is important in modulating incoming

information, the way infants visually explore information predicts social learning. It should be

noted, however that varying aspects of visual exploration were not measured in this study.

Future research should measure aspects of visual exploration and its relationship to NSSI.

Although previous literature (Grandclerc et al., 2016) has proposed that underlying

functions associated with NSSI include impulsivity, this study results suggest that impulsivity

may be associated with dysfunctional problem solving styles (e.g., negative problem solving

orientation). Problem solving styles can be characterized as either adaptive or maladaptive (D'

Zurilla et al., 1998). As Gonzalez and Neader (2018) postulated, dysfunctional problem solving

styles are comprised of a negative problem solving orientation, avoidance, and

impulsivity/carelessness in response to life problems. As indicated earlier, individuals with

NSSI tend to choose a more negative solution as their decision making process becomes impaired in the presence of negative emotions (Schatten et al., 2015). A common thread among the theories reviewed is that the act of self-injury provides the individual with emotional relief or as a way to regulate emotions. The present study results suggested that impulsivity acts as a mediator in the relationship between SES and problem solving (Sobel's Z= -3.9939, p <.001). As previously mentioned, infants who employ strategies to resisting the impulse to take immediate reward has been positively associated with both executive functioning and effortful control (Bialeka-Pikul et al., 2018).

"Children growing up in poverty tend to have low EF performance compared to their higher-income peers, with the number of months spent at or below the poverty line in early childhood being associated with lower executive function performance at age 4 in a linear fashion" (Carlson et al., 2018, p. 1401). According to Vazsonyi and Javakhishvili, learning to control aggressive tendencies is strongly related to the regulation of behavioral impulses as well as perspective-taking, planning and emotion regulation (2019). The researchers found that lower SES was also significantly negatively associated with increased wait times in delay of gratification, and male sex was positively associated with over-reactive aggression. Consistent with the present study, the results suggested that more males (as compared to females) selected more over aggressive solutions in resolving conflict during social situations.

Surprisingly, in the path models, impulsivity did not directly predict NSSI. A theoretical explanation for this finding may be that engaging in NSSI is primarily motivated by the desire to relieve aversive emotions. Because previous research has implicated impulsivity as a function associated with NSSI and, given that a sense of urgency is a form of impulsivity in response to

negative affect (Gonzalez & Neader, 2018), it might be expected that entering impulsivity into a model predicting NSSI would show significance, but it did not in the present study.

As indicated previously, Fielder and Glöckner (2002) study examined attentional bias over the course of decision making in risky choices using eye-tracking analysis, found that attention bias and *gaze-cascade* effect (e.g., the tendency that over the course of decision-making attention shifts to the chosen option) in risky choices, support the idea of systematic information distortions, particularly the accentuation of initial advantages of one option over the other. Individuals high in impulsivity may resort to quick, easily executable strategies as impulsivity may heighten the tendency to choose maladaptive coping strategies rather than functional coping strategies that may take more time to relieve stress. Therefore, it seems that higher levels of impulsivity or novelty-seeking may be associated with a greater likelihood of experiential avoidance which the individual seeks to reduce through NSSI. NSSI may occur due to poor negative emotional response inhibition rather than inhibition control. However, a specific negative emotional response inhibition construct was not measured in this study. Future research should measure emotional response inhibition and its relationship to eye tracking, distress, problem solving, emotion regulation, and NSSI.

Limitations of the Study

There were several limitations to this study. First, the use of the NICHD SECC's archival data set was a limiting factor in this study given the overall demographics of the population. The sample population lacked participants with low socioeconomic status (SES). It is hypothesized that infants with low SES typically experience unstable environments and, high levels of parenting and family stress that have been shown to increase the stability of early childhood behavior problems (as cited in Bagner et al. 2012). A more inclusive set that

represents students from other SES and diverse states may have served to increase the

generalizability of the results and give more validity to the distinct profile deficits that may be

shown by different groups. However, this study was unique in the fact that the amount of male

and female participants was equal, meaning that one gender was not over-represented in this

study which may have influenced result outcomes.

Another limitation of this study was the small sample size that met the current study's

criteria. Although the NICHD SECC began with 1,364 children (ages 0 to 3 years) in Phase I,

attrition occurred during the 16-year span of the study. For this particular study, 957 young

adolescents identified having internalizing behavior problems. Additionally, NSSI results are

based upon self-report of behaviors, so the researcher was not completely sure that participants'

responses were biased by the retrospective nature of the self-report data or tendency to respond

in socially desirable ways. Moreover, concerning the assessment of NSSI, there was no

distinction made between current and previous NSSI behaviors, so individuals' responses

regarding their NSSI behaviors may be inaccurate reflections of historical behaviors. Further,

the measure of impulsivity may have prevented an accurate measure of inhibition in the present

model, which assumes impulsivity in response to negative affect as it related to NSSI. It is

important to note that the current study used an exogenous variable to measure eye tracking

skills by the infant's ability to sustain attention. This may be a weakness of the study, as not

only is the ability to sustain attention during the inspection of a stimuli (e.g. ring inspection)

important, but also the type of gaze following that the infant engages in to establish patterns of

looking in the selection of processing of information (Rosati et al. 2016). Given the small

sample size of this study, the results may not generalize to other individuals engaging in NSSI.

However, because a low percentage of the overall population in the United States engages in

NSSI, most studies consists of small sample sizes. Although distress, impulsivity, emotion regulation, and problem solving did not serve as mediators in the relationship between early eye tracking and NSSI, this study added to the research which supports the important role eye tracking plays in the success of children with self-regulatory and behavior problems. This study also provided further support that more research is needed involving early identifiers related to later engagement in NSSI behaviors.

Conclusion

Despite limitations to the research, the importance of this study holds strong. It is important to note that the current study used an endogenous variable to measure NSSI by using self-reported data. The use of data from multiple raters and history of NSSI may help contribute to a more accurate understanding of the individual's engagement in NSSI. Nock et al. (2006) found that 70% of teenagers engaging in NSSI had made at least one suicide attempt and 55% had made multiple attempts. The findings can help educators, parents, and families to understand potential social outcomes for children who struggle with negative emotions but may not have an anxiety or depression diagnosis. In sum, findings from the current research can help develop possible interventions to promote positive social outcomes and reduce negative social outcomes for children. Such interventions may be used in the home, school, or both.

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