SHYNESS AND SOCIAL COGNITIVE PROCESSES IN EARLY CHILDHOOD: BIOLOGY, HETEROGENEITY, AND DEVELOPMENT

SHYNESS AND SOCIAL COGNITIVE PROCESSES IN EARLY CHILDHOOD: BIOLOGY, HETEROGENEITY, AND DEVELOPMENT

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A Thesis Submitted to the School of Graduate Studies in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy

McMaster University DOCTOR OF PHILOSOPHY (2021) Hamilton, Ontario (Psychology)

TITLE: Shyness and social cognitive processes in early childhood: Biology, heterogeneity, and development

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NUMBER OF PAGES: 214

Lay Abstract

Shyness is an anxious preoccupation with the self in real or imagined social situations, and can be expressed situationally and temperamentally. Individual differences in children's state and trait shyness have been previously examined in the context of self-other understanding and prosocial behaviors, such as helping and empathy. However, we know relatively little about how shyness affects these behaviors over time or at different levels of children's self-regulation. This dissertation provides evidence that more adaptive expressions of shyness can be beneficial for children's self-other understanding in the context of high self-regulation. However, children's understanding of others' negative emotions can be constrained by temperamental shyness in the context of low self-regulation. Finally, early temperamental shyness can have long-term, rather than concurrent, effects on later empathic functioning. Collectively, this dissertation contextualizes relations between individual differences in shyness and developing social outcomes in early childhood.

Abstract

Shyness is an anxious preoccupation with the self in real or imagined social situations, and can be expressed situationally and temperamentally. Although state and trait shyness have been previously examined in the context of social cognitive outcomes such as Theory of Mind (ToM) and prosocial processes in early childhood, relatively little work has considered 1) the role of self-regulatory capacity in these relations, and 2) the longitudinal and transactional relations between shyness and prosocial behaviors. Chapters 2, 3, and 4 of this dissertation include empirical investigations that aim to address these gaps in the literature. In Chapter 2, I contextualized the previously reported positive relation between expressions of positive shyness and ToM by revealing that this relation may only exist in children with relatively high physiological self-regulatory capacity, as measured by baseline respiratory sinus arrhythmia (RSA). Similarly, in Chapter 3, I demonstrated that only children with high temperamental shyness and low baseline RSA appear to experience the performance deficits that lead to relatively lower cognitive empathic response. Finally, in Chapter 4, I reported a longitudinal relation between early shyness and later affective empathic response. This study also detected a mediating influence of instrumental helping on this longitudinal relation. Collectively, these studies extend and further contextualize relations between individual differences in shyness and developing social cognitive outcomes in early childhood. This dissertation also considers and explores heterogeneity in types of shyness, expressions of state shyness, and prosocial behaviors; highlighting that not all shy children experience similar outcomes and not all children express shyness in the same way.

Acknowledgements

I would like to thank the many people who have made this dissertation and graduate school experience possible. First, I would like to acknowledge my supervisor, Louis, who has been an incredible role model and guide. Thank you for your trust, flexibility, and for (what seems like!) endless opportunities.

Thank you to my committee members, Mel and Geoff, for their input on my research and to all members of the Child Emotion Lab who have helped along the way. I would especially like to acknowledge the students, volunteers, and staff who sacrificed their evenings and weekends to help with data collection, and those who put hard work into the behavioral coding for these projects: Angela, Annie, Anya, Erica, John, Natalie, Samantha, and Venezia. And to another very special lab member, Jen, who served as an exceptional data collection sidekick and friend. Thank you to Cristina and Milica for your guidance and encouragement, and for being excellent hosts during my time in Amsterdam. Finally, I would like to express gratitude for the many families who participated in my research, without them, none of this would have been possible.

Thank you to Mom and Dad for the gift of education and for always believing in me, standing up for me, and rescheduling certain life-changing exams. Thank you to Ty and Del for being the first to make me a leader and for all the laughs and camping weekends along the way. Thank you to Biban for your everlasting friendship, it has been amazing to live through another era with you. Thank you to Sadie for consistently going above and beyond to support all my endeavours, in and outside the lab. You’re up next!

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List of Tables and Figures

Chapter 4

List of Abbreviations and Symbols

Δ: delta
α: Cronbach's alpha
***f*:** Cohen's f-statistic
κ: Cohen's kappa
ADC: analog-to-digital converter
ANOVA: analysis of variance
b: unstandardized beta coefficient
CCTI: Colorado Childhood Temperament Inventory
CCTV: closed circuit TV
CI: confidence interval
ECG: electrocardiogram
ERH: emotional reactivity hypothesis
F: F-test statistic
HRV: heart rate variability
Hz: hertz
ICC: intra-class correlation
M: mean
min: minutes
n: sample size
NES: negative expressions of shyness
NPES: non-positive expressions of shyness
p: p-value
PES: positive expressions of shyness
PVT: picture vocabulary test
r: Pearson correlation coefficient
R^2: coefficient of determination
r_{pb}: point-biserial correlation coefficient
RSA: respiratory sinus arrhythmia
s: seconds
SD: standard deviation
SE: standard error
SES: socioeconomic status
SPSS: Statistical Package for the Social Sciences
t: t-test statistic
ToM: theory of mind
***z*:** z-score

Declaration of Academic Achievement

This thesis consists of one study published in an academic journal (Study 2 in Chapter 3), one study in press for an academic journal (Study 3 in Chapter 4), and one study that has been revised and resubmitted for publication in an academic journal (Study 1 in Chapter 2). The author of this thesis is the primary author for all the presented studies, and her supervisor, Dr. Louis A. Schmidt (McMaster University), is the final author on all manuscripts. The contributions of each author in each study are outlined below.

Study 1 (Chapter 2) assesses cross-sectional relations among expressions of state shyness, self-regulatory capacity, and Theory of Mind ability in a sample of 4-year-old children. Taigan L. MacGowan, the primary author, conceptualized the research and experimental design, collected the data, developed the behavioral coding scheme for state shyness, served as primary coder, performed data analyses, and wrote the manuscript. Cristina Colonnesi, the second author, developed the behavioral coding scheme for state shyness and gave feedback on drafts of the manuscript. Milica Nikolic, the third author, developed the behavioral coding scheme for state shyness, served as secondary coder, and gave feedback on drafts of the manuscript. Louis A. Schmidt, the last author, was responsible for conceptualization of research and experimental design, and gave feedback on drafts of the manuscript.

MacGowan, T. L., Colonnesi, C., Nikolic, M., & Schmidt, L.A. (Under Review, *Cognitive Development*). Expressions of Shyness and Theory of Mind in Children: A Psychophysiological Study. *Manuscript Submitted for Publication.*

Study 2 (Chapter 3) is a reprint of the following published article with permission from John Wiley & Sons, Copyright © 2020:

MacGowan, T. L. & Schmidt, L. A. (2020). Getting to the heart of childhood empathy: Relations with shyness and respiratory sinus arrhythmia. *Developmental Psychobiology*. Advance online publication.

This study explored cross-sectional relations among temperamental shyness, self-regulatory capacity, and empathic response in the preschool and early school age years. Taigan L. MacGowan, the primary author, conceptualized the research and experimental design, collected the data, developed the behavioral shyness coding scheme, performed data analyses, and wrote the manuscript. Louis A. Schmidt, the second author, was responsible for conceptualization of research and experimental design, and gave feedback on drafts of the manuscript.

Study 3 (Chapter 4) is a reprint of the following forthcoming article with permission from Elsevier, Copyright © 2021:

MacGowan, T. L., & Schmidt, L. A. (2021). Helping as prosocial practice: Longitudinal relations among children's shyness, helping behavior, and empathic response. *Journal of Experimental Child Psychology*. Manuscript in press.

This short-term longitudinal study explored the intervening effects of helping behavior on the relation between early temperamental shyness and later affective empathic response. Taigan L. MacGowan, the primary author, conceptualized the research and experimental design, collected the data, developed the behavioral shyness coding scheme, performed data analyses, and wrote the manuscript. Louis A. Schmidt, the second author, was responsible for conceptualization of research and experimental design, and gave feedback on drafts of the manuscript.

CHAPTER 1

General Introduction

The term ‘temperament’ has been used to refer to early emerging, biologically based, and stable individual differences in emotional and behavioral responses since Galen’s investigations in the second century (e.g., Kant, 2006). Although this early work conceptualized temperaments as physical ‘humors’ that could cause imbalances in the body, additional knowledge has been gained over the past centuries, from scientists such as Hans Eysenck and Jerome Kagan, who have clarified that temperaments are simply natural variations in patterns of behavior (Eysenck & Eysenck, 1985; Kagan, 1994). Recently, empirical work on temperament has moved from the group classification system of difficult, easy, and slow-to-warm infants (Thomas & Chess, 1977) to a dimensional approach, involving various separately conceptualized attentional, emotional, and behavioral patterns (Rothbart et al., 2014). Presently, temperament is most commonly defined as individual differences in reactivity and self-regulation, which develops before the higher cognitive development and social influences that tend to be prevalent in later toddlerhood and the early preschool years (Rothbart et al., 2004).

Given their biological origins, it can be argued that temperaments appear within human and animal populations as behavioral variation to serve as unique evolutionary strategies for reproducing, gaining access to resources, and co-existing within a social hierarchy (Hassan, MacGowan et al., 2021). For example, temperamental behavioral inhibition has been conserved across a range of animal species and can be thought to motivate physically stronger individuals to investigate unfamiliar objects, places, and conspecifics (i.e., low behavioral inhibition), while simultaneously protecting weaker parties from potentially threatening novel entities (i.e., high behavioral inhibition). In non-human animals, this construct is known as the shy-bold continuum and is well-researched in species of fish, birds, and mammals, whereby some individuals exhibit more risk-taking behavior by approaching novel stimuli (i.e., bold behavioral strategy), while others will display fear and avoidance (i.e., shy behavioral strategy; Groothuis & Carere, 2005; Koolhaas et al., 1999; Wilson et al., 1994). In humans, this behavioral inhibition continuum is evident from infancy and is robustly stable across childhood into adulthood (Kagan, 1994). Given how conserved the shy-bold continuum appears to be across a range of animals, it has likely contributed to species' survival over the course of their evolution.

While individuals who display high behavioral inhibition tend to experience fear and anxiety when presented with novel stimuli in general, another commonly researched temperament embodies competing approach and avoidance motivations in response to novel stimuli of a social nature in particular. That is, individuals who are low in Temperamental Shyness will exhibit bolder behaviors with social conspecifics, while those who have a shy phenotype tend to experience fear and anxiety in response to social interactions and situations (see Schmidt & Schulkin, 1999, for a review). Given the ubiquitous nature and adaptive advantage of social connection within the human species, it is likely that Temperamental Shyness evolved as a strategy to protect less socially skilled or physically small individuals from transgressions that could jeopardize social connection or from potentially dangerous novel outgroup members, respectively. Despite its evolutionary origins, it is important to consider relevant developmental outcomes that are associated with temperamental and state shyness as it is understood and functions within our contemporary society.

Temperamental and State Shyness

Shyness is defined as an anxious preoccupation with the self in real or imagined social situations (Cheek & Melchior, 1991) and can involve social reticence and/or social avoidance in situations that involve unfamiliar individuals or contexts (Coplan et al., 2004, 2009; Schmidt et al., 1999). Childhood shyness has been researched in the context of many negative developmental outcomes such as lower academic achievement (Hughes & Coplan, 2010), lower self-esteem (Crozier, 1995), higher internalizing behaviors (Coplan et al., 2008), and lower quality peer relationships (Eggum-Wilkens et al., 2014; Rubin et al., 2009). However, most research studies that report these associations do not consider heterogeneity within children's shyness.

To examine and account for different expressions and phenotypes of shyness, one must first consider that temperamental shyness contrasts with state shyness. Temperamental shyness (also referred to as trait shyness) represents a disposition that tends to be modestly stable across time and situations and occurs in approximately 10-15% of individuals (Kagan, 1994). In contrast, state shyness is an emotional reaction that can be experienced by any individual (approximately 90% of people have reported feeling shy within their lifetime; Zimbardo, 1977) during situations that elicit social stress, such as during presentations or when encountering new people (Asendorpf, 1990; Lewis, 2001). While state and trait shyness are often conceptualized and studied differently, state shyness can be seen as a context-specific reaction to pre-existing temperamental shyness.

Shyness has been conceptualized by some as a social ambivalence in which both approach and avoidance motivations are experienced simultaneously and in conflict with each other (Asendorpf, 1990; Coplan et al., 2004; Lewis, 2001). This line of thinking has contributed to further classifications of state shyness such that some expressions tend to involve a dominating motivation of approach whereas others reflect an underlying motivation for avoidance. When individuals experience prevailing avoidance or fearfulness during social situations, they will often display non-positive expressions of shyness (NPES; also referred to as negative shyness in some publications), which involve a negative facial expression at the time of an avoidant behavior (i.e., head or gaze aversion; Asendorpf, 1989, 1990; Colonnesi et al., 2014). NPES tend to be positively associated with social inhibition and social anxiety, and inversely related to sociability (Colonnesi et al., 2014; Poole & Schmidt, 2019), suggesting that individuals who express high levels of NPES have trouble coping with social demands (Colonnesi et al., 2014).

NPES are conceptually linked with what Buss (1986a, b) describes as a fearful subtype of shyness, which is thought to be an evolutionarily older phenotype that tends to emerge during the latter half of the first year of life and is characterized by avoidance motivations (Hassan, MacGowan et al., 2021). This type of shyness reflects a heightened sensitivity to social threat and emerges with the onset of stranger fear (i.e., 6-12 months of age; Buss, 1986a, b). Fearful shyness appears to have evolved from a basic fear system to protect vulnerable individuals from possible physical harm by unfamiliar conspecifics (Schmidt & Poole, 2019).

In contrast to NPES, positive expressions of shyness (PES; also known as positive shyness), which involve positive facial expressions at the time of an avoidant behavior (Colonessi et al., 2014, 2017; Reddy, 2001, 2005), are thought to express a dominating motivation for approach. Generally, individuals who display high levels of PES are thought to experience heightened self-esteem during social interactions (Thompson & Calkins, 1996). PES are presumed to signal affiliation and hold others' interest while simultaneously allowing time for the individual to gather information regarding the social situation and social partners involved (Sroufe & Waters, 1976). Although PES have been detected in children as early as infancy (Colonnesi et al., 2014), they are more conceptually related to *self-conscious shyness* when compared to fearful shyness. Self-conscious shyness tends to emerge around the preschool years, when self-awareness, perspective-taking, and the ability to infer others' beliefs is evident (Buss, 1986a, b; Schmidt & Poole, 2019), and is associated with less fear of physical harm and more fear of negative social evaluation and threat to the ego. Self-conscious shyness is assumed to have evolved later in human history when compared to fearful shyness (Schmidt & Poole, 2019). In addition to signalling affiliation and holding the interest of others, PES have been argued to regulate and reduce arousal during uncomfortable or stressful social situations and, as such, have been related to reductions in children's social anxiety (Colonnesi et al., 2014). Indeed, both temperamental and state shyness are conceptually related to the reactivity and regulation of arousal, such that shy children tend to experience a relatively low threshold for arousal, and possibly also encounter difficulty regulating the fear elicited from social novelty.

Shyness, Reactivity, and Regulation

Mary Rothbart's temperamental model of reactivity and regulation states that regulatory abilities are thought to protect against the potential risks, stresses, and negative developmental outcomes that emerge from relatively high reactivity (Posner & Rothbart, 2009; Rothbart, 2004; Rothbart & Bates, 1998). Temperamental shyness has been associated with a relatively lower threshold for arousal in the context of social novelty (Kagan, 1994; Kagan et al., 1988) and so it can be assumed that high levels of self-regulation (stemming from PES or otherwise) can potentially protect shy children from associated negative developmental outcomes.

Generally, self-regulation encompasses behavioral, physiological, cognitive, and affective processes that enable individuals to effectively engage in goal-directed behavior (Hofmann et al., 2012). Some such self-regulatory behaviors such as inhibitory control and attentional shifting have been associated with many positive outcomes in typically developing child and adolescent populations, such as fewer internalizing problems, lower peer rejection, and higher social competence (Denio et al., 2020; Eisenberg et al., 2001; Lengua, 2006; Muris, 2006).

The protective nature of self-regulation in the context of shy-specific reactivity has been supported through some empirical studies, including Henderson (2010), who found that, in middle childhood, shyness was positively associated with socioemotional adjustment in the context of neural correlates of high self-regulation (i.e., N2 event-related potential response to a Flanker task). Adults who experience persisting shyness have also been found to experience high levels of negative reactivity combined with low levels self-regulation (Eisenberg et al., 1995). Finally, Eggum-Wilkens et al. (2016) found that high levels of behavioral self-regulation (i.e., inhibitory control, attention shifting) at 42 months have been found to be negatively predictive of trajectories of shyness over three years.

Aside from well-researched behavioral measures of self-regulation, physiological assessments of self-regulatory capacity have also been explored in the context of child shyness (Hastings et al., 2014; Sulik et al., 2013), and as a moderator of risk when assessing associations within socioemotional development more broadly (El-Sheikh et al., 2006; Khurshid et al., 2019; Morales et al., 2015). These physiological measures are of particular interest when examining shyness correlates since shyness can often be accompanied by physiological symptoms of fear, anxiety, and physiological dysregulation of the internal milieu (LoBue & Perez-Edgar, 2014; Schmidt et al., 1999).

One such measure that is widely used in developmental research due to its non-invasive nature is respiratory sinus arrhythmia (RSA); a measure of heart rate variability (HRV) in correspondence with the respiratory cycle (Porges et al., 1994). Baseline RSA can be easily collected through electrocardiogram (ECG) while a child participant watches an emotionally neutral video. This data can be then used to derive a reliable measure of efficiency of physiological response to environmental changes and challenges (Thayer & Lane, 2000).

Resting RSA has been found to be positively associated with emotion regulation, cognitive self-regulation, and executive functioning (Blandon et al., 2008; Calkins & Keane, 2004; Fabes & Eisenberg, 1997; Graziano & Derefinko, 2013; Hansen et al., 2003; Marcovitch et al., 2010; Mezzacappa et al., 1998; Porges, 1992, 2007; Staton et al., 2009; Suess et al., 1994). Overall, resting RSA is thought to reflect a predisposition to self-regulation and threshold for arousal (Hastings et al., 2006; Porges & Byrne, 1992). As such, relatively higher resting RSA is presumed to reflect a better capacity for adaptable behavioral responding (Porges, 2007, 2011), while lower resting RSA is presumed to reflect a lower capacity for self-regulation in event of mildly stressful or overwhelming environmental stimuli (Beauchaine, 2001; Porges, 2011; Thayer et al., 2012).

The protective nature of self-regulatory capacity within shy children has been supported with RSA measures as well as the previously mentioned behavioral measures of self-regulation. For example, Sulik et al. (2013) reported that relatively lower RSA combined with relatively higher shyness resulted in the lowest levels of effortful control in a sample of typically developing preschoolers. In addition, Hastings, Kahle, and Nuselovici (2014) found that baseline RSA moderated the relation between preschool social wariness and anxiety in middle childhood, such that children with relatively higher RSA, but not relatively lower RSA, exhibited a negative relation between social wariness and later anxiety.

Despite these findings, to our knowledge, no studies have assessed the moderating influence of self-regulation or self-regulatory capacity on the relation between shyness and developing social cognitive abilities. Social cognition, which encompasses skills such as other-understanding, empathy, and instrumental helping behavior, is relevant to both shyness and self-regulatory capacity. Given that temperamental shyness reflects preoccupation with unfamiliar social stimuli and social stressors, there is surprisingly little research assessing how self-regulatory abilities may interact with this phenotype in predicting the development of children's social processing and prosocial functioning. Importantly, self-regulation and parasympathetic control have been found to be beneficial for the development of empathy and helping behavior in early childhood (Eisenberg, 2005; Eisenberg & Fabes, 1992). Taken together, the developmental outcomes that are arguably most important to explore in the context of shyness and self-regulation are those of a socio-cognitive nature.

Shyness and Social Cognitive Outcomes

Although shyness is commonly investigated in relation to behavioral indices of maladjustment in childhood (Findlay et al., 2009; Fox et al., 2005; Kiel et al., 2015; Schmidt & Miskovic, 2013, 2014; Schmidt & Schulkin, 1999; Tang et al., 2017, 2020), emerging evidence suggests that shyness is associated with developmental strengths in certain areas of social cognition (Brunet et al., 2009; Labounty et al., 2017; Lane et al., 2013; LoBue & Perez-Edgar, 2014; MacGowan et al., 2021; Matsuda et al., 2013; Schmidt & Tasker, 2001; Wellman et al., 2011). These strengths appear to primarily involve the social processing skills needed for reading and recognizing social cues. For example, shy children tend to experience a heightened sensitivity to certain emotions depicted on others' faces, such as those that signal threat (LoBue & Perez-Edgar, 2014;

see also Jetha et al., 2012, for studies of shy adults). Shy children also appear to scan others' eye regions faster when presented with faces, suggesting that they adhere to intention-related social cues more than non-shy individuals (Brunet et al., 2009; Matsuda et al., 2013). Recently, we have reported a positive relation between 5-year-old children's shy behaviors and their later automatic imitation at age 6, suggesting that shy children may have a heightened sensitivity to others' motor cues and implement more imitation to 'blend in' with their social environment (MacGowan et al., 2021).

Perhaps most notably, shy children have been found to possess heightened Theory of Mind in the preschool years, which allows them to make better predictions and inferences about others' thoughts, feelings, and beliefs (Labounty et al., 2017; Lane et al., 2013; Wellman et al., 2011). While it is reasonable to argue that temperamental shyness could lead to reticent behavior, therefore slowing the acquirement of ToM as a result of fewer social learning opportunities (which has been supported by a number of studies including de Rosnay et al., 2014; Kokkinos et al., 2016; Pecora et al., 2018; see also Rutherford, 2004 for an examination of ToM in the context of social status), most of the existing literature has provided evidence that, in infancy and through the preschool years, shyness allows for a more observant and vigilant social style, resulting in higher ToM (LaBounty et al., 2017; Lane et al., 2013; Longobardi et al., 2017; Mink et al., 2014; Wellman et al., 2011). As such, temperamental shyness has been found to be both concurrently (LaBounty et al., 2017; Lane et al., 2013; Longobardi et al., 2017) and longitudinally (Mink et al., 2014; Wellman et al., 2011) associated with ToM abilities from infancy to middle childhood. For example, Mink et al. (2014) found that temperamental shyness at 18 months was related to more sophisticated ToM understanding at age 3. In addition, Wellman et al. (2011) found that children with a shy temperament at age 3 displayed more advanced ToM by age 5.

The most commonly argued explanation for the positive relation between shyness and ToM stems from the ontogenetic development of temperament and social cognition, falling under what is referred to as the Emotional Reactivity Hypothesis (ERH; Hare & Tomasello, 2005). This proposition states that inhibited temperaments, such as shyness, promote a more observant social style when compared to aggressive and/or gregarious temperaments (Wellman et al., 2011). Human and non-human animals with inhibited temperaments appear to gain advanced social awareness and social learning in two ways. First, inhibition tends to be associated with vigilance to threat, causing inhibited individuals to be more socially perceptive of potentially dangerous novel conspecifics. Second, inhibited temperaments allow individuals to process their social surroundings without directly participating in interactions; by preventing them from reacting to others strongly or with haste (Hare, 2007; Hare & Tomasello, 2005). These tendencies could grant children who are high in trait shyness with a more encompassed view of social intercommunication, which would involve more reflection on the thoughts and feelings of others.

There has been less work exploring the relation between expressions of state shyness and ToM development. Colonnesi et al. (2017) have reported that, in a sample of 4-year-old children, expressions of non-positive shyness were negatively associated with scores from a basic battery of ToM tasks, while expressions of positive shyness were positively associated with scores from a more sophisticated battery. In addition, a study conducted by Banerjee and Henderson (2001) found that socially anxious children with high negative shy affect displayed poor social cognitive understanding of emotions, intentions, and beliefs of others. Taken together, these findings suggest that perhaps not all shy expressions will benefit children's social cognitive development. Further investigation is required to explore whether there are opposing relations between expressions of state shyness and ToM in early childhood: whether more adaptive expressions of shyness (i.e., PES) advance children's other-inference and whether less adaptive shyness (i.e., NPES) may hinder the development of ToM.

While children who are temperamentally shy appear to possess social cognitive strengths such as heightened ToM, these abilities do not appear to benefit all social interactions. In fact, shyness has been investigated thoroughly as a considerable constraint on young children's concurrent prosocial behaviors (i.e., empathy and helping responses; Beier et al., 2017; Eisenberg et al., 1996; Eisenberg et al., 2019; Findlay, et al., 2006; Karasewich et al., 2018; Stanhope, et al., 1987; Young et al., 1999). Given the findings outlined above, apparent shyness-related social cognitive deficits (i.e., decreased prosocial behaviors) in more socially salient situations have often been explained by performance-related inhibition rather than any issue with shy children's social cognitive competencies (Eisenberg & Fabes, 1998; Findlay et al., 2006; Zava et al., 2020). Shy children are known to experience personal distress in situations that require helping or empathic response, and this self-directed regulation often impedes the child from being able to direct responses to the victim in need (Eisenberg & Fabes, 1998; Kim & Han, 2018; Preston & de Waal, 2002).

Despite the work surrounding this negative association between shyness and prosocial behavior (e.g., Beier et al., 2017; Eisenberg et al., 2019) as well as the positive link between self-regulation and prosocial responses (Blake et al., 2015; Carlo et al., 2012; Eisenberg, 2005; Eisenberg et al., 1996, 1998; Eisenberg & Fabes, 1992; Findlay et al., 2006; Hastings, Zahn-Waxler, & McShane, 2006; Laible et al., 2014), the interaction between shyness and self-regulation has not been explored in predicting empathy in early childhood. Investigating this moderating relation would be important to provide further empirical evidence for Rothbart's theory regarding the protective nature of self regulation in shy children's empathic development. As well, to our knowledge, there has been very few studies assessing longitudinal relations between shyness and prosocial behaviors; it is unclear if this temperament has long-term negative consequences on the development of young children's empathic or helping responses.

Overview of Dissertation

This dissertation broadly examines concurrent and longitudinal associations between shyness and developing social cognitive outcomes during the preschool years. Using observational and physiological data, I carried out three studies in a large sample of typically developing preschool aged children, whose data were collected over the course of three years. Studies 1 and 2 (Chapters 2 and 3) investigated whether self regulation, in accordance with Mary Rothbart's theory, was indeed protective when examining relations between shyness and concurrent social cognitive outcomes in early childhood. Study 3 (Chapter 4) assessed longitudinal relations between shyness and various prosocial behaviors, as well as the intervening impact of early instrumental helping on later empathic response.

All three studies utilize a self-presentation task to obtain a conceptually and empirically derived measure of observed state (Study 1) and temperamental shyness (Studies 2 and 3). In this task, children are spontaneously instructed to stand in front of a video camera and give a speech about their most recent birthday. Children were informed that the video would be shown to other boys and girls that are the same age as themselves. In Study 1, we coded positive and non-positive expressions of state shyness. In Studies 2 and 3, observed behavioral indices of shyness were highly positively correlated with a maternal report of children's temperamental shyness, and therefore a composite measure of temperamental shyness was derived.

In Study 1 (Chapter 2), I assessed the simple relations between both temperamental and state shyness, and ToM in a sample of 4-year-old children. I replicated and extended past work by providing evidence that positive expressions of shyness (PES) were positively associated with performance on a battery of ToM vignette-based tasks, whereas non-positive expressions of shyness (NPES) were negatively associated with ToM scores. We found no relation between temperamental shyness and ToM ability, suggesting that heterogeneity within shy expressions may explain the contrasting findings outlined in the literature. I further explored the moderating influence of physiological self-regulation, as measured by resting respiratory sinus arrythmia (RSA), on the relation between these expressions of shyness and ToM understanding. I found that children who displayed high physiological self-regulation and relatively more

PES exhibited the most sophisticated ToM understanding. This finding suggests that self regulation may not only serve as a protective factor for children's temperamental shyness, but also expands the benefits of more adaptive forms of state shyness in the context of social cognitive development.

In Study 2 (Chapter 3), I extended and complemented work from Study 1 by exploring the moderating role of physiological self regulation on the relation between temperamental shyness and concurrent cognitive and affective empathic response in a cross-sectional sample of 4- and 6-year-old children. In this study, children were exposed to a laboratory-controlled episode in which an experimenter feigned injury to her finger and expressed pain outwardly. Participants were subsequently behaviorally coded for affective (vicarious affective response; concern, gaze, verbal engagement) and cognitive (hypothesis testing; exploring the injury and its cause) empathic responses. I found that children who were coded and reported as being relatively higher in temperamental shyness and possessed relatively lower physiological self regulation displayed the lowest cognitive empathic responses to the experimenter. Children who had both relatively higher shyness and higher physiological self-regulation displayed similar, moderate cognitive empathy as children who were relatively lower in shyness. This study replicated past work by reporting a negative association between temperamental shyness and measures of empathic response toward an experimenter in a laboratory setting. It also supported Rothbart's theory by providing evidence that self regulatory capacity appears to be protective in the context of children's temperamental shyness.

In Study 3 (Chapter 4), I extended past literature by assessing the longitudinal associations between temperamental shyness and various prosocial behaviors, including instrumental helping, affective empathy, and cognitive empathy. Shyness at ages 4 and 5 was longitudinally associated with affective empathic response at age 6; however, this relation was not found for helping or cognitive empathy. Instrumental helping at age 5 mediated the relations between shyness at age 4 and 5 and affective empathy at age 6. It appears that shyness may concurrently hinder more basic prosocial behaviors (i.e., instrumental helping), preventing shy children from engaging in 'prosocial practice' early in development and potentially constraining the development of more complex behaviors, such as affective empathy. This study is, to our knowledge, the first to assess the longitudinal relations between temperamental shyness and these prosocial behaviors of interest, and provides evidence for long-term transactional consequences of shyness on the development of prosocial responding.

Collectively, these studies suggest that certain expressions of shyness in the context of high self regulation may benefit the development of social inference, however, temperamentally shy children encounter performance-related weaknesses that may concurrently and longitudinally hinder prosocial action. I demonstrated that only certain expressions of more adaptive shyness in the context of high self regulatory capacity appear to benefit the development of Theory of Mind in early childhood. In all, self regulation appears to amplify the benefits of more adaptive expressions of shyness and protect temperamentally shy children from deficits in cognitive empathic response. Finally, temperamentally shy children's concurrent reductions in instrumental helping in the preschool years may affect their ability to effectively engage in later, more sophisticated prosocial behavior, such as affective responding to someone in need.

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CHAPTER 2

Study 1: Expressions of State Shyness, Self-Regulatory Capacity, and Theory of Mind Development

MacGowan, T. L., Colonnesi, C., Nikolic, M., & Schmidt, L.A. (Under Review). Expressions of Shyness and Theory of Mind in Children: A Psychophysiological Study. *Manuscript Submitted for Publication.*

Abstract

This study examined relations among expressions of state shyness, Theory of Mind (ToM), and resting respiratory sinus arrhythmia (RSA) in 78 typically developing four-year-old children (M_{age} = 54.59 months; 41 females). Expressions of positive and non-positive state shyness were coded from direct observations during a self-presentation task, ToM was assessed with validated vignette tasks, and resting RSA data was collected while children watched an emotionally neutral video. We found that ToM was positively related to expressions of positive shyness and inversely related to expressions of non-positive shyness. These relations were qualified by an interaction between resting RSA and expressions of positive shyness in predicting ToM, such that children with relatively higher resting RSA and more expressions of positive shyness exhibited the most sophisticated ToM. Results indicate that a combination of more expressions of positive shyness and higher resting baseline RSA may provide children with both behavioral and physiological regulatory strengths during social interactions, possibly providing them with more time for learning the intentions of others thereby contributing to the development of more sophisticated ToM skills.

Introduction

Theory of Mind (ToM) is a social-cognitive skill that involves understanding, predicting, and explaining the behaviors of others by inferring their mental states (Wellman, 1990; Wellman & Liu, 2004). Children's capacity to understand and approach other people as independent mental agents begins in infancy. In this early stage of development, infants learn from social interactions with their parents and other caregivers and can consequently begin to engage in rudimentary mentalizing behaviors such as intentional communication (i.e., pointing) and non-verbal understanding of others' intentions (Brooks & Meltzoff, 2015; Colonnesi et al., 2008). By the preschool years, most children can express their ToM understanding explicitly, which allows for more complex reasoning about others' emotions, the cognitive capacity to engage in pretend play, and even the development of deeper self-consciousness around others. Although other-inference tends to develop most rapidly in the preschool years, children continue to gain more sophisticated mentalizing abilities through the rest of childhood and into adolescence (Muris et al., 1999; Perner & Wimmer, 1985; Wellman et al., 2004).

False-belief tasks presented with vignettes are considered the gold standard of ToM assessment, with more basic tasks assessing the child's ability to understand diverse desires among individuals, as well as the reconstruction of their own past false beliefs. As ToM understanding becomes more sophisticated, children can successfully complete more complex tasks, such as those involving first-order and second-order false belief understanding (Wellman & Liu, 2004), around the age of 4 to 6 years in typically developing children. Children across cultures will generally follow the same developmental sequence in achieving these tasks (e.g., Wellman et al., 2011a).

ToM is an important component of a child's socioemotional development since it contributes to the formation and consolidation of lasting and meaningful relationships with peers and adults (Devine et al., 2016; Longobardi et al., 2016). Identifying individual differences in the development of this skill is important, since delayed ToM has been associated with hostile attributional biases (Choe et al., 2013), aggressive behavior (Song et al., 2016), internalizing problems (Banerjee & Henderson, 2001), and social deficits in some children (Happe, 1994). Some such individual differences that are worth exploring in the context of ToM include temperament, affect, and regulation, which are equally important for children's emotional development. One particular theoretically relevant factor is shyness, since it is applicable to how often and how skillfully children engage in social interaction.

Temperamental Shyness and Expressions of State Shyness

Shyness has been characterized as an anxious preoccupation with the self in real or imagined social situations (Cheek & Melchior, 1990), and can be conceptualized as both a state and a trait. *State shyness* is an emotional reaction that can occur when an individual is in a situation that elicits social stress, such as during a presentation or when encountering new people (Asendorpf, 1990; Lewis, 2001). State shyness can be seen as a context-specific reaction to pre-existing trait shyness (Poole & Schmidt, 2021). *Trait shyness* is, in contrast, an overall temperament or disposition toward social novelty that is modestly stable across time and situations (Coplan & Rubin, 2010; Kagan et al., 1988).

Some have argued that shyness represents a social ambivalence in which approach and avoidance motivations are experienced simultaneously and in conflict during social situations and self-presentation (Asendorpf, 1990; Coplan et al., 2004; Lewis, 2001). However, we know that not all shy children are alike (e.g., Poole et al., 2018; Schmidt & Fox, 1999; Schmidt & Poole, 2018), and not all shyness is expressed in the same way (Colonnesi et al., 2014; Colonnesi et al., 2017; Poole & Schmidt, 2019). An emerging body of recent research has outlined the importance of examining heterogeneity in state shyness by studying facial expressions (Colonnesi et al., 2014, 2017; Nikolić et al., 2016; Poole & Schmidt, 2019). To do this, children's responses to social stimuli can be behaviorally coded during self-presentation tasks, in which the child experiences simulated social evaluation from others. Coding of facial expression can be then used to determine the degree to which approach or avoidance are involved at a given time or in a particular individual (Colonnesi et al., 2014; Nikolić et al., 2016; Poole & Schmidt, 2019).

One such example of categorizing state shyness is through the examination of positive versus non-positive expressions of shyness. Positive expressions of shyness (PES) are defined as positive facial expressions (i.e., smiling) in combination with a gaze and/or head aversion (Asendorpf, 1990; see also Colonnesi et al., 2014). This behavior is thought to express a tension between aversion and enjoyment, with a dominating motivation for approach (Reddy, 2005; Thompson & Calkins, 1996). The development of smiling has been thought to be highly related to processes that concern physiological mechanisms of arousal. It has been argued that PES in early childhood, and even infancy, might exist to reduce arousal during social interaction while simultaneously engaging with another person by holding their interest and attention (Sroufe & Waters, 1976). As such, some argue that this expression may have evolved as a social appeasement behavior as well as a regulatory mechanism to reduce fear during social situations (Colonnesi et al., 2014). Due to the affiliative nature of this expression of shyness, children who display high levels of PES are thought to learn more from social situations and develop higher self-esteem when interacting with others (Thompson & Calkins, 1996). Although individuals who express positive shyness are thought to experience some discomfort and nervousness toward social stimuli, this expression can be seen as a more adaptive form of shyness due to the regulation of arousal in real time as well as the affiliative nature of the smile (Colonnesi et al., 2014; Schmidt & Poole, 2019).

While PES appear to be an adaptive mechanism to deal with the stress involved in social interaction (Colonnesi et al., 2014, 2020; Poole & Schmidt, 2019; Schmidt & Poole, 2019, 2020), expressions of non-positive shyness (NPES) are considered more avoidant reactions to social evaluation. Expressions of non-positive shyness are defined as a gaze and/or head aversion during a negative or neutral facial expression, which largely expresses fear and discomfort rather than pleasure (Asendorpf, 1989, 1990; Colonnesi et al., 2014). These expressions have been found to be related to social inhibition and social anxiety, and inversely related to sociability (Colonnesi et al., 2014; Poole & Schmidt, 2019), suggesting that NPES are associated with less ability to cope with social demands (Colonnesi et al., 2014). It is important to note that, although PES and NPES are mutually exclusive, individuals can express varying degrees of both positive and non-positive expressions of shyness within the same episode.

Shyness and Theory of Mind

Although state shyness has strong behavioral and physiological implications for the development of ToM, the predominant research focus within past literature has been the relation between trait shyness and social cognitive abilities such as ToM. A child's level of shyness can influence his or her social experiences, and thus social learning opportunities, which are vital to the development of social-cognitive abilities (e.g., Astington & Baird, 2005). While it is reasonable to argue that trait shyness could lead to reticent behavior, which might impede ToM and slow the development of social cognitive understanding (de Rosnay et al., 2014; Kokkinos et al., 2016), the majority of existing literature has provided evidence that, in infancy and through the preschool years, trait shyness allows for a more observant and vigilant social style, resulting in higher ToM (LaBounty et al., 2017; Lane et al., 2013; Longobardi et al., 2017; Mink et al., 2014; Wellman et al., 2011). Aside from work surrounding trait shyness and ToM, there is also evidence to suggest that shy children possess unique social-cognitive strengths allowing for heightened detection of social threat (Brunet et al., 2009; Hassan et al., 2021; LoBue & Perez-Edgar, 2014; MacGowan et al., 2021; Matsuda et al., 2013). Thus, trait shyness may support observation rather than direct interaction involving participation. In fact, shyness is, at times, empirically investigated through the assessment of children's preference to watch others rather than engage directly with peers (Asendorpf, 1990; Coplan et al., 2004). This tendency could grant children who are high in trait shyness a more encompassed view of social intercommunication, which would involve more information and reflection on the thoughts and feelings of others.

The most common explanation that has been used for the positive relation between shyness and ToM stems from the ontogenetic development of temperament and social cognition. This proposition states that shyness promotes a less aggressive and more observant social style that benefits social awareness and social learning (Wellman et al., 2011). Being able to detect and respond appropriately to social signals requires that the individual processes his/her social surroundings without reacting to these situations strongly or with haste. Reasoning for this notion has been drawn from the Emotional Reactivity Hypothesis (ERH), which states that less socially reactive[1] temperaments (i.e., more inhibited and shy temperaments) lead to better social-cognitive understanding (Hare & Tomasello, 2005).

In line with this hypothesis, shy children tend to exhibit low gregariousness and high perceptual sensitivity in social contexts, and thus have the potential to develop more sophisticated social cognitive understanding (Kiel & Buss, 2011; Perez-Edgar et al., 2010, 2011). While non-shy children are relatively uninhibited and can be more socially outgoing when engaging in social interaction, high levels of trait shyness often result in less participation and more direct observation. This combination of characteristics presumably allows for enhanced information processing during social learning

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[1] It is important to note that the term *reactivity* as is used within the context of this hypothesis refers to social reactivity, which is the tendency to respond to social stimuli strongly or with haste. This term does not refer to a lower threshold for social or non-social sourced arousal, as it has been defined elsewhere previously (e.g., Rothbart & Bates, 2006).

opportunities that may contribute to the development of social cognitive abilities such as ToM.

While most studies on this topic have explored relations between trait shyness and ToM, relatively few have addressed how state shyness influences the development of this skill. Colonnesi et al. (2017) have recently found that, in a sample of 4-year-old children, expressions of non-positive shyness were negatively associated with scores from a basic battery of ToM tasks, while expressions of positive shyness were positively associated with scores from a more sophisticated battery. In addition, Banerjee and Henderson (2001) found that socially anxious children with high negative shy affect displayed poor social cognitive understanding of emotions, intentions, and beliefs of others in social situations.

Despite our current knowledge regarding relations between trait and state shyness and the development of ToM in early childhood, there is one relevant factor that presumably underlies temperamental shyness and expressions of shy responses to social stimuli: autonomic regulation. Autonomic regulation has not been explored fully in the context of ToM development, nor the relation between shyness and ToM. The assessment of psychophysiological measures of regulation and arousal in the context of shyness and ToM may allow us to gain a deeper understanding of this association and help clarify some prior inconsistent findings on this topic.

Parasympathetic Control and Theory of Mind

While expressions of positive shyness are hypothesized to be a regulatory mechanism for reducing children’s social apprehension and fear (e.g., Sroufe & Waters, 1976), surprisingly few studies have examined measures of physiological regulation in relation to expressions of shyness. Accordingly, it is important to consider children's overall capability for regulating and controlling their emotional and physiological responses to fully understand the relation between shyness and ToM. In early childhood, self-regulation and parasympathetic control have been found to support certain social cognitive processes, such as empathy and prosocial behavior (Eisenberg, 2005; Eisenberg & Fabes, 1992; MacGowan & Schmidt, 2020, 2021). As such, the processing and modulation of arousal is likely valuable for one's ability to pay attention to, and learn from, social cues and interactions. Physiological measures of parasympathetic control are of particular interest when examining shyness correlates since shyness can often be accompanied by physiological symptoms of fear, anxiety, and dysregulation of the internal milieu (LoBue & Perez-Edgar, 2014; Schmidt et al., 1999).

Importantly, Lane et al. (2013) have reported that children who have socially withdrawn temperaments (i.e., shy-related temperaments) and experience high physiological reactivity (i.e., high salivary cortisol), tend to experience low ToM in the preschool years. This suggests that physiological measures of arousal may provide an important context for expressions of shyness in relation to ToM development.

One physiological measure that has not been explored in conjunction with the relation between shyness and ToM is respiratory sinus arrhythmia (RSA). RSA is a measure of heart rate variability due to respiration (Porges et al., 1994). Resting RSA, which is traditionally collected in children while they watch an emotionally neutral video, is commonly used as an index for parasympathetic control and modulation of physiological arousal (Kahle et al., 2018; Reid et al., 2018), and is known to predict self-regulatory behaviors (Graziano & Derefinko, 2013; Porges, 2007). Overall, resting RSA is thought to reflect a predisposition to self-regulation and threshold for arousal (Hastings et al., 2006; Porges & Byrne, 1992). Thus, relatively higher resting RSA is presumed to reflect a better capacity for adaptable behavioral responding (Porges, 2007, 2011), while lower resting RSA is presumed to reflect a lower capacity for self-regulation in the context of mildly stressful or overwhelming environmental stimuli (Beauchaine, 2001; Porges, 2011; Thayer et al., 2012). As such, children with relatively lower resting RSA tend to develop poor attentional and inhibitory control and experience problems surrounding emotion regulation (Blandon et al., 2008; Calkins & Keane, 2004; Mezzacappa et al., 1998; Suess et al., 1994).

Resting RSA has been previously explored in various studies as a moderator of risk (El-Sheikh, Harger, & Whitson, 2001; Khurshid et al., 2019; Morales et al., 2015), and more specifically, as a moderator between shyness and various child outcomes. For example, Sulik et al. (2013) reported that relatively lower RSA combined with relatively higher shyness resulted in the lowest levels of effortful control in a sample of typically developing preschoolers. In addition, Hastings, Kahle, and Nuselovici (2014) found that baseline RSA moderated the relation between preschool social wariness and anxiety in middle childhood, such that children with relatively higher RSA, but not relatively lower RSA, exhibited a negative relation between social wariness and later anxiety.

It can be argued that children with relatively higher baseline RSA, who are presumed to possess higher parasympathetic control at rest, have more adaptive and flexible responses to social contexts in which they are required to focus on others. As well, some empirical evidence has proposed that RSA tends to be particularly relevant when children are experiencing fear (Buss & Goldsmith, 2007), suggesting that this factor may be important to explore in the context of PES and NPES, and how they relate to various social outcomes. In particular, considering parasympathetic control (i.e., RSA), behavioral regulation (i.e., state shyness), and their combination may offer a better understanding of children's ability to approach, observe, and learn from social situations, and as a result, develop the ability to attribute and understand false belief more effectively.

The Present Study

We sought to extend past findings by assessing whether baseline RSA, a proxy for physiological self-regulation and threshold for arousal, interacted with expressions of state shyness in predicting ToM in early childhood. We expected that considering multiple levels of self-regulatory control (i.e., physiological and behavioral) would provide a more comprehensive context for children's ability to approach, observe, and understand social situations, and therefore develop a sophisticated ToM understanding. We explored these relations in a sample of 78 typically developing 4-year-old children. We chose this age group due to the developmental relevance for the emergence of false belief understanding and the acceleration at which ToM develops within this year of life. Specifically, we expected that while some children at this age would exhibit standard attribution of others' states, some would display advanced, or slightly delayed understanding, allowing for conservative inferences to be made about the effect of shyness on the development of this ability.

Positive expressions of shyness (PES: gaze aversion with positive facial expression) and non-positive expressions of shyness (NPES: gaze aversion with neutral *or* negative facial expressions) were coded from a behavioral task that elicits social stress, in which children were asked to perform a spontaneous speech about their most recent birthday in front of a video camera. We assessed ToM with a battery of well-validated tasks drawn from previous studies (Baron-Cohen et al., 1985; Miller, 2013; Perner et al., 1987; Wellman & Liu, 2004). We measured resting RSA while children watched an emotionally neutral video for five minutes prior to beginning any of the procedures.

We addressed the following two questions: First, are individual differences in children's observed positive expressions of shyness (PES) and non-positive expressions of shyness (NPES) associated with their ToM? Second, does resting RSA interact with individual differences in children's observed PES and NPES in predicting ToM?

We predicted that, as reported by Colonnesi et al. (2017), PES would be positively related to ToM, while NPES would be negatively associated with ToM. We also expected that resting RSA would interact with observed expressions of shyness (i.e., positive and non-positive) in predicting ToM. Specifically, we predicted that relatively higher PES combined with relatively higher resting RSA would result in the highest levels of ToM, whereas other PES by RSA combinations would result in moderate ToM understanding. Similarly, we expected that children with relatively lower resting RSA and higher levels of NPES would possess the lowest ToM understanding, whereas other NPES by RSA combinations would result in moderate ToM.

Method

Participants

Seventy-eight typically developing 4-year-old children (M_{age} = 54.59 months, *SD* = 2.82; Range = 48.4 to 59.5 months; 41 females) and their biological mothers participated in the present study. Children were recruited from the McMaster Infant Database, which contains the contact information of healthy, full-term infants who were born at the McMaster University Medical Center, St. Josephs' Healthcare, or Joseph Brant Hospital in the Hamilton, Ontario area, and whose mothers consented at that time to be contacted for future developmental studies. Within the sample, 50 (78%) of the children were White, one (1.6%) was Black, one (1.6%) was Asian, one was Hispanic (1.6%), 6 (9.4%) were reported as mixed race, 2 (3.1%) were reported as another race, and 3 (4.7%) did not report their race. All children were fluent in English; however, four children spoke English as their second language. Among parents, 86% of mothers and 82% of fathers had some form of post-secondary education (i.e., college diploma, university degree, etc.). Mothers reported on their combined family income (in Canadian dollars) on a scale from 1 to 7 (1 = below $15,000; 4 = $45,000-$60,000; 7 = over $100,000). The parents of thirty-four children (53.1%) had combined family incomes of more than $100,000 per year; nineteen (29.7%) had an income between $60,000 and $100,000 per year, and 11 (17.2%) families earned less than $60,000 per year.

Procedure

Informed and written consent were obtained prior to beginning the study. The child completed a series of tasks with one female experimenter while his/her mother sat in a different room and observed her child on a closed-circuit TV (CCTV) monitor. The mother reported demographic information by completing a questionnaire while her child completed the laboratory tasks. All procedures were approved by the McMaster Research Ethics Board. Children and families were compensated with a $20 gift card for their participation.

ECG Recording Procedure and Measure

ECG Recording. Three ECG electrodes were placed on the child's back in the shape of an inverted triangle, and a respiration belt was fastened around the child's chest while the mother was present. Electrodes were placed on the child's back to avoid child distraction and/or tugging and removal. The electrodes and respiration belt were attached to a MindWare Mobile Impedance Cardiograph, Model 50-2303-00, which was placed in an age-appropriate backpack and worn by the child. The mobile unit detected R-waves at a sampling rate of 500 Hz and 24-bit ADC digitization. Resting RSA data was collected for five minutes while the child was seated and watched an emotionally neutral video clip. This video was a 6-minute excerpt taken from the family-friendly film, *Finding Nemo*. This clip was selected to be age-appropriate and engaging but did not include any strong emotions from the characters or any important plot points that would likely elicit emotional or physiological arousal. This clip has been used previously to assess baseline RSA (Hassan et al., 2018, 2020; MacGowan & Schmidt, 2020a, b).

ECG Data Reduction and RSA Quantification. Cardiac and respiratory data were analyzed using the Mindware HRV 3.1.1 software package (Mindware, Gahanna, OH, USA). Peaks were edited manually for erroneous or missing beats according to recommendations of Berntson and Stowell (1998). HRV high-frequency band settings were set from 0.24 to 1.04 Hz, which is recommended for young children (Porges, 2007). Although there is some debate in regard to the frequency range that is suitable for use with young children (e.g., Shader et al., 2017), the present band settings have been recommended by a number of pediatric psychophysiology studies (see Bar-Haim et al., 2000; Porges, 2007; Quigley & Stifter, 2006) as well as by MindWare, the supplier of the mobile ECG unit. Average RSA was estimated for each 1-minute epoch and averaged across 5 consecutive epochs of interest (Caccioppo et al., 1994).

Theory of Mind (ToM) Assessment

Children's ToM was assessed with six well-validated tasks that progressively increased in difficulty from first to last. These included the Knowledge Access, Unexpected Contents, and Real-Apparent Emotion tasks (Wellman & Liu, 2004), the Smarties task (Perner et al., 1987), the Sally-Ann first-order false belief task (Baron-Cohen et al., 1985), and a second-order false belief task (Miller, 2013). Although the Unexpected Contents task and the Smarties task both involve the child witnessing a box containing something unexpected, the Smarties task focuses on the child's ability to reconstruct their own past false beliefs, while Wellman and Liu's version requires that the child understand another character's false belief about the contents of the box. When scoring children on the second-order belief task, they were awarded one point for understanding the first-order question, and a second point for correctly answering the second-order question with a proper explanation for their understanding. Therefore, the overall score for each child was composed of seven points from six tasks. Two coders scored the children from video recordings and obtained strong inter-rater reliability for all tasks (κ = .98). Although these ToM tasks have been validated for use with 4-year-old children, a small subset of children (n = 10) were unable to comprehend one or more of the stories (i.e., could not correctly answer a comprehension question, even after they were corrected). These children were assumed to have poor understanding of the questions asked and were therefore removed from further analyses. These children did not differ from the remaining sample on scores of overall PES (p = .132), overall NPES (p = .590), baseline RSA (p = .126), income (p = .741), age (p = .531), or PVT (p = .197).

Picture Vocabulary Test (PVT)

The Picture Vocabulary Test (PVT) was administered from the National Institute of Health (NIH) Toolbox application on an Apple iPad (HealthMeasures, Evanston, IL, USA), and was used to assess receptive vocabulary. Scores from this task were used as a covariate in our analyses, due to the known association between language and ToM ability (see de Villiers & de Villiers, 2014). The PVT involves a series of audible words, which the child must match to a corresponding series of four picture sets. This application generates age-corrected standard scores, with an average score of 100 and a standard deviation of 15 for the general population.

Birthday Speech Self-Presentation Task

The Birthday Speech Self-presentation task has been previously used to reliably elicit trait shyness (Schmidt et al., 1999; Theall-Honey & Schmidt, 2006) and different expressions of state shyness (Poole & Schmidt, 2019) in children as young as 4 years old (Rubin et al., 1995; Theall-Honey & Schmidt, 2006; see also Colonnesi et al., 2017, for a similar self-presentation task in front of a video camera used at this age). This task is known to put the participant in a situation that involves social exposure. By four years old, children have understood and expressed self-conscious emotions, such as embarrassment, in such situations for at least two years of their life (Lewis, 2001; Lewis et al., 1989), suggesting that they are capable of comprehending and experiencing anxious self-preoccupation in response to social exposure. Importantly, temperamental shyness as behaviorally coded with this task has been found to be consistent with mothers' reports of their children's shyness at this age (MacGowan & Schmidt, 2020), suggesting that this procedure is capable of eliciting the self-conscious preoccupation that is indicative of trait and state shyness in this age group. In this task, the experimenter spontaneously instructed the child to give a short speech about their most recent birthday in front of a video camera. The child was not given time to prepare their speech and was informed that the video would be shown to other children that are the same age as them. This allowed for the measurement of state shyness as a reaction of social stress from both an imagined audience of peers as well as the immediate presence of the experimenter. Parents were not present for this procedure but observed from another room using CCTV.

Although children were prompted for a minimum of 60 seconds, they were allowed to speak for as long as they wished. The first 60 seconds of each child's speech was coded for observed PES and NPES. Five children stood in front of the video camera for less than 60 seconds (ranging from 20 to 42 seconds). Of these children, two asked to use the bathroom during the speech, and three expressed fear and therefore refused to stand in front of the camera. These children did not differ in age (p = .318), income (p = .335), RSA score (p = .496), or ToM (p = .891) from the remaining sample, and thus were not removed from statistical analysis. We handled these varied times by controlling for the total duration of the speech in our regressions below. Four children were coded for more than 65 seconds (ranging from 66 to 75 seconds), due to their walking out of the camera's view for a period of time during their speech. However, we added the amount of time that they spent off screen to end of their speech to allow for the same amount of codeable episode as the rest of the children. Similarly, these four children did not differ in age (p = .966), income (p = .984), RSA score (p = .454), or ToM (p = .257) from the remaining sample, and thus were not removed from analyses. The remaining 69 children had speeches that ranged between 60 and 65 seconds in length.

PES were operationalized as a gaze aversion during a positive facial expression. NPES were measured by assessing shy behaviors expressed both negatively (i.e., gaze aversion during negative facial expression) and neutrally (i.e., gaze aversion during neutral facial expression). We used both frequency of gaze aversions as well as duration of gaze away from a social stimulus during each facial expression as an overall measure of PES and NPES.

Behavioral Coding. Two behaviors (i.e., facial expressions and direction of gaze) were independently coded on Noldus' Observer 13.0 (Zimmerman et al., 2009) behavioral coding software to obtain continuous measures of positive, negative, and neutral expressions of shyness, based on a previous coding scheme used in multiple studies (Colonnesi et al., 2014; Colonnesi et al., 2017; Nikolić et al., 2016). A subset of 23% of participants was scored by two coders and reliability scores were corrected for kappa max (Bakeman et al., 2005). Inter-rater reliability was established for positive (κ = .96), negative (κ = .99), and neutral (κ = .97) expressions of shyness, accounting for both frequency and duration of each.

Facial expression. Facial expression was coded as a continuous mutually exclusive state event where coders distinguished between the children's emotive expressions. A positive facial expression was coded when the corners of the mouth were curled up and/or when the cheeks were raised. A negative facial expression occurred when eyebrows were lowered, furrowed together, or if the outer edges of the brows were lowered with inner edges simultaneously being heightened. This expression was also coded if the outer corners of the mouth curled down. Neutral facial expression was coded when the child did not exhibit characteristics of positive or negative facial expression and when no emotion-relevant muscle activity was observed in the face.

Direction of gaze. The direction of children's gaze was coded as either to the "camera", "experimenter", or "elsewhere" as a continuous mutually exclusive state event. We considered the child to be engaging in social gaze when looking at the video camera or the experimenter. Looking elsewhere was considered non-social. Gaze aversions were defined as the sudden change of gaze from a social to a non-social stimulus as a result of apparent arousal. The coders considered arousal to be apparent when the children's gaze shift was relatively quick and spontaneous. Children were explicitly told within the task instructions that they should look straight into the camera and that the video would be shown to other children who are the same age as them. Although very few children held a steady gaze with the camera, all of them attempted to do so. The gaze aversions observed from the camera were extremely similar (and arguably indistinguishable) from the gaze aversions from the experimenter, suggesting that gaze toward the camera was just as socially salient as gaze toward a person who is physically present.

Attention shifting was not considered a gaze aversion within the present coding scheme and was therefore not coded. Attention shifting was evident when the child shifted their gaze in response to a sound, as a result of engaging in descriptive body language, or if they shifted gaze to something they had already been fidgeting with (i.e., hands, MindWare wire). Instances of children closing their eyes or blinking was not coded as a gaze aversion.

Positive expressions of shyness. Frequencies of positive expressions of shyness were exported by selecting each time a gaze aversion moved to "elsewhere" during a positive facial expression. The duration of positive shy expressions was exported by selecting the entire time that the child was looking at a non-social stimulus (i.e., elsewhere) while engaging in a positive facial expression. Since frequencies and durations were highly correlated, $r = .73$, $p < .010$, a composite score was created by summing z-scored frequency and duration codes.

Non-positive expressions of shyness. Although negative expressions of state shyness are commonly investigated within the literature, this non-positive variable was created to provide a measure with more variability, since negative expressions of shyness alone are characteristically rare. In the current sample, only 15 children (19%) exhibited *negative* expressions of shyness, and thus we used a measure of *non-positive* shyness which included both negative and neutral facial expressions, which occurred in 91% children (M_{freq} = 5.2, *SD* = 3.8). These low levels of negative expressions of shyness are consistent with previous work in this age group (Colonnesi et al., 2017; Nikolic et al., 2016).

Frequencies of non-positive expressions of shyness were exported by selecting each time a gaze aversion moved to "elsewhere" during a neutral or negative facial expression. The duration of non-positive shy expressions was exported by selecting the entire time that the child spent looking at a non-social stimulus (i.e., elsewhere) while engaging in a neutral or negative facial expression. Since frequencies and durations were highly correlated, $r = .82$, $p < .010$, a composite score for non-positive shy expressions was created by summing *z*-scored frequency and duration codes.

Additional coded events. Social gaze during positive and non-positive affect were also coded to serve as covariates. Social gaze during positive affect was defined as gaze toward the experimenter or camera with a positive facial expression. Social gaze during non-positive affect was defined as gaze toward the experimenter or camera with a neutral or negative facial expression.

Maternal Report of Trait Shyness

Mothers reported on their child's trait shyness using the Shyness subscale of the Colorado Childhood Temperament Inventory (CCTI; Buss & Plomin, 1984; Rowe & Plomin, 1977). They reported the degree to which they agreed or disagreed on 5 items set to a scale from 1 to 5 (1 = strongly disagree; 5 = strongly agree). Such statements included "Child tends to be shy" and "Child takes a long time to warm up to strangers". The internal consistency for this scale in the present study was $\alpha = 0.85$.

Statistical Analyses

All analyses were performed in SPSS Version 22 with significance levels set at $\alpha = .050$. Pearson correlations were used to assess relations among observed expressions of shyness, resting baseline RSA, and ToM. We then used partial correlations to control for social gaze in order to ensure that relations could not be better explained by positive and non-positive facial expression in general. We further investigated these findings with point-biserial correlations assessing the relations between state shyness and each of the individual ToM tasks. Finally, separate hierarchical linear regressions were used to assess whether resting RSA interacted with observed expressions of positive and non-positive shyness, respectively, in predicting ToM. In each regression, we controlled for age (in months), sex, combined family income, PVT scores, and speech duration, with covariates being entered into the first step, expressions of shyness (i.e., positive or non-positive) and resting RSA were entered in the second step, and the interaction term was entered in the third step. Expressions of shyness, resting baseline RSA, and covariates were centered before analysis and before the creation of the interaction variables.

Missing Data and Data Loss

Four children were missing ECG data due to recording issues (n = 2) or the child's lack of cooperation in wearing the unit or engaging calmly in the baseline procedure (n = 2) and were therefore removed from further analyses. These children did not differ on age (p = .839), income (p = .169), PES (p = .276), NPES (p = .527), PVT (p = .709), or ToM (p = .282). All of the analyzed sample had five consecutive 1-minute epochs of clean, artifact-free RSA data. Therefore, of the original 78 children in the sample, 4 children were removed due to missing RSA data, and 10 were removed due to poor performance on the comprehension questions from the ToM batteries, resulting in a final sample of 64 children. These 14 eliminated children ranged from 45.9 to 58.7 months of age.

It is important to note that ECG data were collected during the Birthday Speech Self-Presentation Task in addition to the baseline video. These data, however, were unusable and unreliable given the large amounts of artifacts due to motor movements by the children while they were giving their speech.

Results

Descriptive Statistics and Preliminary Analyses

Table 1.1 displays descriptive statistics and correlations among study measures. Overall PES were negatively related to overall NPES, which is in line with previous research using a similar coding scheme (Colonnesi et al., 2017). The frequency and duration of PES were also negatively related to the frequency and duration of NPES. Trait shyness was not correlated with PES, NPES, nor any other study measures.

PES and ToM were positively related, while NPES were negatively related to ToM, replicating Colonnesi et al. (2017). We performed additional partial correlations to examine the relation among these constructs while controlling for positive and non-positive social gaze (i.e., gaze toward the experimenter or camera). Importantly, PES were still associated with ToM while controlling for positive social gaze and duration of the speech, $r(60) = .30$, $p = .019$, while NPES were still associated with ToM while controlling for non-positive social gaze and duration of the speech, $r(60) = -.28$, $p = .030$, suggesting that the relation between expressions of shyness and ToM were not simply due to the presence of positive or non-positive facial expressions. Point-biserial correlations revealed that these associations can be mostly explained by children's performance on first-order false-belief tasks. In particular, NPES was negatively associated with performance on the Sally Ann task, $r_{pb}(61) = -.25$, $p = .039$, and the first-order false belief portion of the Miller (2013) task, $r_{pb}(61) = -.31$, $p = .011$. In addition, PES was positively associated with performance on the first-order false belief portion of the Miller (2013) task, $r_{pb}(61) = .32$, $p = .007$.

Resting RSA was not correlated with ToM, nor any other study measures.

Observed Expressions of Shyness by Resting Baseline RSA in Predicting ToM

Positive Expressions of Shyness. In the regression model with PES, the change in the predictive value of the regression equation was statistically significant at step 1 $\Delta F(5, 58) = 3.17$, $p = .013$, $R^2 = 0.22$, step 2 $\Delta F(2, 56) = 4.03$, $p = .023$, $R^2 = 0.31$, $\Delta R^2 = 0.10$, and step 3 $\Delta F(1, 55) = 5.64$, $p = .021$, $R^2 = 0.38$, $\Delta R^2 = 0.06$ (see Table 1.2). When covariates, both predictors, and interaction term were present, the interaction term was statistically significant, $b = .24$, $t = 2.37$, $p = .021$ (see Figure 1.1). As well, PES significantly contributed to this overall model, $b = .40$, $t = 3.60$, $p = .001$, suggesting that there was a significant relation between PES and ToM at mean levels of RSA. Age and PVT scores also significantly contributed to the model in step 3; however, PVT score was not significant in step 1 or step 2.

We then probed this interaction by generating two new regressions to assess the relation between predictor and dependent variables at one standard deviation above and below the mean of resting RSA (Schubert & Jacoby, 2012). The unstandardized simple slope for children with RSA 1 *SD* above the mean was .65 ($p = .001$), while the slope for children with RSA 1 *SD* below the mean was .15 ($p = .209$). As predicted, relatively higher PES combined with relatively higher baseline RSA was associated with relatively higher levels of ToM when compared to the other PES x RSA combinations, which each yielded moderate ToM (see Figure 1.1). When resting RSA was low, children exhibited similar ToM across different levels of PES.

Post hoc statistical power analysis revealed that our sample of 64 with the 8 predictors used in this multiple regression would yield a power of 0.51 for moderate effect sizes ($f \approx 0.39$) and 0.91 for large effect sizes ($f \geq 0.59$). Given that Step 3 of our model resulted in an R^2 of 0.38, which yields a high effect size of $f = 0.78$, we are confident that our sample was large enough for this analysis.

Non-Positive Expressions of Shyness. In the regression model with NPES, resting RSA did not interact with NPES in predicting ToM[2], *b* = -.05, *t* = -.61, *p* = .543 (see Table 1.3). However, NPES contributed significantly to the overall model where higher levels of NPES resulted in lower levels of Theory of Mind at mean levels of RSA, *b* = -.24, *t* = -2.42, *p* = .019, replicating prior work. Resting RSA did not contribute significantly to the model, *b* = .06 , *t* = .32, *p* = .750.

[2] There was also no interaction between resting RSA and trait shyness in predicting ToM, *b* = -.05 , *t* = -1.06 , *p* = .29, with shyness not contributing significantly to the model at Step 2, *b* = -.16 , *t* = -.38 , *p* = .71, or Step 3, *b* = -.02, *t* = -.35 , *p* = .73.

Table 1.1

Correlations and Descriptive Statistics for all Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	Mean (SD)	Range
1. ToM	--	.10	.35**	-.23	.33**	-.33**	.36**	-.28*	.16	.29*	.21	.00	3.1(1.6)	0-7
2. Resting Baseline RSA		--	-.14	-.03	-.20	-.06	-.18	-.05	-.23	.17	.21	-.02	6.5(1.1)	4.2-8.9
3. Positive Shyness Frequency			--	-.52**	.73**	-.57**	.93**	-.56**	.14	.03	.03	-.03	4.9(4.2)	0-15
4. Non-Positive Shyness Frequency				--	-.55**	.82**	-.57**	.95**	-.27*	.07	.13	-.02	5.0(3.8)	0-14
5. Positive Shyness Duration					--	-.51**	.93**	-.56**	.12	.05	-.03	-.09	7.9(10.0)	0-42
6. Non-Positive Shyness Duration						--	-.59**	.95**	-.16	.06	.13	-.06	11.3(10.0)	0-37
7. Overall Positive Shyness							--	-.61**	.11	.05	-.02	-.06	-0.2(1.8)	-2-4
8. Overall Non-Positive Shyness								--	-.20	.06	.15	-.04	0.1(1.9)	-2-5
9. PVT Scores									--	-.12	-.29**	-.07	109(12)	84-139
10. Age (Months)										--	.14	-.02	55(2.8)	46-60
11. Family Income											--	.13	6.0(1.4)	1-7
12. Maternal Report Trait Shyness												--	11.3(4.4)	5-22

Note. ToM: Theory of Mind; PVT: Picture Vocabulary Test; *p < .05; **p < .01

Table 1.2

Regression Analysis Assessing the Interaction Between Resting RSA and Positive Expressions of Shyness in Predicting Theory of Mind in 4-year-old Children.

Positive Shyness by RSA Interaction	*b*	*SE*	*T*	*P*	95% CI Lower bound	95% CI Upper Bound
Step 1, R^2 = 0.22 (Constant)	5.00	0.68	7.31	<0.001**	3.63	6.36
Age	2.18	0.81	2.71	0.009**	0.57	3.80
Sex	0.26	0.19	1.37	0.177	-0.12	0.63
Income	0.28	0.21	1.35	0.183	-0.13	0.69
PVT	0.41	0.22	1.86	0.069	-0.03	0.86
Speech Duration	-0.06	0.19	-0.33	0.746	-0.44	0.32
Step 2, R^2 = 0.31 (Constant)	4.89	0.66	7.46	<0.001**	3.58	6.20
Age	1.99	0.78	2.56	0.013*	0.44	3.55
Sex	0.12	0.19	0.64	0.526	-0.25	0.49
Income	0.27	0.20	1.39	0.171	-0.12	0.66
PVT	0.38	0.22	1.77	0.083	-0.05	0.81
Speech Duration	-0.04	0.18	-0.23	0.817	-0.41	0.32
Positive Shyness	0.30	0.11	2.80	0.007**	0.09	0.51
Resting RSA	0.17	0.17	0.97	0.337	-0.18	0.51
Step 3, R^2 = 0.38 (Constant)	5.33	0.66	8.12	<0.001**	4.01	6.64
Age	2.40	0.77	3.13	0.003**	0.86	3.94
Sex	0.13	0.18	0.75	0.460	-0.23	0.49
Income	0.29	0.19	1.53	0.132	-0.09	0.67
PVT	0.41	0.21	1.99	0.052	-0.01	0.83
Speech Duration	-0.12	0.18	-0.68	0.501	-0.48	0.24
Positive Shyness	0.40	0.11	3.60	0.001**	0.18	0.62
Resting RSA	0.25	0.17	1.48	0.146	-0.09	0.59
Positive Shyness x RSA	0.24	0.10	2.37	0.021*	0.04	0.44

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

Table 1.3

Regression Analysis Assessing the Interaction Between Resting RSA and Non-Positive Expressions of Shyness in Predicting Theory of Mind in 4-year-old Children.

Non-Positive Shyness by RSA Interaction	*b*	*SE*	*t*	*P*	95% CI Lower bound	95% CI Upper bound
Step 1, R^2 = 0.22 (Constant)	5.00	0.68	7.31	<0.001**	3.63	6.36
Age	2.18	0.81	2.71	0.009**	0.57	3.80
Sex	0.26	0.19	1.37	0.177	-0.12	0.63
Income	0.28	0.21	1.35	0.183	-0.13	0.69
PVT	0.41	0.22	1.86	0.069	-0.03	0.86
Speech Duration	-0.06	0.19	-0.33	0.746	-0.44	0.32
Step 2, R^2 = 0.29 (Constant)	4.99	0.67	7.49	<0.001**	3.65	6.32
Age	2.16	0.79	2.73	0.008**	0.58	3.74
Sex	0.22	0.18	1.22	0.227	-0.14	0.59
Income	0.33	0.20	1.62	0.111	-0.08	0.73
PVT	0.35	0.22	1.57	0.123	-0.10	0.79
Speech Duration	0.01	0.19	0.06	0.956	-0.36	0.39
Non-Positive Shyness	-0.24	0.10	-2.41	0.019*	-0.44	-0.04
Resting RSA	0.04	0.17	0.23	0.822	-0.31	0.39
Step 3, R^2 = 0.30 (Constant)	5.03	0.67	7.47	<0.001**	3.70	6.38
Age	2.2.1	0.80	2.77	0.008**	0.61	3.81
Sex	0.25	0.19	1.33	0.188	-0.13	0.64
Income	0.32	0.20	1.60	0.115	-0.08	0.73
PVT	0.36	0.22	1.59	0.118	-0.09	0.80
Speech Duration	0.00	0.19	0.00	0.999	-0.38	0.38
Non-Positive Shyness	-0.24	0.10	-2.42	0.019*	-0.44	-0.04
Resting RSA	0.06	0.18	0.32	0.750	-0.30	0.41
Non-Positive Shyness x RSA	-0.05	0.09	-0.61	0.543	-0.23	0.12

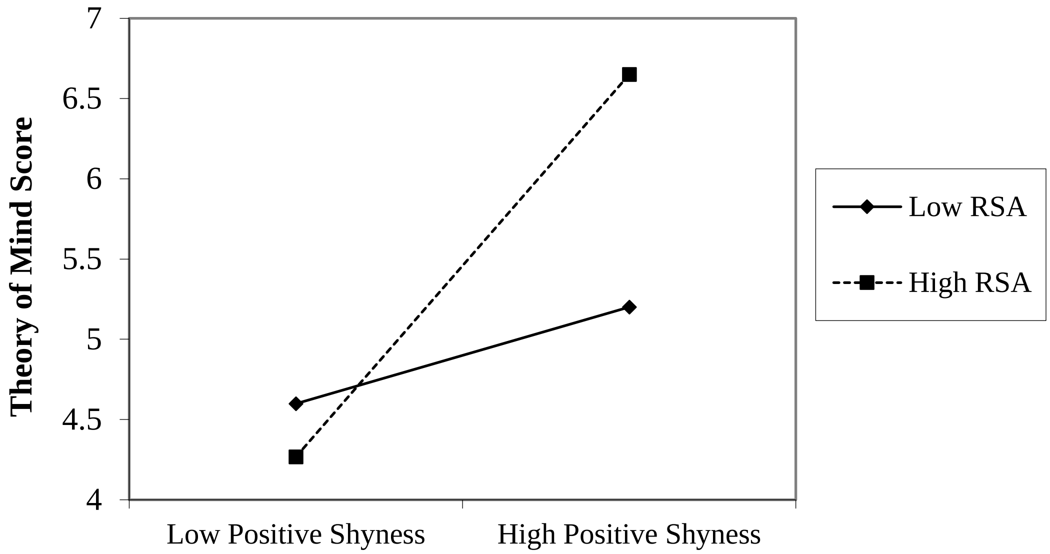

Figure 1.1. *The interaction between resting baseline RSA and expressions of positive shyness in predicting ToM in 4-year-old children.*

Discussion

The present study revealed that PES were associated with higher ToM, while NPES were related to relatively lower ToM. We also found that resting RSA, a measure of parasympathetic control and proxy for physiological self-regulation, interacted with PES in predicting ToM. As predicted, relatively higher baseline RSA combined with relatively higher PES was associated with relatively higher levels of ToM. We discuss and interpret each of these findings below in turn.

Relations between Expressions of Shyness and ToM

The opposing relations of PES and NPES with ToM are consistent with recent findings by Colonnesi et al. (2017). Importantly, however, Colonnesi and colleagues reported that each expression of shyness was related to different ToM task batteries. Specifically, PES were positively associated with more sophisticated ToM and expressions of non-positive shyness were inversely related with a more basic battery of ToM tasks.

Our findings are also consistent with and extend previous work by Lane et al. (2013) who found that, in preschoolers who experienced high physiological reactivity (i.e., proxy for low physiological control), social withdrawal was negatively associated with ToM. These children were assumed to be socially avoidant and can be compared to children who exhibit high levels of NPES, whose shyness is presumed to be less adaptive. Lane et al. also found that children who were relatively low in physiological reactivity (i.e., proxy for high physiological control) experienced a positive relation between social withdrawal and ToM. Similarly, these children can be compared to the participants in our study who displayed relatively high levels of PES.

The relation between shyness and ToM is undoubtedly complex, and causation is difficult to establish. Based on existing interpretations, most have assumed that shyness precedes and therefore predicts the development of social cognitive abilities (LaBounty et al., 2017; Lane et al., 2013; Longobardi et al., 2017; Mink et al., 2014; Wellman et al., 2011). To our knowledge, only a few studies have investigated ToM and other social cognitive abilities as predictors for later temperament outcomes (e.g., Song et al., 2016). However, the degree to which temperament and social cognition have transactional affects on one another throughout development remains an empirical question.

Existing interpretations linking trait shyness and ToM seem contingent on the relatively high level of social attentiveness that shy children appear to possess, and perhaps to some extent, on shy children's tendency to observe others rather than participating directly in social interaction (LaBounty et al., 2017; Lane et al., 2013; Wellman et al., 2011). Indeed, shy children are known to possess unique social cognitive strengths, which perhaps evolved as an adaptive mechanism for detecting social threat from unfamiliar conspecifics (Brunet et al., 2009; Hassan et al., 2021; LoBue & Perez-Edgar, 2014; MacGowan et al., 2021; Matsuda et al., 2013). However, theory surrounding the link between trait shyness and ToM may be extended to affect-specific reasoning given our present findings.

Children with higher incidences of PES, who are more inclined to approach social situations, may experience more positive interactions and therefore may be more inclined to seek out opportunities for relatively low-risk social observation. The positive nature of these children’s social experiences may also cause them to be more motivated to understand the thoughts and intentions of others. The direct relation between PES and ToM abilities observed in the present study is therefore in line with the notion that children who are exposed to social learning opportunities more often may develop ToM at a faster rate or establish expanded social cognitive strengths.

Children who display high NPES, on the other hand, are more motivated to avoid others, presumably discouraging peers from approaching and preventing seamless interaction with new people. Poole and Schmidt (2019) have proposed that negative expressions of shyness may reflect what Buss (1986a,b) describes as a fearful subtype of shyness, and what Kagan and colleagues (1988) characterize as behavioral inhibition, which involves heightened sensitivity to fear and low levels of sociability. Children who express high levels of negative expressions of shyness have been found to experience more social fear (Colonnesi et al., 2014; Poole & Schmidt, 2019), suggesting that this phenotype aligns well with the Emotional Reactivity Hypothesis (ERH; Hare & Tomasello, 2005). The ERH states that individuals who display less fear and aggression tend to develop more sophisticated social cognitive abilities. This theory, which is often considered in non-human animal behavior, can be extended to the ontogenetic development of children: as aggression and fear decrease, capacity for social cognitive ability increases (LaBounty et al., 2017; Lane et al., 2013; Wellman et al., 2011).

In the present study, trait shyness and ToM were unrelated. This result suggests that expressions of state, rather than trait, shyness serve as sensitive and valuable measures that may contribute to the development of ToM. In contrast, parent-reported trait shyness may provide a more general and undifferentiated measure of anxious self-preoccupation, which does not capture the heterogeneity necessary to fully explain this relation. These findings are important in the context of the historically discordant results regarding the relation between shyness and ToM and call for future assessments of heterogeneity within state shyness when examining other relevant child outcomes.

Influence of RSA on Relations Between Expressions of Shyness and ToM

We found that resting RSA, a measure of parasympathetic control and proxy for physiological self-regulation, interacted with PES in predicting ToM. As predicted, children who experienced relatively higher baseline RSA combined with relatively higher PES possessed the highest ToM when compared to children with other RSA by PES combinations.

These results extend and further contextualize our prior findings by highlighting that PES was related to relatively higher ToM, but only in the presence of more adaptable parasympathetic control (i.e., relatively higher RSA). Children who experience both adaptable functions are likely capable of concurrently adjusting to changes in the environment (i.e., parasympathetic control) while using positive facial expression to signal appeasement to strangers. This phenotype is presumably optimal for smooth social interactions as well as social processing and observation of others. It not only allows for more frequent social learning opportunities with novel peers and adults, but also for the physiological reduction of arousal elicited by social situations that may be stressful and overwhelming for some children.

Children with relatively lower RSA had similar ToM across different levels of PES. It is possible that children with low resting RSA may not reap the same regulatory benefits of high PES when compared to children with high RSA, since they are less capable of effectively and flexibly adapting to the changing demands of the social environment. These findings strengthen the notion that biological predispositions are important to consider when analyzing the link between individual differences in expressions of shyness and social-cognitive processes.

This interaction was detected at an age in which children are simultaneously being exposed to more social situations with new peers (i.e., preschool, daycare, kindergarten), and are beginning to understand the intentions, beliefs, and feelings of others. It is expected that encountering novel individuals and being responsible for one's own communication for perhaps the first time can be overwhelming. Heightened arousal in such situations can likely impede both the observation of others and the likelihood to interact with peers. It appears that children who possess both behavioral and physiological strategies to regulate this arousal may develop ToM (mostly notably first-order false belief) at a somewhat faster rate than children who possess only one or neither of these abilities. Further work should establish the causality of these relations as well as the degree to which this interaction of variables can have longitudinal effects on children's socio-cognitive development.

The interaction between RSA and NPES was not significant in predicting ToM. Children exhibited lower levels of ToM as expressions of NPES increased, regardless of resting RSA. These findings suggest that optimal resting RSA was not sufficient in acting as a protective factor against high levels of NPES. However, children who displayed high NPES and low resting RSA did not perform worse on the ToM tasks when compared to children with relatively high NPES and higher resting RSA. This suggests that resting RSA may only reinforce social inference when children possess relatively high PES. It is important to note that we may have detected an interaction between RSA and *negative* expressions of shyness (NES) if more children in our sample had engaged in these behaviors. We suspect that NES may serve as a more emotionally salient negative reaction to social exposure when compared to NPES. However, most studies assessing state shyness within this age group detect low occurrences of NES, with many children not engaging in this expression at all.

Strengths and Limitations

There were several strengths to our study, including children's expressions of shyness coded from direct observation, a biological measure of parasympathetic control, multiple tasks to derive a measure of ToM, and the consideration of a developmental period which coincides with the emergence of false belief understanding. Our study also assessed both frequency and duration of PES and NPES, providing information on number of gaze aversions as well as the length of time that the child looked away from social stimuli.

This study also has some limitations that are important to consider. First, since the current sample was primarily White, with a high average family income, the extent to which are findings would generalize to more ethnically and economically diverse groups is unknown. Second, the findings of the present study were based on concurrent correlations and a cross-sectional design, limiting causal inferences.

Future studies should examine expressions of shyness and ToM longitudinally to explore possible age-related and developmental differences that might exist within these relations from infancy to adolescence. In addition, cross-lagged designs could further evaluate the direction of these relations (Song et al., 2016; Wellman et al., 2011). It would also be beneficial to determine if expressions of shyness serve as possible mediators between ToM and the development of certain problematic social outcomes such as low social competence and peer rejection. This would allow for possible intervention before such problems arise at or around the time of formal school entry. Future work should also investigate the role of early parasympathetic control and physiological self-regulation (i.e., resting RSA and RSA change, respectively) in the longitudinal development of ToM, PES, and other relevant adaptive strategies for social functioning. Finally, it is important to explore these relations in more culturally and ethnically diverse samples to enhance the generalizability of these findings.

Conclusion

We have provided evidence that heterogeneity within expressions of state shyness contributes to ToM understanding in 4-year-old children; PES appears to reinforce ToM in the context of high parasympathetic control while NPES appears to hinder false belief understanding regardless of physiological self-regulatory capacity. Our findings suggest that children with relatively higher resting RSA and higher PES experience adaptive appeasement and regulatory functions during social interactions, conferring the highest levels of ToM compared to other RSA by shyness combinations. Our work extends prior findings and strengthens the importance of considering heterogeneity in shyness and parasympathetic control when considering the development of social-cognitive processes in early childhood.

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CHAPTER 3

Study 2: Temperamental Shyness, Self-Regulatory Capacity, and Empathic Response

MacGowan, T. L. & Schmidt, L. A. (2020). Getting to the heart of childhood empathy: Relations with shyness and respiratory sinus arrhythmia. *Developmental Psychobiology*. Advance online publication.

Abstract

Although prior studies have found that shyness and empathy are inversely related and that well-regulated children tend to express empathic behaviors more often, little work has assessed combinations of these factors in predicting affective and cognitive empathy in early childhood. The authors examined relations among shyness, resting respiratory sinus arrhythmia (RSA), and observed affective and cognitive empathy in a sample of 130 typically developing children (M_{age} = 63.5 months, *SD* = 12.2; 62 males). Shyness was assessed by observing children's behaviors during a self-presentation task and this observed measure was then combined with a maternal report of children's temperamental shyness. Children's shyness predicted lower levels of both affective and cognitive responses to an experimenter feigning an injury. Resting RSA moderated the relation between children's shyness and observed empathy such that relatively higher shyness combined with lower RSA levels conferred the lowest levels of cognitive empathy. Children who were relatively low in shyness exhibited similar levels of cognitive empathy across different levels of RSA. However, this moderation was not found when predicting children's affective empathy. Our results suggest that not all shy children are alike in terms of their empathic behaviors: shy children who are physiologically dysregulated appear to have difficulties exploring and/or processing others' pain.

Introduction

Empathy can be defined as an affective state that is (a) elicited by observing or imagining another's affective state, (b) similar to the other's emotional state, and (c) caused by the other's emotional state (Tone & Tully, 2014). The degree to which children are empathic tends to be stable over development, environment, and context (Moreno, Klute, & Robinson, 2008; Robinson, Zahn-Waxler, & Emde, 1994; Young, Fox, & Zahn-Waxler, 1999; Zahn-Waxler, Schiro, Robinson, Emde, & Schmitz, 2001). However, there are individual differences in the development of, and the degree to which, each child expresses empathy. Some within-child factors that could contribute to these differences, and have been previously explored (e.g., Hastings et al., 2006; Laible et al., 2014; Young et al., 1999), include temperament and biological predispositions for reactivity and regulation. Despite these findings, combinations of these factors have not been explored in predicting empathic response. In addition, past work is limited in that most studies approach empathy as a homogenous construct.

Empathy-related behaviors are important for healthy socioemotional development and are often used as indicators of overall well-being and psychosocial adjustment (Eisenberg & Fabes, 1998; Eisenberg, Fabes, & Spinrad, 2006). Empathy has been linked to higher academic achievement (Killian & Killian, 2011) and higher self-esteem (Zuffiano et al., 2014) in early school-aged children. As such, it is meaningful to explore factors that affect the development of empathy during this period. Here, we explore the possible moderating role of parasympathetic control, as measured by respiratory sinus arrhythmia (RSA), on the relation between shyness and two components of empathy in a sample of 4- and 6-year-old children.

Different Components of Empathy

Empathy has been conceptualized as having cognitive and affective components (Decety & Jackson, 2004; de Vignemont & Singer, 2006). Cognitive empathy is defined as the ability to understand the nature or cause of another's state (Cohen & Strayer, 1996; Decety & Jackson, 2004). This is commonly measured through *hypothesis testing*, which is the inquisitiveness or effort to comprehend distress encountered in an empathic situation (Zahn-Waxler, Robinson, & Emde, 1992). In contrast, affective empathy is a vicarious affective response to another's emotional expressions, leading to either personal distress or response through empathic concern (Decety & Lamm, 2009; Knafo et al., 2009; Shamay-Tsoory, Aharon-Peretz, & Perry, 2009; Tone & Tully, 2014).

There is evidence to suggest that cognitive and affective expressions of empathy represent the same underlying disposition, since some work has found that these measures are positively correlated (Gill & Calkins, 2003; Knafo, Zahn-Waxler, Van Hulle, Robinson, & Rhee, 2008; López-Pérez, Hanoch, Holt, & Gummerum, 2017). However, these components are thought to be subserved by different information processing systems and involve different functions (Coplan, 2011; Shdo et al., 2017). Accordingly, these components are often analyzed separately and can provide more detailed information when assessing relations among other constructs (Gill & Calkins, 2003; Knafo et al., 2008; López-Pérez et al., 2017; Lyons, Brewer, & Bethell, 2017; Volbrecht, Lemery-Chalfant, Aksan, Zahn-Waxler, & Goldsmith, 2007; Zahn-Waxler et al., 2001).

For example, Zonneveld, Platje, Sonneville, Goozen, and Swaab (2017) found that children who were at risk for criminal behavior showed lower levels of affective empathy but similar cognitive empathy when compared to a control group. Although many studies approach empathy as a homogenous construct by only examining one component (e.g., Findlay, Girardi, & Coplan, 2006; Robinson et al., 1994), it is important to underscore that empathy appears to be a heterogeneous construct and that not all empathic responses are the same.

Children's Shyness and Empathy

One within-child level factor that may contribute to individual differences in children's empathy is shyness; a temperament that manifests within a social context, which is critical for the expression of empathy. Shyness is defined as an anxious preoccupation with the self in real or imagined social situations (Cheek & Melchior, 1990). Although there has been considerable work examining emotional processes and problem behaviors in shy children (see Tang et al., 2017, for a review), relatively few studies have examined empathy-related behaviors in the context of children's shyness.

The extant literature linking shyness (and related traits) and empathy-related behaviors suggests an inverse relation between these constructs. For example, Robinson et al. (1994) found that infants who exhibited high levels of sociability at 14 months (i.e., less socially inhibited) had higher empathic functioning at 20 months. In addition, Young et al. (1999) reported that behaviorally inhibited children showed less empathy toward a stranger at 2 years old. Finally, Findlay et al. (2006) have noted that highly empathic 5-

and 6-year-old children may be less shy than children who display less empathy. Still other studies have reported that shy preschool and school-aged children tend to exhibit less helping behavior than children who are less shy (Beier, Terrizzi, Woodward, & Larson, 2017; Eisenberg, Spinrad, Taylor, & Liew, 2017; Eisenberg et al., 1996; Findlay et al., 2006; Stanhope, Bell, & Parker-Cohen, 1987; Young et al., 1999).

Compared to the relations between empathy and shyness, the link between shyness-related constructs and helping behaviors is relatively well-supported: shy children may be too inhibited to initiate helping behaviors. However, the relation between children's shyness and lack of empathy is not a foregone conclusion considering most studies have not examined the issues of heterogeneity in empathy.

Children's Shyness and Empathy Caveats

There are several limitations to research on children's shyness and empathy that should be considered. First, as noted above, it is important to understand the relation between shyness and the different components of empathy (i.e., affective and cognitive) to determine whether existing results have been confounded by examining empathy as a homogenous construct. For example, Findlay et al. (2006) used a scale that did not differentiate between cognitive and affective empathy, treating empathy as a unitary construct. In addition, Robinson et al. (1994) used criteria that assessed empathic and helping responses simultaneously, which confounded these constructs. Young et al. (1999) reported negative relations between behavioral inhibition and a similar prosocial composite, which combined empathic and helping components. However, Young and colleagues did not detect a relation between behavioral inhibition and affective or cognitive empathy when assessed independently. Therefore, it is difficult to determine whether separate components of empathy that are properly parsed from helping behaviors are associated with shyness in childhood. Since many previous findings regarding the relation between shyness and empathy are organized in this manner, we know relatively little about this association from the standpoint of different components of empathy.

Second, although shy children's reduced empathy may suggest a social cognitive deficit, previous work has argued that this inverse relation is likely accounted for by a performance issue rather than a competence issue (Eisenberg, Shepard, Fabes, Murphy, & Guthrie, 1998; Findlay et al., 2006). In fact, many researchers have reported that shy children may experience heightened processing in socio-cognitive areas such as emotion understanding and intention inference (i.e., Theory of Mind; Labounty, Bosse, Savicki, King, & Eisenstat, 2017; Lane et al., 2013; Longobardi, Spataro, D'Alessandro, & Cerutti, 2017; Wellman, Lane, LaBounty, & Olson, 2011). Thus, it is reasonable to argue that shyness does not affect the understanding of another's emotions, but rather the processing of, and responding to, others' highly salient negative emotions.

Third, shy children's empathic responses will likely vary in different contexts, environments, and among different people (e.g., Chow et al., 2017; Kagan, Reznick, & Snidman, 1987). Stanhope et al. (1987) have found that shy children's empathic responding can differ in a home versus laboratory environment, and also depends on whether the child is responding to his/her mother versus an experimenter. In addition, Knafo et al. (2008) have found that children older than 36 months tend to show less cognitive and affective empathy toward an experimenter when compared to their mother. While empathy-related behaviors within the home and among family are valuable, it is also important to assess how children will react in other contexts. In all, while heterogeneity in empathy, competence versus performance, and the study of context are important to assess in relation to shyness, it is also necessary to explore possible moderators that could explain some such relations.

Respiratory Sinus Arrhythmia and Empathy

One such factor that has yet to be explored as a moderating influence on the relation between children's shyness and empathy is parasympathetic control, which is highly relevant to both shyness and empathy-related behaviors.

Empathy requires detection, processing, and response to social stimuli (Decety & Jackson, 2004). Response can occur in affective and/or prosocial (i.e., helping) expressions (Cohen & Strayer, 1996; Feshbach, 1975) whereas processing is more in line with cognitive empathy (Cohen & Strayer, 1996; Hoffman, 1977). A child's performance on each empathic component will depend on, among other factors, the level of arousal that the child experiences during an empathic situation.

Moreover, individual differences in physiological reactivity and regulation are relevant to how children react to situations requiring empathic response, since these situations tend to elicit arousal in both the victim and the responder. In children, if arousal cannot be regulated and therefore remains high, distress will be directed internally rather than toward the victim (Eisenberg & Fabes, 1998; Kim & Han, 2018; Preston & de Waal, 2002). As such, many studies have reported that well-regulated children tend to exhibit higher levels of empathic functioning and will engage more often in prosocial behavior (Blake, Piovesan, Montinari, Warneken, & Gino, 2015; Carlo, Crockett, Wolff, & Beal, 2012; Eisenberg, 2005; Eisenberg & Fabes, 1992; Eisenberg et al., 1996, 1998; Hastings, Zahn-Waxler, & McShane, 2006; Laible, Carlo, Murphy, Augustine, & Roesch, 2014). However, like many behavioral responses, empathy requires an optimal level of arousal (e.g., Hebb & Thompson, 1954); not too high and not too low (see below for discussion on this phenomenon).

Individual differences exist within biological predispositions that govern the peak level of arousal reached in response to a situation (i.e., reactivity) as well as the modulation of that arousal (i.e., regulation). One non-invasive method that is commonly used to assess these physiological systems in children is the collection of electrocardiogram (ECG) data. This data can be used to derive an index of respiratory sinus arrhythmia (RSA): heart rate variability (HRV) measured in correspondence with the respiratory cycle (Porges, Doussard-Roosevelt, & Maiti, 1994). The Polyvagal Theory states that RSA represents the parasympathetic influence of the 10th cranial nerve (i.e., the vagus nerve) on the heart. Resting RSA, which is traditionally collected while the child watches an emotionally neutral video, has been found to be positively related to intelligence (Staton, El-Sheikh, & Buckhalt, 2009) and sociability (Blair & Peters, 2003; Buss, Goldsmith, & Davidson, 2005; Hastings, Rubin, & DeRose, 2005), and negatively related to internalizing problems (Forbes, Fox, Cohn, Galles, & Kovacs, 2006; Schmitz, Kramer, Tuschen-Caffier, Heinrichs, & Blechert, 2011; Shannon, Beauchaine, Brenner, Neuhaus, & Gatzke-Kopp, 2007).

As such, resting RSA is commonly used as an index for parasympathetic control, tends to be predictive of self-regulatory behaviors (Graziano & Derefinko, 2013; Porges, 2007) and, to some extent, measures the modulation of physiological arousal (Kahle, Utendale, Widaman, & Hastings, 2018; Lunkenheimer, Kemp, Lucas-Thompson, Cole, & Albrecht, 2017; Porges, 2007; Reid et al., 2018). Within most of the existing literature, relatively high resting RSA is presumed to reflect a better capacity for adaptable behavioral responding (Porges, 2007, 2011), while lower resting RSA has been linked to poor attentional and inhibitory control, and problems surrounding emotion regulation (Blandon, Calkins, Keane, & O'Brien, 2008; Calkins & Keane, 2004; McLaughlin, Rith-Najarian, Dirks, & Sheridan, 2015; Mezzacappa, Kindlon, Saul, & Earls, 1998; Rudd & Yates, 2019; Suess, Porges, & Plude, 1994). Therefore, children with relatively lower RSA are presumed to experience increases in arousal in response to stressful or overwhelming environmental stimuli (Beauchaine, 2001; Porges, 2011; Thayer, Ahs, Fredrikson, Sollers, & Wager, 2012). Generally, children with relatively higher resting RSA are presumed to possess higher parasympathetic control at rest, while also having higher adaptive and flexible responses to contexts in which they are required to focus on others. Overall, resting RSA has been argued to index both self-regulation and threshold for arousal (Hastings et al., 2006; Porges & Byrne, 1992), and can be seen as an individual’s average state as they approach events and adapt to a changing environment.

Despite the general advantages of high RSA and the general disadvantages of low RSA, some argue that RSA extremes (i.e., too high or too low) are maladaptive in the context of empathic and prosocial response. For example, some recent studies have reported a quadratic (inverted-U) relation between resting RSA and prosocial and empathy-related behaviors in children (Miller, Kahle, & Hastings, 2017; Zhang & Wang, 2019) and adults (Kogan et al., 2014). These results suggest that individuals with moderate RSA experience the highest levels of prosociality, observed affective empathy, and reported subjective empathy while those with relatively higher or lower RSA appear to display lower levels of prosocial and empathy-related behaviors. Acland, Colasante, and Malti (2019) have replicated this trend in a sample of 8-year-old children, however, they found the opposite pattern (i.e., U-shaped pattern) in a sample of 4-year-olds. In keeping with this younger age group, in a sample of 4- to 6-year-old children, Tully, Donohue, and Garcia (2015) have also reported a quadratic relation between these variables: moderate HRV was associated with lower empathic engagement while relatively higher or lower HRV was associated with higher empathic responses. It is important to note that this quadratic relation has only been explored in predicting affective empathy and helping behaviors and has yet to be investigated in the context of cognitive empathy.

Parasympathetic control is relevant to the study of shyness and empathy, since both latter factors are highly related to the level of arousal that a child feels in a social situation. Resting RSA has been previously explored as a moderator of risk (El-Sheikh, Harger, & Whitson, 2006; Khurshid, Peng, & Wang, 2019; Morales, Beekman, Blandon, Stifter, & Buss, 2015), and more specifically, as a moderator between shyness and various child outcomes. For example, Sulik, Eisenberg, Silva, Spinrad, and Kupfer (2013) have reported that relatively low RSA combined with relatively high shyness resulted in the lowest levels of effortful control in a sample of typically developing preschoolers. In addition, Hastings, Kahle, and Nuselovici (2014) have found that baseline RSA moderated the relation between preschool social wariness and middle childhood anxiety such that children with relatively high RSA, but not relatively low RSA, experienced a negative relation between social wariness and later exhibited anxiety. Empirical evidence has suggested that RSA tends to be particularly relevant when children are experiencing fear (Buss & Goldsmith, 2007). Thus, RSA may be an important moderator to explore in the context of shy reactions to others' distress.

The Present Study

The primary goal of the present study was to examine the relations among individual differences in shyness, observed empathy-related behaviors, and resting RSA in a sample of typically developing children. We used a physiological measure of parasympathetic control and emotion regulation (i.e., RSA) and explored its moderating influence on the relation between shyness and the different components of empathy. Exploring the interaction between temperamental (i.e., shyness) and biological predispositions (i.e., RSA) in predicting different components of empathy provides a more fulsome and integrative understanding of individual differences in empathic development when compared to assessing the main effects of temperament or physiology alone. Since recent studies have reported quadratic relations between RSA and prosocial measures in children, for exploratory purposes, we first examined whether our RSA data followed the same quadratic trend (Kogan et al., 2014; Miller et al., 2017; Zhang & Wang, 2019).

We assessed a sample of 130 typically developing children at separate cross-sectional ages of 4 and 6 years old during a laboratory visit. Children's shyness was measured through direct observation of a social stress task (i.e., birthday speech) and was correlated and combined with a validated parent report measure of shyness. In order to account for the possible confounding effect of language ability during the birthday speech, we collected children's receptive vocabulary using a Picture Vocabulary Test (PVT). Cognitive and affective empathic behaviors were observed during a widely used feigned injury task in which an adult female experimenter pretended to pinch her finger on a clipboard. We assessed the cognitive processing component of empathy by coding behaviors indicative of the child's hypothesis testing. To measure each child's affective response, we coded a separate set of behaviors which included empathic concern, gaze, and verbal engagement.

Research Questions and Predictions

We addressed two questions: (1) Are individual differences in children's shyness linearly associated with their observed empathy-related behaviors? and (2) Does resting RSA moderate the linear relation between individual differences in children's shyness and empathy behaviors?

We tested the following two predictions. First, we hypothesized that children's shyness would be negatively related to both affective and cognitive empathy. Although Young et al. (1999) did not find that cognitive nor affective empathy alone were related to behavioral inhibition in toddlerhood, we anticipated that shyness would affect the responses of this older sample of children. We reasoned that older children would ostensibly have a more advanced socio-cognitive understanding of the empathic situation, and therefore, would feel more arousal in reaction to the experimenter's pain. We predicted that the distress of the victim would be more socially salient to children who were higher in shyness and that these children would experience more personal distress, leading to reduced empathic processing (i.e., cognitive empathy) and response (i.e., affective empathy). As mentioned above, some have reported that there is a positive relation between shyness and ToM, providing evidence that shy children may be better at processing social cues (e.g., Wellman et al., 2011). Nonetheless, we expected that cognitive empathy would be inversely related to shyness since it tends to take place in more emotionally salient social situations than does ToM processing.

Second, we hypothesized that resting RSA would moderate the relation between children's shyness and observed empathy. We predicted that children displaying relatively higher shyness combined with relatively lower RSA levels (i.e., physiologically dysregulated) would exhibit relatively lower cognitive and affective empathy. In contrast, we expected that shy children with relatively higher resting RSA levels (i.e., physiologically regulated) would exhibit relatively higher cognitive and affective empathy. We predicted this result because shy children are presumed to experience high levels of arousal due to performance anxiety within the provocative social context of an empathic situation. When this temperamental predisposition is combined with lower RSA, we expected children to have especially high arousal levels and therefore exhibit lower levels of empathic response and processing. However, since shyness has been linked to higher social cognitive understanding, we expected shy children to exhibit higher empathy when their parasympathetic control (i.e., RSA) was relatively high, which would presumably allow them to be more flexible in the face of potentially stressful changes in the environment. We predicted that children with relatively low shyness and high RSA would exhibit the highest levels of cognitive and affective empathy since they would likely experience low arousal in response to this social situation and possess relatively high parasympathetic control to monitor and adapt to this sudden change in the social environment.

Method

Participants

One hundred thirty typically developing 4- and 6-year-old children (M_{age} = 63.4 months, *SD* = 12.1 months; 63 males) and their biological mothers participated in the present study. Children and their mothers were recruited from the McMaster Infant Database. The database contains the contact information for parents and their healthy, full-term infants who were born at the McMaster University Medical Centre, St. Joseph's Healthcare Hamilton, or Joseph Brant Hospital in the Hamilton, Ontario area and whose mothers consented at that time to be contacted for future developmental studies. Demographic information of the sample is outlined in Table 2.1.

Procedure

Informed and written consent were obtained prior to the child completing a number of tasks with one female experimenter (each described below in order of occurrence). Mothers sat in a different room and observed her child on a closed-circuit

TV monitor. During this time, the mother also completed questionnaires related to demographics and her child's temperament. All procedures were approved by the McMaster University Research Ethics Board. Children and families were compensated with a $20 gift card for their participation.

ECG Recording Procedure and Measure

ECG Recording. While the mother was present, three ECG electrodes were placed on the child's back in the shape of an inverted triangle, and a respiration belt was fastened around the child's chest. Electrodes were placed on the child's back to avoid child distraction and/or tugging and removal. In our previous experience, we have been able to reliably record ECG data from the child's back, and this procedure has resulted in less behavior-sourced artifact (e.g., Waxman et al., 2020). The electrodes and respiration belt were attached to a MindWare Mobile Impedance Cardiograph, Model 50-2303-00, which was placed in an age-appropriate backpack worn by the child. The mobile unit detected R-waves at a sampling rate of 500 Hz and 24-bit ADC digitization.

Resting RSA was measured for 5 minutes while the child watched an emotionally neutral video clip. The video was 6 minutes of the animated motion picture, *Finding Nemo*, which was chosen to hold the interest of the child but did not involve any strong emotions or important plot points that might elicit arousal.

Unfortunately, we were unable to collect reliable measures of RSA during the behavioral tasks due to the birthday speech involving a high level of motor movements (resulting in a significant degree of artifact) and the empathy task being too short. As such, we were unable to obtain a proper challenge task to assess RSA suppression within this study. We chose instead to use a measure of resting RSA, which allows us to focus on a known within-child biological factor that reflects parasympathetic control and emotion regulation and has been previously investigated as a moderator of risk (El-Sheikh et al., 2006; Khurshid et al., 2019; Morales et al., 2015).

ECG data reduction and RSA quantification. Cardiac and respiratory data were analyzed using the Mindware HRV 3.1.1 software package. Peaks were edited manually for erroneous or missing beats according to recommendations of Berntson and Stowell (1998). Respiratory frequency of 0.3–0.5 Hz was used, which is recommended for young children (Shader et al., 2017). Average RSA was estimated for each 1-min epoch and averaged across the five consecutive epochs of interest (Caccioppo, 1994).

Picture Vocabulary Test

We assessed receptive vocabulary with the Picture Vocabulary Test (PVT) from the National Institute of Health Toolbox iPad application to control for the possible confounding effects of language ability and use as a proxy for IQ. For each trial, the child was presented with an audible word and four pictures from which they then had to pick the best-fitting option. Data from the application were exported as age-corrected standard scores with an age-specific global mean of 100 and standard deviation of 15.

Empathy Task

This task was modeled after existing tasks and procedures that have been previously used in toddlers and young children (Knafo et al., 2009; Young et al., 1999; Zahn-Waxler et al., 1992). While putting papers away on a clipboard, the experimenter feigned injury to her finger by pretending to pinch it on the clip. She expressed pain outwardly for 35 s while refraining from making eye contact with the child. Both experimenter and child were seated.

A primary and secondary coder overlapped on a subset of 22% of participant videos to obtain inter-rater reliability. Our coding scheme assessed verbal (e.g., utterances) and nonverbal behaviors (e.g., body orientation, leaning, touching) with equal salience. This was done to ensure that empathic behaviors were not confounded by the child's level of shyness. Each child's behavior was coded for affective and cognitive empathy during the 35-s episode. Affective empathy was composed of three different codes as described below: empathic concern (κ = 0.84), gaze to the victim (κ = 0.79), and verbal engagement with the victim (κ = 0.92). Altogether, these codes effectively encompass vicarious affective response to a victim's injury in the forms of facial expression, verbal concern, active engagement, and direct immersion in the victim's experience. These codes were *z*-scored and added together to form the overarching measure of affective empathy. Cognitive empathy was coded by use of a single code called hypothesis testing (κ = 0.79). More detailed information about the individual codes is provided below.

Empathic Concern. This code was used to account for level of affective expression of concern for the victim (e.g., facial, gestural, and vocal signals of sympathy and/or sadness). A similar coding scheme has been used previously as an observed measure of affective empathy (Zahn-Waxler et al., 1992) and was coded on a 4-point scale (0 = *none;* 1 = *facial expression lacked smile for entire episode;* 2 = *combination of two behaviors that could include facial expression, one verbal concern, and presence of* *body orientation toward the victim;* 3 = *repeated verbal concerns or facial expression combined with complete body orientation and leaning, pointing, touching*). Children who engaged in rare and salient concern behaviors such as touching or brow furrowing were given a score of 3.

Gaze. This code examined the extent to which the child was visually engaged with the victim and the situation, and was coded on a 4-point scale (0 = *averted gaze from victim and context-relevant stimuli for more than half the episode*; 1 = *darting or unsustained gaze;* 2 = *periods of sustaining gaze, but not fully sustained for entire episode*; 3 = *sustained gaze of victim's face, injury, or clipboard for nearly entire period*).

Verbal Engagement. This code was used to measure the extent to which the child engaged with the victim's state by relating to their own or others' experiences and was coded on a 4-point scale (0 = *no verbal engagement*; 1 = *one utterance;* 2 = *two utterances or 10 s of sustained engagement*; 3 = *three or more utterances or sustained engagement for at least 15 s*).

Hypothesis testing. This code was used to assess the child's attempts to understand the cause and nature of the victim's distress. Hypothesis testing is considered to be a measure of cognitive empathy (Zahn-Waxler et al., 1992), which can be expressed through gaze, verbal inquiries, and physical exploration. This was coded on a 4-point scale (0 = *none*; 1 = *looking from face/injury to clipboard, touching the clipboard*; 2 = *combining verbal inquiry with nonverbal exploration*; 3 = *repeated verbal or nonverbal exploration, pushing down on clip of clipboard*).

Shyness Measures

Birthday Speech Self-Presentation Task

The birthday speech involved the child being spontaneously instructed to talk about his/her most recent birthday in front of a video camera. Self-presentation tasks such as this are widely used to elicit shy/anxious behaviors in children (Colonnesi, Nikolic, de Vente, & Bogels, 2017; Poole & Schmidt, 2019; Theall-Honey & Schmidt, 2006). While there has been some debate on the definition of shyness and how to measure this construct, this particular task is known to elicit a state of anxious preoccupation with the self in an imagined social situation with another person present, which is synonymous with how shyness is defined and operationalized.

The experimenter placed a video camera in front of the child and asked him/her to give a short speech about their most recent birthday. The child was informed that the video would be shown to other children who would see and hear them giving the speech. The child was prompted for a minimum of 60 s; however, the child was allowed to speak for as long as he/she wished. Speeches ranged from 60 to 268 s (M = 79 s, SD = 26), however, only the first 2 min of the speech was coded. Due to the reliance on verbal expression during this task, we used data on receptive vocabulary from the PVT to account for the possible confounding effects of language ability.

Behavioral Coding and Observed Shyness Measure. Episodes were scored by two coders for time spent speaking within each 10-s epoch of the speech. Times were then averaged across all coded epochs, resulting in an average time spent speaking for each epoch, ranging from 0 to 10 s. Each coder also recorded the child's latency to speak following the experimenter's instructions. A subset of 20% of participants was scored by both coders. These two individual behavioral measures of observed shyness (i.e., average time spent speaking and latency to speak) were correlated ($r = -.59$, $p < .01$), and both showed strong inter-rater reliability, with latency to speak having an intraclass correlation of 0.96, 95% *CI* [0.94, 0.97], and average time spent speaking showing $\kappa = 0.85$. Although other shy-related behaviors such as fidgeting, body avoidance, and gaze were coded, they were not correlated with latency to speak, average time spent speaking, or parent-reported shyness.

Parent-Reported Shyness

Mothers reported on their child's trait shyness using the Shyness subscale of the Colorado Childhood Temperament Inventory (CCTI; Buss & Plomin, 1984; Rowe & Plomin, 1977). Mothers reported the degree to which they agreed or disagreed on five items on a scale from 1 to 5 (1 = strongly disagree; 5 = strongly agree). Such statements included "Child tends to be shy" and "Child takes a long time to warm up to strangers." The internal consistency for this scale in the present study was $\alpha = 0.85$.

Overall Shyness Measure

Due to the strong correlation between the two observed measures of shyness ($r = -.59$, $p < .01$), these variables were *z*-scored and combined following a reversal of the average time spent speaking measure. This standardized behavioral measure (i.e., reversed average time spent speaking and latency to speak) was correlated with the maternal report of shyness ($r = .27$, $p < .01$). As such, the maternal report was *z*-scored and combined with the standardized behavioral measure to create a conceptually and empirically derived composite measure of *overall shyness*[3].

Statistical analyses

Pearson correlations were used to assess simple relations among shyness, the two coded empathy measures, and resting RSA. Hierarchical regressions were used to further explore these associations as well as the quadratic relation between RSA and empathy-related behaviors and the moderating effect of linear RSA on the relation between shyness and empathy-related behaviors. We probed emerging interactions at 1 standard deviation above and below the mean of RSA. Variables entered in each step of the regressions are listed in the Results section and on Tables 2.3, 2.4, and 2.5.

Four- and 6-year-old children did not differ on the measures of affective ($t = 0.34$, $p = .74$) or cognitive empathy ($t = -0.20$, $p = .85$). Accordingly, these age groups were combined and analyzed as one sample.

All analyses were controlled for continuous age, sex, and combined family income. Analyses involving the observed shyness measure were also controlled for PVT scores.

All analyses were performed in SPSS Version 22 with significance levels set at $\alpha = 0.05$.

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[3] It is important to note that although the latency to speak measure had a positive skew, when 4 outliers were removed we found statistically significant correlations between all three measures [latency and parent-reported shyness (r=0.23, p<0.01), latency and time speaking ($r = -0.53$, $p < 0.01$), parent-reported shyness and time speaking ($r = -0.37$, $p < 0.01$)]. These 4 outliers washed out when the latency measure was *z*-scored and combined with the other two measures (i.e., there were no outliers for the overall shyness measure).

Missing data and data loss

Four children were not coded for observed shyness due to refusal to stand in front of the video camera for more than 30 s. We suspect that all four children were too anxious or nervous to complete the birthday speech (with two children expressing their fear directly to the experimenter), and so we assigned a ceiling score for each of the observed shyness measures (i.e., 0 s of average time spent speaking during each 10-s epoch, and 60 s latency) for each of these children. These ceiling scores were then aggregated with their existing maternal reports in the same manner as the rest of the sample.

Nine participants had missing RSA data, with five having technical issues in data storage and four having issues in data recording. These children did not differ from the remaining sample on measures of shyness or empathy (*p*s > .05). These data were missing completely at random ($p > .05$) and were handled using multiple imputation.

Results

Descriptive Statistics

Table 2.2 displays the correlations and descriptive statistics for the study measures. As expected, cognitive and affective empathy were positively correlated, $r(128) = .42$, $p < .001$. In addition, cognitive empathy was associated with average time spent speaking, $r(128) = .25$, $p = .005$, and mother-reported shyness, $r(128) = -.38$, $p < .001$. Although cognitive empathy was not found to be associated with latency to speak alone, $r(128) = .05$, $p = .59$, it was negatively related to overall shyness, $r(128) = -.25$, $p = .004$. Affective empathy was associated with average time spent speaking, $r(128) = .23$,

$p = .007$, and mother-reported shyness, $r(128) = -.28$, $p = .002$, but not latency to speak, $r(128) = -.13$, $p = .16$. However, affective empathy was negatively related to overall shyness, $r(128) = -.28$, $p = .001$.

PVT scores were negatively related to resting RSA levels, $r(128) = -.20$, $p = .02$, and age was positively associated with resting RSA levels, $r(128) = .18$, $p = .04$.

Preliminary Analyses: Testing the Quadratic Relation Between RSA and Empathy

Before conducting our primary analyses, we first determined whether there was a quadratic relation between RSA and the empathy-related measures, given recent work (e.g., Miller et al., 2017). Separate hierarchical regressions revealed that the relation between resting RSA and observed empathy followed a quadratic pattern, but only for affective empathy. For this analysis, covariates (age, sex, and income) were entered into step 1, linear resting RSA was entered into step 2, and quadratic RSA was entered into step 3.

Affective Empathy

We found that the model was not significant for step 1 $\Delta F(3, 126) = 1.06$, $p = .37$ or step 2 $\Delta F(1, 125) = 1.27$, $p = .26$, but the change in predictive value of the regression equation was significant at step 3 $\Delta F(1, 124) = 6.78$, $p = .01$. When covariates, linear RSA, and quadratic RSA were present, quadratic resting RSA was significant, $b = 0.32$, $t = 2.61$, $p = .010$, 95% CI [0.08, 0.56] (Table 2.3A). In contrast to previous findings (e.g., Miller et al., 2017), however, the quadratic relation followed a non-inverted-U shape relation. As shown in Figure 2.1, children with moderate resting RSA levels exhibited the lowest, not highest, observed affective empathy, while relatively higher and lower resting

RSA levels resulted in higher, not lower, affective empathy. Johnson-Neyman analyses revealed that the slope was significant for all data points (i.e., all children with a resting RSA of 19.16 and lower). Given this finding, we explored both linear and quadratic RSA as a moderator when assessing the relation between shyness and empathy as part of research question 2.

Cognitive Empathy

There was no quadratic relation detected for RSA in predicting cognitive empathy (see Table 2.3B).

Research Question 1: *Are individual differences in children's shyness linearly associated with their observed empathy-related behaviors?*

To examine our first question, we conducted separate hierarchical linear regressions to determine whether there was a linear relation between overall shyness and affective and cognitive empathy, separately. For each regression, age, sex, annual family income, and PVT scores were entered into step 1, and overall shyness was entered into step 2.

Affective Empathy

In the linear model predicting affective empathy, the regression was not significant at step 1 $\Delta F(4, 125) = 0.87$, $p = .48$; however, the change in predictive value of the regression equation was significant at step 2 $\Delta F(1, 124) = 10.70$, $p = .001$, with shyness predicting lower affective empathy, $b = -0.24$, $t = -3.27$, $p = .001$, 95% CI [−0.39, −0.10] (Table 2.4A).

Cognitive Empathy

Similarly, in the model predicting cognitive empathy, the model was not significant at step 1 $\Delta F(4, 125) = 0.60$, $p = .66$, but step 2 yielded a significant change in predictive value $\Delta F(1, 124) = 8.79$, $p = .004$, with shyness predicting lower cognitive empathy, $b = -0.10$, $t = -2.97$, $p = .004$, 95% CI [−0.17, −0.03] (Table 2.4B).

Overall, both of these regressions support the inverse relation between observed shyness and observed affective and cognitive empathy-related behaviors.[4]

Research question 2: *Does resting RSA moderate the relation between individual differences in children's shyness and empathy-related behaviors?*

To address our second question, we conducted separate hierarchical regressions to determine whether resting RSA moderated the relation between observed shyness and affective and cognitive empathy, separately. For each regression, age, sex, annual family income, and PVT scores were entered into step 1, shyness and resting RSA were entered into step 2, and the interaction term was entered into step 3.

Affective Empathy

We did not find a significant interaction between shyness and linear resting RSA in predicting affective empathy (see Table 2.5A). Specifically, we found that the model was not significant for step 1 $\Delta F(4, 125) = 0.87$, $p = .48$, but the change in predictive

[4] We detected a trend for the moderating effect of age group (i.e., 4 and 6 year olds) on the linear relation between shyness and cognitive empathy while controlling for sex, income, and PVT score, $F(6, 123) = 2.45$, $p = 0.03$, $b = -.17$, $t = -1.78$, $p = .08$, 95% CI [-.36, .02]. In 6-year-olds, there was an inverse relation between shyness and cognitive empathy, while in 4-year-olds, the strength of this inverse relation was weaker. This moderation was not detected in affective empathy, $F(6, 123) = 2.43$, $p = 0.03$, $b = -.14$, $t = -0.71$, $p = .48$, 95% CI [-.55, .26]. In the following analyses assessing both age groups together, we have controlled for continuous age to remove this possibly confounding effect.

value of the regression equation was significant at step 2 $\Delta F(2, 123) = 5.66$, $p < .001$. The change in predictive value was not significant at step 3 $\Delta F(1, 122) = 2.12$, $p = .15$; when covariates, predictor, moderator, and interaction term were present, the interaction term was not significant, $b = 0.10$, $t = 1.46$, $p = .15$, 95% CI [−0.04, 0.23]. There was also no interaction between quadratic RSA and shyness ($F(8, 112) = 2.50$, $b = 0.02$, $t = 0.30$, $p = .76$, 95% CI [−0.10, 0.14]) in predicting affective empathy.

Cognitive Empathy

Due to there being no quadratic relation between resting RSA and cognitive empathy, we explored the moderating role of linear RSA on the relation between shyness and cognitive empathy. We did this by assessing the relation between shyness and cognitive empathy at high, low, and moderate levels of RSA in a multiple linear regression.

As predicted, we found that resting RSA moderated the relation between observed shyness and observed cognitive empathy (Table 2.5B). We found that the model was not significant for step 1 $\Delta F(4, 125) = 0.60$, $p = .66$, but the change in predictive value of the regression equation was significant at step 2 $\Delta F(2, 123) = 4.37$, $p = .02$ and step 3 $\Delta F(1, 122) = 4.17$, $p = .043$. When covariates, predictor, moderator, and interaction term were present, the interaction term was significant, $b = 0.07$, $t = 2.04$, $p = .04$, 95% CI [0.002, 0.13], with a simple effect of shyness, $b = -0.11$, $t = -3.05$, $p = .003$, 95% CI [−0.17, 0.04].

The unstandardized simple slope for children with RSA 1 *SD* above the mean was −0.03 ($p = .52$), while the slope for children with RSA 1 *SD* below the mean was −0.16

(p = .001). According to Johnson-Neyman analyses, the slope was significant when RSA values were 7.14 or lower.

As shown in Figure 2.1, at relatively high levels of resting RSA, individual differences in observed shyness levels had similar effects on cognitive empathy. However, at relatively lower levels of resting RSA, observed shyness was inversely related to cognitive empathy.

Table 2.1

Demographics of the sample (*N* = 130)

Variable	Value	Frequency	%
Sex	Males	62	47.7
	Females	68	52.3
Age	4 years	82	63.1
	6 years	48	36.9
Race	Caucasian	100	76.9
	African American	5	3.8
	Asian	1	0.8
	Hispanic	2	1.5
	Mixed	10	7.7
	Other	5	3.8
	Not Reported	7	5.4
Income*	Less than $15,000	2	1.5
	$15-30,000	2	1.5
	$30-45,000	4	3.1
	$45-60,000	12	9.2
	$60-75,000	11	8.5
	$75-100,000	27	20.8
	Over $100,000	72	55.4

(*in Canadian Dollars)

Table 2.2

Descriptive statistics and correlations for study measures

	1	2	3	4	5	6	7	8	9	10	Mean (SD)	Range
1. Cognitive Empathy	--	0.42**	0.02	0.05	0.25**	-0.38**	-0.25**	0.06	-0.06	-0.06	1.6(0.9)	0-3
2. Affective Empathy		--	-0.10	-0.13	0.23**	-0.28**	-0.28**	0.02	0.01	0.06	0.0(1.8)	-5.5-4.0
3. Resting RSA			--	0.09	-0.10	-0.03	0.03	0.18*	0.06	-0.20*	6.8(1.0)	4.2-8.9
4. Latency to Speak (s)				--	-0.57**	0.10	0.73**	-0.19*	-0.11	-0.16	5.9(11.9)	0-60
5. Average Time Speaking (s)					--	-0.38**	-0.86**	0.47**	0.10	0.28**	5.0(2.2)	0-10
6. Parent-Reported Shyness						--	0.67**	-0.14	0.02	0.04	11.1(4.3)	5-22
7. Overall Shyness							--	-0.35**	-0.08	-0.17	0.0(2.3)	-3.9-7.0
8. Age (months)								--	0.12	0.24**	63.4(12.1)	45.9-83.9
9. Annual Family Income									--	-0.03	6.1(1.4)	1-7
10. PVT Score										--	110.1(13.3)	73-151

N = 130; *p < 0.05; **p <0.01

Note. Means, standard deviations (SDs) and ranges represent untransformed data. RSA = respiratory sinus arrhythmia, PVT = Picture Vocabulary Test.

Table 2.3

Hierarchical regression analysis testing the quadratic relation between resting respiratory sinus arrhythmia (RSA) and (A) affective empathy and (B) cognitive empathy

	b	*SE*	*t*	*p*	95% CI Lower bound	95% CI Upper bound
A) Affective Empathy						
Step 1 (Constant)	0.04	0.16	0.24	0.81	-0.28	0.36
Age	0.00	0.01	0.25	0.80	-0.02	0.03
Sex	0.59	0.33	1.76	0.08	-0.07	1.25
Annual Income	-0.04	0.12	-0.33	0.74	-0.28	0.20
Step 2 (Constant)	0.04	0.16	0.22	0.83	-0.28	0.35
Age	0.01	0.01	0.44	0.66	-0.02	0.03
Sex	0.56	0.33	1.69	0.09	-0.10	1.22
Annual Income	-0.03	0.12	-0.28	0.78	-0.27	0.21
Resting RSA	-0.19	0.17	-1.13	0.26	-0.51	0.14
Step 3 (Constant)	-14.5	5.58	-2.60	0.01*	-25.54	-3.45
Age	0.01	0.01	0.65	0.52	-0.02	0.04
Sex	0.59	0.33	1.81	0.07	-0.06	1.24
Annual Income	-0.04	0.12	-0.37	0.71	-0.28	0.19
Resting RSA	-4.31	1.59	-2.71	0.01*	-7.46	-1.16
RSA x RSA	0.32	0.12	2.61	0.01*	0.08	0.56
B) Cognitive Empathy						
Step 1 (Constant)	1.60	0.08	21.11	<0.01**	1.45	1.75
Age	0.01	0.01	0.79	0.43	-0.01	0.02
Sex	0.10	0.16	0.62	0.54	-0.21	0.41
Annual Income	-0.05	0.06	-0.89	0.38	-0.16	0.06
Step 2 (Constant)	1.60	0.08	21.02	<0.01**	1.45	1.75
Age	0.01	0.01	0.76	0.45	-0.01	0.02
Sex	0.10	0.16	0.62	0.53	-0.21	0.41
Annual Income	-0.05	0.06	-0.89	0.38	-0.16	0.06
Resting RSA	0.01	0.08	0.12	0.91	-0.15	0.16
Step 3 (Constant)	-2.10	2.68	-0.78	0.44	-7.41	3.21
Age	0.01	0.01	0.87	0.39	-0.01	0.02
Sex	0.10	0.16	0.67	0.51	-0.21	0.42
Annual Income	-0.05	0.06	-0.94	0.35	-0.17	0.06
Resting RSA	-1.04	0.77	-1.36	0.18	-2.56	0.47
RSA x RSA	0.08	0.06	1.38	0.17	-0.04	0.20

Note. $*p < 0.05$; $**p < 0.01$; $F_{\text{affective emapthy}}(5, 124) = 2.29$, $p = 0.05$; $F_{\text{cognitive empathy}}(5, 124) = 0.68$, $p = 0.64$

Table 2.4

Hierarchical regression analyses testing linear relations between children's overall shyness and observed (A) affective and (B) cognitive empathy

(A) Shyness predicting Affective Empathy	*b*	*SE*	*t*	*p*	95% CI	
					Lower bound	Upper bound
Step 1 (Constant)	0.05	0.16	0.28	0.78	-0.28	0.37
Age	0.02	0.16	0.10	0.92	-0.31	0.34
Sex	0.29	0.17	1.72	0.09	-0.04	0.62
Annual Income	-0.05	0.17	-0.29	0.77	-0.38	0.28
PVT Score	0.09	0.17	0.56	0.58	-0.24	0.43
Step 2 (Constant)	0.03	0.16	0.21	0.83	-0.28	0.34
Age	-0.16	0.17	-0.95	0.35	-0.48	0.17
Sex	0.26	0.16	1.59	0.12	-0.06	0.58
Annual Income	-0.07	0.16	-0.41	0.68	-0.38	0.25
PVT Score	0.05	0.16	0.29	0.77	-0.28	0.37
Overall Shyness	-0.24	0.07	-3.27	<0.01**	-0.39	-0.10

(B) Shyness predicting Cognitive Empathy	*b*	*SE*	*t*	*p*	95% CI	
					Lower bound	Upper bound
Step 1 (Constant)	1.61	0.08	21.13	<0.01**	1.46	1.76
Age	0.08	0.08	1.01	0.31	-0.07	0.23
Sex	0.05	0.08	0.68	0.50	-0.10	0.21
Annual Income	-0.07	0.08	-0.95	0.35	-0.23	0.08
PVT Score	-0.08	0.08	-0.96	0.34	-0.23	0.08
Step 2 (Constant)	1.60	0.07	21.70	<0.01**	1.45	1.75
Age	0.00	0.08	0.04	0.97	-0.15	0.16
Sex	0.04	0.08	0.52	0.60	-0.11	0.19
Annual Income	-0.08	0.08	-1.07	0.29	-0.23	0.07
PVT Score	-0.10	0.08	-1.25	0.22	-0.25	0.06
Overall Shyness	-0.10	0.04	-2.97	<0.01**	-0.17	-0.03

Note. *$p < 0.05$; **$p < 0.01$; $F_{\text{affective empathy}}(5, 124) = 2.89$, $p = 0.02$; $F_{\text{cognitive empathy}}(5, 124) = 2.27$, $p = 0.05$; PVT = Picture Vocabulary Test.

Table 2.5

Hierarchical regression analysis testing the moderating effect of resting respiratory sinus arrhythmia (RSA) on the relation between overall shyness and (A) affective empathy and (B) cognitive empathy Note. $F_{\text{affective empathy}}(7, 122) = 2.47$, $p = .02$; $F_{\text{cognitive empathy}}(7, 122) = 2.25$, $p = .035$; PVT = Picture Vocabulary Test

	b	*SE*	*t*	*p*	95% CI	
					Lower bound	Upper bound
A) Affective Empathy						
Step 1 (Constant)	0.04	0.16	0.26	0.80	-0.28	0.36
Age	0.00	0.01	0.10	0.92	-0.03	0.03
Sex	0.58	0.33	1.72	0.09	-0.09	1.24
Annual Income	-0.04	0.12	-0.29	0.77	-0.28	0.21
PVT Score	0.01	0.01	0.56	0.58	-0.02	0.03
Step 2 (Constant)	0.03	0.16	0.20	0.84	-0.28	0.34
Age	-0.01	0.02	-0.72	0.47	-0.04	0.02
Sex	0.50	0.32	1.55	0.12	-0.14	1.14
Annual Income	-0.05	0.12	-0.38	0.70	-0.28	0.19
PVT Score	0.00	0.01	0.08	0.94	-0.02	0.03
Overall Shyness	-0.24	0.07	-3.20	<0.01**	-0.38	-0.09
Resting RSA	-0.13	0.17	-0.80	0.43	-0.46	0.20
Step 3 (Constant)	0.03	0.16	0.17	0.86	-0.28	0.34
Age	-0.01	0.02	-0.73	0.47	-0.04	0.02
Sex	0.49	0.32	1.51	0.13	-0.15	1.13
Annual Income	-0.04	0.12	-0.34	0.73	-0.27	0.19
PVT Score	0.00	0.01	0.28	0.78	-0.02	0.03
Overall Shyness	-0.24	0.07	-3.25	<0.01**	-0.39	-0.09
Resting RSA	-0.09	0.17	-0.51	0.61	-0.42	0.25
Shyness x RSA	0.10	0.07	1.46	0.15	-0.04	0.23
B) Cognitive Empathy						
Step 1 (Constant)	1.60	0.08	21.05	<0.01**	1.45	1.75
Age	0.01	0.01	1.01	0.31	-0.01	0.02
Sex	0.11	0.16	0.68	0.50	-0.20	0.42
Annual Income	-0.05	0.06	-0.95	0.35	-0.17	0.06
PVT Score	-0.01	0.01	-0.96	0.34	-0.02	0.01
Step 2 (Constant)	1.59	0.07	21.56	<0.01**	1.45	1.74
Age	0.00	0.01	0.02	0.99	-0.01	0.01
Sex	0.08	0.15	0.52	0.60	-0.22	0.38
Annual Income	-0.06	0.06	-1.07	0.29	-0.17	0.05
PVT Score	-0.01	0.01	-1.18	0.24	-0.02	0.01
Overall Shyness	-0.10	0.04	-2.95	<0.01**	-0.17	-0.03
Resting RSA	0.01	0.08	0.09	0.93	-0.15	0.16
Step 3 (Constant)	1.59	0.07	21.79	<0.01**	1.45	1.74
Age	0.00	0.01	0.01	0.99	-0.01	0.01
Sex	0.07	0.15	0.46	0.64	-0.23	0.37
Annual Income	-0.06	0.06	-1.03	0.31	-0.17	0.05
PVT Score	-0.01	0.01	-0.91	0.37	-0.02	0.01
Overall Shyness	-0.11	0.04	-3.05	<0.01**	-0.17	-0.04
Resting RSA	0.04	0.08	0.48	0.63	-0.12	0.19
Shyness x RSA	0.07	0.03	2.04	0.04*	0.01	0.13

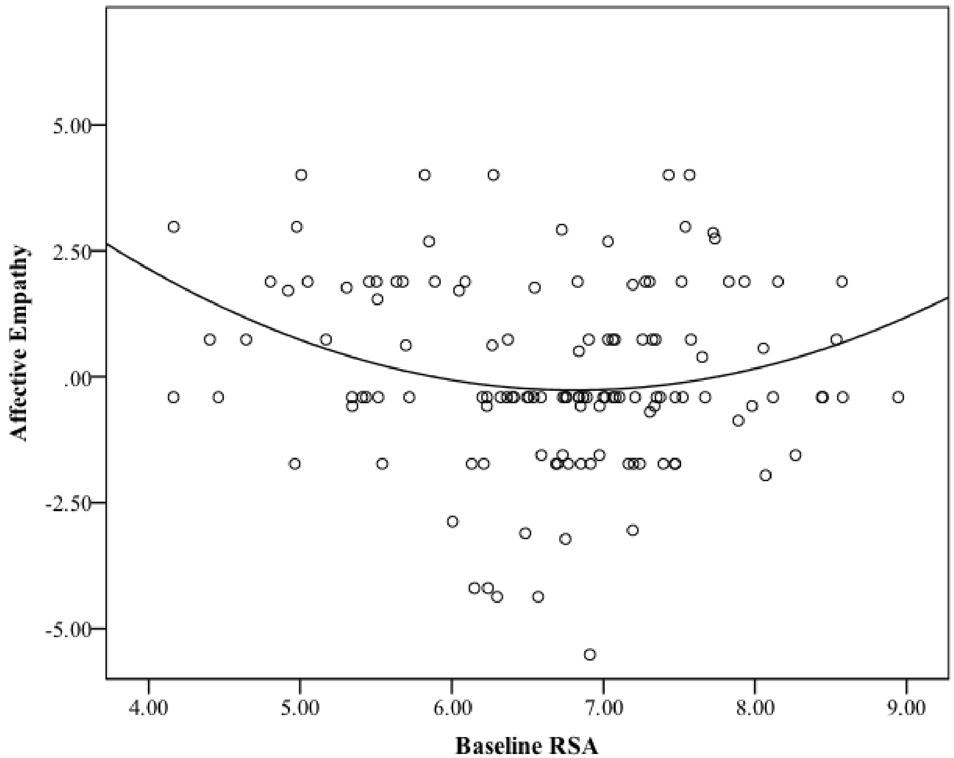

Figure 2.1. *Quadratic (U-shape) relation between resting respiratory sinus arrhythmia (RSA) levels and observed affective empathy in early childhood, with fit line*

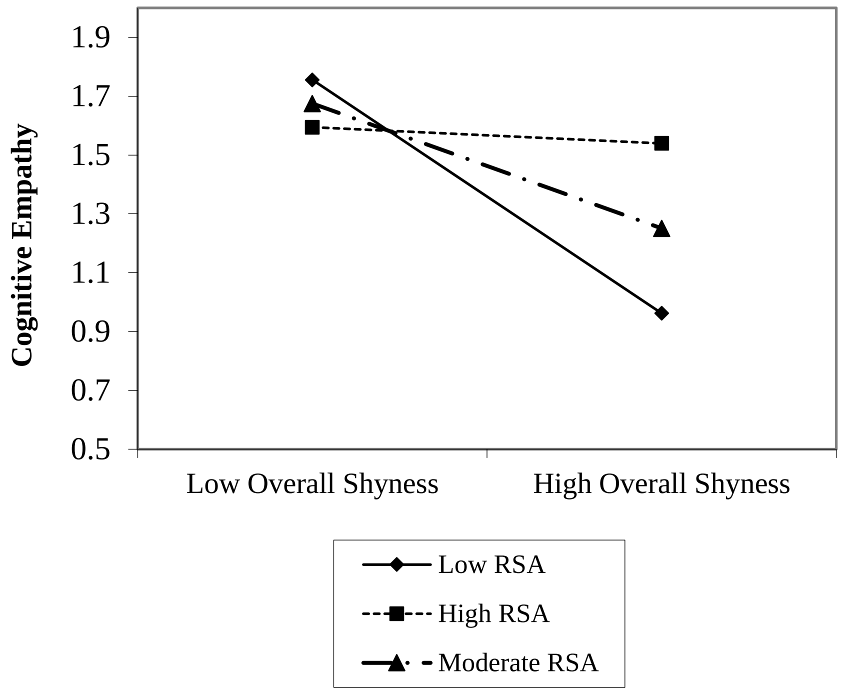

Figure 2.2. *Moderating influence of resting respiratory sinus arrhythmia (RSA) on the relation between overall shyness and observed cognitive empathy in early childhood, displaying 1 SD above and below the mean, and average RSA*

Discussion

In the present study, we found three noteworthy results. First, relatively higher shyness was associated with relatively lower expressions of cognitive and affective empathy in young children. Second, resting RSA moderated the relation between shyness and cognitive empathy: relatively high shyness was associated with lower cognitive empathy when resting RSA was relatively low. Children who had relatively higher resting RSA exhibited the same levels of cognitive empathy regardless of their overall shyness. Third, we found a quadratic relation between resting RSA and affective empathy, which followed a U-shaped pattern such that moderate RSA resulted in the lowest, not highest, affective response. We discuss each of these three major findings in turn below.

Shyness and Empathy Findings

The inverse relations between shyness and empathy largely replicate and are consistent with previous work (Findlay et al., 2006; Robinson et al., 1994; Young et al., 1999). Shy children are known to experience high anxiety and accompanying arousal in social situations when compared to their non-shy peers (e.g., Tsui, Lahat, & Schmidt, 2017), and these states can be amplified when they encounter a victim expressing a negative emotional state (i.e., requiring empathic response; Hoffman, 1975). Accordingly, in these situations, shy children are thought to direct attention to their own personal distress rather than toward another person (Eisenberg & Fabes, 1990; Kim & Han, 2018), resulting in a supposed indifference toward the pain or distress of others (Hoffman, 1975; Kim & Han, 2018).

Warden and Mackinnon (2003) have postulated that the capacity to respond to social situations is the most important factor for the formation of empathic behavior. Shy children tend to experience difficulties in navigating their social world. For example, shy-withdrawn children have been found to use fewer social reasoning skills when compared to non-shy children (Rubin & Rose-Krasner, 1992). In addition, some have reported that shy children tend to engage in more non-assertive strategies to conflict (Walker, Henderson, Degnan, Penela, & Fox, 2014; Wichmann, Coplan, & Daniels, 2004). In fact, Bandstra, Chambers, McGrath, and Moore (2011) have argued that children who are high in surgency/extraversion (i.e., not shy) tend to show more assertion in their empathic concern behaviors. Indeed, shy children tend to lack social initiative in general and experience social anxiety in difficult social situations in particular.

One important concept to be mindful of when considering both shyness and empathy-related behaviors is eye gaze. Gaze aversion is conceptually vital for the observation of behavioral shyness (Asendorpf, 1990; Cheek & Buss, 1981; Cheek & Krasnoperova, 1999) and is one of the most researched behavior cues used to assess this temperamental profile (e.g., Colonnesi et al., 2017; Nikolić, Colonnesi, de Vente, & Bogels, 2016; Spooner, Evans, & Santos, 2005). Eye gaze is also an important component of sophisticated affective and cognitive empathic response (Knafo et al., 2009; Young et al., 1999; Zahn-Waxler et al., 1992) such that eye gaze toward the victim is often indicative of affect sharing, expressions of concern, and exploration of distress. As such, more frequent gaze aversions performed by shy children during situations requiring empathic response may be one of the key reasons for less refined affective and cognitive empathy.

Our findings are consistent with, and extend, the extant literature by examining different components of observed empathy and observed measures of shyness in the same study. While affective empathy (i.e., concern) and helping behaviors are more commonly assessed within the literature, it is also important to consider the level of empathic processing in which the child engages.

Although there are many interpretations that could be made regarding the inverse relation between cognitive empathy and shyness, we believe that one of the most plausible explanations involves performance anxiety rather than a lack of social cognitive reasoning. Since cognitive empathy is conceptually related to Theory of Mind (e.g., Baron-Cohen & Wheelwright, 2004), some may postulate that shy children's reduction in empathic processing is a result of deficits in social inference and understanding. However, there is evidence to suggest that shy children may possess heightened social cognitive skills in the areas of emotion understanding and Theory of Mind when compared to more sociable and outgoing children (Labounty et al., 2017; Lane et al., 2013; Longobardi et al., 2017; Wellman et al., 2011). Taking this evidence into account, the supposed deficits in hypothesis testing that we observed in our study may indicate a performance issue rather than a competence issue: shy children's increased arousal and personal distress may affect their ability to explore their social surroundings (i.e., cognitive empathic response). Specifically, we found that shyness may have limited the child's exploration of the experimenter's distress in the form of glances, manual exploration of the clipboard, and verbal inquiries.

Shyness, RSA, and Empathy Findings

Parasympathetic control is relevant to shyness and empathy in the context of this study, since both are highly related to the level of arousal that a child experiences in a social situation. We found that resting RSA moderated the relation between individual differences in overall shyness and cognitive empathy. Specifically, relatively higher shyness combined with low resting RSA levels were associated with the lowest scores on cognitive empathy. As mentioned above, shy children are likely more sensitive to stressful social situations when compared to more sociable children. Combining this factor with low resting RSA, which has been linked with problems surrounding emotion regulation (McLaughlin et al., 2015; Rudd & Yates, 2019), therefore, may result in lower expressions of cognitive exploration of the empathic situation. This can be seen as a "double-hit," whereby children with both "suboptimal" attributes experience a higher level of resulting arousal, and lower capacity to regulate themselves, when compared to children who possess only one of these characteristics. In all, these children likely experience less flexible responding to the arousal that the feigned injury elicits, are less capable of regulating this arousal, and encounter increased psychological and physiological distress as a result of the social nature of the situation.

Children who are high in shyness and have relatively high RSA displayed a moderate level of cognitive empathy, suggesting that these shy children may be better equipped to effectively modulate their arousal and subsequently explore the nature of the situation and surroundings. Children low in shyness also displayed moderate cognitive empathy, regardless of their RSA level. Taken together, it appears that shyness is related to lower levels of cognitive empathy, however, only at lower levels of resting RSA. Children who are high in shyness may be protected by higher resting RSA, such that they display the same cognitive empathy as children who are relatively low in shyness. In all, our results suggest that only children who possess both "suboptimal" attributes (i.e., high shyness and low RSA) are at risk for displaying lower cognitive empathy. Children who exhibit only one or neither of these traits demonstrate moderate hypothesis testing. This finding highlights the importance of considering biological and temperamental factors as well as a combination of both when attempting to understand individual differences in complex social behaviors such as empathy.

We did not observe this interaction when predicting affective empathy. The reason for this difference remains unclear but strengthens the notion that there is heterogeneity in empathic processes such that certain individual differences can affect each component differently. We postulate that perhaps cognitive empathic response requires more conscious control from the child. While affective empathic response involves more behaviors in line with emotion contagion, such as facial expression (Hoffman, 1975), hypothesis testing is comprised more of inquiring behaviors that are likely not as 'automatic' and/or immersive. As such, the combination of high shyness and low RSA may have more of an effect on these supposed performance behaviors when compared to those that are more reflexive.

RSA and Empathy Quadratic Findings

Although we found a statistically significant quadratic relation between resting RSA and affective empathy, our data followed a U-shaped pattern such that moderate RSA resulted in the lowest, not highest, levels of affective response. This finding is consistent with Tully et al. (2015) and one of the relevant samples assessed by Acland et al. (2019), however, not with other studies reporting moderate levels of RSA being optimal for affective empathic responding (Miller et al., 2017; Zhang & Wang, 2019). We believe that a U-shaped pattern of resting RSA in relation to affective empathy makes conceptual sense.

We presume that children with higher resting RSA would adapt quickly and overcome arousal elicited from the distress of the victim to effectively respond to their needs. In contrast, we speculate that children with lower baseline RSA may not be able to physiologically cope with the distress of the victim, and therefore be motivated to comfort the experimenter to alleviate their own heightened arousal. Specifically, experiencing high arousal and low parasympathetic control may shift the method of their coping, and motivate attempts to eliminate the environmental stress: by trying to stop the victim from expressing their negative emotions.

Meanwhile, children who possess moderate baseline RSA may not experience enough arousal modulation to effectively and comfortably engage in comforting behaviors, resulting in personal distress rather than attention toward the victim (Eisenberg & Fabes, 1998; Preston & de Waal, 2002). However, these children may be able to calm themselves enough to not require comforting actions toward the victim for the purpose of removing their own source of distress.

It is not completely clear why the present findings varied from other studies that have explored this quadratic relation. However, there were a few notable differences between our methodologies and those of Miller et al. (2017). Primarily, the accident simulation used in the study by Miller and colleagues lasted for approximately 90 s. Although designing a longer task allows for more opportunity to code children's behaviors, and this time period is consistent with Zahn-Waxler et al.’s (1992) original guidelines, we would argue that maintaining believability for this period of time would be difficult for a sample of 4- and 6-year-old children. This 90 s period was originally designed in the context of empathy measurement in toddlers; however, older children would likely not believe an adult expressing pain for such an extended period. Although we do not have empirical evidence for this argument, we did observe this lack of believability when piloting a 90 s feigned pain episode in 4- and 6-year-old children. For these reasons, children from the Miller et al. study may have been coded as more empathic due to the longer temporal period that they were assessed. In addition, Miller et al. used nine different female experimenters for this task, which may have compromised standardization and believability. Although the authors incorporated a credibility check, the impact of child biases toward the experimenters is unknown. Meanwhile, our study used the same female experimenter for all participants within the present sample. Given the differences in how the empathy task was carried out, coded behaviors may vary among similar samples of children, resulting in different findings when analyzed in relation to natural variability in resting RSA.

Strengths and Limitations

There were several strengths to the present study, including shyness and empathy-related behaviors coded from direct observations, and the assessment of cognitive and affective empathy as separate components. Procedures were also carried out during a critical time in socioemotional development, coinciding with transition to formal schooling, the development of peer relationships, and the ability to take on the perspective of others.

There were, however, some limitations that warrant discussion. First, while we successfully collected data on children’s empathy, we did not examine helping behavior, limiting general inferences about prosocial behaviors. Thus, it would be constructive to analyze relations not only among the empathy components, shyness, and resting RSA levels, but also other measures of prosocial behavior, such as helping. Second, we did not have access to ECG collected during the empathy task, which would be needed to derive measures of RSA suppression. We required at least 1 min of continuous ECG data to derive reliable estimates of on-task RSA; however, the empathy task was only 35 s. Surpassing 35 s would have likely compromised the believability of the experimenter's injury and pain expression. Given the circumstances of this study, we assessed resting RSA, derived from several consecutive epochs of baseline measurement, as a measure of the child's physiological ability to adapt to environmental changes and challenges.

A third limitation to this study was that our sample was relatively homogenous in nature. This group of children was primarily White, with a relatively high combined family income. Thus, the extent to which findings would generalize to more ethnically and economically diverse groups is unknown. Fourth, we were unable to counterbalance our empathy and birthday speech tasks, which could potentially have contributed to differences in children's responses to the tasks, particularly among shy children. However, we were careful to order our tasks from least distressing (i.e., resting video) to potentially most stressful (i.e., birthday speech task) to ensure that arousal from a previous task did not carry over to another. In addition, there were at least 5 min (and up to 30 minutes) of “wash out” activity between each task.

Fifth, we only assessed children’s empathic responses toward a female experimenter, and not the child's mother. As such, the present study did not explore whether familiarity may have affected expressions of empathy in some children more than others. Sixth, the findings of the present study were based on a cross-sectional design, so causality cannot not be established among the measures. Lastly, the nature of one-timing sampling of the observed shyness and empathy measures provides little opportunity to report on the convergence of these behaviors. We have attempted to amend this with the shyness construct by including a parent report measure that was combined with observed behaviors to create an overall measure of shyness. Unfortunately, we were not able to do the same with the observed empathy measure.

Future studies should use a larger, more ethnically and economically diverse sample and longitudinal designs to ensure the generalizability of the current findings and to enhance causal inferences. Future investigations should also attempt to observe children's empathic behavior among peers, mother, father, and siblings in their everyday environments in addition to an unfamiliar adult experimenter in a controlled laboratory setting. This would allow for generalization to more common real-world situations and examination of personal familiarity in the context of children's expressions of empathy.

Conclusions and Implications

This study appears to be the first to provide evidence of an association between individual differences in children's shyness and their observed empathy-related behaviors that have been delineated into different empathy components and parsed from prosociality in early childhood. Our research has provided evidence for an inverse relation between shyness and cognitive empathy as well as affective empathy. Resting RSA was also found to have a moderating influence on the relation between children's shyness and cognitive empathy, with the combination of relatively high shyness and low RSA resulting in the lowest cognitive empathy scores. It appears that relatively high RSA may serve as a protective factor in shy children's cognitive empathy such that children who are relatively high in shyness do not experience reductions in observed hypothesis testing when they have higher RSA. These findings provide evidence that certain combinations of temperamental and biological factors may play a role in governing individual differences in children's empathy-related behaviors. Our findings have implications for parents' and teachers' understanding of children's socioemotional behavior, especially by increasing their awareness that some children may have temperamental difficulties engaging in empathy-related behaviors.

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CHAPTER 4

Study 3: Longitudinal relations among temperamental shyness and prosocial behaviors

MacGowan, T. L., & Schmidt, L. A. (2021). Helping as prosocial practice: Longitudinal relations among children's shyness, helping behavior, and empathic response. *Journal of Experimental Child Psychology*. Manuscript in press.

Abstract

Although shyness has been reported as a concurrent constraint on young children's empathy and instrumental helping, there is limited evidence to suggest that this temperamental profile has longitudinal effects on prosocial behaviors. Here, we examined concurrent and longitudinal relations between children's shyness and prosocial behaviors, as well as the intervening impact of instrumental helping behavior on later empathic response in typically developing children (*N* = 86; 45 female). Shyness was coded from direct observations and reported by parents at Time 1 (M_{age} = 54.3 months, *SD* = 2.9), Time 2 (M_{age} = 66.5 months, *SD* = 2.8), and Time 3 (M_{age} = 77.9 months, *SD* = 2.8), helping behavior was assessed at Time 2, and data on cognitive and affective empathy were collected at Time 3. Increases in shyness resulted in longitudinal reductions of affective empathy but not cognitive empathy or instrumental helping. As well, Time 2 helping mediated the relation between Time 1 shyness and Time 3 affective empathy and, to some extent, the relation between Time 2 shyness and Time 3 affective empathy. These findings suggest that shyness concurrently impedes early helping behaviors, and that this withdrawal may contribute to reductions in shy children's prosocial learning opportunities that inform later empathic responses.

Introduction

Since the 1970s, several observational and experimental studies have significantly advanced our understanding of prosocial development (for reviews, see Eisenberg, Fabes, & Spinrad, 2006; Eisenberg et al., 2015). Despite our current knowledge of typical developmental timelines for prosocial acts, we know relatively little about individual differences in prosocial development: Why do some children respond to others' needs, while others do not? Although nearly all preschool-aged children have the cognitive capacity to engage in basic prosocial behaviors (i.e., they understand when and how to help; Karasewich, Kuhlmeier, Beier, & Dunfield, 2018), there is evidence to suggest that those who struggle with helping tend to experience motivational challenges with the intensive social involvement that these behaviors often require (e.g., Karasewich et al., 2018). In particular, an emerging body of work has begun to explore children's shyness as a constraint on early prosocial behavior (e.g., Eisenberg, Spinrad, Taylor, & Liew, 2019; MacGowan & Schmidt, 2020a). Despite this growing literature, very few studies have investigated longitudinal relations between shyness and prosocial behaviors in children. As well, to our knowledge, no work has explored possible intervening developmental relations among different prosocial behaviors. Investigating individual differences in prosocial behavior is important because prosociality is considered vital for healthy socioemotional development and is often used as an indicator of overall well-being and psychosocial adjustment (Eisenberg & Fabes, 1998; Eisenberg et al., 2006). The current study investigated longitudinal relations between children's shyness and prosociality, as well as the developmental impact of different prosocial behaviors on one another over time.

Components of Prosociality

Prosocial behaviors are defined as intervening beneficial actions that are preceded by the direct observation or inference of another's negative state (e.g., Dunfield & Kuhlmeier, 2013). Children engage in prosocial behaviors through three steps. First, they will acknowledge the presence of behavioral and/or situational cues that suggest another individual is experiencing a negative state. Second, the child will determine an appropriate course of action to alleviate the other's negative state. Finally, the child must be motivated to follow through with the appropriate behaviors to effectively relieve the other's negative state (Dunfield & Kuhlmeier, 2013). Such behaviors can include *responses to instrumental need* (i.e., helping behavior; usually to complete a goal-directed action) and *responses to emotional distress* (i.e., empathic response to an individual experiencing a negative emotional state); both of which have been examined and well documented during early childhood (e.g., Dunfield, 2014; Dunfield & Kuhlmeier, 2013; Dunfield, Kuhlmeier, O'Connell, & Kelley, 2011; Paulus, 2014; Warneken & Tomasello, 2006; Zahn-Waxler, Robinson, & Emde, 1992).

Responses to emotional distress can be further classified into cognitive and affective empathic components (Decety & Jackson, 2004; de Vignemont & Singer, 2006). Cognitive empathy is defined as the ability to understand the nature or cause of another person's state (Cohen & Strayer, 1996; Decety & Jackson, 2004) and is conceptually relevant to the first step of response to emotional distress (i.e., recognizing the negative state). This empathic component is commonly measured through *hypothesis testing*: the inquisitiveness or effort to comprehend distress encountered in an empathic situation (Zahn-Waxler et al., 1992). In contrast, affective empathy is vicarious affective response to another person's negative state, leading to either personal distress or concerned responses (Decety & Lamm, 2009; Knafo et al., 2009; Shamay-Tsoory, Aharon-Peretz, & Perry, 2009; Tone & Tully, 2014). Although there is evidence to suggest that cognitive and affective expressions of empathy represent the same underlying disposition (Gill & Calkins, 2003; Knafo, Zahn-Waxler, Van Hulle, Robinson, & Rhee, 2008; López-Pérez, Hanoch, Holt, & Gummerum, 2017), these components are thought to be subserved by different information processing systems and involve different functions (Coplan, 2011; Shdo et al., 2017). Accordingly, these components are often analyzed separately and can provide more detailed information when assessing relations among other constructs (Gill & Calkins, 2003; Knafo et al., 2008; Lopez-Perez et al., 2017; Lyons, Brewer, & Bethell, 2017; Volbrecht, Lemery-Chalfant, Aksan, Zahn-Waxler, & Goldsmith, 2007; Zahn-Waxler, Schiro, Robinson, Emde, & Schmitz, 2001). For example, children who are at risk for criminal behavior have been found to exhibit lower affective empathy but similar cognitive empathy when compared to a control group who do not experience the same risk (Zonneveld, Platje, Sonneville, Goozen, & Swaab, 2017). In addition, certain populations, such as bullies and psychopaths, can reason cognitively about the needs and desires of others (i.e., cognitive empathy) but do not exhibit high levels of affective response (Bosacki & Astington, 1999; Mealey, 1995). Thus, it appears that affective empathy may possibly be more affected by external and personality factors when compared to cognitive empathy.

Although helping behavior, affective empathy, and cognitive empathy are conceptually and empirically inter-related to one another (e.g., Eisenberg-Berg & Hand, 1979), considering heterogeneity within the overarching construct of prosociality is important, since not all components emerge at the same time or have the same developmental course (Dunfield & Kuhlmeier, 2013; Dunfield et al., 2011). Helping behaviors (i.e., responses to instrumental need) tend to emerge during early infancy and continue to increase in frequency through the second year of life. In contrast, empathic response (i.e., response to emotional distress) tends to develop from 2 to 5 years of age. Interestingly, cognitive empathy often continues to become more sophisticated even past the point of affective response reaching developmental stability (e.g., Roth-Hanania, Davidov, & Zahn-Waxler, 2011). Regardless of developmental course, shyness has been found to be negatively related to each of these prosocial behaviors (Findlay, Girardi, & Coplan, 2006; Tan, Mikami, Luzhanska, & Hamlin, 2020; Young, Fox, & Zahn-Waxler, 1999; Zarra-Nezhad et al., 2018).

Children's Shyness and Prosociality

Children's shyness is known to result in lower levels of prosocial behavior broadly (Findlay et al., 2006; Tan et al., 2020; Young et al., 1999; Zarra-Nezhad et al., 2018) and more specifically across the three components of interest: affective empathy (MacGowan & Schmidt, 2020a, 2020b; Tan et al., 2020; Zhai et al., 2020), cognitive empathy (MacGowan & Schmidt, 2020a), and helping behavior (Beier, Terrizzi, Woodward, & Larson, 2017; Karasewich et al., 2018; Stanhope, Bell, & Parker-Cohen, 1987). Shyness can be defined as an anxious self-preoccupation in real or imagined social situations (Cheek & Melchior, 1990). Temperamental shyness is generally stable across development; however, some argue that more fearful expressions of shyness emerge during infancy whereas self-conscious shyness is first observed in the preschool years (Buss, 1986a, 1986b; Hassan et al., 2021; Schmidt & Poole, 2019). Generally, children's shy preoccupation is especially marked when they experience demands from a social situation, such as an expectation to perform (Crozier & Hostettler, 2003; MacGowan & Schmidt, 2020b; Wilson & Henderson, 2020). As such, many proffer that shy children are too inhibited to engage in prosocial acts and that their shyness interferes with the motivation required for the third and final step of prosocial action (e.g., Karasewich et al., 2018). That is to say, the social nature of a situation requiring prosocial response appears to impede the child's ability to feel comfortable initiating a helpful action.

Witnessing the negative emotions of other persons, whether it be in other children or adults, is likely stressful and has the potential to dissuade prosocial response for any child. Nonetheless, shy children are more likely to become inhibited in response to the social saliency of these emotions, especially in the case of emotional distress (i.e., requiring empathic response). As such, shy children have been found to direct comforting responses to themselves before they focus their attention to a victim (Eisenberg & Fabes, 1990; Kim & Han, 2018). This personal distress (i.e., self-directed comforting) can interfere with responses to instrumental need as well as both cognitive and affective aspects of empathic response (i.e., less exploration of emotion's cause, less expressed concern for the victim).

Although much work has investigated concurrent and cross-sectional relations between shyness and prosocial behaviors (e.g., Findlay et al., 2006; Karasewich et al., 2018; MacGowan & Schmidt, 2020a; Stanhope et al., 1987; Young et al., 1999), relatively few studies have explored the longitudinal and prospective developmental relations among these constructs. As well, there is little work exploring possible intervening effects of different prosocial behaviors when assessing longer-term relations with shyness.

Relations between shyness and various social outcomes are often mediated by other factors (e.g., Hipson, Coplan, & Séguin, 2019; Ye et al., 2019; Zhao, Gao, Xu, Sun, & Han, 2020). As well, relations between certain personality factors and prosocial behavior can often be explained by relevant intervening mechanisms (e.g., Fang, Dong, & Fang, 2019; Ornaghi, Pepe, & Grazzani, 2016; Shi, Wang, He, Wu, & Zhang, 2020). In particular, some studies have used empathy as a mediator in predicting other prosocial behaviors in adults and young adolescents (Benita, Levkovitz, & Roth, 2017; Graziano, Habashi, Sheese, & Tobin, 2007; Guo, Sun, & Li, 2018). Whereas feelings of empathy may logically precede helping behavior in older child and adult samples (in which empathic and helping behaviors are developmentally established), we argue that helping behaviors may reasonably mediate the relation between shyness and empathic response in a relatively younger sample of children, whose prosocial behaviors are still developing.

We hypothesized that shy children may be limited in their first-emerging responses to instrumental need, which in turn may impede later prosocial development in other areas, such as cognitive and affective empathic response. Because empathic responses tend to be more emotionally demanding and socially salient than the more elementary helping behaviors (Dunfield & Kuhlmeier, 2013), we believe that children will require early “practice” in their prosocial responses by first engaging in the more straightforward acts of instrumental helping. We suggest that early experiences and consequences of shyness-related social reticence and withdrawal from social learning opportunities (i.e., helping opportunities) may have long term transactional consequences as children develop in the prosocial realm.

The Present Study

The objective of the current study was to explore longitudinal relations between child shyness and later prosocial behaviors, and to assess the possible mediating effect of helping on the relation between early shyness and later empathic response. We explored these behaviors during the preschool years, right around the age of formal school entry, to assess children who are presumably being exposed to situations that require prosocial response toward unfamiliar individuals for the first time. As well, both early-emerging fearful shyness and later-emerging self-conscious shyness tend to be evident by this point in development (Buss, 1986a, 1986b; Hassan et al., 2021; Schmidt & Poole, 2019). Therefore, we expected shyness to have the largest effect on the development and refinement of prosocial behaviors in this age group.

We collected data on directly observed shyness and maternal report of shyness in a cohort of typically developing 4-year-old children, who were also followed up at 5 and 6 years old. We assessed children's helping behaviors at 5 years and empathic response at 6 years with tasks used to elicit these responses toward a female experimenter.

We addressed two questions: (a) Do individual differences in children's shyness result in longitudinal changes in prosocial behaviors such as affective empathy, cognitive empathy, and helping behaviors? (b) Does instrumental helping mediate the relation between children's shyness and later empathic responses?

We tested two predictions: First, we predicted that children's shyness at Time 1 would result in lower helping at Time 2 and lower affective and cognitive empathy at Time 3 (see "Participants" section for ages at Times 1, 2, and 3). We also anticipated that shyness would be concurrently related to helping and empathy at Time 2 and Time 3, respectively. We reasoned that, in line with previous findings, shyness would impede children's motivations to respond to instrumental need and emotional distress, and that early shyness would have long-term consequences for the development of prosocial responses.

Second, we predicted that Time 2 helping would mediate the relations between Time 1 shyness and Time 3 cognitive and affective empathy. We expected that early shyness would concurrently impede responses to instrumental need and, in turn, the lack of helping practice would hamper more sophisticated responses to emotional distress later in development.

Method

Participants

A total of 86 typically developing children (45 girls) and their biological mothers visited the laboratory at 4 years of age (Time 1: M_{age} = 54.3 months, *SD* = 2.9). Of the original sample of children, 60 (69.8%) returned approximately 1 year later (Time 2: M_{age} = 66.5 months, *SD* = 2.8; 32 girls), and 45 (52.3%) were followed up at 6 years of age (Time 3: M_{age} = 77.9 months, *SD* = 2.8; 25 girls). All children were recruited from the McMaster Infant Database, which contains the contact information of healthy, full-term infants who were born at the McMaster University Medical Centre, St. Joseph's Healthcare, or Joseph Brant Hospital in the area of Hamilton, Ontario, Canada. Most of the attrition between Time 2 and Time 3 was due to the COVID-19 pandemic. As such, children who attended both the Time 1 and Time 2 visits were included in analyses below and Time 3 data were handled with multiple imputation within the mediation analyses (described below).

Of the analyzed sample, 80% of the children were White, 10% were non-White, 6.7% were reported as mixed race, and 3.3% did not report their race. All children were fluent in English; however, 4 spoke English as their second language. Among parents, 85% of mothers and 86.7% of fathers had some form of postsecondary education (e.g., college diploma, university degree). Mothers reported on their combined family income (in Canadian dollars) on a scale from 1 to 7 (1 = *<$15,000*, 4 = *$45,000–$60,000*, 7 = *>$100,000*) at all three visits. At Time 1, 52% of children had combined family incomes of $100,000 or more per year, whereas 7% of families made less than $60,000 per year.

Procedure

Informed and written consent were obtained prior to beginning procedures for each child at each visit. For each visit, the child completed a series of tasks with one female experimenter while his or her mother sat in a different room and observed her child on a closed-circuit TV (CCTV) monitor. Data on shyness were collected at all three visits, helping behaviors were assessed at Time 2, and empathy was coded at Time 3. At Times 2 and 3, the birthday speech self-presentation task used to assess observed shyness was carried out following all prosocial tasks to reduce the possible confounding influence of arousal carried over to other tasks. Children were not expected to remember their previous visits, and based on casual observation and conversations with the participants, there was no evidence that either mother or child remembered the important details of the three tasks of interest. All procedures were approved by the research ethics board of McMaster University. Children and families were compensated with a $20 gift card for their participation at each visit.

Shyness Measures

Observed Shyness: Birthday Speech Self-Presentation Task

The Birthday Speech involved the child being spontaneously instructed to talk about his or her most recent birthday in front of a video camera. Self-presentation tasks such as this are widely used to elicit shy/anxious behaviors in children (Colonnesi, Nikolic, de Vente, & Bogels, 2017; MacGowan & Schmidt, 2020b; Poole & Schmidt, 2019; Theall-Honey & Schmidt, 2006). Although there has been some debate on the definition and measurement of shyness, this particular task is known to elicit a state of self-anxious preoccupation in an imagined social situation with another person present, which is synonymous with how shyness is defined and operationalized.

During each visit, the experimenter placed a video camera in front of the child and asked him or her to give a short speech about the child's most recent birthday. The child was informed that the video would be shown to other children who would see and hear the child giving the speech. The child was prompted for a minimum of 60 s; however, the child was allowed to speak for as long as he or she wanted. Only the first 2 min of the speech was coded.

Behavioral Coding and Observed Shyness Measure. Episodes were scored by two coders for time spent speaking within each 10-s epoch of the speech. Times were then averaged across all coded epochs, resulting in an average time spent speaking per epoch, ranging from 0 to 10 s. Each coder also recorded the child's latency to speak following the end of the experimenter's instructions. A subset of 20% of participants for each visit were scored by both coders. Latency to speak had high intraclass correlations for each visit (r_{T1} = .96, 95% confidence interval (CI) [.94, .97]; r_{T2} = .99, 95% CI [.98, .99]; r_{T3} = .99, 95% CI [.96, .99], where T1/2/3 subscripts indicate Time 1/2/3), and strong inter-rater reliability was established for average time spent speaking (r_{T1} = .95, 95% CI [.93, .97]; r_{T2} = .92, 95% CI [.88, .95]; r_{T3} = .95, 95% CI [.92, .97]).

Parent-Reported Shyness

Mothers reported on their child's trait shyness using the Shyness subscale of the Colorado Childhood Temperament Inventory (CCTI; Buss & Plomin, 1984; Rowe & Plomin, 1977). Mothers reported the degree to which they agreed or disagreed with five items on a scale from 1 to 5 (1 = *strongly disagree*, 5 = *strongly agree*). Examples of such statements included "Child tends to be shy" and "Child takes a long time to warm up to strangers." The internal consistency for this scale was acceptable for each visit (Time 1: $\alpha = .88$; Time 2: $\alpha = .86$; Time 3: $\alpha = .61$).

Overall Shyness Composite Measure

There was a strong inverse correlation between the two observed measures of shyness (i.e., average time spent speaking and latency to speak) at each visit (Time 1: $r = -.56$, $p < .01$; Time 2: $r = -.56$, $p < .01$; Time 3: $r = -.31$, $p = .02$). In addition, maternal report of shyness was positively related to latency to speak (Time 1: $r = .25$, $p = .05$; Time 2: $r = .33$, $p = .01$; Time 3: $r = .26$, $p = .04$) and inversely related to time speaking at each visit (Time 1: $r = -.53$, $p < .01$; Time 2: $r = -.52$, $p < .01$; Time 3: $r = .46$, $p < .01$). Accordingly, these three variables were *z*-scored and combined following a reversal of the average time spent speaking measure. Thus, we created a conceptually and empirically derived composite measure of *overall shyness* for each individual visit. Although other shy-related behaviors, such as fidgeting, body avoidance, and gaze, were coded, they were not correlated with latency to speak, average time spent speaking, or parent-reported shyness; thus, these behaviors were not included in our analyses.

Helping Tasks

Two helping tasks were implemented at Time 2 and were administered between other tasks. First, while the experimenter attempted to fasten a poster to the wall, she dropped a roll of masking tape. She immediately said "Oops" and continued to hold the half-fastened poster up on the wall to prevent it from falling. She prompted the child approximately every 6 s with increasing directedness until the child retrieved the tape. A maximum of six prompts were delivered in the same order for each child (e.g., "I can't reach my tape"), which were used to code the child's latency to help on a 6-point scale (5 = *helped after one prompt,* 0 = *helped after six prompts or did not help at all*).

Next, the experimenter attempted to open a small box of paperclips and spilled them on the floor. Children were coded for latency to help the experimenter gather the paperclips on a 6-point scale (5 = *helped after 0–1 s,* 3 = *helped after 4–7 s,* 0 = *did not help*). No prompts were given for this task.

These episodes were coded by two experimenters, who established inter-rater reliability on a subset of 11 videos (18% of sample) for the poster task (κ = 1.00) and the paperclips task (κ = .75).

Empathy Task

This episode was modeled after existing tasks and procedures that have been previously used with toddlers and young children (Knafo et al., 2009; Young et al., 1999; Zahn-Waxler et al., 1992). At Time 3, while putting papers away on a clipboard, the experimenter feigned injury to her finger by pretending to pinch it on the clip. She expressed pain outwardly for 35 s while refraining from making eye contact with the child. Both the experimenter and the child were seated.

Behavioral Coding and Observed Empathy Measures

Primary and secondary coders overlapped on a subset of 13 of the participant videos (29% of children who completed this task at Time 3) to obtain inter-rater reliability. Our coding scheme assessed verbal behaviors (e.g., utterances) and nonverbal behaviors (e.g., body orientation, leaning, touching) with equal salience to ensure that these behaviors were not confounded by the child's level of shyness. Each episode was coded for affective and cognitive empathy within the 35-s period that the experimenter expressed pain. Affective empathy was composed of three different codes as described below: empathic concern (κ = .70), gaze to the victim (κ = 1), and verbal engagement with the victim (κ = .76). Altogether, these codes effectively encompassed vicarious affective responses to a victim's injury in the forms of facial expression, verbal concern, active engagement, and direct immersion in the victim's experience. These codes were *z*-scored and added together to form the overarching affective empathy measure. Cognitive empathy was assessed with a single code called hypothesis testing (κ = 1). More detailed information about the individual codes is provided below. It is important to note that although gaze and verbal measures were included in both the affective and cognitive coding schemes, parameters for these behaviors were different. Verbal utterances involved in affective response reflected either concern or relation to the victim's experience (see below), whereas cognitive responses inquired about the cause and severity of the injury. Similarly, gaze coded within affective responses reflected engagement with the victim (gaze toward the victim or relevant objects), whereas cognitive gaze responses involved inquiring about the cause of the injury (presence of gaze toward the injury and/or clipboard).

Empathic Concern. This code was used to account for level of affective expression of concern for the victim (e.g., facial, gestural, and vocal signals of sympathy and/or sadness). This has been previously used as an observed measure of *affective* *empathy* (Zahn-Waxler et al., 1992) and was coded on a 4-point scale (0 = *none,* 1 = *facial expression lacked smile for entire episode,* 2 = *combination of two behaviors that could include facial expression, one verbal concern, or body orientation toward the victim,* 3 = *repeated verbal concerns or facial expression combined with complete body orientation and leaning, pointing, or touching*). Children who engaged in rare and salient concern behaviors, such as touching and brow furrowing, were given a score of 3.

Gaze. This code examined the extent to which the child was engaged with the victim and the situation and was coded on a 4-point scale (0 = *averted gaze from victim and context-relevant stimuli for more than half the episode,* 1 = *darting or unsustained gaze,* 2 = *periods of sustaining gaze but not fully sustained for entire episode,* 3 = *sustained gaze of victim's face, injury, or clipboard for nearly entire period*).

Verbal Engagement. This code was used to measure the extent to which the child engaged with the victim's state by relating to the child's own or others' experiences (e.g., "I hurt my finger once," "My mom needed a bandage when that happened to her") and was coded on a 4-point scale (0 = *no verbal engagement,* 1 = *one utterance,* 2 = *two utterances or at least 10 s of sustained engagement,* 3 = *three or more utterances or sustained engagement for at least 15 s*).

Hypothesis Testing. This code was used to assess the child's attempts to understand the victim's distress. Hypothesis testing is considered to be a measure of *cognitive empathy* (Zahn-Waxler et al., 1992), which can be expressed through gaze-related inquiry, verbal inquiries, and physical exploration. This was coded on a 4-point scale (0 = *none,* 1 = *looking from face/injury to clipboard, touching the clipboard,* 2 =

combining verbal inquiry with nonverbal exploration, 3 = *repeated verbal or nonverbal exploration, pushing down on clip of clipboard*).

Missing Data and Attrition

Of the 86 children who attended the Time 1 visit, 5 were eliminated from the study for suspected developmental delay and/or insufficient fluency in English. At Time 2, 21 additional children chose not to return or failed to show up to a scheduled visit (n = 16), could not be reached (n = 3), or had moved out of the area (n = 2). These 21 children did not differ from the analyzed sample on Time 1 income, $t(79) = 0.88$, $p = .38$, age, $t(79) = 0.23$, $p = .82$, or shyness, $t(79) = 1.02$, $p = .31$. At Time 3, 15 more participants were unable to attend the laboratory visit due to the COVID-19 pandemic. As such, missing data from Time 3 were handled with multiple imputation for the mediation analyses, resulting in a sample of 60 children, all of whom attended both the Time 1 and Time 2 visits.

Statistical Analyses

All analyses were performed using SPSS Version 22 with the significance level set at $\alpha = .05$. Pearson correlations were used to assess simple relations among shyness, helping behavior, and empathy responses. Multiple linear regression was used to assess longitudinal relations between shyness and prosocial behaviors while controlling for concurrent shyness. Mediation analyses were carried out with the PROCESS SPSS macro, treating shyness as the predictor, helping as the mediator, and empathy as the outcome variable.

Results

Preliminary Analyses

We first assessed zero-order correlations among the study variables (see Table 3.1). Time 1 shyness was associated with Time 2 ($r = .62$, $p < .01$) and Time 3 ($r = .38$, $p = .02$) measures of shyness. Time 2 and Time 3 shyness were also positively related ($r = .54$, $p < .01$). Helping and affective empathy were positively related to one another ($r = .43$, $p < .01$) and cognitive empathy was positively related to helping behavior and affective empathy ($r = .36$, $p = .02$ and $r = .30$, $p = .05$, respectively).

Within the sample, no measures of interest differed between boys and girls (T1 shyness: $t = 0.42$, $p = .68$, $d = 0.11$; T2 shyness: $t = 0.98$, $p = .33$, $d = 0.26$; T3 shyness: $t = 0.93$, $p = .36$, $d = 0.30$; helping: $t = 0.57$, $p = .57$, $d = 0.15$; affective empathy: $t = 0.85$, $p = .47$, $d = 0.27$; cognitive empathy: $t = 0.92$, $p = .37$, $d = 0.29$), and Time 1 combined annual family income was not correlated with T1 shyness ($r = .09$, $p = .50$), T2 shyness ($r = −.08$, $p = .55$), T3 shyness ($r = −.05$, $p = .75$), helping behavior ($r = .10$, $p = .46$), affective empathy ($r = −.26$, $p = .10$), or cognitive empathy ($r = −.17$, $p = .29$).

Study Question 1: ***Do individual differences in children's shyness result in longitudinal changes in prosocial behaviors (i.e., affective empathy, cognitive empathy, and helping behavior)?***

Time 1 shyness was negatively correlated with Time 2 helping behavior ($r = −.47$, $p < .01$) and Time 3 affective empathy ($r = −.37$, $p = .02$) but not Time 3 cognitive empathy ($r = −.10$, $p = .52$). As well, Time 2 shyness was related to Time 2 helping behavior ($r = −.54$, $p < .01$) and Time 3 affective empathy ($r = −.32$, $p = .04$) and cognitive empathy ($r = -.37$, $p = .02$). Finally, Time 3 shyness was related to Time 3 cognitive empathy ($r = -.36$, $p = .02$) but not affective empathy ($r = -.22$, $p = .17$).

Due to the stability of shyness across the three visits, we aimed to determine whether these relations were due to longitudinal, rather than concurrent, influences of shyness by conducting multiple linear regressions that controlled for concurrent shyness. We found that there was no statistically significant longitudinal relation between Time 1 shyness and Time 2 helping behavior ($b = -.32$, $t = -1.64$, $p = .11$, 95% CI [−.71, .07]) in that Time 2 shyness eliminated the effect of Time 1 shyness ($b = -.57$, $t = -2.80$, $p = .007$, 95% CI [−.97, −.16]) (see Table 3.2A).

However, Time 1 shyness predicted Time 3 affective empathy ($b = -.31$, $t = -2.90$, $p = .006$, 95% CI [−.53, −.10]), eliminating the effect of Time 3 shyness ($b = -.04$, $t = -0.30$, $p = .77$, 95% CI [−.29, .22]) (see Table 3.2B). Similarly, Time 2 shyness predicted Time 3 affective empathy ($b = -.27$, $t = -2.22$, $p = .033$, 95% CI [−.51, −.02]), with Time 3 shyness remaining unrelated ($b = .00$, $t = -0.01$, $p = .99$, 95% CI [−.30, .29]) (see Table 3.2C).

Time 1 shyness did not have a longitudinal effect on cognitive empathy ($b = .01$, $t = 0.17$, $p = .87$, 95% CI [−.09, .11]) in that Time 3 shyness eliminated the effect of this predictor ($b = -.12$, $t = -2.23$, $p = .03$, 95% CI [−.24, −.01]) (see Table 3.2D). Finally, Time 2 shyness did not predict cognitive empathy ($b = -.07$, $t = -1.46$, $p = .15$, 95% CI [−.17, .03]), and Time 3 was not predictive in this model ($b = -.07$, $t = -1.19$, $p = .24$, 95% CI [−.19, .05]) (see Table 3.2E).

Study Question 2: ***Does instrumental helping behavior mediate the relation between children's shyness and later empathic responses?***

Due to the above findings indicating that helping behavior appears to be impeded by concurrent shyness at Time 2 rather than Time 1 shyness, we conducted four mediation analyses involving the mediating influence of Time 2 helping behavior on (a) the relation between Time 1 shyness and Time 3 affective empathy, (b) the relation between Time 2 shyness and Time 3 affective empathy, (c) the relation between Time 1 shyness and Time 3 cognitive empathy, and (d) the relation between Time 2 shyness and Time 3 cognitive empathy.

Mediation Analysis: Time 1 Shyness, Time 2 Helping, and Time 3 Affective Empathy

The relation between Time 1 shyness and Time 3 affective empathy was mediated by Time 2 helping behavior. As shown in Figure 3.1, there was an inverse relation between Time 1 shyness and Time 2 helping behavior ($b = -.65$, $SE = .16$, $p < .01$) while the relation between Time 2 helping behavior and Time 3 affective empathy was found to be positive ($b = .17$, $SE = .06$, $p < .01$). This relation between Time 2 helping and Time 3 affective empathy was also significant while controlling for Time 1 shyness ($b = .14$, $SE = .07$, $p = .04$). Finally, the total effect model of Time 1 shyness predicting Time 3 affective empathy was negative ($b = -.17$, $SE = .08$, $p = .04$).

The indirect effect was computed by using 10,000 bootstrapped samples to create a 95% confidence interval. This analysis resulted in a standardized indirect effect of −.14 with confidence intervals ranging from −.23 to −.05. The direct effect of Time 1 shyness on Time 3 affective empathy was -.08 with confidence intervals ranging from -.26 to .11.

Mediation Analysis: Time 2 Shyness, Time 2 Helping, and Time 3 Affective Empathy

We detected an inverse relation between Time 2 shyness and Time 2 helping behavior ($b = -.74$, $SE = .16$, $p < .01$). As shown in Figure 3.2, the relation between Time 2 helping behavior and Time 3 affective empathy was positive ($b = .17$, $SE = .06$, $p < .01$). This relation approached significance while controlling for Time 2 shyness ($b = .13$, $SE = .07$, $p = .06$). Finally, the total effect model of Time 2 shyness predicting Time 3 affective empathy was negative ($b = -.19$, $SE = .09$, $p = .03$).

Similar to above, the indirect effect was computed with 10,000 bootstrapped samples to create a 95% confidence interval. This analysis resulted in a standardized indirect effect of −.14 with confidence intervals ranging from −.29 to −.02. The direct effect of Time 2 shyness on Time 3 affective empathy was -0.09 with confidence intervals ranging from -.28 to .11.

Mediation Analysis: Time 1 Shyness and Time 2 Shyness, Time 2 Helping, and Time 3 Cognitive Empathy

We did not detect a mediating influence of Time 2 helping behavior on the relation between Time 1 shyness and Time 3 cognitive empathy nor the relation between Time 2 shyness and Time 3 cognitive empathy. Helping behavior did not predict Time 3 cognitive empathy while controlling for Time 1 ($b = .01$, $SE = .03$, $p = .72$) or Time 2 shyness ($b = .05$, $SE = .03$, $p = .16$).

Table 3.1

Descriptive statistics and correlations among study variables

	1	2	3	4	5	6	7	Mean (SD)	Range
1. T1 Shyness	--	.62**	.38*	-.47**	-0.37*	-.10	.09	0.3(2.4)	-4.9-7.6
2. T2 Shyness		--	.54*	-.54**	-.32*	-.37*	.04	0.0(2.4)	-3.8-7.3
3. T3 Shyness			--	-.34*	-.22	-.36*	-.05	-0.2(2.1)	-4.5-6.2
4. T2 Helping Behavior				--	.43**	.36*	.10	5.4(3.3)	0-10
5. T3 Affective Empathy					--	.30*	-.26	0.2(1.6)	-4.2-5.1
6. T3 Cognitive Empathy						--	-.17	2.2(0.7)	0-3
7. Annual Family Income							--	6.1(1.3)	2-7

Note. *$p<0.05$, **$p<0.01$

Table 3.2

Longitudinal relations among shyness and prosocial behaviors controlling for concurrent shyness: A) T1 shyness predicting T2 helping behavior; B) T1 shyness predicting T3 affective empathy; C) T2 shyness predicting T3 affective empathy; D) T1 shyness predicting T3 cognitive empathy; E) T2 shyness predicting T3 cognitive empathy

	b	*SE*	*t*	*p*	95% CI Lower bound	95% CI Upper bound
A) T2 Helping Behavior (Constant)	5.48	.38	14.39	.00	4.72	6.24
T1 Shyness	-.32	.20	-1.64	.11	-.71	.07
T2 Shyness	-.57	.20	-2.80	.007**	-.97	-.16
B) T3 Affective Empathy (Constant)	.33	.25	1.33	.19	-.17	.84
T1 Shyness	-.31	.11	-2.90	.006**	-.53	-.10
T3 Shyness	-.04	.13	-.30	.77	-.29	.22
C) T3 Affective Empathy (Constant)	.24	.26	.90	.38	-.30	.77
T2 Shyness	-.27	.12	-2.22	.03*	-.51	-.02
T3 Shyness	.00	.15	-.01	.99	-.30	.29
D) T3 Cognitive Empathy (Constant)	2.18	.11	19.49	.00	1.95	2.40
T1 Shyness	.01	.05	.17	.87	-.09	.11
T3 Shyness	-.12	.06	-2.23	.03*	-.24	-.01
E) T3 Cognitive Empathy (Constant)	2.17	.11	20.05	.00	1.95	2.39
T2 Shyness	-.07	.05	-1.46	.15	-.17	.03
T3 Shyness	-.07	.06	-1.19	.24	-.19	.05

Note. *p<0.05, **p<0.01

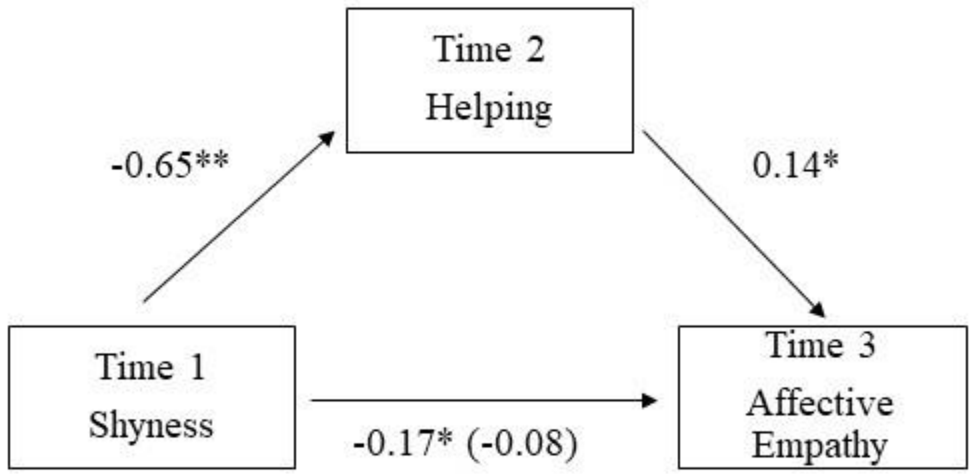

Figure 3.1. *Standardized regression coefficients for the mediating effect of Time 2 helping behavior on the relation between Time 1 shyness and Time 3 affective empathy. The direct effect of Time 1 shyness on Time 3 affective empathy is in parentheses.*

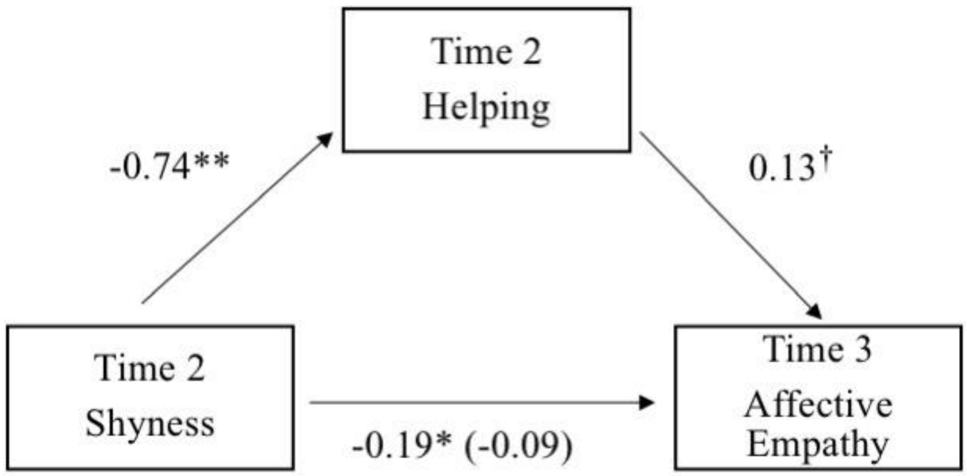

Figure 3.2. *Standardized regression coefficients for the mediating effect of Time 2 helping behavior on the relation between Time 2 shyness and Time 3 affective empathy. The direct effect of Time 2 shyness and Time 3 affective empathy is in parentheses.*

Discussion

This study replicated past findings involving concurrent relations between shyness and prosocial behaviors, and provided evidence for negative long-term effects of shyness on affective empathy. Although we detected longitudinal relations between shyness and instrumental helping behavior as well as between shyness and cognitive empathy, these effects were eliminated by controlling for concurrent shyness. We further report a mediating effect of instrumental helping at 5 years on the relation between shyness and affective empathy at 6 years. This suggests that shyness may concurrently curtail helping behavior, possibly reducing the prosocial practice required for shy children to engage in the more complex and emotionally distressing empathic responses later in development.

Our findings are in line with past literature that has reported concurrent relations between shyness and instrumental helping behavior (Beier et al., 2017; Karasewich et al., 2018; Stanhope et al., 1987) as well as cognitive empathy (MacGowan & Schmidt, 2020a). Much of the literature surrounding this concurrent relation postulates that shy children, who are wary of social stimuli, are more emotionally affected by the social saliency, as well as the negative emotions, associated with situations requiring prosocial response (Hoffman, 1975) and thus tend to direct their attention to their own personal distress rather than toward a victim (Eisenberg & Fabes, 1990; Kim & Han, 2018). This personal distress can result in children exhibiting seeming indifference to the situation (Hoffman, 1975; Kim & Han, 2018). Shyness is also theoretically and empirically relevant to other factors that are important for the development of prosocial behavior such as emotion regulation, motivation to help, and the desire to affiliate with others (Beier et al., 2017; Brownell & Early Social Development Research Lab, 2016; Carpendale, Kettner, & Audet, 2015; Dahl, 2015; Eisenberg, 2000; Hoffman 1975; Karasewich et al., 2018; Spinrad et al., 2007; Waugh & Brownell, 2017).

Our analyses provide evidence, however, that the negative relation between shyness and affective empathy may result from longitudinal and developmental changes rather than the concurrent interference of shyness. Namely, it was Time 1 and Time 2 shyness that were found to be negatively related with Time 3 affective empathy; not concurrent shyness. It is possible that shyness may impede predictors or earlier-emerging and rudimentary affective behaviors that are important for the development of sophisticated affective response during the preschool years. Because some -mechanisms that are crucial for the development of empathic response, such as self–other differentiation and basic false belief understanding, are established by the preschool age (Brownell, Nichols, & Svetlova, 2013; Brownell, Svetlova, Anderson, Nichols, & Drummond, 2013; Kartner, Schuhmacher, & Collard, 2014), we suspected that one such behavior that may contribute to developing higher affective empathy in these years is experience engaging in instrumental helping behavior.

We found that helping behavior fully mediated the relation between Time 1 shyness and Time 3 affective empathy and, to some extent, the relation between Time 2 shyness and Time 3 affective empathy. This finding suggests that helping behavior during the preschool years may act as a precursor to affective empathic response as children transition into the early school-age years. As such, helping behavior may be impeded by concurrent shyness in that self-conscious inhibition and/or social fearfulness is the source of children's lack of instrumental helping. If shyness continuously and repeatedly disrupts instrumental helping behavior toward unfamiliar individuals, young children who are relatively high in shyness may be at a disadvantage when developing responses to more demanding, physiologically distressing, and emotionally complex situations such as those involving empathy. As such, early instrumental helping opportunities may aid children in practicing approaching others when they are expressing a negative state, and these relatively simple and low-stress situations may in turn allow for better capacity to maturely respond to more complex and potentially distressing negative states later.

Although shyness was concurrently and negatively related to cognitive empathy, reasoning for the lack of longitudinal relation between these constructs, as well as the mediating effect of instrumental helping on this relation, is unknown. This disparity from the relations found with affective empathy is especially interesting given the relatively few studies that have found developmental differences among the cognitive and affective components of empathic response. It is possible that because cognitive empathy appears to be less affected by environmental or personality factors (Bosacki & Astington, 1999; Mealey, 1995; Zonneveld et al., 2017), it is more likely to be interrupted by concurrent shyness than transactional developmental "practice" that occurs over an extended period of time. Rather, cognitive empathy may be affected by shy children's situation-specific personal distress rather than the lack of practice dealing with situations requiring prosocial action.

In interpreting the current findings, it is important to take two constraints on the relation between shyness and prosocial behavior into consideration. First, although the pattern of reduced prosociality in shyness appears to suggest that shy children are experiencing a social cognitive deficit, previous studies have argued that this relation is likely accounted for by a performance issue rather than a competence issue (Eisenberg & Fabes, 1998; Findlay et al., 2006; Zava et al., 2020). In fact, there is evidence to suggest that higher shyness is related to stronger abilities in sociocognitive areas such as emotion understanding and Theory of Mind (LaBounty, Bosse, Savicki, King, & Eisenstat, 2017; Lane, Wellman, Olson, & Miller, 2013; Longobardi, Spataro, D'Alessandro, & Cerutti, 2017; Wellman, Lane, LaBounty, & Olson, 2011). Taking this evidence into account, the supposed deficits in prosociality that we observed in our study may indicate a performance issue rather than a competence issue: shy children's increased personal distress may affect their ability to explore and attend to the needs of another.

Second, shy children likely possess different prosocial motivations and constraints in different contexts, in different environments, and among different people (e.g., Chow et al., 2017; Kagan, Reznick, & Snidman, 1987). Stanhope et al. (1987) noted the importance of familiarity of both the setting and the victim by reporting that shy children tend to help their mothers in familiar environments (i.e., home) more often than they will help an experimenter in a laboratory environment. Knafo et al. (2008) also found that children older than 36 months tend to show less cognitive and affective empathy toward an experimenter when compared to their mother. Although empathy-related behaviors within the home and among family are valuable, our present findings also provide important information on how children will react in other contexts.

Strengths and Limitations

The current study has many strengths, including behavioral observations of shyness and prosocial behaviors and a focus on the longitudinal nature of intervening variables. In addition, we were able to examine these relations during a critical time in socioemotional development, coinciding with transition to formal schooling, the development of peer relationships, and the ability to take on the perspectives of others.

However, this study also experienced some limitations that warrant discussion. First, our sample size was relatively small for mediation analysis. In line with this issue, the attrition within our study was largely affected by the COVID-19 pandemic, causing laboratory data collection of 15 participants to be impossible at Time 3. We attempted to remedy this problem by using multiple imputation to approach the missing data at Time 3 for use in the mediation analyses. A second limitation of this study was that our sample was relatively homogeneous in nature. This group of children was primarily White with a relatively high family income. Thus, the extent to which our findings would generalize to more ethnically and economically diverse groups is unknown. Third, we collected prosocial data from the child only in response to a female experimenter and not a peer or familiar adult such as the child's mother. As such, we do not know whether level of familiarity may be more salient for some children than others in their expressions of empathy and helping behaviors. As well, it is unclear whether our findings would extend to children's prosocial behaviors toward peers, classmates, and siblings. Fourth, our tasks were not long enough to obtain a reliable measure of physiological arousal that could have been used to confirm that the tasks were arousing. Lastly, the nature of one-time sampling of the observed shyness and prosocial measures provides little opportunity to report on the convergence of these behaviors. We attempted to amend this with the shyness construct by including a parent-report measure that was combined with observed behaviors to create an overall measure of shyness. We coded helping behavior during two separate tasks that were presented at two different time points throughout the course of the visit; however, we were unable to obtain a parent report of children's helping behavior toward other unfamiliar individuals.

Future studies should use a larger, more ethnically and economically diverse sample and attempt to observe children's prosocial behavior among peers, mothers, fathers, and siblings in their everyday environments.

Conclusion

This study replicated previously reported relations between shyness and prosocial behaviors during the preschool years, and extended this work by providing evidence for longitudinal relations among shyness and affective empathic response. As well, we provided evidence that early helping behaviors may provide some children with practice opportunities that aid in the in development of sophisticated affective empathy. Our findings suggest that shyness can have long-term transactional consequences for certain areas of development and that the impact of shyness on earlier developing social cognitive and socioemotional milestones has the potential to affect later outcomes, especially in areas that are pertinent to social interaction with unfamiliar peers and adults.

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CHAPTER 5

General Discussion

Summary of Findings

This dissertation examined cross-sectional and longitudinal relations among state and temperamental shyness in predicting several developing social cognitive outcomes in the preschool years. The program of work acknowledged and explored heterogeneity in shy expressions and prosocial behaviors, and considered the moderating context of physiological measures of arousal and self-regulation. Studies 1 and 2 support Mary Rothbart's temperamental model of reactivity and regulation (Posner & Rothbart, 2009; Rothbart, 2004; Rothbart & Bates, 1998) such that baseline respiratory sinus arrhythmia (RSA), a proxy for physiological self-regulation, may serve as a protective (and promoting) factor in the context of shy-related reactivity and the development of social cognitive abilities in the preschool years. Study 3 considered the intervening effect of more basic and early emerging prosocial behaviors on the longitudinal relation between shyness and later developing, more sophisticated prosocial reactions to an adult victim in need.

Past literature surrounding shyness and social cognitive outcomes has suggested that shyness may advance the development of Theory of Mind (ToM; Labounty et al., 2017; Lane et al., 2013; Wellman et al., 2011), but impede the motivation required to engage in prosocial behaviors (Beier et al., 2017; Eisenberg et al., 1996; Eisenberg et al., 2019; Karasewich et al., 2018). Within this dissertation, I showed that temperamental shyness appears to be a cross-sectional constraint on instrumental helping behavior, cognitive empathy, and affective empathic response, and longitudinally hinders expressions of affective empathy. However, based on my findings, temperamental shyness may not truly accelerate and/or advance the development of ToM in the preschool years. Rather, affect-specific expressions of state shyness may explain the historically discordant results regarding the relation between shyness and ToM development in early childhood. Positive expressions of shyness (PES), which may play an adaptive and regulatory role in novel and/or stressful social interactions, appear to benefit the development of ToM in the context of high self-regulatory capacity, while non-positive expressions of shyness (NPES) may hinder the development of this skill. Despite replicating relations between temperamental shyness and prosocial behaviors as well as the relation between expressions of state shyness and ToM development, this dissertation did not examine the relation between expressions of state shyness and early prosocial behaviors (see more in the Future Directions section below).

Studies 1 and 2 explored the moderating role of baseline RSA, a proxy for physiological self-regulation, in the relation between shyness and social cognitive outcomes in early childhood. I explored these relations in the context of Mary Rothbart's temperamental model of reactivity and regulation to determine if physiological self-regulatory capacity protects children who are relatively high in shyness (and therefore experience relatively high levels of shyness-related reactivity) from experiencing a curtailment in empathic response (Study 2). In addition, I wanted to determine if this component of Rothbart's theory extends past temperament. Therefore, in Study 1, I explored whether RSA served as a protective and/or promoting factor in the context of shyness-related reactivity as expressed through state, rather than trait, shyness. In line with Rothbart's model, I expected that RSA would advance the perceived benefits of PES on early ToM and/or protect children from a ToM reduction in the context of NPES.

Although data from Study 1 did not support the notion that high RSA is protective in the context of negative reactivity stemming from NPES, high physiological self-regulatory capacity in combination with high PES appears to facilitate the development of ToM in the preschool years. By collecting baseline RSA data, we assessed the extent to which the children were prepared for potential changes within their environment and their capacity to physiologically regulate themselves through cognitive, emotional, and social challenges. Study 1 suggests that this physiological capacity can increase ToM in children who engage in relatively high levels of PES, which are assumed to be associated with expression-specific regulatory functions. Thus, children who possess a larger capacity for online regulation of environmental challenges (i.e., relatively high RSA), as well as the regulatory approaches that are specific to performance and self-conscious arousal (i.e., relatively high PES), are presumed to attend to and effectively process social stimuli, even through relatively stressful situations. In turn, these children appear to develop ToM earlier than their peers, perhaps due to their regulated state through situations of a social nature, allowing them to engage with others more often and with better capacity to attend to social cues.

In contrast, relatively high self-regulatory capacity does not appear to be sufficient in protecting children who engage in high NPES from having lower ToM when compared to their peers. That is, high NPES may be associated with more arousal in the context of a social stressor when compared to PES and temperamental shyness more generally. I presume that children with high NPES would experience more difficulty effectively regulating their arousal through these situations and that their non-positive affect would discourage themselves and others from engaging in future interactions, thus limiting opportunities to learn from social exchange.

In Study 2, Rothbart's temperamental theory was supported, such that temperamental shyness was associated with lower levels of cognitive empathy in a simple linear regression, but relatively higher shyness resulted in moderate, not lower, levels of cognitive empathy in the context of relatively high physiological self-regulatory capacity. Only children who were relatively high in shyness and relatively low in physiological self-regulatory capacity displayed lower levels of cognitive empathy. These children presumably possess a relatively low capacity to physiologically regulate themselves through the challenge of a spontaneous and mildly stressful empathic event and encountered difficulty achieving the motivation required to engage in cognitive empathic response. Although resting RSA was found to be protective in the relation between shyness and cognitive empathy, the same was not true in predicting affective empathy. This discordant finding raises the importance of examining cross-study differences and heterogeneity in empathic responses within the present dissertation.

In Studies 2 and 3, both cognitive and affective components of empathy were measured to attend to heterogeneity within empathic responses and to detect any possible differences in their relations to temperamental shyness. Although both cognitive and affective empathy were concurrently, inversely related to temperamental shyness in Study

2 (i.e., 4- and 6-year-olds), only cognitive empathy was inversely related to shyness in a cross-section of 6-year-olds in Study 3. This divergence may simply be due to the difference in sample size between the two studies (i.e., 130 vs. 45, respectively). However, Study 2 detected a moderating effect of age group that trended toward significance, suggesting that 4-year-old children's cognitive empathy may be less affected by temperamental shyness than 6-year-olds'. This finding is consistent with literature showing that cognitive empathy may continue to develop past the point that affective empathy appears to be stable (Roth-Hanania et al., 2011). Individual differences may affect cognitive empathy later when compared to affective empathy; in this case, shyness appears to be a constraint on cognitive empathy into the school age years once ToM is presumably more well-developed.

Taken together, these results suggest that while cognitive empathy appears to be robustly constrained by temperamental shyness into the age of formal school entry (i.e., 6 years old), the effect of shyness on affective empathy may be slightly more complex. Some of this complexity may stem from the detected curvilinear relation between baseline RSA and affective empathy, but not cognitive empathy, as presented in Study 2. In this relation, children who experienced high or low RSA extremes displayed the highest levels of affective empathy, whereas children with moderate RSA displayed the lowest affective empathic responses.

Findings from this dissertation have heavily implied that the links between shyness and prosocial outcomes are not simply linear in nature; further context is of critical importance. Therefore, it is not surprising that, given the complex relation between baseline RSA and affective empathy, there are slightly varied findings for the simple linear relation between temperamental shyness and affective empathic response in Studies 2 and 3.

Although we did not detect an interaction between temperamental shyness and this curvilinear relation (i.e., a three-way RSA x RSA x shyness interaction), we may expect to see one if our sample size had been larger and perhaps if our participant pool had been more homogenous in age. Specifically, we may have expected that, in the context of high shyness, children with low RSA would have displayed lower affective empathy than children with moderate or high RSA.

Another difference that we detected between affective and cognitive empathic responding within this dissertation was in Study 3, with only affective empathy being longitudinally related to earlier temperamental shyness. Although the reason for this phenomenon is unknown, it is acknowledged within the literature that cognitive empathy appears to be less affected by environmental or personality factors (Bosacki & Astington, 1999; Mealey, 1995; Zonneveld et al., 2017). Therefore, it would be less likely that long term individual deviations in development or personal experience would interrupt behaviors such as hypothesis testing. Rather, it appears that cognitive empathy is more likely to be interrupted by concurrent arousal whereas affective empathy (or perhaps the regulation specific to affective empathy) is a more practiced process.

Limitations, Considerations, and Future Directions

The studies within this dissertation experienced some limitations that highlight important areas for future research. First, the analyzed sample in all three studies were relatively homogenous in terms of socioeconomic status and race, such that most children came from families who earned a relatively high income and who were primarily White. The extent to which these findings extend to a more racially, ethnically, and economically diverse sample is unknown. Second, although Study 3 assessed longitudinal relations across three years, from early preschool to the age of formal school entry, Studies 1 and 2 were limited to a cross-sectional design. To determine the directionality of our findings and make more robust developmental inferences in the latter studies, it is important to assess these relations over time in larger scale prospective studies.

Third, the nature of some of the tasks (i.e., Empathy Task, Birthday Speech Self-Presentation Task) made it difficult to assess RSA change from baseline to a challenging or emotion-eliciting task. While it is useful to assess self-regulatory capacity with baseline RSA, RSA change is a more reliable measure of physiological self-regulation since it assesses the physiological change that the body experiences as it adjusts from relatively comfortable to stressful or challenging conditions. The Empathy Task was too short to obtain a reliable reading of RSA while the child engaged in affective and cognitive empathic responding toward the experimenter. In addition, children's standing posture as well as their fidgeting and nervous behaviors during the self-presentation task (which sometimes included jumps, spins, and kicks) caused the data to have too many ECG artifacts for analysis. Future studies should adapt similar tasks to ensure that children can sit still, and for a longer period, so that RSA change calculation can be possible. For example, in addition to carrying out the Empathy Task for the purposes of behavioral observation and coding, children could also be asked to watch an empathyinducing video that lasts closer to five minutes for the purpose of RSA recording. In addition, children could be asked to engage in a speech or conversation while seated during a 'Zoom call' with an unfamiliar child confederate to gauge behavioral shyness as well as concurrent RSA recording (while monitoring whether children engage in persistent levels of fidgeting and/or hyperactive motor movements).

Finally, our studies assessed children's empathic and instrumental helping responses to a relatively unfamiliar adult experimenter, limiting our inferences regarding children's behaviors with familiar adults, siblings, and peers (as well as unfamiliar peers), and in relatively familiar environments. Previous work has shown that familiar environments and victims tend to elicit different helping and empathic reactions of shy children when compared to an experimenter in a laboratory setting. More specifically, children who are high in shyness tend to show similar prosociality to children who are low in shyness when they are in familiar contexts and exposed to familiar victims (Stanhope et al., 1987; Young et al., 1999). Therefore, future work should compare current findings and procedures to the intricacies and regulatory differences of shy children's prosocial reactions to familiar victims in familiar environments.

Future studies should continue to assess heterogeneity within shy expressions, prosocial behaviors, and social understanding, and should consider context when exploring individual differences in social cognitive development. Further work should be conducted on possible associations between expressions of state shyness and various prosocial behaviors, and examine the role of physiological and behavioral self-regulation in these relations. Subsequent studies should continue to assess physiological reactivity and regulation, using RSA and other physiological measures during social stress episodes, including those that involve empathic responding. Further physiological measures could include salivary cortisol to assess physiological reactivity (e.g., Schmidt et al., 2007), cheek temperature and blood volume to assess blushing-related arousal (e.g., Nikolic et al., 2016), and electroencephalography to assess competing approach and avoidance motivations as measured by frontal asymmetry (e.g., Schmidt et al., 2010). Finally, to empirically support Rothbart's theory regarding the protective nature of self-regulation in the context of shyness-related reactivity and developing social cognitive abilities, future studies should use multiple measures of self-regulation to assess children's self-regulatory functioning in behavioral domains (i.e., inhibitory control, attentional shifting, private speech), and in different environments (i.e., school, home, laboratory).

Implications and Conclusion

This dissertation replicates and extends existing literature on cross-sectional and longitudinal relations between shyness and social cognitive outcomes in early childhood. Findings from this series of studies suggest that while certain expressions of state shyness can be beneficial for the acquisition of Theory of Mind understanding at around age 4, temperamental shyness tends to interfere with the motivation required to effectively engage in various prosocial behaviors throughout the preschool years. I demonstrated that self-regulatory capacity can have a protective effect on the shyness-related curtailment of cognitive empathy, and act to 'boost' Theory of Mind understanding in the context of positive expressions of state shyness. Finally, I extended the previously reported cross-sectional relation between temperamental shyness and affective empathy to show that at age 4 and age 5, shyness can prospectively predict affective empathic response at age 6, and that instrumental helping can mediate these relations.

Aside from outlining important findings regarding relations between shyness and social cognition at an important developmental period, this dissertation has also brought light to other, broader implications within the field of developmental and child psychology. First, these works emphasize the importance of considering heterogeneity within constructs such as shyness, prosocial behaviors, and further, empathic responses. Second, my investigations strengthen the notion that acknowledging context (i.e., context of self-regulatory capacity) through the examination of moderating factors can provide more information than simple linear relations. Within this dissertation, the exploration of moderating factors reinforced the notion that not all shy children behave in the same way, and not all children who engage in high levels of positive expressions of shyness, or who possess high self regulatory capacity, will experience similar outcomes. Finally, it is important to consider that some associations between factors may be curvilinear rather than linear. Study 2 presented a quadratic relation between resting RSA and affective empathy, which introduces some additional complexity when exploring and evaluating the relation between shyness and affective empathy in the context of self-regulatory capacity.

Findings from this dissertation also have theoretical implications for the evolution and development of human social cognitive processes. It has been predominantly assumed that shy children experience heightened and/or accelerated development of social cognitive understanding due to shyness-specific observational advantages and perceptual sensitivity (Lane et al., 2013; Wellman et al., 2011); however, the present body of work provides more details on this complex phenomenon. While it is possible that children who are high in temperamental shyness possess some social cognitive strengths that are specific to the detection and processing of social threat (Brunet et al., 2009; Matsuda et al., 2013), our findings suggest that only children who express shyness in a positive manner, and who concurrently experience high physiological self-regulatory capacity, tend to develop advanced explicit and emotionally neutral social inference abilities in early childhood. Although increased sensitivity to social threat cues (evident in children who are temperamentally shy) may *aid* in developing ToM at a relatively fast rate, only children who successfully regulate through stressful social interactions while holding others' interest appear to attain this developmental and cooperative advantage. Taken together, these findings suggest that more approach-oriented and regulatory expressions of shyness (i.e., PES) may have evolved in part for the purposes of protecting the individual from potential social transgressions while simultaneously enabling the processing of others' social cues. In contrast, the evolutionary purpose of less regulatory expressions of shyness (i.e., NPES) may be solely for the benefit of the individual's physical safety.

Inverse relations between temperamental shyness and various prosocial behaviors are also arguably relevant to evolutionary theory. Temperamental shyness may involve an evolutionary strategy by which some individuals avoid possible social transgressions or physical harm in the context of an unfamiliar victim in distress. Situations that involve an unfamiliar individual expressing high levels of distress or other negative affectivity may logically signal risk to a potential helper or empath and thus, shy children may avoid involving themselves for fear of possible social blunder or physical threat. Despite this line of thought, my findings suggest that high self-regulatory capacity and/or continued practice of prosocial regulation provides more context to this relation. Perhaps withdrawal from situations that require prosocial action toward an unfamiliar individual may only be adaptive (i.e., protect the individual from physical or social harm) for children who experience high levels of shy reactivity and low capacity for self-regulation. In other cases, (i.e., low shy reactivity, high self-regulatory capacity) the cost of potential threat from the victim may not outweigh the cooperation-specific adaptive advantage of approaching an individual in need. In all, this dissertation sheds new light on the complexity of environmental and endogenous context that can affect the development of social cognitive processes in children who experience varying degrees and expressions of shyness-related reactivity.

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