Louis A. Schmidt
Kristie L. Poole *Editors*

Adaptive Shyness

Multiple Perspectives on Behavior and Development

Springer

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To Alison, Willow, and our parents

Preface

Shyness is defined as inhibition and anxiousness in social situations. Shyness is an inherently interesting phenomenon to study because social interaction and social connection are so fundamental to human existence. Although a ubiquitous part of the human condition that has transcended time, as reflected with abundant references to it noted in religion, literature, poetry, music, and other arts over the years, we know little about the reasons for shyness. To date, much of the scientific work on shyness has been directed towards understanding the negative correlates and consequences of it. However, this "deficit" approach to the study of shyness began to change 20 years ago in which my colleague, Jay Schulkin and I, in the epilogue of an edited volume on shyness (Schmidt & Schulkin, 1999; see also, Schmidt & Tasker, 2000), recommended that future work should consider the positive and adaptive aspects of shyness. A number of the contributors to that volume also have contributions to this volume. Importantly, the "de-pathologizing" of shyness has continued to remain active in still more recent years (e.g., Crozier, 2014; Lane, 2008) in which researchers have begun to further question the pathologizing and over medicalization of normal variation in human personality behaviors and traits such as shyness. The reasons for pathologizing shyness are many, and beyond the scope of this volume for a detailed coverage of them, but they include societal and medical shifts in defining what constitutes emotional health and illness, the advent of the internet and social media, and the conceptualization and scientific study of the phenomenon from largely a Western and North American cultural view, to name a few.

In the spirit of the promissory note we left 20 years ago in the Schmidt and Schulkin (1999) volume on shyness, our goal in this volume is to provide readers with a collection of chapters in a single source that challenge existing views of shyness as a maladaptive behavior or trait. We bring together a group of leading international experts from multiple and diverse perspectives under one forum to examine the adaptive aspects of shyness. These perspectives include developmental, biological, social, cultural, comparative, and evolutionary approaches to the study of

temperament and personality development. It is our hope that casting a light on the adaptive aspects of shyness will inform theory and practice in terms of the conceptualization of shyness, its meaning and function, and the management of extreme forms of shyness that are predictive of social anxiety disorder.

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Louis A. Schmidt is Professor and Director of the Child Emotion Laboratory in the Department of Psychology, Neuroscience & Behaviour at McMaster University where he holds a Faculty of Science Research Chair in Early Determinants of Mental Health. His research interests are in the areas of temperament, socioemotional development, and developmental psychophysiology. He is particularly interested in how biology and early experiences shape the development of individual differences in temperament and socioemotional processes in typical and atypical populations.

Kristie L. Poole is a PhD candidate in Developmental Psychology in the Department of Psychology, Neuroscience & Behaviour at McMaster University. Broadly, her research investigates the interaction among temperamental, physiological, and contextual factors involved in socioemotional development. She is particularly passionate about studying the developmental origins and biological foundations of shyness, as well as investigating factors that maintain or alter shyness across development.

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Part I
Historical Precedents

The Study of Behavioral Inhibition and Temperamental Shyness Across Four Academic Generations

Louis A. Schmidt, Kristie L. Poole, Nathan A. Fox, and Jerome Kagan

It is the supreme art of the teacher to awaken joy in creative expression and knowledge.
—Albert Einstein

Introductory Remarks

The idea for this chapter originated from three events that transpired at the most recent Biennial Meeting of the Society for Research in Child Development (SRCD) in Baltimore, Maryland, March 2019, and three "take-home" points from these events. The first event occurred while preparing notes for my role as a discussant in a symposium on transactional models in child development. While all three papers in the symposium were very thoughtful, timely, and important, I was somewhat surprised that all three presentations ostensibly assumed that the idea of transactional models was a relatively recent occurrence in the field of child development. I soon reflected on the first course I taught as a new assistant professor over 20 years ago on the history of psychology. In the class that week, I was covering functionalism and functionalist schools of thinking and, in particular, the work of John Dewey. Of course, if you are going to cover Dewey, a good place to begin is his seminal paper, *The Reflex Arc Concept in Psychology*, published in *Psychological Review* nearly 125 years ago. In this paper, Dewey (1896) was opposed to the traditional

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stimulus-response understanding of the reflex arc, which later became a dominant theme of behaviorism. Dewey suggested that stimulus and response (i.e., action) were not distinct and separate events, but were transactional in nature. As others later noted (e.g., Biesta, Miedema, & van IJzendoorn, 1990), Dewey's reconstruction of the reflex arc informed transactional paradigms and, in my opinion, could be argued as the nascent beginnings of transactional models in human development, nearly a half century before John Bowlby and his theory on attachment (Bowlby, 1958). Take-home point #1: Appreciate the history of ideas and historical precedents in science.

The second event transpired while in the audience of a symposium on *Developmental Models of Shyness* organized by one of my current doctoral students, Kristie Poole. In this symposium, there were contributed papers from my current doctoral student (Kristie Poole) and me, a second from my former doctoral student (Alva Tang) and my doctoral advisor and mentor (Nathan Fox), and a third by my colleague (Rebecca Brooker) for whom I served as a mentor on her NIH K-99 transition to independence award. Another one of my graduate supervisory mentors (Ken Rubin) served as the symposium discussant. I reflected on the fact that not only are ideas shaped in science by larger generational influences and the historical eras in which they occur, but these ideas also are shaped intimately within and across academic generations, and what largely links us to the past, present, and future is the academic intergenerational transmission of these ideas. Take-home point #2: The student-mentor relationship is lifelong and key to the transmission and shaping of ideas and, interestingly, transactional in nature in the spirit of Dewey.

The third event took place when I was preparing notes for my role as a panel member on a roundtable on *Solitude and Social Withdrawal*. Given that SRCD was held in Baltimore, I thought that right at the outset of the roundtable, I would pay homage to two of Baltimore's most famous historical residents, Edgar Allan Poe and Billie Holiday, both of whom spent time living in Baltimore and struggling with social relationships. I wondered what they each had to say about solitude. For Poe, what came to my mind was his 1829 poem, entitled "Alone," in which he writes in the opening stanza, "From childhood's hour I have not been; as others were – I have not seen; as others saw – I could not bring…and all I lov'd—*I* lov'd alone." Scholars have interpreted this poem as Poe lamenting on his uniqueness and his inability to fit in with others in childhood and the resulting melancholy that haunted him throughout his life. For Holiday, the lyrics of her 1952 song, "Solitude," are a poignant reminder of her own struggles with relationships, "In my solitude, you haunt me with reveries of days gone by… in my solitude, I'm afraid." Take-home point #3: Pursue inherently interesting psychological phenomena that deeply impact the human condition and also transcend time.

The purpose of these introductory remarks and chapter is to illustrate these three take-home points: (1) Appreciate the historical precedent of ideas linked to the phenomenon under investigation; (2) student-mentor relationships are critical in shaping ideas across time; and (3) study inherently interesting phenomena that have long been a part of the human condition. To this end, this chapter focuses on a discussion

of the phenomenon of behavioral inhibition and temperamental shyness as viewed from representatives of four academic generations that span seven decades and multiple student-mentor relationships.

In the first section (Generation I), Jerome Kagan discusses the origins of the idea of behavioral inhibition and traces these ideas across seven decades of his work in this area. In the second section (Generation II), Nathan Fox, a student of Jerome Kagan, reflects on the behavioral and physiological correlates and consequences of behavioral inhibition and discusses the development of these ideas across five decades of inquiry. In the third section (Generation III), Louis Schmidt, a student of Nathan Fox, considers three issues important to understanding temperamental shyness (heterogeneity, context, and function) that he has been exploring over the last three decades. In the fourth section (Generation IV), Kristie Poole, a student of Louis Schmidt, presents her ideas and work on the developmental origins and adaptive aspects of temperamental shyness that she has been studying for several years. We conclude the chapter with some reflections on where future generations may want to go in the study of behavioral inhibition and temperamental shyness.

Louis Schmidt

Generation I: Jerome Kagan

The Origins of the Idea of Behavioral Inhibition

The concept of behavioral inhibition (BI), as well as its opposite, the uninhibited child, had its origins in three sets of observations, rather than an a priori hypothesis. The first occurred in the 1960s when Howard Moss and I were analyzing the relations between his ratings of the behaviors of 89 white children born between 1929 and 1939 in southwest Ohio and the data I had gathered on these individuals as adults. The narrative descriptions were based on frequent and direct observations of the child in the home and at the Institute from infancy to 14 years of age. Moss made separate ratings for the intervals birth to age 3 years, 3–6, 6–10, and 10–14 years with no knowledge of the adult information. These individuals were in their third decade in the late 1950s when I interviewed them with no knowledge of the childhood information.

A small proportion of children consistently withdrew from unfamiliar people and settings during the first 3 years. We called this bias "passivity." These children preserved this bias through age 14 and, as adults, were more likely than others to report being dependent on a love object, parent, or friend when a challenge arose. This relation was stronger for females than for males. In the book-length summary of this work, we wrote of the possibility that "a predisposition to passivity is a function, in part, of biological variables" (Kagan & Moss, 1962, p. 83). I did not pursue this observation because my politics and the emphasis on S-R learning theory when I

was a graduate student at Yale in the 1950s bred a resistance to acknowledging the influence of biology on personality.

Nature gave me a second opportunity to study this phenomenon in the 1970s when Richard Kearsley, Philip Zelazo, and I were conducting a study designed to assess the effects on early development of attendance at a day care center. We had planned to enroll only African-American families, but the suspicions held by a black political group in Boston in the 1970s forced us to exclude black infants from the study. They argued that racists would interpret any result as implying blacks were deficient. If our curriculum at the day care center did not help black infants, racists would say that black infants could not profit from benevolent interventions invented and supervised by white Harvard faculty. If the black infants who remained at home were no better than those at the center, racists would argue that black mothers were incompetent.

Because NIH had given us the funds, we needed to enroll other ethnic groups. Fortunately, the minister of the Chinese Christian church came to our rescue. He suggested we study Chinese-American and white infants from the same social rank, mainly working class. We enrolled infants who were 3–5 months old and studied them until they were 29 months old. Thirty-three infants (16 Chinese and 17 white) attended the day care center 5 days a week, and 67 infants were raised only at home (30 Chinese and 37 white). We observed all the infants in a variety of test situations on eight occasions between their age at enrollment and 29 months. There were minimal differences between the infants attending day care and those raised only at home. But the differences between the Chinese and white infants were striking. The former were less vocal, were less likely to smile, stayed closer to their mother, were more inhibited in unfamiliar settings, were more likely to cry when the mother left them temporarily, and had less variable heart rates at rest (Kagan, Kearsley, & Zelazo, 1978). Because Freedman (1974) had reported similar results, I became receptive to the idea that temperamental biases were far more influential than I had been willing to acknowledge.

I was now ready to study the bias we called BI more directly. One of my students, Cynthia Garcia-Coll, probed this idea for her doctoral thesis. She observed the behaviors of a large sample of 21-month-old white children in varied laboratory settings because she did not have confidence in the accuracy of parent reports. Each child encountered a variety of unfamiliar, but harmless, events, and the video records were coded for signs of BI. About 20% of the sample displayed consistent BI responses, and a somewhat larger proportion displayed the opposite pattern called uninhibited (Garcia-Coll, Kagan, & Reznick, 1984). Members of both groups were observed 40 months later in their kindergarten classrooms. Those who had been BI were shyer than the uninhibited children (Gersten, 1989). Nancy Snidman replicated Garcia-Coll's finding with 31-month-olds. Observations of the two samples at 5 and 7 years revealed modest preservation of the BI behavioral profile. However, the BI children displayed higher and less variable heart rates, larger pupillary dilations during cognitive tasks, and less pitch period variability (jitter) in vocal utterances (Kagan, Reznick, & Snidman, 1987, 1988). The biological evidence implied

greater sympathetic tone on the cardiovascular system as well as greater muscle tension in the larynx.

The data gathered by the late 1980s led us to believe that some children who showed a BI profile in unfamiliar contexts had inherited a neurochemistry that rendered the amygdala and/or sites connected to the amygdala more responsive to unexpected events. But we also believed that life experiences could establish a BI profile in children without any biological bias. Hence, the next challenge was to study young infants to discover if BI children who inherited a biological bias showed any signs of their predisposition. This research led to the discovery of highly reactive 4-month infants who react to unexpected events with vigorous motor activity and crying and signs of an excitable amygdala (Kagan & Snidman, 2004).

Our current view is that about 20% of white infants raised under benevolent home conditions inherit a lower threshold to unfamiliar or unexpected events. This bias leads to BI responses during the first year or two. But with each succeeding year, some of these children learn to suppress withdrawal and timidity to the unexpected. By adolescence, only a small proportion of high reactives continue to show BI profiles. However, high reactives who learned to hide their timidity to the unexpected find it difficult to suppress the private feelings of tension that fuel the BI profile. Evidence from EEG and fMRI confirm this claim (Schwartz et al., 2012).

The adults who had been high reactive infants and BI during the first year or two but find a life setting that is congruent with their temperament often lead satisfying lives. T.S. Eliot is an example. The less fortunate who do not possess the talents that make a more solitary life possible, as well as those who cannot avoid frequent challenges, are at risk for an anxiety disorder. This claim is consistent with the biological data indicating that the animal's setting makes a major contribution to its behavioral profile. Highly reactive infants who develop a BI profile are apt to develop a maladaptive adjustment if they encounter a stress that triggers a reaction in a setting in which the reaction is inappropriate.

Consider a pair of monozygotic twin sisters who had been highly reactive infants and who grew up in a supportive family in a small town. Both conquered the BI characteristics they had displayed as children. One sister remained in the town, became a librarian, and married a man she dated in high school. Her sister decided to go to Los Angeles to attend UCLA. She did not make many friends during her freshman year, had poor grades, and developed an anxiety disorder.

The studies of BI over the past 50 years have taught me three lessons. First, do not rely on one source of evidence, whether a parent report or behavior in one setting, as the basis of a psychological category. Second, always examine a corpus of data for different patterns of measures for males and females as well as social class and ethnic groups. Finally, remain open to any outcome. Do not let a favored hypothesis blind you to an important idea. Psychology is a young discipline and its most important insights continue to evade us.

Generation II: Nathan Fox

Correlates and Consequences of Behavioral Inhibition

My initial entry into the area of temperament and then to the study of behavioral inhibition was the result of a series of fortuitous and perhaps serendipitous events. After completing a fellowship on cross-cultural psychology with Jerry Kagan as my mentor where I spent 1 year in his lab studying infant cognitive development and a second in Israel studying infants raised on communal farms (kibbutzim), I found myself in his office trying to figure out what to do next. He told me he had received a call from Michael Lewis, a developmental psychologist, who years earlier had studied with Jerry at the Fels Institute, asking if Jerry knew of anyone who could fill a postdoc/research position in New York City to work on a study of the effects of prematurity on infant development. Jerry suggested I call Michael, which I did, and then subsequently visited him at his office which at the time was at the Educational Testing Service in Princeton New Jersey. Michael offered me the position with the idea that I would set up a lab to assess infants born prematurely, mostly to measure their attention to visual and auditory stimuli using heart rate measures. After leaving Jerry's office and walking across the campus I bumped into Richie Davidson who had just finished his graduate work and was taking a position as an assistant professor in psychology at SUNY Purchase. We talked and decided to look each other up, me in NYC and him in Westchester. Richie had studied EEG asymmetry in graduate school and was setting up a psychophysiology lab at Purchase. After many visits to his lab and intense discussions, he and his research associate Cliff Saron helped me set up a psychophysiology/EEG lab at Roosevelt Hospital where I was based. Three things happened: First, between Richie and Cliff, I learned intensively about EEG. Second, I focused my work on the development of infant emotion, and third, in collaboration with Richie, we published a series of papers on the development of emotion and EEG asymmetry (Davidson & Fox, 1982; Fox & Davidson, 1986, 1987, 1988). The conceptualization was that frontal EEG asymmetry reflected the motivational states of either approach or withdrawal (right frontal EEG asymmetry reflecting withdrawal, left frontal EEG asymmetry reflecting approach) (Fox, 1991). Richie and I published a paper in which we demonstrated that we could predict infant response to maternal separation based upon their pattern of asymmetry. Indeed, we suggested that this pattern might reflect a temperamental bias to approach or withdraw from novelty (Davidson & Fox, 1989).

Around that time, Jerry along with a number of other senior developmental scientists had received funding from the MacArthur Foundation to organize a working group on social and emotional development. Jerry invited me to attend the meetings and join his subgroup. I had read his work on behavioral inhibition and suggested that we could assess EEG asymmetry in these children to see whether they showed the predicted pattern of right frontal EEG asymmetry associated with avoidance. That set off my first grant application to recruit a sample of infants, screening them

in the same manner that Jerry and his group had done in their initial work, and follow them to assess their social behavior and EEG asymmetry. I was joined at this time by Ken Rubin who at that time was at the University of Waterloo and who had been invited to present at Jerry's MacArthur working group. Ken studied peer relationships, and he and I decided that we would follow these temperamentally reactive, behaviorally inhibited infants long enough to be able to assess their peer competencies and relationships. Our first grant was funded (after a site visit that included Manny Donchin and Michael Lamb), and we set off to study behavioral inhibition.

There were four significant observations from that work. First, when we screened 4-month-old infants for motor and affective reactivity, we identified not only the high negative reactive infants that Jerry found but also a group of infants who displayed equally high motor reactivity but coupled with positive affect. We call these infants temperamentally exuberant, and they have their own unique biology and behavioral profile. Second, we found that behaviorally inhibited infants (assessed using Jerry's laboratory paradigm) did in fact display right frontal EEG asymmetry (Fox et al., 1995; Fox, Henderson, Rubin, Calkins, & Schmidt, 2001). Third, as these toddlers aged into preschool, they displayed social reticence in the presence of unfamiliar peers (Rubin, Coplan, Fox, & Calkins, 1995). And fourth, with regard to change and continuity, among the behaviorally inhibited children, they were equally likely to go on to display social reticence as not (Fox et al., 2001).

Among the many insights that Jerry had regarding the biology of behavioral inhibition was the possibility that their biology was analogous to the systems being described at that time by Joe LeDoux and Michael Davis, who were studying rodents and describing the biology of fear conditioning. The behavioral outputs in their work—freezing and avoidance and the autonomic reactivity and startle—were quite similar to that observed in the behaviorally inhibited child. Jerry's work here was taken up by biological psychiatrists at that time with an interest in understanding the etiology of anxiety. The behaviorally inhibited child, as it turns out, is the best "phenotype" for understanding the origins of anxiety and particularly social anxiety in the clinical literature. I pursued study of the physiological responses of behaviorally inhibited children with my then graduate student Louis Schmidt. We examined their neuroendocrine responses (Schmidt et al., 1997) and fear potentiated startle (Schmidt & Fox, 1998) finding patterns analogous to those of the fear conditioned animal.

Yet another fortuitous event in my career studying behavioral inhibition came when Danny Pine, a child psychiatrist and neuroscientist, moved from his academic position at Columbia to head a lab at the National Institute of Mental Health. The children in our first cohort were just turning 12, and we already had a second, larger cohort of young children who were again screened at 4 months of age, and we were now following to examine biology and social behavior. Danny brought his expertise in clinical ratings to this work and his interest in neuroscience. We began scanning the brains of these children and working together in a collaboration that has continued to this day—because it is so interesting and so much fun.

A final fortuitous event and one that has played an important role in the work we have conducted on behavioral inhibition over the past almost 20 years involved recruiting Heather Henderson. At one meeting of the MacArthur group, Ken and I spoke and he mentioned that he knew of an outstanding graduate/Master's student who needed a good home for her doctoral work. He recommended, and I recruited Heather who at that time was at the University of Guelph to come work with me. Heather has many gifts and a broad knowledge of social development, but most importantly she is a keen observer of behavior. She worked on the first longitudinal cohort and was instrumental in the design of the second. But most importantly, it was her interest in why some behaviorally inhibited children were able to "cope" with their temperament and be just fine as they got older while others could not and had increased risk for social anxiety that influenced our research direction.

Heather (reading the Berkeley Growth Study and Letzring, Block, & Funder, 2005) argued that these kids appeared stuck, rigid, and unable to be flexible in their responses—overcontrolled in their behavior. She looked around for assessments of cognitive control and found the Flanker task. The interesting thing about the Flanker is that one could assess behavioral performance with regard to accuracy and reaction time but also if one recorded EEG while the participant was performing the task one could synchronize the EEG to the button press (as well of course to the stimulus presentations) and examine an ERP component called the error-related negativity. So, with another graduate student of mine at the time (Jennifer McDermott), we tested the adolescents in our first cohort and found that behaviorally inhibited children displayed enhanced ERN responses (they were, if you will, more sensitive to errors). More surprising was that those behaviorally inhibited children with elevated ERN responses were more likely to go on to have a diagnosis of social anxiety (McDermott et al., 2009).

We have pursued this idea of cognitive control and temperament now for some time. It is counterintuitive. Why should a skill that is supposed to help you adapt (control) work to increase the likelihood of anxiety in this temperamental group? For a reasoned account, see Henderson, Pine, and Fox (2014).

But what is more important for this essay is the nature of inquiry itself. It relies not only on preparation but also serendipity: I took advantage of good graduate training, a brilliant advisor and smart colleagues and graduate students, to observe nature and carve it at its joints.

Generation III: Louis Schmidt

Heterogeneity, Context, and Function in Temperamental Shyness

I have had an inherent interest in, and natural curiosity about, the phenomenon of shyness and related traits such as introversion for as long as I can remember. However, my scientific and research interests in the study of shyness developed dur-

ing my undergraduate years in the mid-1980s and can be traced to at least three factors during that time. The first was an undergraduate special topics course on shyness that I took in 1985 taught by Tom Robinson (a personality psychologist and psychophysiologist) at the University of Maryland Baltimore County which also coincided with a newly published edited volume on *Shyness: Perspectives on Research and Treatment* by Jones, Cheek, and Briggs (1986) that was assigned reading for the course. I was fascinated by the idea that shyness could be studied scientifically, and by the range of ideas covered in class and in the edited volume on the topic of shyness, particularly the chapters by Jerome Kagan on temperament and shyness and Arnold Buss on the development of shyness subtypes.

The special topic course led to the second factor: an opportunity to do research with Tom Robinson and the late Alice Isen (a social psychologist) which we also continued after she moved to Cornell University. This work was focused on understanding individual differences in adult shyness and examining their psychophysiological correlates during resting states and during mood induction and social challenges using heart rate measures. This research was particularly rewarding as it exposed me to the complex conceptual and methodological issues around conducting psychophysiological research and an appreciation of the difficulties inherent in this work.

The third factor was a talk by Jerome Kagan in the early spring of 1987. A group of students, including myself, went to hear Jerry give a keynote address on behavioral inhibition at the College of Notre Dame of Maryland (now Notre Dame of Maryland University). The College was hosting a weeklong series of speakers in celebration of "The Week of the Child." This event was particularly memorable as Jerry was discussing his recent research at the time on behavioral inhibition (now seminal work) that he was doing with his students which had been recently published (Garcia-Coll et al., 1984) and other work that was soon to be published (Kagan et al., 1987). During his talk, Jerry spoke very affectionately of one of his former graduate students, Nathan Fox, and the cutting-edge work Nathan was doing down the road at the University of Maryland, College Park, using brain-based measures (EEG) to understand individual differences in infant and child temperament. The timing was coincidental, as I was, independent of Jerry's talk, becoming quite familiar with Nathan's important series of recent studies and publications on the EEG correlates of infant emotion and temperament (e.g., Davidson & Fox, 1982; Fox & Davidson, 1984, 1986, 1987), aligning with my emerging interests in the biological basis of individual differences in personality.

It soon dawned on me that if I were going to truly understand shyness, it is likely too late to study it in adulthood. This, coupled with the realization that although the peripheral psychophysiological measures that I had been using provided indirect information about the brain, I really needed to know what was going on in the brain. The timing was perfect; two newly emerging disparate lines of research inquiry were interfacing: the phenomenon of behavioral inhibition and the brain within a developmental framework.

And my story begins. The desire to take a developmental perspective to the study of shyness and extend research questions to central brain-based measures, in addi-

tion to the peripheral cardiovascular measures that I was already examining, led me to work with Nathan, a truly inspirational and supportive lifelong mentor, now colleague and friend. I was also very fortunate during my graduate studies at Maryland to discuss many of my ideas with very supportive members of my doctoral committee (Stephen Porges, Ken Rubin, Jay Schulkin), providing me with an opportunity to examine ideas from diverse areas of inquiry and perspectives. Since then, I continue to be very fortunate to work with supportive colleagues and highly passionate and bright students.

Over the last 30+ years, dating to my undergraduate and graduate days and continuing in the research that my students and I are conducting today, issues of heterogeneity, context, and function have been foundational to my research interests and program on shyness. Below I briefly discuss some of our earlier and recent selected, representative work on these three topics.

One of the first studies we did on the heterogeneity of shyness was to empirically test Buss' (1986) Theory of Shyness Subtypes. Over two decades ago, Tom Robinson and I found that Buss' early developing shyness subtype was associated with lower self-esteem than a later developing shyness subtype (Schmidt & Robinson, 1992). A couple of years later using the Cheek and Buss measurement model on the independence of shyness and sociability (Cheek & Buss, 1981), the first study I completed as a graduate student with Nathan was to examine whether we could distinguish shyness subtypes on "state-related" behavioral, central (regional EEG), and peripheral (cardiac vagal tone) psychophysiological measures in anticipation of an unfamiliar social interaction in a sample of adults (Schmidt & Fox, 1994). We found evidence that shyness and sociability were distinguishable on a psychophysiological level. Five years later, as a new assistant professor at McMaster, my laboratory was able to extend these earlier findings on the independence of shyness and sociability on "state-related" psychophysiological measures to "trait-related" central physiology measures using resting EEG (Schmidt, 1999).

In a series of studies since that time, my students and I have provided empirical support for the distinction among shyness subtypes and the independence of shyness and sociability on a range of measures, ages, and populations (Jetha, Schmidt, & Goldberg, 2009; Poole, Khalesi, Rutherford, Swain, Mullen, Hall, & Schmidt, 2019; Poole, Van Lieshout, & Schmidt, 2017; Schmidt, Miskovic, Boyle, & Saigal, 2008; Tang, Beaton, Schulkin, Hall, & Schmidt, 2014; Tang, Santesso, Segalowitz, & Schmidt, 2016; Tang, Santesso, Segalowitz, Schulkin, & Schmidt, 2016; Xu, Poole, Van Lieshout, Saigal, & Schmidt, 2019). Considering heterogeneity in shyness increases conceptual clarity and enhances prediction.

A second major theme in our work has been a consideration of context. Does temperamental shyness generalize to other contexts? My graduate student Paul Brunet and I used what was then considered a recent methodological advance in computer-mediated communication to address long-standing questions in experimental social psychology and person x context interactions (Brunet & Schmidt, 2007, 2008). We found that adults who were classified as temperamentally shy

looked no different than socially outgoing individuals on computer-mediated self-disclosures when they interacted in dyads without a webcam present, but shy adults exhibited fewer self-disclosures than sociable adults when the webcam was present and turned on, mirroring findings from traditional face-to-face interactions of reduced self-disclosures in shyness, suggesting the importance of context in understanding shyness in social interactions.

In more recent work, we have considered shyness within more ecologically salient contexts than used in the past. Using arguably one of the most stressful and anxiety-provoking contexts (i.e., the surgical setting), my graduate student Cheryl Chow and our group recently found that temperamentally shy children were consistently less anxious than socially outgoing children in response to impeding elective surgery across two visits: a preoperative visit and day of surgery (Chow, Nejati, Poole, Van Lieshout, Buckley, & Schmidt, 2017). Although this seems paradoxical, we speculated that perhaps temperamentally shy children were better able to regulate their emotions in some contexts, given that they may have learned how to cope overtime with these same emotions in their everyday environments.

Still a broader context that we have also recently considered is the generation context, or birth cohort, in which the child is socialized. Caspi and his colleagues (Caspi, Bem, & Elder, 1988; Kerr, Lambert, & Bem, 1996) reported that shy children born in the 1920s and 1950s had delayed marriage and parenthood, less stable careers, and lower occupation attainment as adults than other children. We were interested in knowing whether these effects still held true today? My graduate student Alva Tang and our group recently reported that shy children born between 1977 and 1982 who outgrew their shyness (i.e., decreasing trajectory) were indistinguishable from those who were consistently low on shyness measures on social (e.g., marriage and parenthood) and economic (income levels) outcomes (Schmidt et al., 2017). Considering shyness within different contexts is important to increase reliability and generalizability of findings.

A third issue we have been exploring over the years concerns the function of shyness. What is its function? In two recent studies with my graduate student Kristie Poole, we have found empirical evidence of a relatively lower ratio of spectral power in faster (alpha) to slower (delta) EEG frequencies in children's shyness (Schmidt & Poole, 2018, 2019a). This EEG ratio was used as a proxy of brain maturation. We have speculated that a relatively lower frontal alpha-to-delta ratio score might reflect a delaying of brain maturation possibly linked to the approach-avoidance conflict that characterizes some aspects of shyness. We have further argued that this delaying of maturation may reflect the process of neoteny (i.e., the delaying of maturity and retention of childhood features) (Schmidt & Poole, 2019b). The function of this delaying of frontal brain maturation may allow for additional learning to take place about conspecifics intentions and motives before acting. Accordingly, it is possible that some types of shyness may be adaptive. Considering some aspects of shyness as adaptive has implications for how we view the "pathologizing" of shyness in society today.

Generation IV: Kristie Poole

On the Developmental Origins and Adaptive Aspects of Temperamental Shyness

Having been an extremely shy child, I was frequently asked: *Why were you so shy as a child*? It was a question that (particularly as a youngster) was very difficult to answer; a question that as an adult is still very difficult to answer; but importantly, a question that has fueled my passion and interest in better understanding the developmental origins of children's shyness; and a question that has been the launching point of my research to date.

I have always had an innate interest in trying to understand individual differences in shyness. As an adolescent, I remember spending hours reading papers online (that I had limited access to) related to shyness. Without realizing it, I had begun my informal research into studying what contributes to the development of shyness. It was, however, not until the second year of my undergraduate studies that I discovered that the systematic study of shyness was an actual area of research. One of my favorite undergraduate elective courses was developmental psychology. During the lecture on social development, my professor very briefly skimmed over the topic of shyness, which of course sparked my interest. She referred the interested student to contact Dr. Louis Schmidt who she mentioned was an expert in the study of children's shyness. I remember excitedly writing down Louis's name on my lecture notes and reading his work online. Two years later, I was fortunate enough to do a senior undergraduate research project with Louis. Shortly thereafter, I enthusiastically began my doctoral research under his supervision, and my passion to formally begin research on the developmental origins of shyness was realized.

Previous generations of research into the biological and developmental origins of temperamental shyness have been foundational to my own research (Fox et al., 1995, 2001; Fox, Henderson, Marshall, Nichols, & Ghera, 2005; Kagan et al., 1987, 1988; Schmidt et al., 1997; Schmidt, Fox, Schulkin, & Gold, 1999). In conjunction with this earlier theoretical and empirical work, there have been advances in both theory and methodology related to developmental psychology that have placed current generations of academic researchers in a position to further study human behavior in general and temperamental shyness in particular.

For example, there have been increases in theoretical frameworks for understanding human development, such as an increasing interest in elucidating epigenetic mechanisms and testing developmental programming hypotheses, which posit that the prenatal and early postnatal environments can exert long-term influence on social-emotional and physical development (Gluckman, Hanson, & Buklijas, 2010; Harris & Seckl, 2011). Recently, we tested the hypothesis that temperamental shyness may be developmentally programmed in utero in response to stressors, using a sample of individuals who were born at extremely low birth weight (ELBW; <1000 g) as a developmental model of programming. We found that individuals who were exposed to the greatest relative levels of early stress (i.e., ELBW and fetal

exposure to synthetic steroids) in the perinatal period exhibited the highest levels of childhood shyness which remained stable into their early 30s compared to individuals born ELBW and not exposed to synthetic steroids and normal birth weight controls (Poole, Saigal, Van Lieshout, & Schmidt, 2019). We interpret these findings to imply that for some individuals, there may be adaptations that take place in utero in response to early stressors that prepare the fetus for a threatening postnatal environment through physiological modifications. Although adaptive in a stressful prenatal environment, if the postnatal environment is not as comparably harsh and threatening as the prenatal environment, the individual may be more prone to manifest threat sensitivity and hypervigilance, which may lay the developmental blueprint for temperamental shyness. We speculate that this study provides preliminary evidence that temperamental shyness may have its very early developmental origins in utero for some individuals.

There also recently has been an increase in the availability of statistical techniques and analytical frameworks that have facilitated the quest for examining stability and change in behavior across development. Indeed, advanced statistical modeling such as latent class growth curves and multilevel modeling have allowed researchers to systematically chart developmental change in shyness and related constructs (e.g., Booth-LaForce & Oxford, 2008; Degnan et al., 2014; Oh et al., 2008). Likewise, these longitudinal frameworks have been a central theme of our own work and have allowed us to begin charting the trajectory of shyness across developmental periods and investigating factors that influence different developmental pathways of shyness and its long-term outcomes (Lahat et al., 2018; Poole, Cunningham, & Schmidt, 2019; Poole, Santesso, Van Lieshout, & Schmidt, 2019; Poole, Van Lieshout, McHolm, Cunningham, & Schmidt, 2018; Tang et al., 2017). Importantly, longitudinal data analytic techniques have allowed us to not only examine the trajectory of shyness but to also begin investigating the longitudinal trajectories of the psychophysiological processes such as autonomic and brain activity that had been previously proposed to underlie the development of shyness and related phenotypes in typical (Poole, Santesso, Van Lieshout, & Schmidt, 2018; Poole & Schmidt, 2018; Schmidt & Poole, 2018) and atypical (Poole, MacMillan, & Schmidt, 2018) development. Together, this idea has furthered our understanding of the developmental and biological processes that may underlie the emergence of shyness and its long-term behavioral and physiological correlates.

Finally, a relatively recent line of research that has been of interest is to move beyond the idea that shyness is always inherently maladaptive. While there are indeed some individuals for whom shyness may be problematic, researchers have long illustrated that not all shy individuals are alike (Buss, 1986; Crozier, 1999; Schmidt, 1999; see also, Schmidt, this chapter). We have been particularly interested in identifying sources for heterogeneity in shyness, including differences in developmental onset, contextual elicitors, social motivations, and emotional expression (Poole & Schmidt, 2019b). The objective of this research has been to better understand why some subsets of shy children seem to thrive whereas other shy children seem to struggle.

To this end, we have recently begun a series of studies investigating how emotional expression in shy children can result in different outcomes. We found support for the idea that the expression of positive affect is adaptive for shy children and that these children were not distinguishable from their non-shy counterparts on measures of sociability, fear, and social anxiety (Poole & Schmidt, 2019a). This research is consistent with previously published work examining the role of positivity in shyness (e.g., Colonnesi, Napoleone, & Bögels, 2014; Colonnesi, Nikolić, de Vente, & Bögels, 2017; Nikolić, Colonnesi, de Vente, & Bögels, 2016). Most recently, we have begun investigating the developmental origins and biological correlates of different adaptive and maladaptive subtypes of shyness (Poole & Schmidt, 2019c, 2019d). This work has provided preliminary evidence that not only do shy children show heterogeneity in terms of their adaptive and maladaptive developmental outcomes, but some types of shyness may also have different underlying developmental and biological origins. In the future, it will be informative to integrate our emerging findings related to adaptive subtypes of shyness within longitudinal frameworks in order to better understand the developmental trajectory of various shyness subtypes.

Concluding Remarks

This chapter traces the study of temperamental shyness across four academic generations and multiple student-mentor relationships. Kagan's essay (Generation I) illustrates the importance of ideas, observations, using multiple sources of information, and remaining open to multiple outcomes in the study of behavioral inhibition. Fox's reflections (Generation II) demonstrate the importance of solid preparation and at the same time serendipity in research. Schmidt's essay (Generation III) highlights the importance of historical precedent in research when considering issues such as heterogeneity, context, and function in the study of temperamental shyness. Poole's reflections (Generation IV) showcase the importance of considering different origins of temperamental shyness reflected in developmental programming and developmental methods. Several consistent themes also emerged across the four academic generations presented in this chapter that inform recommendations for future generations.

1. *Directly observe behavior*. Some of the first known published research on the scientific study and discussion of shyness, well over a century ago, was rooted in observations (Campbell, 1896; Darwin, 1877; Hall, 1897). These studies were largely based on behavioral and clinical observations of fearful children and adults, not losing sight that, as psychologists, we are interested in understanding behavior as our primary objective. Understanding behavior is particularly salient in this day and age where there is a heavy emphasis on biological methods at the exclusion of the behavior we seek to understand. Accordingly, we run the danger of method-driven rather than theory-driven research. Methods will come and go, but good questions transcend time.

2. *Considering context is critical*. In the study of children's personality development, we often limit our studies to peer and familial/caregiving contexts and traditional conceptualizations of context, reflecting exogenous influences on the child. Macro-level exogenous influences such as cultural (Chen & Schmidt, 2015) and generational (Schmidt et al., 2017) contexts are an important source of variance as is the endogenous context within the child across early (Schmidt, Fox, Perez-Edgar, & Hamer, 2009) and later (Fortier et al., 2014) development. Rethinking traditional definitions of context is important to understanding heterogeneity in children's personality development as well as observing children in ecologically salient and natural settings, and using new computer-mediated communication methods in controlled laboratory environments to exploit longstanding questions in personality science regarding context may also prove fruitful (e.g., Brunet & Schmidt, 2007, 2008).
3. *Explore and establish measurement properties*. Many of the behavioral and biological measures that we use today have not undergone rigorous psychometric testing. Is the measure reliable, valid, and internally consistent? Does the measure have the same meaning across age, sex, and personality type (i.e., have issues of measurement invariance been established, see, e.g., Putnick & Bornstein, 2016; see also Brook & Schmidt, 2019)? Ironically, although subjective, self-reported personality measures are sometimes viewed pejoratively, they are often the measures in the psychological sciences that are the most rigorously subjected to psychometric and measurement testing. At the end of the day, biological and behavioral indices are similar to items on personality surveys that need to be psychometrically tested and measurement issues established before being rolled out. Perhaps some of the replication crisis confronting the psychological sciences today is due to a lack of establishing psychometric properties and measurement soundness of the many behavioral and biological measures used, which is ironic given that the establishment of psychometric properties of measures, test construction, and measurement rigor has been arguably one of the major hallmarks and contributions of the field of psychology (e.g., Cronbach & Meehl, 1955).
4. *Engage the history of ideas*. Many phenomena that we study today in the psychological sciences are linked to a rich past. An appreciation of this history ultimately helps us to refine theory, questions, and hypotheses in the pursuit of inquiry.
5. *Appreciate the importance of student-mentor relationships*. The student-mentor relationship and its transactional nature are critical to linking us to the past, present, and future.

Perhaps Pavlov (1936) said it best for advice to future academic generations. In a bequest of Pavlov to the academic youth of his country translated from Russian and published in the journal *Science* just before his death, he asks: "What can I wish to the youth of my country who devote themselves to science?" His advice: gradualness, modesty, and passion.

Louis Schmidt

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Part II
Developmental Perspectives

Adaptive Shyness: A Developmental Perspective

Kristie L. Poole and Louis A. Schmidt

Introduction

Shyness is characterized by wariness in response to social novelty or situations of perceived social evaluation (Kagan, Reznick, & Snidman, 1988; Rubin, Coplan, & Bowker, 2009). Although shyness is a ubiquitous phenomenon with up to 90% of the population experiencing shyness at some point in their lives (Zimbardo, Pilkonis, & Norwood, 1975), a smaller proportion of approximately 15% of individuals are characterized by temperamental shyness, which is presumed to have an early developmental onset and exhibits stability across context and development (Kagan, 1994; see also Kagan, this volume, Chap. 1).

One common misperception is that shyness is a maladaptive or "pathological" trait that should be medically treated (Crozier, 2014; Lane, 2008). This may be in part due to the fact that some studies have found shyness to be a predictor of concurrent and prospective difficulties across several domains and developmental periods. For example, work has found that childhood shyness is correlated with academic difficulties (Crozier & Hostettler, 2003; Hughes & Coplan, 2010), lower self-esteem (Crozier, 1995), internalizing difficulties including anxiety (Coplan, Arbeau, & Armer, 2008), and poorer peer relations (Eggum-Wilkens, Valiente, Swanson, & Lemery-Chalfant, 2014; Rubin et al., 2009). Longitudinal work also has investigated the life course outcomes of shy children, and this work found that childhood shyness was predictive of delayed developmental milestones in adulthood such as later age for marriage, parenthood, and stable careers and lower levels of education (Caspi, Elder, & Bem, 1988; Kerr, Lambert, & Bem, 1996). More recent work examined trajectories of shyness from childhood to adulthood and found that it was only individuals with increasing levels of shyness from childhood

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to adulthood who exhibited lower attained income and occupational attainment and poorer psychosocial adjustment such as loneliness and poorer self-esteem (Schmidt et al., 2017). Children who were shy in childhood but had decreasing patterns of shyness into adulthood were not distinguishable from their non-shy counterparts across demographic, social, and psychological measures. This study illustrates the importance of examining developmental change in shyness over time as a predictor of maladjustment.

Although some shy individuals are at risk for poorer adjustment, shyness is not always inherently problematic. Researchers have long investigated the factors that may protect the shy child from manifesting nonadaptive developmental outcomes (see Coplan, et al., this volume, Chap. 4). Other work has actually found shyness to be correlated with positive outcomes across development such as fewer externalizing problems (Oldehinkel, Hartman, De Winter, Veenstra, & Ormel, 2004), lower risk-taking behaviors (Addison & Schmidt, 1999), increased levels of creativity (Kwiatkowska, Rogoza, & Poole, 2019), as well as parental perception of diligence, compliance, and being well-behaved (Schmidt & Tasker, 2000). A central goal of our own work has been to identify heterogeneity in shyness in order to bring greater precision to understanding the social, emotional, and biological foundations of different shyness subtypes (e.g., Poole & Schmidt, 2019a, 2019b, 2019c, 2019d; Schmidt & Poole, 2019). Perhaps most importantly, accounting for heterogeneity in shyness allows us to identify how certain subsets of shy individuals may display distinct adaptive or nonadaptive outcomes across development and enhance prediction of future behavior.

In the current chapter, we describe how shyness may be an adaptive trait. First, we broadly describe heterogeneity in shyness and how different subtypes of shyness may have different adaptive and nonadaptive developmental outcomes. Second, we highlight the subtype of shyness referred to as "positive shyness" which has been consistently linked to adaptive outcomes (Colonnesi, Napoleone, & Bögels, 2014). We review theoretical and empirical work on positive shyness, as well as possible mechanisms that may result in adaptive developmental outcomes. Third, we describe a speculative model to describe the development of adaptive subtypes of shyness. Finally, we conclude with recommendations for future research to consider in understanding the adaptive aspects of shyness.

Heterogeneity in Shyness: Adaptive and Nonadaptive Subtypes

One limitation of the majority of empirical studies of childhood shyness is that the phenomenon has been largely treated as a homogeneous construct. This may be potentially problematic, given the theoretical and empirical evidence suggesting heterogeneity in shyness, as well as differences in the origins, developmental course, and outcomes of different shy phenotypes (see, e.g., Schmidt & Fox, 1999, for a review).

We have been particularly interested in identifying sources for heterogeneity in shyness, including differences in developmental onset, contextual elicitors, social motivations, and emotional expression (Poole & Schmidt, 2019b). The objective of this research has been to better understand why some subsets of shy children seem to thrive whereas other shy children seem to struggle.

There is a long and rich history demonstrating that not all shy individuals are alike. For example, early theoretical work by Buss (1986a, 1986b) presented the idea that there is an early emerging *fearful shyness* which is rooted in early temperament and maintained by fear sensitivity and a later-developing *self-conscious shyness* that is closely tied to the experience of self-conscious emotions such as embarrassment. Fearful shyness manifests in response to social novelty and intrusiveness (e.g., close proximity of a stranger or interaction with an unfamiliar peer). Behaviorally, fearfully shy individuals display inhibition, fear-related behaviors (e.g., freezing), or escape behaviors in the context of social novelty (Buss, 1986a, 1986b; Cheek & Krasnoperova, 1999; see also Schmidt & Buss, 2010, for a review). Buss proposed that fearful shyness is closely linked to physiological stress arousal and may be maintained by underlying dysregulated fear systems. Self-conscious shyness is elicited in contexts in which an individual is socially exposed and/or the object of social attention, as well as being available to possible social evaluation and scrutiny (Buss, 1986a, 1986b). Behaviorally, self-conscious shyness may manifest as conflicted behavior (e.g., coy smiles), nervous fidgeting, and embarrassment. Physiologically, self-conscious shyness has been hypothesized to be associated with blushing (i.e., reddening of the face).

Despite the assertions proposed by Buss (1986a, 1986b), there exists little consensus as to whether fearful or self-conscious shyness is more or less adaptive than the other, which is due in part to the fact that there exists relative little empirical research on the topic. In terms of psychosocial adjustment between these shyness subtypes, some early work with adults reported that fearful shyness not only had an earlier developmental onset than self-conscious shyness, but fearful shy adults self-reported more symptoms of physiological anxiety, behavioral inhibition, and poorer social skills compared to self-conscious shy adults (Bruch, Giordano, & Pearl, 1986). Later work revealed that fearful shy adults self-reported lower self-esteem relative to self-conscious shy adults (Schmidt & Robinson Jr, 1992). More recent developmental work examined the growth of fearful and self-conscious shyness during toddlerhood and found that these two shyness subtypes were not significantly related; however, this study did not investigate functional correlates of the shyness subtypes (Eggum-Wilkens, Lemery-Chalfant, Aksan, & Goldsmith, 2015). We also have recently demonstrated differences in biological and behavioral correlates among children with early-developing and later-developing shyness (Poole & Schmidt, 2019d).

Still others have examined how social approach motivations (i.e., sociability) may interact with levels of shyness to confer *conflicted shyness* and *avoidant shyness* (Asendorpf, 1990). According to the conceptual framework proposed by Asendorpf (1990), some shy individuals have little motivation to interact with others (i.e., low on sociability) and comprise a subtype referred to as avoidant shyness.

In contrast, some shy individuals have a strong motivation to approach and interact with others (i.e., high on sociability) and feel too fearful and inhibited to fulfill this desire. These shy, but sociable, individuals are presumed to experience a motivational approach-avoidant conflict (Asendorpf, 1990) and constitute a subtype referred to as conflicted shyness.

Across development, avoidant and conflicted shyness have been associated with distinct psychosocial correlates (see also Poole & Schmidt, this volume, Chap. 9). Recently, a longitudinal study by Kopala-Sibley and Klein (2016) found that conflicted shyness in preschool-aged children was predictive of internalizing and externalizing behaviors in later childhood. During adolescence (Page, 1990), emerging adulthood (Santesso, Schmidt, & Fox, 2004), and adulthood (Poole, Van Lieshout, & Schmidt, 2017a), a combination of shyness and sociability is known to place individuals at a heightened risk for alcohol abuse and other recreational substance misuse relative to shyness alone. Conflicted shyness during emerging adulthood also has been shown to be associated with increased social distress, increased fear of negative evaluations, and more social comparisons with peers (Nelson, 2013) relative to the avoidant shyness subtype. We also have demonstrated that beyond emerging adulthood, adults who are classified with conflicted shyness are at an increased risk for experiencing the cognitive, behavioral, and somatic symptoms underlying social anxiety disorder (Poole et al., 2017a). We have also found that conflicted shy adults have poorer adjustment in adulthood across demographic, psychological, social, and health domains of adaptive functioning (Poole, Van Lieshout, & Schmidt, 2017b).

More recent work has illustrated that a shy individual's emotional expression during social situations may yield subtypes referred to as *positive shyness and negative shyness* (See also Colonnesi et al., this volume, Chap. 3). Specifically, shyness can be expressed and experienced in either a positive or negative way, that is, displaying avoidant shy behavior with or without a smile, respectively (Colonnesi, Bögels, de Vente, & Majdandžić, 2013; Reddy, 2000, 2001). Although our work to date has aimed to study each of the above reviewed shyness subtypes, in the current chapter, we focus on positive shyness and negative shyness in childhood to illustrate adaptive and nonadaptive subtypes of shyness, respectively. We chose to focus on these subtypes as there has been consistent research among children highlighting the adaptive and nonadaptive nature of these shyness subtypes in particular. We first review the existing theoretical and empirical research on these shyness subtypes, and then we propose a hypothetical model to describe the development and maintenance of adaptive and nonadaptive subtypes of shyness.

Positive Shyness as an Adaptive Subtype

In this section, we review the theoretical and empirical work related to positive and negative shyness, including the operationalization of positive and negative shyness, proposed adaptiveness of the two subtypes, and empirical research examining correlates of positive and negative shyness. The key points are summarized in Table 1.

Table 1 Overview of hypothesized and empirical distinctions between positive shyness and negative shyness

	Positive shyness	Negative shyness
Phenotypic expression	• Combined avoidance and positive affect	• Avoidance in the absence of positive affect
Motivational underpinnings	• Approach-dominant	• Avoidance-dominant
Behavioral correlates	• Sociability*	• Fear-related behavior* • Social anxiety*
Cognitive correlates	• Advanced theory of mind* • Controlled processes	• Relatively lower theory of mind* • Automatic processes
Neural correlates	• Left frontal asymmetry* • Higher overall absolute left frontal activity versus right frontal activity • Higher frontal delta-beta correlation*	• Right frontal asymmetry* higher overall absolute right frontal activity versus left frontal activity • Relative lower frontal delta-beta correlation*

Note: Empirical correlates designated by an asterisk

Phenotypic Expression and Motivational Underpinnings

As mentioned, one factor underlying heterogeneity in shyness may be an individual's emotional expression during social encounters. Positive shyness is described as the expression of shy behavior (e.g., avoidance, gaze aversion) while also expressing positive affect (e.g., smiling), and negative shyness is characterized by shy behavior in the absence of positive affect in social situations (Colonnesi et al., 2013; Colonnesi, Napoleone, & Bögels, 2014; Colonnesi, Nikolić, de Vente, & Bögels, 2017; Nikolić, Colonnesi, de Vente, & Bögels, 2016; Reddy, 2000, 2001; see also Colonnesi et al., this volume, Chap. 3).

Positive shyness is thought to emerge due to competing feelings of fear and interest in social situations (Colonnesi et al., 2014, 2017; Nikolić et al., 2016; Reddy, 2001). That is, these children may feel a desire to engage in social situations but simultaneously feel fearful during these situations. Positive shyness may be conceptualized as an approach-dominant form of shyness. On the other hand, negative shyness is presumed to reflect a dominant avoidance motivation and may be conceptualized as an avoidance-dominant form of shyness (Poole & Schmidt, 2019c). We have speculated that negative shyness is conceptually similar to the constructs of fearful shyness and behavioral inhibition (Poole, Tang, & Schmidt, 2018; Schmidt & Poole, 2019).

Adaptive Social Functions of Positive Shyness

The expression of positivity during social situations is hypothesized to be adaptive for the shy individual for at least two reasons. First, the expression of positive affect may signal one's interest in social interaction and serve an appeasement function to

social partners. This signal of social interest may facilitate approach from social partners and consequently fulfill the positive shy individual's social affiliative desires (Sroufe & Waters, 1976). Expressions of positive shyness are thought to signal that the shy individual is concerned with social norms and that he/she wants to be socially accepted (Colonnesi et al., 2014; Keltner, 1995; Keltner & Buswell, 1997). It has been hypothesized that these positive shy expressions may reflect a nonverbal "apology" to social partners and reflect a signal of prosociality and serve to signal one's trust (Feinberg, Willer, & Keltner, 2012). This may actually facilitate interpersonal liking, as social partners witnessing these coy behaviors may show compassion toward the positive shy individual. We have speculated that some forms of shyness may reflect more recent human evolution and socio-cognitive processes (Schmidt & Poole, 2019), which may have evolved to serve simultaneous caution and interest, facilitating additional time for learning to take place about conspecifics motives and intentions. This may be reflected in the phenotype of positive shyness.

Second, the expression of positivity may play an adaptive regulatory function in modulating arousal during stressful situations which is consistent with the tension-releasing hypothesis of positive affect (Sroufe & Waters, 1976). While positive shy children may experience fear in a social situation, they are simultaneously regulating their arousal through positive emotional expressions which allow them to remain oriented and engaged with their social partner (Colonnesi et al., 2014, 2017; Nikolić et al., 2016; Reddy, 2000; Sroufe & Waters, 1976; Sroufe & Wunsch, 1972). Across time, this social engagement during feared social situations can help to develop social competence and protect the shy child from developing behaviors associated with emotion dysregulation such as anxiety (Colonnesi et al., 2014, 2017; Poole & Schmidt, 2019b).

In contrast to positive shyness, the expression and experience of negative shyness may reflect a relatively *nonadaptive* strategy for coping with social situations perceived as stressful. The reason is that it reflects active avoidance of presumably threatening social situations and consequently does not allow the individual to develop social competencies in such situations (Colonnesi et al., 2014, 2017). We have further speculated that some forms of less adaptive shyness (e.g., negative shyness) may be subserved by evolutionarily old brain circuits and may have evolved to facilitate withdrawal from danger which may reflect a sensitivity bias to detect threat (Schmidt & Poole, 2019). Although this avoidance behavior may serve an immediate function in alleviating arousal, this social disengagement is a short-term regulatory strategy. This social avoidance may result in a lack of social interaction practice and may lead to a lack of coping strategies to deal with the perceived stress of social situations, resulting in heightened levels of anxiety.

Correlates of Positive and Negative Shyness

A series of recent empirical studies has demonstrated differences in social adjustment in relation to positive and negative expressions of shyness in toddlers and preschoolers. For example, Colonnesi et al. (2014, 2017) have examined positive and negative

facial expressions of shyness in relation to social functioning in young children. In their work, they have performed microlevel coding of positive expressions of shyness which is operationalized as positive facial expression, smiling, with co-occurring gaze/head aversion (See also Colonnesi et al., this volume, Chap. 3). This operationalization of coded expressions of positive shyness is similar to the coding and conceptualization of *embarrassment* in early work by Lewis and colleagues (see Lewis, 1995; Lewis & Ramsay, 2002; Lewis, Sullivan, Stanger, & Weiss, 1989).

In toddlers, positive shyness expressed during a social performance was associated with higher parent-reported sociability and lower parent-reported anxiety, while negative expressions of shyness (operationalized as negative facial expression with co-occurring gaze/head aversion) were associated with lower parent-reported sociability (Colonnesi et al., 2014). Further, work by the same group found that negative expressions of shyness in preschool-aged children were associated with more symptoms of parent-reported social anxiety and lower theory of mind abilities, while positive expressions of shyness were associated with fewer symptoms of parent-reported social anxiety and more advanced theory of mind abilities (Colonnesi et al., 2017). The finding of more advanced theory of mind abilities among preschoolers expressing positive shyness has been recently replicated in a different sample of children (MacGowan, Colonnesi, Nikolić, & Schmidt, 2019). This work highlights the point that positive expressions of shyness may have benefits in early childhood, including increased sociability and social understanding and fewer symptoms of anxiety relative to negative shyness.

We recently examined if positive and negative shyness were distinguishable on measures of social adjustment and behavior in middle childhood (Poole & Schmidt, 2019a). Examination of positive and negative shyness in school-aged children is important because during this developmental period, children enter a school setting and are expected to engage in increasingly complex social interactions, undergo further cognitive development underlying social-evaluative concerns (Crozier & Burnham, 1990; Lagattuta & Thompson, 2007), and rely heavily on peer acceptance (Werner & Crick, 2004).

Our operationalization of positive and negative shyness differed somewhat from previous studies in that we used macro-level coding (as opposed to microlevel) of children's full-body avoidance and the expression of positive affect observed during a task in which children presented a speech. Using these data, we formed three shyness groups as follows: (1) *positive shy* (high avoidance and high positivity), (2) *negative shy* (high avoidance and low positivity), and (3) *low shy* (low avoidance). Similar to previous work in toddlers and preschoolers, we found that negative shy school-aged children were more socially anxious according to both parent- and teacher-report and less sociable according to parent-report, and they also displayed reduced activity level (a fearful behavioral response) during the delivery of a speech relative to the positive shy and low shy children. The positive shy and low shy children were indistinguishable across all of the study dependent measures of social behavior and functioning (Poole & Schmidt, 2019a). This is an important point as it demonstrates that shy children who expressed positive affect during a social stressor had similar psychosocial functioning as low shy children which means that despite

their shyness, they are similarly adjusted to low shy children possibly highlighting the adaptiveness of the behavioral responses in positive shy children.

As mentioned above, positive shyness is thought to reflect a desire to engage in social situations (i.e., approach) while also experiencing feelings of fear. In contrast, negative shyness is thought to reflect a dominant avoidance motivation in social situations. These postulations have been supported when examining psychosocial and behavioral correlates such that positive shyness is correlated with social approach (i.e., sociability; Colonnesi et al., 2014, 2017; Poole & Schmidt, 2019a) and negative shyness is correlated with social avoidance (anxiety and fear; Colonnesi et al., 2017; Poole & Schmidt, 2019a).

These different underlying motivations among positive and negative shyness may be mediated by biological processes involved in the expression and experience of approach and avoidance-related emotions. Using frontal brain activation models of emotion (e.g., Davidson, 1993, 2000; Fox, 1994), we recently tested the hypothesis that adaptive (i.e., positive shyness) and nonadaptive (i.e., negative shyness) forms of shyness may be differentially instantiated in the brain (Poole & Schmidt, 2019b). As in our previous study (Poole & Schmidt, 2019a), we operationalized three shyness groups as follows: (1) *positive shy* (high avoidance and high positivity), (2) *negative shy* (high avoidance and low positivity), and (3) *low shy* (low avoidance). This sample was comprised of children who were selected for heightened symptoms of social anxiety through referral from children's mental health agencies. In this study, children had resting state electroencephalography (EEG) collected, which measures electrical brain activity across different frequency ranges and is a helpful tool for measuring biological predispositions underlying motivation and emotion. Resting state, baseline measures of brain activity are routinely conceptualized as trait-like measures that are stable across time and context (see Coan & Allen, 2004; Harmon-Jones & Gable, 2018; Reznik & Allen, 2018, for reviews). We were specifically interested in two EEG metrics that have previously been implicated in approach-avoidance motivation and emotion regulation, which included frontal alpha asymmetry and delta-beta correlation, respectively.

Frontal alpha asymmetry scores are computed by determining the difference in EEG alpha power in the right frontal hemisphere *minus* EEG alpha power in the left frontal hemisphere. The left frontal brain is thought to underlie positive affect (e.g., happy) and approach-related motivations (e.g., sociability), while the right frontal brain is thought to underlie negative affect (e.g., fear) and withdrawal-related motivations (e.g., social avoidance) (Davidson, 1993, 2000; Fox, 1994; Schmidt, 1999; Sutton & Davidson, 1997). Thus, frontal alpha asymmetry scores can provide information on an individual's underlying emotions and motivations. Our results revealed that children classified as negative shy displayed greater relative resting right frontal EEG activity (a neural correlate of avoidance), whereas children classified as positive shy and low shy displayed greater relative resting left frontal EEG activity (a neural correlate of approach) (Poole & Schmidt, 2019b). Among this study, convergent evidence for motivational differences among different types of shy children was found with a parent-reported measure, such that the negative shy children showed higher levels of school avoidance relative to the positive shy and

low shy children who did not differ on this measure. These findings parallel previous work and provide further evidence that positive shyness may be an approach-dominant form of shyness, whereas negative shyness is an avoidance-dominant form of shyness.

The second neural correlate we examined was delta-beta correlation which is thought to reflect the efforts of regulatory networks to downregulate arousal in the subcortical networks (Knyazev, 2007; Knyazev & Slobodskaya, 2003; Schutter & Knyazev, 2012), and thus some researchers have conceptualized delta-beta correlation as a proxy for emotion regulatory abilities. Our results revealed a relatively higher frontal delta-beta correlation among the positive shy children compared to the negative shy and low shy children (Poole & Schmidt, 2019b). Positive shy children may display greater synchrony of delta and beta oscillations due to their efforts to regulate feelings of arousal.

In summary, empirical work has found that from toddlerhood through to middle childhood, positive shyness tends to be correlated with more adaptive outcomes and may be conceptualized an approach-dominant form of shyness, whereas negative shyness may be relatively less adaptive and conceptualized as an avoidance-dominant subtype of shyness.

Proposed Developmental Model of Adaptive Shyness Subtypes

Although the early developmental origins of adaptive and nonadaptive forms of shyness have been largely unexamined empirically, we have proposed a theoretical model that might help explain the development and maintenance of shyness subtypes in Fig. 1. We speculate that both positive and negative shyness may be rooted in early temperamental biases in the opening months of life (Poole et al., 2018; Schmidt & Poole, 2019). Specifically, it is likely that both types of shyness are linked to behavioral inhibition in infancy and toddlerhood, which is a temperament characterized by a tendency to react to novel stimuli with wariness (Garcia-Coll, Kagan, & Reznick, 1984). However, there may be divergence in shyness subtypes as some shy toddlers may be experiencing and/or expressing fear and competing sociability/positive affect in early life (Colonnesi et al., 2013; Reddy, 2000). These children may be characterized by an approach-dominant form of shyness placing them on a path to positive shyness. In contrast, there is another subset of shy toddlers who retain a high sensitivity to fear in novel social situations reflective of an avoidance-dominant form of shyness, placing them on a path toward negative shyness. We hypothesize that this negative shyness may be similar to the fearful subtype of shyness described by Buss (1986a, 1986b) and behavioral inhibition described by Kagan and his colleagues (Garcia-Coll et al., 1984; Kagan et al., 1988), which is thought to emerge in the first year of postnatal life and be maintained across development due to heightened sensitivity to fear and low levels of sociability. Indeed, work has found that negative shy children display more

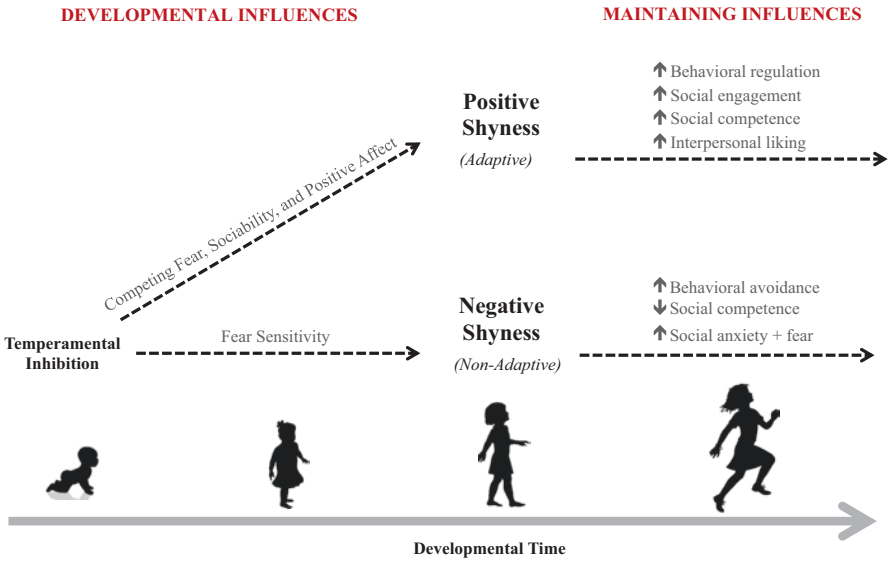

Fig. 1 Proposed model for the development and maintenance of adaptive and nonadaptive subtypes of shyness

fear-related behavior during a social stressor and lower levels of sociability (Colonnesi et al., 2014, 2017; Poole & Schmidt, 2019a).

The different underlying social motivations among positive shy and negative shy children may be mediated by biological processes involved in approach-avoidance emotion and motivation. For example, some shy children may have underlying biological diatheses corresponding to approach-related behavior such as left frontal asymmetry (Poole & Schmidt, 2019a), which may result in the positive shy child to experience rewarding aspects of social interaction and also have higher levels of social approach, as reflected by higher levels of sociability in early and middle childhood. In contrast, some shy children may have the corresponding underlying biological diatheses for avoidance-related behavior such as right frontal asymmetry (Poole & Schmidt, 2019a), which may play a role in them perceiving the socially threatening aspects of social interaction and facilitate maintenance of social avoidance in new situations. It should be noted that, given the relative lack of longitudinal studies in positive and negative shyness, it remains unclear whether these biological influences result in the development of these shyness subtypes or, conversely, if these patterns of brain activity develop in response to the behavioral patterns of the two shyness subtypes (Although see Colonnesi et al., this volume, Chap. 3).

Beyond developmental and biological influences, it is also important to note the processes that may play a role in the maintenance of adaptive and nonadaptive subtypes of shyness and ultimately how these processes may result in different developmental outcomes. As mentioned, the expression of positive affect characteristic of positive shyness may signal one's interest in social interaction and result in approach from social partners (Sroufe & Waters, 1976). Although these social inter-

actions may be initially overwhelming for the shy child, over time this may actually yield benefits as it may have allowed for greater social exposure and help modify the child's perceptions of the threatening aspects of social situations. With continued exposure to, and engagement in, social situations, the positive shy child may be able to develop adaptive coping strategies. Ultimately, this may play a protective role in the manifestation of nonadaptive outcomes such as heightened social anxiety.

Further, expressions of positive shyness are thought to signal that the shy individual is concerned with social norms and that he/she wants to be socially accepted (Colonnesi et al., 2014; Keltner, 1995; Keltner & Buswell, 1997). This may facilitate interpersonal liking, as social partners witnessing these coy behaviors may show compassion toward the positive shy individual. These empathetic responses from novel social partners toward the shy individual may serve to reinforce the shy individual's perceptions and cognitions related to threat in social situations. Across time, this may result in a cycle through which positive shy expressions increase positive interpersonal relations which in turn modify cognitions related to the nature of social threat.

In contrast, although the avoidance behavior characteristic of negative shy children may serve an immediate function in alleviating arousal, this social disengagement is a short-term regulatory strategy. Across development, this avoidance response may become habitual for the shy child and result in a behavioral blueprint of disengaging from social situations and ultimately lead to a lack of coping strategies to deal with the perceived stress of social situations. As children undergo further social cognitive development, this may feed into a cycle of social-evaluative concerns and possibly underlie risk for some types of psychopathology such as social anxiety disorder. As well, social partners may not view the characteristic withdrawn behaviors of negative shy children as socially attractive, particularly by middle to late childhood. Because these children do not have a strong approach motivation to interact, they may not have the same opportunities for social engagement and social learning or the social benefits accompanying these processes relative to positive shy children. It is possible that lack of positive affect in social challenges may be one mechanism for continuity of negative shyness.

Future Directions

Although emerging work has been instrumental in better understating the adaptive aspects of shyness, there are still many areas that remain to be examined. The majority of published work has focused on normative samples of typically developing children. Among these samples, it appears that positive shyness may serve adaptive social functions. In light of these findings, it seems plausible that encouraging shy children to express positivity in feared social situations may be a regulatory behavior that may help them to deal with arousal and increase long-term social success. We know, however, comparably little about how positive expressions of shyness may promote adaptive outcomes among children with extremely high levels of social fear. Recently, among a clinical sample of children selected for high levels of

social fear, we found (marginally) significant differences in patterns of social functioning based on shyness subtype among children who, as a group, were relatively high on social fearfulness. Specifically, we found that children classified as positive shy had the highest levels of parent-reported social cooperation relative to the negative shy and low shy children. As well, the negative shy children were rated as having the highest levels of parent-reported social anxiety relative to positive shy and low shy children (Poole & Schmidt, unpublished observations). This is an important point as this was a clinically recruited sample comprised of children selected for high levels of social anxiety. This illustrates that even among highly socially fearful children, the expression of positivity in feared social situations may serve adaptive social functions. Similar to findings in community samples, the expression of positivity may facilitate social cooperation perhaps due to an appeasement function as well as help to modulate social anxiety. It will be important for future work to systematically examine how positivity may influence developmental outcomes among clinical samples.

An additional area of future research is to empirically examine if the expression of positive shyness and negative shyness is differentially related to peer relations. As mentioned, examining positive and negative shyness in school-aged children is important because during this developmental period, children enter a school setting and are expected to engage in increasingly complex social interactions and rely heavily on peer acceptance (Werner & Crick, 2004). This is particularly important because previous work has reported that shy children may be at higher risk of peer rejection and victimization (Eggum-Wilkens et al., 2014; Rubin et al., 2009). Based on emerging work, it may be hypothesized that children expressing positive shyness may have more positive peer relationships, either due to the appeasement role of positivity or due to their developed social competencies and social skills. Differences in peer relations among positive shy and negative shy children could be assessed using questionnaire-based indices of friendship quality and peer relations, as well as through direct observations of children interacting on the school playground or in the laboratory during dyadic interactions. This would help to confirm if interpersonal liking may be one mechanism facilitating adjustment in positive shyness.

The majority of published work related to adaptive (i.e., positive shyness) and nonadaptive (i.e., negative shyness) has been in relatively young children. An important and interesting future direction for this work is to study whether different expressions of shyness may result in different adaptive and nonadaptive outcomes across different domains later in development. For example, the expression of positive shyness has been regarded as similar to that of embarrassment and is correlated with a blushing response (Nikolić et al., 2016). Interestingly, these expressions are thought to serve an appeasement function to social partners and may be viewed as attractive attributes in samples of adults. Thus, it will be interesting to examine if positive and negative expressions of shyness are related to mate selection and reproductive success.

An additional area that has been relatively unexplored in the context of shyness subtypes is the attentional and cognitive underpinnings of adaptive and less adaptive subtypes of shyness. Previous work has hypothesized that fear-based subtypes of

shyness may be related to *automatic* attentional processes (e.g., novelty detection, attention bias to threat), whereas other types of self-conscious or positive shyness may be related to *controlled* attentional processes (e.g., attention shifting and inhibitory control) (Schmidt & Poole, 2019). However, this has yet to be empirically tested. It will be informative to examine whether different cognitive processing styles may serve as mechanism linking shyness subtypes to adaptive and nonadaptive outcomes in children.

Conclusion

Overall, we have provided evidence that there is heterogeneity in the phenomenon of shyness. Importantly, we have illustrated that not all shy children are at risk for poor developmental outcomes. By using the phenotypes of positive shyness and negative shyness, we have aimed to illustrate that some types of shyness may actually have adaptive values in terms of psychosocial functioning. Specifically, it appears that the expression of positivity in feared social situations may have an adaptive social function that helps to facilitate social interaction and modulate behavioral arousal. We recommend that future work continue to examine heterogeneity in shyness in order to bring greater precision and clarity into understanding how and why some subsets of shy children appear to adapt well to their social environments and others do not.

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Development and Psychophysiological Correlates of Positive Shyness from Infancy to Childhood

Cristina Colonnesi, Milica Nikolić, and Susan M. Bögels

Introduction

Human facial expressions of emotions are supposed to be, already from infancy and in all the cultures around the world, a reflection of our internal emotional states (Ekman, 1994; Izard, 1994; Izard & Malatesta, 1987). From an evolutionary perspective, emotions arise to prepare the organism to react to environmental demands (Darwin, 1872; Ekman, 1992; Izard, 1977; Lazarus, 1991). In social contexts, emotional facial expressions have the function to regulate interactions and to influence the receiver in ways that are beneficial to the sender (Russell, Bachorowski, & Fernández-Dols, 2003). Facial expressions are, thus, an essential aspect of social communication, and difficulties in showing (or understanding) these expressions can impair social relations and possibly lead to abnormal development (Keltner & Kring, 1998; Keltner, Moffitt, & Stouthamer-Loeber, 1995). One of the most fascinating facial expressions is the expression of shyness, which can be displayed through gaze or head aversions produced during a neutral or negative facial expression (negative valence) or during a positive facial expression (positive valence). Shy facial expressions communicate one's concern or worry about being socially exposed to others' attention or evaluations but, at the same time, the wish to remain engaged in the situation and to make a good impression (Asendorpf, 1990; Buss, 1986; Colonnesi, Napoleone, & Bögels, 2014; Reddy, 2000; Schlenker & Leary, 1982). In the present chapter, we illustrate how the facial expressions of shyness

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develop from infancy to childhood and to what extent they are related to specific physiological reactions.

Human expressions of shyness are manifestations of their individual experience of emotions, which can vary based on their temperament (Keltner & Ekman, 2003) and the specific social situation (Colonnesi et al., 2014). In this regard, a distinction should be made between trait and state shyness (Asendorpf, 1989; Crozier, 1990). Trait shyness refers to the individual predisposition or temperamental shyness. Trait shyness is generally indexed through parents' or child's report on questionnaires, and it is based on a deep knowledge of the child's feelings and behavior across situations for a long period of time (Colonnesi, Engelhard, & Bögels, 2010; Crozier, 1995; Russell, Cutrona, & Jones, 1986). Therefore, it is assumed to be a stable characteristic of the child. Empirical evidence shows a modest to moderate developmental stability of trait shyness from infancy to childhood (e.g., Karevold, Ystrom, Coplan, Sanson, & Mathiesen, 2012) and from childhood to adulthood (e.g., Tang et al., 2017). In contrast, state shyness refers to the feeling and expression of shyness that everyone can experience, during a specific event. State shyness is regarded as an interaction among characteristics of the specific social situations, child's temperament or personality, level of self-consciousness, and social coping abilities (Colonnesi, Nikolić, de Vente, & Bögels, 2017). State shyness is usually assessed with experimental procedures eliciting shy reactions (e.g., Colonnesi et al., 2014, 2017; Colonnesi, Bögels, de Vente, & Majdandžić, 2013; DiBiase & Lewis, 1997; Poole & Schmidt, 2019). To date, no empirical study has investigated the developmental trajectories of state shyness from infancy to childhood. Knowledge on the developmental stability of state shyness is paramount to understanding to what extent children expressions of shyness change as a result of development and environmental influences.

The transition from infancy to childhood is probably one of the most interesting aspects of the developmental stability of the expressions of shyness. According to Lewis and colleagues, state shyness is a manifestation of the development of self-consciousness in children (DiBiase & Lewis, 1997; Lewis, Stanger, Sullivan, & Barone, 1991; Lewis, Sullivan, Stanger, & Weiss, 1989). That is, in order to experience a self-conscious emotion, the child needs to develop self-awareness, which is the ability to recognize oneself as an individual separate from the environment and other individuals. Self-awareness is manifested in self-referential behavior, such as the self-recognition in a mirror (i.e., self-recognition task), which emerges around the age of 15–18 months (Amsterdam, 1972). Since self-awareness is not yet developed in the first year of life, infants are expected to be incapable of experiencing and displaying shy emotions (Lewis et al., 1989). Lewis and colleagues also provided empirical evidence about a positive concurrent association between self-recognition and shyness in children older than 12 months, confirming their association only after the first year of life. Similarly, Buss (1986) proposed two different and independent forms of shyness in infancy and childhood: a fearful shyness in infancy, manifested with negative behavior like crying, distress, and other fear reactions, and a self-conscious shyness in childhood, manifested with embarrassment, blushing, disorganized behavior, and cognitive anxiety. A longitudinal study corroborated

Buss' theory, finding no concurrent, nor longitudinal, association between fearful and self-conscious shyness in the transition from infancy to childhood (Eggum-Wilkens, Lemery-Chalfant, Aksan, & Goldsmith, 2015).

An alternative perspective has been proposed by Reddy and colleagues (Draghi-Lorenz, Reddy, & Costall, 2001; Draghi-Lorenz, Reddy, & Morris, 2005; Reddy, 2003). Infants are able, already in early infancy, to interact socially. Hence, Reddy (2005) argued that infants already have a form of pre-awareness of others as attending beings and of the self as an object of others' attention (Reddy, 2003; Trevarthen, 1993). This first form of awareness precedes and shapes the later self-conscious representations. In line with this hypothesis, some evidence of shyness should be observable already in the first year of life, and the expressions of shyness in infancy should be to some extent associated to the expressions of shyness after infancy. Testing the developmental stability of state shyness in the transition between infancy and childhood would shed some light on the possible role of self-awareness in the development of state shyness.

A last crucial aspect in the development of shyness is the association between the expressions of shyness and physiological reactions. As every other emotional state, shyness is accompanied not only by the behavioral component (i.e., facial expression), which serves a social function, but also by physiological reactions, which help the organism to respond to the demands of the environment in adaptive ways (Cannon, 1914; Darwin, 1872). In line with this assumption, physiological arousal should accompany the facial expressions of shyness. In this chapter, the research on the psychophysiology of positive and negative shyness is reviewed and discussed. Because not much research has been done on physiological underpinnings of positive or negative shyness specifically, we will first shortly draw on psychophysiological research of shyness usually defined as a temperamental trait (Buss, 1980; Rubin, Coplan, & Bowker, 2009). Then, we will discuss what physiological underpinnings are expected in positive shyness based on the theory and past research of more adaptive forms of shyness. Finally, we will build on the theory and existing evidence by offering empirical findings from our laboratory on the psychophysiology of positive vs. negative shyness.

Positive and Negative Expressions of Shyness

A fascinating question is when expressions of shyness do appear in human development. Already in the first months of life, infants display positive and negative facial expressions with clear social functions (Colonnesi, Zijlstra, van der Zande, & Bögels, 2012; Messinger & Fogel, 2007). Facial expressions of shyness, called "coy smiles" or "shy smiles," have been observed in early infancy (Colonnesi et al., 2013; Reddy, 2000; Stifter & Moyer, 1991; Young & Décarie, 1977). They are smiles, with closed or open mouth, in combination with gaze aversion, head aversion (downward or sideways), or both (Asendorpf, 1990; Colonnesi et al., 2014; Reddy, 2000). Head aversions during coy smiles appear to be uncontrolled contractions of the muscles

directed to decrease or avoid the social contact and to seek protection (e.g., turning to the upper body of the mother when the infant is in the parent's arm). The possible function of head and gaze aversions is to regulate internal states and to reduce arousal by avoiding social contact (Stern, 1974; Stifter & Moyer, 1991). Head aversions are often combined with upper-body aversion or arm rising. Interestingly, although when displaying a coy smile infants break the interaction with the aversion, gaze or head returns are often observed. Doing so, they do not break completely the social interaction (Reddy, 2005).

To our knowledge, Reddy (2000) conducted the first study on positive shyness in early infancy, observing the production of coy smiles in five infants longitudinally (from 7 weeks till 20 weeks) during positive interactions in natural contexts with the parents, a stranger, and the self in a mirror. On average, 21% of the smiles produced by the infants were coy smiles (with gaze aversion, head aversion, or both gaze and head aversions). The first occurrence of coy smiles ranged from 8.4 to 11.1 weeks, and the frequency of production increased with age in four of the five infants. Interestingly, parents reported that after 15 weeks, coy smiles were increasingly directed to strangers. This study established the structural configuration of the facial expressions of shyness in infancy and showed clear morphological similarities between the expressions of shyness in early infancy and those reported in studies with older children and adults. The similarities in the structural configuration between the shy expressions in infancy and in adults was confirmed by the study of Draghi-Lorenz et al. (2005) in which the same videos were rated by independent adult observers who were able to distinguish the shy expressions from the other expressions (e.g., happy, interested, surprised, and upset).

Besides the structural configuration, empirical research has been conducted to investigate the functional similarities between the expressions of shyness in infancy and at later age. In children and adults, shyness is enhanced by interactions with novel persons (Bretherton & Ainsworth, 1974) or when seeing one's own reflection in the mirror (Amsterdam, 1972; Amsterdam & Greenberg, 1977; Lewis et al., 1989; Reddy, 2000). Colonnesi et al. (2013) tested this hypothesis in young infants. The authors systematically observed the production of coy smiles of eighty 4-month-old infants during a series of situations in front of a mirror: seeing only themselves in the mirror, seeing only a familiar (mother, father) or unfamiliar (stranger) person in the mirror, and seeing both themselves and the other person in the mirror. Infants' produced significantly more coy smiles in the situations in which they could see themselves interacting with the social partner in the mirror as compared to the situation in which they could see only the social partner, confirming the finding in adults that shyness is enhanced by one's own mirror reflection because of heightened self-awareness. In addition, as already reported by the parents in Reddy's study (2000), infants produced significantly more coy smiles when they interacted with a novel person than when they interacted with a familiar person or when there was no interaction. The results established functional similarities between the expression of shyness in infancy and at a later age.

Far less investigated in infancy are the negative expressions of shyness. Young and Décarie (1977) distinguished in 9- to 12-month-old infants' two expressions of

shyness. The first was the "positive expressions of shyness" (shy smile) in which the eyes may be directed downward during a closed-mouth smile. The second was the "nonpositive expression of shyness" (shy face), in which the eyes are directed downward or sideways, during the absence of smile or with lips slightly retracted laterally and pressed together. These two facial expressions, however, have been never empirically investigated in infancy. In childhood, facial expressions of shyness, especially negative facial expressions, have been generally observed together with verbal and body behaviors in more general coding systems of children's embarrassment or shy and inhibited behaviors (e.g., movement of the hand to touch part of the body, face or hair, or blushing; DiBiase & Lewis, 1997; Greenberg & Marvin, 1982; Lewis et al., 1989, 1991).

Only a few studies have explored facial expressions of shyness alone in childhood. Colonnesi et al. (2014) observed 2.5-year-olds' facial expressions of positive and negative shyness during a performance task in which children were asked to imitate the noise of different animals in front of a mirror. The pattern of positive expressions of shyness was analogous to the one found in 4-month-old infants in the study by Colonnesi et al. (2013). Besides, negative expressions of shyness were also observed in toddlers. Negative shy expressions were observed when a gaze aversion, head aversion, or both appeared during a negative facial expression (e.g., frown). The same coding system was used by Colonnesi et al. (2017) and Nikolić, Colonnesi, de Vente, and Bögels (2016) to observe 4.5-year-old children's shy expressions during a performance task, in which children were asked to sing a song on stage. In both studies, positive and negative expressions of shyness were found to be negatively associated with each other. Colonnesi et al. (2014) suggest that both expressions are likely to serve the purpose to cope with the arousal during social anxiety-provoking situations. Positive shy expressions seem to have, however, a more adaptive function because they reduce arousal without interrupting the social interaction and because they enhance social affiliation (Feinberg, Willer, & Keltner, 2012). Conversely, negative expressions of shyness seem to absolve the short-term function of reducing arousal but can be more maladaptive in the long term reducing social contact and self-confidence (Thompson & Calkins, 1996). Similarly, Poole and Schmidt (2019) recently investigated the expressions of positive and negative shyness in 7-year-old children during a performance task (i.e., self-presentation task). In this study, positive shyness was qualified as high positivity (i.e., smiling, giggling) and high avoidance behavior (i.e., leaning or stepping away from the camera), negative shy as low positivity and high avoidance behavior, and non-shy as low avoidance behavior. The authors found that negative shy children had high levels of social anxiety and lower level of sociability, while positive shy children were equivalent to non-shy children. All together, these findings provide evidence about the heterogeneity of shyness and suggest the presence of two specific subtypes of expressions: positive shyness which is an adaptive way to cope with shy feelings by reducing arousal and enhancing social affiliation and negative shyness, which is a maladaptive form of shyness, related to social anxiety and a low social understanding.

Developmental Stability in the Expressions of Shyness from Infancy to Childhood

Although a series of cross-sectional studies illustrated the structural configurations and functions of the facial expressions of shyness in infancy and childhood, no past studies have investigated the developmental stability of shy expressions. Research shows that temperamental shyness, as reported by parents, presents a moderate stability from infancy to late childhood and appears to be less stable from infancy to childhood and increasingly stable from early childhood to middle childhood (e.g., Asendorpf, 1990; Degnan, Henderson, Fox, Rubin, & Nichols, 2008; Karevold et al., 2012; Pedlow, Sanson, Prior, & Oberklaid, 1993) and from middle childhood to adulthood (Tang et al., 2017). Since the expressions of shyness are regarded as manifestations of temperamental shyness, a similar pattern should be expected.

We combined data of our longitudinal study from 4 to 72 months (Colonnesi et al., 2013, 2014, 2017) in order to test the temporal stability (rank order stability over time) of the positive and nonpositive or negative expressions of shyness from infancy to late childhood. We included data of positive expressions of shyness at 4 months (Colonnesi et al., 2013 and unpublished data), positive and nonpositive expressions of shyness at 12 months (unpublished data), and positive and negative expressions of shyness at 30 months (Colonnesi et al., 2014), 48 months (Colonnesi et al., 2017; Nikolić, Colonnesi, et al., 2016), and 72 months (unpublished data). Participants were 115 children (51 boys and 64 girls). Although different tasks were used during infancy (attention of a stranger), toddlerhood (performance in front of a mirror), and childhood (performance: singing a song for a small public), we always used the comparison data of situations (first 60 s) in which the child obtained the attention of or performed for a novel person (stranger).

Table 1 shows the main characteristics, task used, and coding systems selected in each measurement to test the developmental stability of the expressions of positive and nonpositive shyness across studies. The correlations between positive and neutral/negative shyness at each time were as follows: $r(99) = -0.12$, $p = 0.220$ at 12 months; $r(96) = -0.24$, $p = 0.019$ at 30 months; $r(92) = -0.31$, $p = 0.003$ at 48 months; and $r(78) = -0.08$, $p = 0.484$ at 72 months (based on only four children who displayed negative shyness).

We performed two autoregressive models using structural equation modeling with the software AMOS 25.00 to test the temporal stability of the expressions of positive shyness from 4 till 72 months and of nonpositive shyness from 12 to 72 months. The key feature of the autoregressive model is the regression of a variable on its earlier value, and it is, therefore, a well-suited method for analyzing the stability of observed or latent variables (Bollen & Curran, 2004). Missing data were estimated using the full information maximum likelihood estimation in AMOS. The model for positive expressions of shyness presented a good fit, $\chi^2 = 3.81$, $df = 6$; CFI = 1.00; RMSEA = 0.00, 90% CI [0.00, 0.09]. Figure 1 presents the standardized estimation weights for the model of positive expressions of shyness. Stability was significant in the first year of life (4–12 months) and early childhood (30–48 months)

Table 1 Overview of the longitudinal study

Measurement moment	No. of children	Tasks or subtask	Measures of shyness (coding)	Measures of autonomic arousal
4 months (Colonnesi et al., 2013; unpublished)	119	Interactions in front of a mirror with a stranger	*Positive expressions of shyness (coy smiles)*: number of smiles in which a gaze aversion, a head aversion, or both occurred in the time between 1.5 and 0 s before the apex of the smile	–
12 months (unpublished)	110	Interactions in front of a mirror a stranger	*Positive expressions of shyness (coy smiles)*: number of smiles in which a gaze aversion, a head aversion, or both occurred in the time between 1.5 and 0 s before the apex of the smile *Nonpositive expressions of shyness*: number of neutral or negative facial expressions in which a gaze aversion, a head aversion, or both occurred in a temporal episode of 2 s	–
30 months (Colonnesi et al., 2014)	102	Mimic of animal sounds together with a novel person	*Positive expressions of shyness*: number of positive facial expressions in which an aversion (gaze, head, or both) occurred within 1.5–0.0 s prior to the apex of the smile *Negative expressions of shyness*: number of negative facial expressions in which an aversion (gaze, head, or both) occurred in a temporal episode of 2 s	–
48 months (Colonnesi et al., 2017)	96	Sing a song in front of a small audience (two experimenters and the father)	*Positive expressions of shyness*: number of positive facial expressions in which an aversion of gaze, head, or both occurred within 2–0.0 s prior to the apex of the smile *Negative expressions of shyness*: number of negative facial expressions in which an aversion of gaze, head, or both occurred in a temporal episode of 2 s	Heart rate (HR) Heart rate variability (HRV) Skin conductance (SC) level
72 months (unpublished)	83	Sing a song in front of a small audience (two experimenters and the father)	*Positive expressions of shyness*: number of positive facial expressions in which an aversion of gaze, head, or both occurred within 2–0.0 s prior to the apex of the smile *Negative expressions of shyness*: number of negative facial expressions in which an aversion of gaze, head, or both occurred in a temporal episode of 2 s	Heart rate (HR) Heart rate variability (HRV) Skin conductance (SC) level

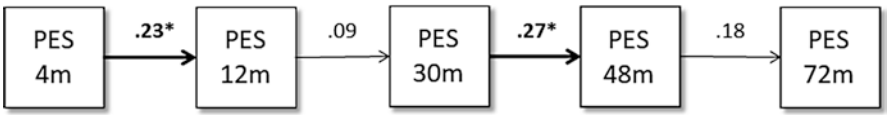

Fig. 1 Autoregressive model testing the expressions of positive shyness (PES) at 4 months (4m), 12 months (12m), 30 months (30m), 48 months (48m), and 72 months (72m)

but not in the transition from infancy to childhood (12–30 months) and from early to later childhood (48–72 months).

A second model was performed for the expressions of nonpositive at 12 months and negative shyness at 30 and 48 months. The expressions of negative shyness at 72 months were too infrequent (i.e., only four children displayed these expressions) to be included in the analysis. Moreover, for this model, we excluded four participants who dropped out after 12 months. The model presented a good fit, $\chi^2 = 0.63$, $df = 1$; CFI = 1.00; RMSEA = 0.00, 90% CI [0.00, 0.21]. Stability between 12 and 30 months was not significant, $\beta = 0.17$, $p = 0.114$, while stability between 30 months and 48 was significant, $\beta = 0.23$, $p = 0.030$. We can, therefore, conclude that the expressions of nonpositive or negative shyness were unstable from infancy to childhood, but they were stable in middle childhood.

Our findings for the facial expressions of shyness are only partially in line with previous results on shyness as a temperamental trait. While shy temperament seems to be moderately stable from infancy to late childhood, the way shyness is displayed via positive or negative facial expressions is not stable in the transition from infancy to childhood and from early childhood to later childhood. The instability in the transition from infancy to childhood can be explained by the development of self-awareness and self-consciousness in the second year of life (DiBiase & Lewis, 1997; Lewis et al., 1989, 1991). From this perspective, the first manifestation of shyness in infancy is only a mere and undifferentiated emotional reaction to others' attention, and it is not determined by self-awareness. Beyond infancy, shyness becomes a self-conscious reaction, displayed in specific situations in which the child experiences the feeling and the awareness of others' attention and possible evaluations. Still, the expressions of shyness in infancy can be, as proposed by Reddy (2000), a form of pre-awareness of others' attention, preceding and shaping the later development of self-consciousness. This can be assumed on the basis of the shared structural (i.e., facial expression configuration) and functional (i.e., reaction to others' attention of self-reflection) features (Colonnesi et al., 2013). A last possible explanation is the assessment of positive shyness. While at 4 and 12 months we used tasks in which the infants were exposed to positive attention of adults (e.g., compliments), at later ages children were asked to perform in a task (i.e., imitating animal noises or singing a song). The lack of an approach-exposure task during childhood did not allow us to test a task-effect hypothesis.

Less expected was the lack of stability of both positive (i.e., no significant association) and negative (i.e., lack of negative expressions) shy expressions from 48 to

72 months. A possible explanation is that later individual socio-cognitive development (e.g., advanced social cognition, social skills) and effortful control are responsible for less frequent and more regulated shy reactions (Karevold et al., 2012; Raffaelli, Crockett, & Shen, 2005). In other words, in later childhood, children's perception and evaluation of social situations, as well as their emotional reactions, become more defined. This determines specific individual developmental trajectories of the expressions of shyness.

Psychophysiology of Positive Shyness

Physiological Underpinnings of Shyness

Shyness is assumed to originate in dysregulation of the fear system (Kagan, Reznick, & Snidman, 1988; Schmidt, Polak, & Spooner, 2005). Because shy children perceive social situations as a threat and fear how others will evaluate and react to them, the fight-or-flight reaction to threat is activated and shy children become hyperaroused in social situations (Kagan et al., 1988; Schmidt, Fox, Schulkin, & Gold, 1999). On the physiological level, peripheral changes, which are innervated by the autonomic nervous system, occur. Specifically, the activation of sympathetic and/or withdrawal of parasympathetic autonomic nervous system arise (Berntson, Cacioppo, Quigley, & Fabro, 1994). This has been referred to as "autonomic hyperarousal." Autonomic hyperarousal is most commonly reflected in peripheral changes such as increased heart rate (HR), reduced heart rate variability (HRV), and elevated skin conductance (SC) levels. Increased HR is thought to be a reflection of both the activation of the sympathetic system and the withdrawal of the parasympathetic system (Kreibig, 2010). Sympathetic responses to a stressor include increased adrenergic activity which causes the heart to beat faster. Besides this sympathetic influence on HR, certain pathways from subcortical structures such as the amygdala to the vagus nerve also influence HR, suggesting parasympathetic influences of HR (Levy, 1971). The reduction in high-frequency heart rate variability (HRV), which reflects variations in time intervals between heart beats, is primarily a result of parasympathetic influences on the heart (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). Finally, increased SC is thought to reflect primarily sympathetic activation because sweat glands in the skin are influenced only by sympathetic nerves (Dawson, Schell, & Filion, 2007). Thus, children who experience shyness are expected to show elevated HR, reduced HRV, and increased SC level and response due to their hyperarousal in social situations. Besides the elevated autonomic response in social situations, shy children may display elevated autonomic activity during rest (i.e., during baseline preceding the social situation) suggesting that they are more vigilant and alert than non-shy children, even when a social threat is not present (Kagan & Snidman, 1991).

In terms of elevated HR, one of the first studies on psychophysiology of shy children (Kagan, Reznick, & Snidman, 1987) showed that shy children who are extremely inhibited and cautious in unfamiliar situations have higher heart rate than less inhibited children throughout early childhood. Later studies confirmed this finding. For example, in a study with 7-year-olds (Schmidt et al., 1999), shy children displayed increases in HR as the self-presentation task became more challenging compared with children low in shyness. In another study with children aged 3 years, inhibited children who were slow to start a conversation with a stranger and who showed signs of distress in a situation with unfamiliar people showed higher HR reactivity during a task selected to elicit orienting responses (Scarpa, Raine, Venables, & Mednick, 1997). Also, higher resting HR was found to be related to temperamental shyness in 5-year-old children (Doussard-Roosevelt, Montgomery, & Porges, 2003). Only one study did not find increased baseline HR and increased HR in response to unfamiliar social situations in primary school children (Asendorpf & Meier, 1993). This result may be due to the fact that this study investigated the reactions of shy children in everyday social settings whereas all other studies investigated physiological reactions of shy children in laboratory settings, in situations which involved strangers or scrutiny/evaluation by others. Thus, it may be that shy children are hyperaroused specifically in novel social situations, including either unfamiliar people or scrutiny and evaluation by others.

Besides the increased HR, shy children tend to display reduced HRV as well. For example, shy children who were extremely inhibited and cautious in unfamiliar situations had less variable heart rate throughout early childhood (Kagan et al., 1987). Also, temperamentally shy 5-year-old children showed decreased baseline HRV (Doussard-Roosevelt et al., 2003). However, differences in HRV between more and less shy children in the self-presentation task were not found in a study with 7-year-olds (Schmidt et al., 1999). Thus, past studies offer mixed findings on reduced HRV in shy children.

To date, only one study investigated the association between shyness and skin conductance (SC) in children (Scarpa et al., 1997), showing that inhibited 3-year-old shy children who were slow in starting a conversation with a stranger and who showed signs of distress in a situation with unfamiliar people displayed increased SC reactivity (Scarpa et al., 1997). Although more evidence on increased SC in shy children is lacking, research on constructs closely related to shyness, such as social anxiety, showed that socially anxious children who become easily distressed in social situations and tend to avoid them display the patterns of increased SC during baseline and in socially challenging situations (e.g., Nikolić, de Vente, Colonnesi, & Bögels, 2016; Schmitz, Krämer, Tuschen-Caffier, Heinrichs, & Blechert, 2011).

In sum, most of the past evidence suggests the following pattern of autonomic hyperarousal in social situations in shy children: Both baseline levels and reactivity measures that reflect the activation of autonomic nervous system seem to be heightened in shy children. Of note, in all the above studies, shyness was defined as avoidance and inhibition. However, not all studies that investigated the relations between shyness and autonomic activity in children defined shyness as avoidance and inhibition. For example, regulated shyness, which is defined not as avoidance but the

ability to engage and remain in social situations in a nonassertive and unassuming way, has been related to higher HR while interacting with strangers (Xu, Farver, Yu, & Zhang, 2009).

Physiological Underpinnings of Positive and Negative Facial Expressions of Shyness

Similar to temperamental shyness, negative shyness, which is characterized by high avoidance, is expected to be accompanied by autonomic hyperarousal. However, up to date, no study investigated autonomic arousal in negative shyness. Only one study examined the relation between negative shyness and physiological blushing and found no significant relations (Nikolic, Colonnesi, et al., 2016). Unlike negatively shy children who avoid potential social threats, children who express positive shyness are assumed to show not only avoidance but also approach in social situations (Asendorpf, 1990; Colonnesi et al., 2014; Nikolic, Colonnesi, et al., 2016; Poole & Schmidt, 2019). The reason is that they experience social interest, next to feeling nervous and experiencing the motivation to avoid the social situation (Thompson & Calkins, 1996). The question is, then, whether positively shy children experience the same fight-or-flight psychophysiological reaction to socially threatening situations as negatively shy children or whether they react physiologically differently from negatively shy children.

The physiological underpinnings of positive shyness have been largely unexplored so far. In our laboratory, we found that a higher number of positive shy expressions during a social performance task are associated with more physiological blushing in 4.5-year-old children (Nikolic, Colonnesi, et al., 2016). Physiological blushing is assumed to be sympathetically driven response which occurs due to an accumulation of blood in the superficial venous plexus of the facial skin (Drummond, 2012). Therefore, physiological blushing is also, at least partly, under the control of the autonomic nervous system. However, unlike the measures of HR, HRV, and SC, physiological blushing is not typically assumed in the fight-or-flight response, but rather, it is assumed to appear when a child experiences a high level of ambivalent arousal (Nikolic, Colonnesi, et al., 2016; van Hooff, 2012). Just as positive shyness, physiological blushing may be seen as a result of the motivational conflict to approach and avoid social situations at the same time. Indeed, our study confirmed this idea by showing that positive shyness is related to physiological blushing (Nikolic, Colonnesi, et al., 2016). In this study, children were put in a socially challenging situation in which they were asked to sing a song on stage dressed up as "pop stars" in front of a small audience while being video-recorded. The findings showed that children's production of positive expressions of shyness was positively associated with blushing in the same situation. As this result did not occur for negative shyness, it may be that physiological blushing may be specific to positive shyness.

Besides physiological blushing, other indices of sympathetic activation, such as elevated HR and increased SC, may be expected in positively shy children. However, evidence on these physiological markers in positively shy children are currently lacking; thus, we do not know whether sympathetic activation indeed accompanies positive shyness. In addition, the influence of the parasympathetic system in positive shy behaviors is also currently unexplored.

A positive association between positive shyness and indices of the parasympathetic system such as HRV can be expected because children who have a higher baseline and a higher decrease in HRV are better able to regulate their emotions (Appelhans & Luecken, 2006; Porges, 1995). Assuming that positive shyness is an adaptive mechanism which helps children regulate their arousal in socially challenging situations (Colonnesi et al., 2014; Nikolic, Colonnesi, et al., 2016), one can assume that, unlike negatively shy children, positively shy children would be characterized by higher baseline HRV, which reflects a higher capacity for emotion regulation. Moreover, positively shy children can be hypothesized to have higher decreases in HRV during socially challenging situations, as this reflects better emotional coping. Two studies investigated approach and avoidance tendencies in relation to HRV in infants and young children. They found that baseline high-frequency HRV, indexed as respiratory sinus arrhythmia, was related to the tendency to approach a stranger and novel objects (Fox & Stifter, 1989; Richards & Cameron, 1989). Based on these findings, it may be expected that positively shy children, who are characterized by strong motivation to approach in social situations, display high levels of baseline HRV.

Empirical Evidence on the Physiological Underpinnings of Positive and Negative Shyness

Although there is some evidence that may suggest increased HR in positive shyness (Xu et al., 2009), it is still unclear how positive shyness relates to other measures of autonomic arousal, such as HRV, which is assumed to reflect the activation of the parasympathetic branch of the autonomic nervous system, and SC, which is an index of the activation of the sympathetic branch of the autonomic nervous system. Even more important, it is unclear how positive shyness and physiological measures relate to each other longitudinally, predicting and reinforcing each other across child development. This knowledge would allow us to better understand the nature of positive shyness and the physiological factors that may influence its development.

In the longitudinal study conducted in our laboratory in which we followed shyness from infancy to late childhood, we also measured HR, HRV, and SC levels as indices of autonomic hyperarousal at 48 and 72 months. We were, thus, able to examine how the indices of autonomic nervous system relate to, predict, and are predicted by positive shyness from infancy to later childhood. For comparison, we

also report on the associations between physiological indices and negative shy expressions.

All physiological measures were recorded and analyzed with the Vsrrp98 software (Molenkamp, 2011) on a personal computer running Windows 7. The actual data acquisition in the program was performed by a National Instruments NI6224 data-acquisition card sampling at a rate of 200S/s per channel. ECG was recorded using a standard Lead-II configuration. R-waves were automatically detected and corrected for artifacts. Two parameters were computed: HR was calculated as the number of R-waves per minute, and HRV was calculated as the square root of the mean squared differences (RMSSD) of successive normal-to-normal (NN) intervals—a commonly used HRV measure (Malik, 1996). Skin conductance level was recorded with two curved Ag/AgCl electrodes placed on the middle phalanx of the middle and index finger of the child's left hand. We measured HR, HRV, and SC during a 2-min baseline preceding the social performance task and the first 30 s of the social performance task. Therefore, we report on six models that examine positive shyness and six models that examine negative shyness in relation to baseline of HR, HRV, and SC and reactivity of HR, HRV, and SC ($n = 105$). To calculate reactivity, we subtracted the mean of 2-min baseline from the mean of the first 30-s of the performance.

We built on the auto-regressive models reported above by adding the physiological indices at 48 and 72 months. Thus, for shyness, we modeled the regression of a variable on its earlier value, and we estimated all the paths to autonomic indices concurrently and longitudinally at 48 and 72 months. Missing data were estimated using the full information maximum likelihood estimation. All the path models fitted the data well according to χ^2, CFI, and RMSEA (ranges positive shyness: $\chi^2 = 4.72–10.43$ ($df = 12$), $p = 0.578–0.967$, CFI = 1.00, RMSEA = 0.00–0.00, 90% CI [0.00, 0.09]; ranges negative shyness: $\chi^2 = 2.06–8.14$ ($df = 5$), $p = 0.149–0.840$, CFI = 1.00, RMSEA = 0.00–0.08, 90% CI [0.00, 0.17]). In the model in which we investigated the relations between positive shy expressions at 4, 12, 30, 48, and 72 months and HR levels during baseline at 48 and 72 months, only one significant relation occurred: positive shyness at 48 months predicted lower baseline HR at 72 months, $\beta = -0.26$, $p = 0.021$. In the model with HR reactivity, one significant relation occurred as well; a larger increase in HR during performance at 48 months predicted more positive shyness at 72 months, $\beta = 0.34$, $p = 0.003$. These findings suggest that children who show positive shyness in early childhood are less alert and less oriented to a possible threat in resting states (baseline) later in their childhood, which is opposite to what has been found in temperamental shyness (Doussard-Roosevelt et al., 2003). However, the increase in autonomic activity at 48 months predicted more positive shyness at 72 months, suggesting that perceiving social situations as a threat may contribute to becoming more positively shy later in childhood. No significant relations between positive shyness and SC levels were found in the model in which we investigated the relations between positive shy expressions at 4, 12, 30, 48, and 72 months and SC levels in baseline at 48 and 72 months. Regarding the model with SC reactivity, one significant relation occurred—more positive shyness at 48 months predicted less SC reactivity at 72 months, $\beta = -0.24$,

p = 0.046. This finding suggests that, similarly to the finding with baseline HR, being positively shy in early childhood contributes to less autonomic arousal in social situations later in childhood.

In Fig. 2a, the relations between positive shy expressions and HRV during baseline are presented, and in Fig. 2b, the relations between positive shy expressions and HRV reactivity are shown. As can be seen from Fig. 2a, more positive shyness at 48 months predicted higher baseline HRV at 72 months, $\beta = 0.26$, $p = 0.018$. Also, higher baseline HRV at 48 months showed a trend toward predicting more positive shyness at 72 months, $\beta = 0.23$, $p = 0.064$. Thus, more positive shyness is related to a better capacity to regulate emotions. It seems that displaying positive shy expressions is adaptive, fostering better physiological emotion regulation later in childhood. Also, better physiological emotion regulation in early childhood contributes to displaying more positive shyness later in childhood. Thus, it seems that positive shyness and physiological emotion regulation reinforce each other throughout childhood.

Regarding the model with HRV reactivity (Fig. 2b), a higher decrease in HRV during the performance at 48 months predicted a higher number of positive shy expressions at 72 months, $\beta = -0.29$, $p = 0.011$. A higher decrease in HRV during

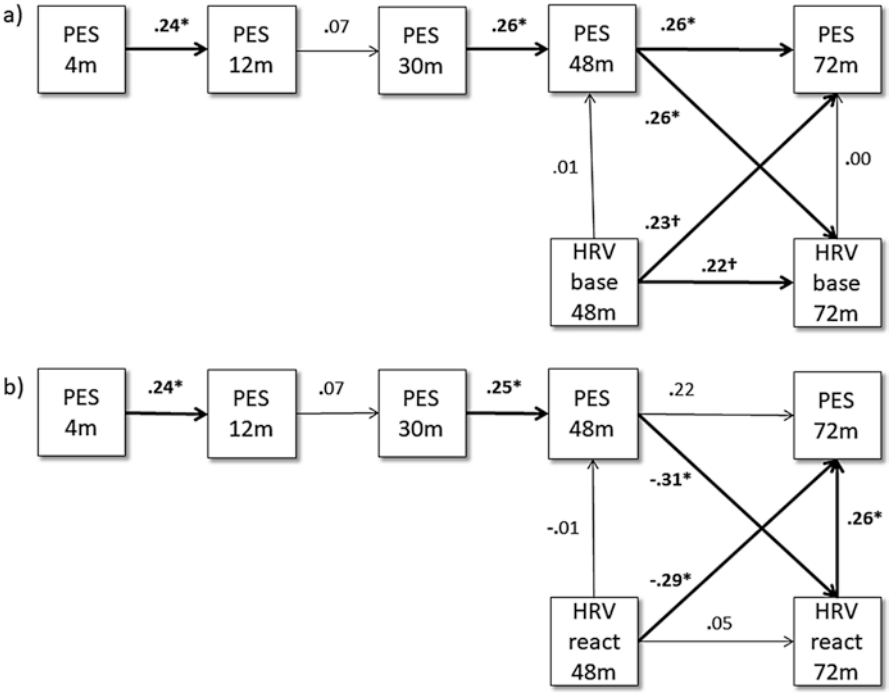

Fig. 2 Associations between expressions of positive shyness (PES) at 4 months (4m), 12 months (12m), 30 months (30m), 48 months (48m), and 72 months (72m) and (**a**) baseline HRV and (**b**) HRV reactivity at 48m and 72m

challenging situations relative to baseline is indicative of good emotion regulation in that particular situation (Porges, 2003; Shahrestani, Stewart, Quintana, Hickie, & Guastella, 2014). The reason is that the decrease in HRV reflects the withdrawal of the parasympathetic branch of the autonomic nervous system during challenging situations allowing the sympathetic activation and active coping with the challenge (Porges, 2003). Therefore, our findings show that children who are able to better cope with the challenging performance situation at 48 months also display more positive shyness later in their childhood. Next to the finding that the stronger decrease in HRV during performance predicts later positive shyness, we also found that positive shyness at 48 months predicts higher reduction in consequent HRV reactivity, $\beta = -0.31$, $p = 0.011$. Therefore, we again found that good physiological emotion regulation and positively shy expressions during socially challenging tasks reinforce each other.

In sum, children who display frequently positively shy expressions at 48 months show better capacity for emotion regulation (indexed as higher baseline HRV) and better actual coping with the challenging performance situation (indexed as decrease in HRV during performance relative to baseline) at 72 months. One unexpected finding occurred regarding positive shyness and HRV at 72 months. Higher number of positive shy expressions was related to a smaller decrease in HRV during performance at the same time. Although this result was not expected, it may be explained by the assumption that positive shyness is an adaptive social strategy long term, but maybe not short term. That is, children who express positive shyness may be aroused in the same moment, but because they remain in the social situation, they get positive feedback from others, build self-confidence, and are able to better cope with similar situations in the future (Nikolic, Colonnesi, et al., 2016).

We also investigated the relations between HR, HRV, SC, and negative shyness in our study. In the model with negative shyness and baseline HR as well as in the model with negative shyness and HR reactivity, no significant relation between negative shyness and HR occurred. This was also the case for the models with baseline HRV and HRV reactivity. In the model with negative shyness and baseline SC, no significant relation was found. In the model with SC reactivity, only one path that showed a trend toward significance was found—more negative shyness at 48 months was related to higher SC reactivity at 72 months, $\beta = 0.23$, $p = 0.060$. This was expected as avoidant and inhibited children are assumed to react with higher sympathetic arousal in social situations (Scarpa et al., 1997). The null findings regarding negative shyness and the indices of autonomic arousal are unexpected, considering that, similarly to temperamental shyness, we would expect that children who display negative shyness perceive social situations as a threat and their fight-or-flight system activates preparing them to flee from and avoid social situations. This was indeed shown in the small effect with increased SC reactivity, but not in HR and HRV, suggesting that negative shyness may be dominantly a sympathetically and not parasympathetically driven phenomenon.

In summary, positive shyness seems to be related to good physiological emotion regulation indicated by high baseline HRV and a strong decrease in HRV in a challenging situation relative to baseline. This finding confirms the notion that positive

shyness seems to be an adaptive emotion regulation strategy in challenging social situations (Colonnesi et al., 2014; Nikolic, Colonnesi, et al., 2016). It allows the child not only to deal with the current challenging situation, but it also reinforces adaptive physiological emotion regulation later in child development. On the other hand, we did not find evidence for sympathetic activation (i.e., increased SC levels) in positive shyness. We actually found the opposite—positive shyness was related to decreased SC reactivity. Therefore, it seems that positive shyness has different physiological underpinnings from negative shyness. Unlike positive shyness, negative shyness seems less adaptive. Children who display negative shy expressions are those who seem to be hyperaroused (high SC reactivity) in socially challenging situations.

Conclusion

Recent theoretical and empirical work shows that the expressions of shyness, which reflect the approach-avoidance conflict in social situations, can be already observed in the facial expressions of babies (Colonnesi et al., 2013; Reddy, 2000) and children (Colonnesi et al., 2013, 2014, 2017; DiBiase & Lewis, 1997; Poole & Schmidt, 2019) and can have positive or negative structural and functional configurations (Colonnesi et al., 2013, 2014, 2017). In this chapter, we examined (1) the developmental stability of positive and negative shyness and (2) the physiological correlates of positive and negative shyness. Our empirical results provide evidence for the stability of positive shyness in infancy, and then again in early childhood, but not in the transition from infancy to early childhood and from early childhood to late childhood. A similar pattern was found for the expressions of negative shyness. When looking at the physiological underpinnings of positive and negative facial expressions of shyness, we found that positive and negative shyness have different physiological correlates. Specifically, positive shyness in early and late childhood was found to be related to higher baseline HRV levels and higher decreases in HRV during socially challenging tasks, indicating that positively shy children have well-developed emotion regulation system. This finding strengthens the theoretical assumption that positive shyness is an adaptive mechanism to regulate arousal in social situations (Colonnesi et al., 2014; Nikolic, Colonnesi, et al., 2016). Regarding negative shyness, elevated baseline SC levels indicated higher sympathetic arousal in negatively shy children. Thus, negative shyness seems to be a less adaptive strategy to cope with social arousal.

Developmental instability of shyness can be related to children's individual differences in their socio-cognitive development. In the transition from infancy to childhood, and from early to late childhood, there is a significant development of children's social awareness and cognition (e.g., self-consciousness; DiBiase & Lewis, 1997; Lewis et al., 1989, 1991; Theory of mind; Colonnesi, Rieffe, Koops, & Perucchini, 2008), determining more consistent representations of the self and others during social interactions and, as a consequence, better emotional reactions.

For instance, children with a low level of theory of mind have been found to display more negative shyness, while children with a high level of theory of mind have the tendency to display more positive shyness (Colonnesi et al., 2017; see also MacGowan, Colonnesi, Nikolic, & Schmidt, 2019). Moreover, in both transitions, social experiences, such as interactions with parents and peers, play a role in the socio-cognitive development and are, at the same time, influenced by newly acquired self-awareness and socio-cognitive skills. The interplay between social experience and development of self-awareness might, thus, contribute to the instability in positive and negative shyness that arises in the transition from infancy to early childhood (Carpendale & Lewis, 2004).

Developmental instability in the expressions of shyness can also be related to individual developmental changes in the ability to regulate emotional arousal and more specifically the capacity to regulate social fear (Colonnesi et al., 2014, 2017; Poole & Schmidt, 2019). That is, positive social experience with significant adults and peers can impact the development of emotion regulation and related behavioral manifestations such as more adaptive expressions of shyness. For instance, in the transition from infancy to childhood, children's shift from behaviors directed toward a primary attachment figure to an internalized model of attachment (i.e., internal working model) is based on trust in others, feelings of being accepted, and self-perceived value (Bowlby, 1969). The acquired internal working model, in combination with socio-cognitive development, can shape children's way to cope with social arousal-eliciting situations (Nolte, Guiney, Fonagy, Mayes, & Luyten, 2011). In conclusion, the lack of stability in the expressions of shyness can result from the interplay between individual social-emotional maturation and social experiences.

Regarding the relations with autonomic activity, only positive shy expressions showed multiple associations with the indices of autonomic activity, both with the indices reflecting the activity of the sympathetic and the indices reflecting the activity of the parasympathetic nervous system. Negative shy expressions, however, were not strongly related to autonomic indices and showed only one trend toward a significant association with SC, which reflects the activity of the sympathetic system. These findings suggest that positive shyness, which is accompanied by both sympathetic activation and parasympathetic withdrawal, is a combination of high arousal and high capacity to regulate the arousal. Positively shy children, although hyperaroused, are able to remain in threatening social situations, possibly because they are also able to physiologically regulate their arousal. It may be this ability that allows positively shy children to gain experience and self-confidence in social situations and to develop their regulation capacities even better later in childhood. Unlike positively shy children, negatively shy children are also aroused in social situations but lack the ability to regulate their arousal; thus, they do not remain in situations but avoid them and do not develop regulation capacities as much as positive shy children do.

In conclusion, the way children express shyness depends on children's levels, and regulation, of arousal. Although their structural and functional configurations remain the same, the propensity to express these emotions changes across development. Future research should further investigate environmental and psycho-

neurological factors that can affect individual differences in the expressions of positive and negative shyness. Clinical implications concern the application of more specific interventions for shy and socially anxious children. That is, knowing that negatively shy children lack emotion regulation capacities, efforts to help them overcome their negative shyness may focus on emotion regulation strategies. Positively shy children do not appear to need such help, considering that their shyness seems to be adaptive and contributes to good emotion regulation later in childhood.

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Shy but Getting By: Protective Factors in the Links Between Childhood Shyness and Socio-Emotional Functioning

Robert J. Coplan, Danielle Baldwin, and Katherine R. Wood

Introduction

There is a long history of theoretical and empirical writings related to the development and implications of shyness (see Schmidt & Buss, 2010, for a review). The extant literature has been particularly punctuated by debates about the conceptualization, operationalization, and measurement of this construct (e.g., Asendorpf, 1993; Cheek & Buss, 1981; Crozier, 1979; Jones, Briggs, & Smith, 1986; Kagan, Reznick, Clarke, Snidman, & Garcia-Coll, 1984; Zimbardo, 1977). However, one consistent theme that emerged was that extremely shy children are at increased risk for maladaptive outcomes, internalizing problems, peer difficulties, and school-related challenges (Rubin, Coplan, & Bowker, 2009).

Accordingly, researchers have long sought to develop and implement early intervention programs specifically designed to ameliorate social functioning among extremely shy-withdrawn children (e.g., Lowenstein & Svendsen, 1938) and continue to pursue such work over 80 years later (e.g., Barstead et al., 2018). Notwithstanding, it is certainly also the case that many extremely shy children do not go on to experience substantive socio-emotional difficulties (Degnan & Fox, 2007; Tang et al., 2017). In the present chapter, we propose an integrative and comprehensive conceptual model that attempts to delineate and synthesize the various *protective* factors that may jointly serve to attenuate links between childhood shyness and indices of socio-emotional difficulties.

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Overview of Shyness in Childhood

Contemporary theory and research in this area now encompass several different *types*, *incarnations*, and/or *expressions* of shyness, which may differentially confer both costs and (as evidenced by this volume) even potential benefits for socio-emotional functioning. For the purposes of this chapter, we focus on the *classical* conceptualization of shyness, as a temperamental trait reflecting wariness in the face of social novelty and/or self-consciousness in situations of perceived social evaluation (Asendorpf, 1991; Cheek & Buss, 1981; Crozier, 1995; Zimbardo, 1977). There are several similar constructs that share considerable conceptual overlap with shyness, including behavioral inhibition (Kagan, 1997), social reticence (Coplan, Rubin, Fox, Calkins, & Stewart, 1994), and anxious solitude (Gazelle & Ladd, 2003). As outlined by Coplan and Rubin (2010), these terms all share a common underlying core related to social fear, wariness, and anxiety and (as described below) display similar patterns of associations with indices of socio-emotional difficulties. Accordingly, we will consider them herein as functionally equivalent.

Shyness in childhood is concurrently and predictively associated with the development of a wide range of adjustment difficulties. For example, childhood shyness is robustly and consistently related to indices of internalizing problems, including negative and self-conscious affect (Coplan, Ooi, Xiao, & Rose-Krasnor, 2018; Sette, Baldwin, Zava, Baumgartner, & Coplan, 2019), low self-esteem (Coplan, Findlay, & Nelson, 2004; Crozier, 1995; Nelson et al., 2009), and subclinical but elevated symptoms of anxiety (Coplan, Arbeau, & Armer, 2008; Shamir-Essakow, Ungerer, & Rapee, 2005; Weeks, Ooi, & Coplan, 2016). As well, extreme shyness in childhood is considered one of the strongest predictors of later clinical anxiety disorder, particularly social anxiety (Chronis-Tuscano et al., 2009; Essex, Klein, Slattery, Goldsmith, & Kalin, 2010; for a meta-analysis see Clauss & Blackford, 2012). Shyness also tends to be associated with negative peer experiences, including peer dislike, rejection, exclusion, and victimization (Eggum-Wilkens, Valiente, Swanson, & Lemery-Chalfant, 2014; Kopala-Sibley & Klein, 2017; Sette, Baumgartner, Laghi, & Coplan, 2016). Finally, there is also increasing evidence to suggest that shy children are also prone to school-related difficulties, including a lack of engagement, poorer academic performance, and less school liking (Coplan & Weeks, 2009; Crozier & Hostettler, 2003; Hughes & Coplan, 2010).

Of additional note, there is continued debate among developmental researchers and clinicians concerning the conceptual and empirical distinctions between shyness and social anxiety in childhood (e.g., Degnan & Fox, 2007; Lemery, Essex, & Smider, 2002) and adulthood (Chavira, Stein, & Malcarne, 2002; Heiser, Turner, Beidel, & Roberson-Nay, 2009). Although some suggest that shyness and social anxiety represent different parts of the same continuum (e.g., Rettew, 2000), we share the notion that as a temperament trait, shyness is more appropriately conceptualized as a vulnerability toward the development of later anxiety (see Rapee & Coplan, 2010, for a review).

Rubin and colleagues (Rubin, Hymel, Mills, & Rose-Krasnor, 1991; Rubin, LeMare, & Lollis, 1990; Rubin & Mills, 1991) proposed a comprehensive theoretical model of the transactional processes that may connect early temperamental shyness with later socio-emotional functioning. This theoretical framework considers the joint influences of (and interplay among) child characteristics, parental socialization practices, the quality of relationships inside and outside of the family, and macro-systemic forces. A purported *worst-case* scenario was included (colorfully labeled the *Temple of Doom* model), outlining a specific developmental pathway in the etiology of social withdrawal and internalizing problems.

Briefly, this model starts with a child who is born with a highly reactive/inhibited temperament (i.e., low threshold for arousal in the face of social stimulation). The child's parents come to perceive him/her as socially vulnerable, evoking parental anxiety and a pattern of socialization characterized by overcontrol and overprotection. In combination, these setting conditions contribute to the formation of an insecure-anxious parent-child attachment relationship, and in turn, the child develops an internal working model of *felt insecurity* (i.e., core beliefs that "the world is a scary and unpredictable place").

When the child enters formal educational contexts (and consequently the peer group), feelings of social wariness and insecurity lead him/her to display socially withdrawn behaviors in the presence of peers. Such withdrawn behaviors, in turn, increasingly elicit negative responses from peers because they violate age-related social norms and expectations regarding the quantity and quality of peer interactions. Over time, a *negative feedback loop* is created, whereby negative peer experiences exacerbate the shy child's negative feelings about the self and others, leading to increased social wariness and social withdrawal, further evoking and promoting negative peer experiences and so on. According to Rubin and colleagues (Rubin et al., 1990, 1991; Rubin & Mills, 1991), this pathway ultimately culminates in the shy child developing low self-regard and feelings of loneliness, as well more serious problems of anxiety and depression.

Subsequent empirical research findings have largely supported the primary assertions of this theoretical framework (see Rubin et al., 2009, for a relevant review). Notwithstanding, it has also become clear that beyond the proposed transactional processes, additional and more complex (i.e., nonlinear) mechanisms are likely involved. For example, Gazelle and colleagues (Gazelle & Ladd, 2003; Gazelle & Rudolph, 2004) described a *diathesis-stress* model that incorporated moderation effects when considering the links between shyness and maladjustment: Shy (anxious-solitary) children are posited to be particularly vulnerable to the effects of negative peer experiences (e.g., exclusion), which serve to exacerbate their risk for internalizing problems such as depression.

As mentioned previously, despite the possibility of such worst-case scenarios, many shy children do not go on to experience socio-emotional difficulties (Degnan & Fox, 2007; Tang et al., 2017). This leads to the question of *why* some shy children do better than others over time. In our previous work, we (along with many others) have explored several different *protective* factors (i.e., variables which appear to attenuate links between shyness and indices of socio-emotional difficulties) in the

domains of individual (child) characteristics (e.g., Karevold, Coplan, Stoolmiller, & Mathiesen, 2011), parenting and the family environment (e.g., Coplan et al., 2008), peer relations (Sette, Zava, Baumgartner, Baiocco, & Coplan, 2017), and schools (Arbeau, Coplan, & Weeks, 2010). However, to date, these potential buffering effects have been explored predominantly as individual factors and have yet to be synthesized into a comprehensive theoretical framework. Accordingly, herein we sought to propose an integrative conceptual model of protective factors in the development and implications of childhood shyness.

"Shy but Getting By": A Proposed Conceptual Model

It should not be surprising that peer relations are a key domain for almost all theoretical models describing the development of shyness and social withdrawal (Asendorpf, 1993; Ladd, 2006; Rubin et al., 1991). Peers also play critical roles in early intervention programs designed to assist extremely shy children (see Coplan, Schneider, Ooi, & Hipson, 2018, for a recent review). As compared to their more sociable counterparts, shy children tend to display deficits in social skills and comparatively low rates of social interaction in peer contexts such as playgrounds, schoolyards, and classrooms (Bohlin, Hagekull, & Andersson, 2005; Chen, DeSouza, Chen, & Wang, 2006; Coplan et al., 2013). Moreover, poorer social skills are more likely to evoke peer rejection, exclusion, and victimization (Chen et al., 2006; Coplan, Ooi, & Rose-Krasnor, 2015; Crawford & Manassis, 2011; Perren & Alsaker, 2006). Also, children who consistently avoid peer interactions (for whatever reasons) are also at an increased risk for a wide range of adjustment difficulties because they miss out on the important and unique benefits afforded by these social exchanges (Rubin, Bukowski, & Bowker, 2015). Indeed, after summarizing the *Temple of Doom* model of the development of social withdrawal, Rubin et al. (2009) acknowledged that "the ability to cope with one's fearful and shy dispositions by displaying socially and emotionally competent behaviors may move the child off the pathway to peer rejection and victimization" (p. 160). There is little doubt that, in general, social, social-communicative, and socio-emotional competencies directly contribute toward positive adjustment outcomes in childhood (see Rubin et al., 2015, for an extensive review). Notwithstanding, we posit herein that such competencies may be particularly critical for the socio-emotional functioning of children who tend to be shy. Accordingly, we made social, socio-communicative, and socio-emotional competencies the *lynchpins* of our conceptual model of protective factors in the development of shyness.

The essential components of this conceptual model are displayed in Fig. 1. The central pathway of this framework is the link between shyness and socio-emotional functioning, moderated by social/socio-communicative/socio-emotional competencies. In the sections to come, we will review the conceptual underpinnings and empirical support for this core component of the model. As depicted in the figure, we have incorporated some aspects of the transactional processes (i.e., teacher-child

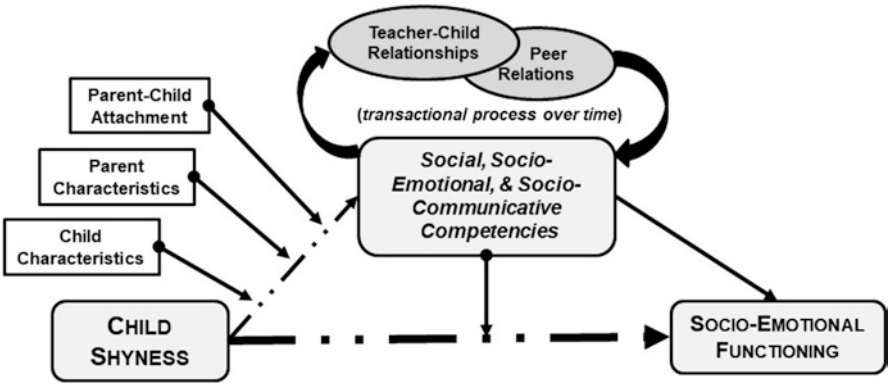

Fig. 1 Conceptualization of protective factors and underlying processes of the links between shyness and indices of socio-emotional functioning

relationships, peer interactions) described by Rubin et al. (1991) and others. In our case, we anticipate these processes to reinforce positive outcomes over time. Specifically, shy children who display greater social, socio-communicative, and socio-emotional competencies would be expected to more consistently evoke more positive responses from peers and teachers at school.

Chen (2010, 2019) has argued that positive support from important others (including teachers and peers) would be particularly helpful for shy children to succeed socially and academically at school. This argument was originally forwarded to help explain the positive outcomes associated with childhood shyness in Mainland China during studies conducted in the 1990s (e.g., Chen, Cen, Li, & He, 2005; Chen, Rubin, & Li, 1995; Chen, Rubin, & Sun, 1992). However, there is also accumulating empirical evidence that positive relationships with peers and teachers also serve to buffer shy children from negative school adjustment outcomes, both in Western samples (Arbeau et al., 2010; Baardstu, Coplan, Karevold, Laceulle, & von Soest, 2019; Sette et al., 2017) and in contemporary China (Coplan, Liu, Cao, Chen, & Li, 2017; Liu et al., 2018) and other non-Western cultures such as Turkey (Bayram Özdemir, Cheah, & Coplan, 2017). In our model, positive exchanges with teachers and peers create a *positive feedback loop* for shy children, serving to further encourage social interaction and promote the continued development of social, socio-communicative, and socio-emotional competencies, in turn, leading to better adjustment outcomes.

Notwithstanding, the question remains as to *why* some shy children go on to develop higher levels of these competencies, whereas others do not. In this regard, we consider some possible precursors that may influence the development of competencies among shy children, including individual characteristics (child, parent), as well as the parent-child relationship (as depicted in Fig. 1). More specifically, we speculate that there are moderating effects of specific child characteristics (e.g., psychophysiology, other temperamental traits) that may promote resiliency among shy children as well as aspects of parenting (e.g., parental personality, parenting styles) and the parent-child relationship (e.g., attachment) in the links between shyness and adjustment outcomes.

In short, this proposed theoretical framework can be thought of as a purported *best-case* scenario in the development and implications of childhood shyness. It should be noted from the outset that such complex mechanisms have not been systematically examined in the extant empirical literature. Notwithstanding, in the following sections, we further describe the conceptual and empirical rationale for the *Shy but Getting By* model.

Protective Roles of Socio-Emotional, Socio-Communicative, and Social Competencies

Social competencies are a major determinant of positive adjustment outcomes in childhood (Rubin et al., 2015). As we discussed, one mechanism through which these positive effects propagate is via positive feedback from peers and teachers (Rubin et al., 1991). As part of our conceptual model (see Fig. 1), we speculate that this process would be particularly beneficial for children who tend to be *shy*. Simply stated, shy children who display greater social, socio-emotional, and socio-communicative skills would be expected to evoke more positive responses from peers and teachers at school, serving to further encourage subsequent positive social interactions, which in turn would promote the continued development of social competencies and so on.

Socio-Emotional Competencies

It has been suggested that for some shy children, problematic social behaviors are more reflective of deficits in *performance* rather than *competence* (Coplan, Schneider, et al., 2018). That is, shy children may *know* how to behave competently, but social fear and social-evaluative concerns deter their abilities to demonstrate such behaviors in stressful social contexts. This would suggest that emotion-related competencies would be of particular benefit.

For example, children who struggle with recognizing emotions may display inappropriate responses to their peers' emotions (e.g., aggressive or withdrawn behaviors) and experience more peer rejection (Garner & Waajid, 2008; Izard et al., 2001). In contrast, children who are better able to identify the emotions of others (and their causes) tend to be more socially competent and are more popular with peers (Denham, 2006; Denham et al., 2003; Izard et al., 2001; Mostow, Izard, Fine, & Trentacosta, 2002; Schultz, Izard, Ackerman, & Youngstrom, 2001). However, our review of the literature revealed only one previous study specifically examining emotion-related competencies as a protective factor for shy children.

Sette et al. (2016) reported significant interactions between shyness and emotion recognition in the prediction of social functioning among a sample of Italian preschoolers. More specifically, shyness was associated with anxious-withdrawal and peer rejection among children with lower levels of emotion recognition, but these

associations were attenuated for children with higher levels of emotion recognition. The authors speculated that the ability to recognize the emotions of others may help shy children respond to peers and teachers in more socially acceptable ways, encouraging more positive responses from them, thus facilitating better social and emotional adjustment.

From a somewhat different perspective, we can also conceptualize *coping* strategies as reflecting children's abilities to effectively regulate emotional responses to social stressors (Causey & Dubow, 1992). For example, whereas emotion-focused coping styles (e.g., worrying, getting mad) are often associated with lower social competence and greater behavior problems (e.g., Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001; Endler & Parker, 1990), problem-focused strategies (e.g., seeking social support, considering alternative proactive solutions) are typically considered to be a more effective means of coping with controllable social situations such as peer conflict (Causey & Dubow, 1992).

Overall, shyness in childhood is associated with the use of emotion-focused coping strategies in response to social stressors (Eisenberg, Shepard, Fabes, Murphy, & Guthrie, 1998; Findlay, Coplan, & Bowker, 2009; Jackson & Ebnet, 2006; Markovic, Rose-Krasnor, & Coplan, 2013). Shy children may overly rely on such emotion-focused styles because they involve low assertiveness and tend not to draw attention (Burgess, Wojslawowicz, Rubin, Rose-Krasnor, & Booth-LaForce, 2006; Findlay et al., 2009). However, by emphasizing the negative emotional component of an event, emotion-focused coping styles may instead serve to increase stress (Endler & Parker, 1990). In support of this notion, there is evidence to suggest that emotion-focused coping partially mediates the relations between shyness and adjustment outcomes (Ding et al., 2014; Findlay et al., 2009).

These findings suggest that the inability to effectively cope with negative emotions arising from challenging social experiences helps to explain why shy children experience socio-emotional difficulties. However, there is at least some evidence to suggest that more adaptive coping responses serve to modulate this process among shy children. Kingsbury, Coplan, and Rose-Krasnor (2013) tested a complex moderated-mediation model linking shyness, coping, and indices of socio-emotional functioning in a sample of children aged 9–13 years. Internalizing coping (a subtype of emotion-focused coping) was found to partially mediate the association between shyness and adjustment difficulties (e.g., internalizing problems, negative perceptions of peer experiences). However, problem-solving coping was found to be a significant moderator in this model, with higher levels of problem-solving coping essentially *interrupting* these mediated pathways. In other words, at higher levels of problem-solving coping, mediated links between shyness, internalizing coping, and socio-emotional difficulties were attenuated. These findings suggest that although shy children tend to rely on emotion-focused coping styles to handle social stressors, shy children who are able to employ more adaptive coping strategies (e.g., problem-solving coping) are at reduced risk for negative outcomes.

In a subsequent study of the complex interassociations, Penela, Walker, Degnan, Fox, and Henderson (2015) examined a model linking shyness (behavioral inhibition) in toddlerhood (ages 2–3), emotional regulation strategies at age 5 years, and

social competence at age 7 years. Evidence was found for a moderated mediation effect, whereby emotional regulation characterized by social support-seeking and problem-solving significantly mediated the relation between early shyness and later social competence, but only among children with high levels of initial shyness. These findings further suggest that more adaptive emotion regulation strategies may serve a particularly important function for shy children.

Although the mechanisms underlying the links between shyness, emotion-related competencies, and psychosocial outcomes appear complex, shy children appear to particularly benefit from emotion-related skills (e.g., recognizing, labeling, and identifying causes of emotions) and the use of adaptive emotion regulation strategies (e.g., seeking social support, problem-solving). Such competencies could assist shy children to better cope with social stresses, promote more frequent positive social interactions, and evoke more favorable responses from teachers and peers.

Socio-Communicative Competencies

Another domain to consider for protective factors for shy children is socio-communicative competencies. Speech reticence is a defining characteristic of shyness (Asendorpf & Meier, 1993; Buss, 1984; Crozier, 1995; Evans, 1993; Rezendes, Snidman, Kagan, & Gibbons, 1993). Moreover, shy children typically perform more poorly than their more sociable age-mates on tests of different aspects of language abilities (Crozier & Perkins, 2002; Evans, 1996; Spere, Schmidt, Theall-Honey, & Martin-Chang, 2004), although there is continued debate as to the underlying nature of these associations (Coplan & Evans, 2009).

Notwithstanding, it has been further argued that the possession of linguistic competencies may be particularly helpful for shy children. For example, Coplan and Weeks (2009) suggested that shy children may be less prone to feel anxious around peers if they are better able to verbalize their thoughts. Similarly, confidence in their ability to use appropriate language may help to reduce socio-evaluative concerns among shy children and foster increased positive social interactions. Essentially, language skills represent particularly important additional *tools* to help shy children make and keep friends. However, there again seems to be only limited relevant empirical support for these notions.

Asendorpf (1994) reported that children's verbal IQ predicted decreased observed and teacher-rated shyness (behavioral inhibition) in a longitudinal study of children from ages 4 to 10 years. Although this finding focuses on reduced *stability* of shyness over time, it can be extrapolated that decreases in shyness would be potentially accompanied by increases in peer interaction. More directly, Coplan and Armer (2005) investigated the moderating role of expressive vocabulary in the relations between shyness and indices of maladjustment in early childhood. Among children with lower expressive vocabulary, shyness was related to social withdrawal, need for teacher attention, and lower self-perceptions. However, among children with higher vocabulary scores, these associations were attenuated. In a follow-up study,

Coplan and Weeks (2009) reported similar results with pragmatic language in a sample of early elementary school children. Associations between shyness and indices of internalizing problems (i.e., social anxiety, loneliness, withdrawn behaviors) were again attenuated among children with higher levels of pragmatic language skills (see also Cheung & Elliott, 2017). Taken together, these findings suggest that having competence with different aspects of language may make it easier for shy children to engage with their peers.

Finally, although not directly pertaining to language, Chen, Yang, and Wang (2013) reported better adjustment outcomes for academically high-achieving shy children. Specifically, they found that shyness predicted later teacher-rated internalizing problems, loneliness, and depression for low-achieving children, but these relationships did not exist for high-achieving children. Given the well-established links between language abilities and academic achievement, this finding could be interpreted as further indirect support for the protective role of language in shy children's development. However, Chen et al. (2013) also suggested that because of the extremely high value placed on academic success in China (Li, 2011), shy children who perform particularly well academically may elicit more positive responses from teachers and peers at school, which may in turn foster positive outcomes. This notion is expanded upon in the next section, where we explore other *social* competencies that may serve a similar function for shy children.

Social Competencies

A core tenet of our conceptual model is the notion that some shy children may evoke more positive responses from peers (and teachers), thus putting them on a pathway toward more positive socio-emotional outcomes. At its simplest, this supposition suggests that for shy children, simply being *nicer* to peers could impart particularly important benefits. There is at least some empirical support for this assertion.

Gazelle and colleagues (Gazelle, 2008; Gazelle & Shell, 2017) have explored the protective role of prosocial characteristics and behaviors in the adjustment trajectories of highly shy (anxious-solitary) children. Across these two studies, shy (anxious-solitary) children who also tended to be more *agreeable* were better liked and had higher-quality peer relations as compared to shy children who were also characterized by either attention-seeking, externalizing, or normative social behaviors. Additionally, Markovic and Bowker (2015) found that *humor* was associated with increases in acceptance for shy adolescent girls and decreases in overt victimization and increases in popularity for shy adolescent boys as compared to their less humorous shy counterparts. Finally, by way of contrast, there is also evidence to suggest that shy children and adolescents who exhibit negative social behaviors (e.g., aggression) are particularly prone to peer difficulties, such as peer rejection, exclusion, and victimization (Bowker, Markovic, Cogswell, & Raja, 2012; Farmer & Bierman, 2002; Ladd & Burgess, 1999).

Perhaps the strongest direct evidence of the central importance of social skills in the socio-emotional functioning of shy children comes from studies of *social skills training* (SST, for a review, see Coplan, Schneider, et al., 2018). Results from recent studies have indicated that multicomponent early intervention programs for extremely shy (behaviorally inhibited) young children that incorporate social skills training produce significant reductions in anxiety symptoms post-intervention (Chronis-Tuscano et al., 2015; Lau, Rapee, & Coplan, 2017). Shy children who feel less anxious might be more likely to engage in social interactions. However, most germane to our current model, results from three recent studies suggest that ameliorative SST-based interventions might afford extremely shy children social benefits that generalize to school settings.

First, Coplan, Schneider, Matheson, and Graham (2010) observed the social behaviors of a group of extremely shy (behaviorally inhibited) young children during unstructured free play at preschool. Half of these children then received eight sessions of SST and facilitated play (i.e., small group free play facilitated by trained intervention group leaders), and the other half served as a waitlist control group. Shy children who received the intervention displayed significant increases in observed social competencies (e.g., group play, peer conversation, social initiations made to peers, positive affect during peer interaction) at preschool post-intervention, as compared to the shy waitlist control group.

Li et al. (2016) conducted a similar intervention with a sample of extremely shy (behaviorally inhibited) children in Mainland China. Among their results, as compared to shy children in the waitlist control group, shy children who participated in the intervention were observed to demonstrate significantly greater post-intervention frequencies of group play and peer conversations, as well as greater prosocial behaviors (e.g., cooperation, sharing) during free play with novel peers. Moreover, these improvements were maintained when assessed again 2 months post-intervention.

Most recently, Barstead et al. (2018) also evaluated peer-related outcomes for a comprehensive multicomponent intervention program for extremely shy (behaviorally inhibited) young children that included SST and facilitated play (as well as parental education and parent-child interaction therapy). From pre- to post-intervention, shy children who received the intervention demonstrated greater increases in the frequency of observed peer play and social initiations to peers as compared to a waitlist control group.

Thus, there is at least some evidence to suggest that improvements in social skills among extremely shy young children can lead to more frequent positive social interactions with peers. As we have previously speculated, children who display such positive social, emotional, and communicative behaviors will likely have better social standing among peers (Rubin et al., 2015) and more positive relationships with teachers (Birch & Ladd, 1998; Rudasill & Rimm-Kaufman, 2009). Notwithstanding, the question remains as to *why* some shy children develop greater competence in these domains than others. In this regard, our model further postulates that other child characteristics, aspects of parental personality and parenting styles, and the parent-child attachment relationship all serve as antecedents that influence the development of competencies among shy children.

Precursors of Competencies: Child Characteristics

It seems plausible that some shy children are born with other temperamental and/or psychophysiological characteristics that may be particularly adaptive for them in terms of the development of social, social-emotional, and socio-communicative competencies. Such *temperamental x temperament* interactions remain under-explored empirically but are believed to play a potentially important role in developmental outcomes (Rothbart & Bates, 2006). As we suggested previously, the ability to adaptively cope with negative emotions would appear to be a particularly beneficial characteristic for shy children. Some additional support for this assertion can be found in a handful of recent studies exploring interaction effects between shyness and aspects of temperamental self-regulation that are known to play an important role in children's emotion regulation (Rothbart, 2011).

First, inhibitory control (IC) is the self-regulatory ability to suppress automatic responses in lieu of more subordinate ones (Rothbart & Bates, 2006). IC is important for children's ability to suppress inappropriate social responses, with lower levels of IC associated with externalizing problems (Buss, Kiel, Morales, & Robinson, 2014; Gusdorf, Karreman, Van Aken, Deković, & Van Tuijl, 2011; Kochanska & Knaack, 2003). Although IC is generally associated with positive indices of adjustment (e.g., Schmitt, Finders, & McClelland, 2015), some evidence suggests that higher levels of IC may actually be *problematic* for shy children's social outcomes (e.g., Sette et al., 2018; Thorell, Bohlin, & Rydell, 2004).

For example, Thorell et al. (2004) found that the combination of high IC and high shyness (behavioral inhibition) in young children was positively related to social anxiety and negatively related to social initiative. More recently Sette et al. (2018) examined the moderating effect of IC on the links between shyness and adjustment outcomes in a sample of Italian preschoolers. Among the results, at higher levels of IC, shyness was negatively associated with prosocial behaviors and peer popularity. However, at lower levels of IC, these associations were attenuated. Given that the shy child is already inhibited in their interactions with others, it stands to reason that having lower levels of temperamental restraint during social interactions may be beneficial. Shyness is characterized by an approach-avoidance conflict, such that shy children are motivated to both approach and avoid social interactions with others (Coplan, Prakash, O'Neil, & Armer, 2004). Thus, it is plausible that among shy children, higher IC promotes the *suppression* of approach motivations (instead of motivating behavioral restraint), thus leading to fewer opportunities for the development of social skills.

A second self-regulatory ability, attentional control (AC), entails the ability to regulate and shift one's attentional focus (Posner & Rothbart, 2000; Rueda, Posner, & Rothbart, 2004). AC plays an important role in the promotion of positive social relationships (Hughes, Dunn, & White, 1998; Rudasill, 2011). Research suggests that shy children may have an attentional bias toward threat, which may promote socially withdrawn behaviors (Barker et al., 2015; Morales, Pérez-Edgar, & Buss, 2015). Accordingly, the ability to regulate and shift one's attention may

be particularly beneficial for shy children's social functioning. In support of this notion, Acar, Rudasill, Molfese, Torquati, and Prokasky (2015) reported that among children with lower levels of AC, shyness was positively associated with peer conflict and negatively associated with peer interaction. However, at higher levels of AC, these associations were attenuated. Given that shy children experience high levels of distress in their interactions with others, the ability to shift one's attention to a less distressing stimulus may be particularly beneficial, helping to alleviate negative emotions that are experienced during these interactions (Grolnick, Bridges, & Connell, 1996).

We also considered *psychophysiological* indicators of emotion regulation, such as changes in cortisol. Exposure to a stressor activates a neurobiological cascade of events, culminating in the release of cortisol. Cortisol plays an important function in the stress response, serving to motivate appropriate behavioral responses aimed at alleviating the stressor (Selye, 1950). However, when the stress response system is chronically activated, the associated cortisol response becomes dysregulated, causing difficulties effectively managing and responding to stressors (McEwen, 1999). Accordingly, the ability to effectively regulate cortisol serves an important function in the physiological regulation of emotions.

Cortisol regulation may have important implications for shy children's socioemotional outcomes. For example, Davis and Buss (2012) reported a significant interaction between shyness and cortisol regulation (i.e., the speed at which cortisol levels declined after children interacted with peers) in the prediction of social behaviors in a sample of kindergarten children. Among children who displayed a slower decrease in cortisol post-stressor (i.e., poorer cortisol regulation), shyness was associated with the display of reticent behaviors among peers (i.e., watching others but not joining in, remaining unoccupied). However, among children with better cortisol regulation, these associations were attenuated. These results suggest that shy children's inability to effectively regulate cortisol may promote ineffective behavioral responses (e.g., withdrawn behaviors) to distress experienced in social situations. In turn, such behavioral responses are likely to reinforce the pairing of social interactions with stress, potentially further dysregulating the stress response.

In further support of these ideas, Tang, Beaton, Schulkin, Hall, and Schmidt (2014) reported that a higher cortisol awakening response (CAR) may foster sociability in shy individuals. The CAR is defined as a peak in cortisol levels shortly after waking up and is believed to serve an adaptive function in preparing individuals for the day (Fries, Dettenborn, & Kirschbaum, 2009; Wust et al., 2000). Tang et al. (2014) found shyness was associated with higher sociability among adults with a higher compared to a lower CAR. Furthermore, among shy individuals who had a lower CAR, exposure to social threat promoted activation in brain regions known to be associated with fear and withdrawal. The authors speculated that among shy individuals, a lower CAR may reflect an adaptation of the neurobiological systems in response to repeated activation of the stress system in social situations. Taken together, these studies suggest that children's ability to regulate their physiological response to distress may mitigate ineffective behavioral responses to social situations, in turn allowing for the development of important social skills and competencies.

Finally, although most of this work has focused on aspects of self-regulation, Karevold et al. (2011) explored the moderating role of *activity* level in the links between shyness and outcomes in a longitudinal study of Norwegian children from ages 1.5 to 8.5 years. Among the results, activity level appeared to act as a protective factor in the development of internalizing problems for shy boys, but not for shy girls. The authors speculated that, among shy boys, higher activity level may promote more positive interactions with peers, particularly in the domain of sports. Although this assertion has yet to be examined empirically, there is some evidence to suggest that participation in sporting activities might impart particular benefits for shy children (Findlay & Coplan, 2008).

Taken together, these studies provide some preliminary evidence to suggest that temperaments characterized by lower inhibited control, higher attentional control, and better cortisol regulation may foster more adaptive responses among shy children to the anxiety elicited in social situations. In turn, this may promote the development of important social skills and competencies.

Precursors of Competencies: Parent Characteristics

Parents play a foundational role in the development of children's social, socio-emotional, and socio-communicative competencies (Grusec & Hastings, 2015). Accordingly, we also considered *parental* factors that may serve as particular precursors to the development of such competencies among shy children.

To begin with, certain parental personality characteristics and socialization practices have been found to exacerbate negative outcomes related to shyness. For example, neuroticism is a personality trait characterized by emotional instability and a tendency to readily experience negative emotions (e.g., anxiety, hostility; Vondra & Belsky, 1993). Parents high in neuroticism are more likely to model anxious responses (Jorm et al., 2000), which may particularly exacerbate anxious feelings in children who are already prone to anxiety (Burstein, Ginsburg, & Tein, 2010).

Parents who are high in neuroticism are also more likely to employ maladaptive parenting styles such as overprotection and overcontrol (Coplan et al., 2008; Kendler, Sham, & MacLean, 1997). *Overprotective* parents tend to be restrictive, micromanaging their child's behaviors and activities, which may deter normative development of child independence (Rubin & Burgess, 2002). Moreover, parents who tend to be anxious themselves are particularly likely to employ overprotective parenting when they perceive their child as being shy (Coplan, Reichel, & Rowan, 2009). Such maladaptive parenting styles may exacerbate shy children's social wariness, effectively reinforcing their social fears and deterring the development of necessary social coping skills and competencies (Rubin & Burgess, 2002).

In support of these notions, Coplan et al. (2008) found that *fretful* parenting (characterized by a combination of high neuroticism, high behavioral inhibition system sensitivity, and overprotective parenting) significantly exacerbated links between young children's shyness and both internalizing and peer difficulties.

Similarly, Bullock et al. (2018) reported that shyness was significantly associated with peer and internalizing difficulties only among Chinese adolescents who reported higher levels of parental psychological control (use of coercive and manipulative parenting tactics such as guilt and shame; Yu, Cheah, Hart, Sun, & Olsen, 2015).

In contrast, less is known about parenting characteristics that may serve a *protective* role for shy children. Parents who are higher in agreeableness, a personality trait characterized by interpersonal trust, compassion, and modesty (Belsky & Barrends, 2002), tend to have warmer, more sensitive, and more responsive interactions with their children (Metsäpelto & Pulkkinen, 2003). Coplan et al. (2008) speculated that agreeable parents would also be more likely to model positive emotion regulation skills, creating a particularly adaptive environment to address the needs of shy children. In their study of kindergarten children described earlier, Coplan et al. (2008) reported some initial support for these suppositions: Relations between child shyness and both internalizing problems and peer problems were attenuated among mothers who were high in a combination of agreeableness and warmth/support (i.e., authoritative parenting; Baumrind, 1989). In further support of the protective role of authoritative parenting, Chen et al. (2014) subsequently reported that the negative association between shyness (behavioral inhibition) and social competence was attenuated at higher levels of maternal support in a sample of Chinese children.

There is also further evidence to suggest that the socialization of emotions plays a particularly critical role for shy children. For example, engaging in rich discussions with children about emotions (beyond simply teaching children emotional labels) provides children with important knowledge that fosters emotional competence and teaches them how to cope with and regulate their emotions (Denham, Bassett, & Wyatt, 2015; Eisenberg, Cumberland, & Spinrad, 1998; Grady & Hastings, 2018). Given that shy children experience fear pertaining to social situations, their ability to regulate these negative emotions may be particularly important for their social adjustment (Davis & Buss, 2012). Consistent with this assertion, Grady and Hastings (2018) found a significant interaction between shyness and parents' use of elaborative emotion language (i.e., using emotional explanations and questioning children's emotional understanding), such that shyness was associated with higher levels of prosocial behavior when parents used more compared to less elaborative emotion language.

Perhaps the strongest direct evidence for the importance of parental characteristics in the development of child shyness comes from early intervention programs focused on parents of shy children. For example, Rapee and colleagues (e.g., Rapee, 2013; Rapee, Kennedy, Ingram, Edwards, & Sweeney, 2005) have provided strong empirical support for the efficacy of education and training programs for parents in reducing anxiety among extremely shy (behaviorally inhibited) young children. These programs aim to reduce parental anxiety, teach parents about the development of children's anxiety, and focus on the potentially negative implications of overparenting.

There is even some preliminary evidence to suggest that such interventions can alter maladaptive parenting behaviors. As described earlier, Chronis-Tuscano et al. (2015) designed a multicomponent intervention program for extremely shy young children that also included parental education/training and parent-child interaction therapy (PCIT). This program was designed to teach parents appropriate techniques for responding to their shy children. Moreover, as children engage in interactions with peers, parents were instructed on adaptive ways to respond to and reinforce children's appropriate social behaviors and how to help them manage their emotions during anxiety-provoking situations. Of particular note, among their results, mothers who experienced the intervention program demonstrated greater improvements in observed positive parenting behaviors (e.g., warmth, sensitivity) as compared to waitlist controls.

Although these results must be considered preliminary in nature, the pattern of results suggests that certain parental characteristics may buffer against negative socio-emotional outcomes associated with shyness. Specifically, parents who are agreeable, who employ a warm and supportive approach to parenting, and who utilized elaborative strategies for teaching children about emotions appear to provide an ideal environment for their shy child, promoting the development of social skills and competencies.

Precursors of Competencies: Parent-Child Attachment

The final set of precursors considered is in the domain of parent-child attachment relationships. According to attachment theory, infants possess an innate drive that motivates them to seek proximity to their caregivers and social connection. Through these early interactions, infants come to internalize a view of the world and of themselves (Bowlby, 1969). These cognitive representations, or *internal working models*, serve as a foundation for the child's future social interactions.

When parents are inconsistent, unsupportive, or unresponsive to their child's needs, the child develops an insecure attachment style characterized by an internalized view of others as unreliable or untrustworthy and of the self as unworthy of love and belonging (Bartholomew & Horowitz, 1991). Such negative internalized views interfere with the development of social and emotion regulation skills, leading to a pattern of poor interpersonal relationships. Indeed, insecure attachment in infancy has been linked to the later development of a host of socio- emotional difficulties of both an internalizing and externalizing nature (e.g., Groh, Roisman, van IJzendoorn, Bakermans-Kranenburg, & Fearon, 2012; O'Connor, Collins, & Supplee, 2012). In contrast, when parents are consistent, supportive, and responsive to the child's needs, the child develops a secure attachment style, internalizing a view of themselves as worthy and lovable and of others as trustworthy. The presence of parental support and nurturance allows the child to explore their social environment and develop important social skills (Ainsworth, 1979; Bowlby, 1969).

Shy children are predisposed toward wariness in the face of novel social situations (Kagan, 1997). Manassis (2001) similarly argued that insecurely attached children might be particularly prone to develop anxiety if they are predisposed to high behavioral inhibition (i.e., wariness toward the unfamiliar). In this regard, the development of secure attachment relationships may be particularly critical, providing the shy child with a greater sense of security that might facilitate social explorations. However, to date, only a handful of studies have specifically examined interactions between shyness and attachment style in the prediction of adjustment outcomes.

For example, Lewis-Morrarty et al. (2015) found that shyness (behavioral inhibition) was positively associated with adolescent anxiety only among those with an insecure attachment style. Similarly, Peter and Gazelle (2017) found that shy (anxious-solitary) youth who developed an insecure attachment with their parents became increasingly self-critical over time, whereas secure attachment promoted self-compassion when faced with negative emotions and personal challenges.

Our review of the literature revealed that only three studies specifically focus on social outcomes. Bohlin et al. (2005) reported that among insecurely attached young children, shyness (behavioral inhibition) predicted deficits in later social competence, whereas among those who were securely attached, this association was attenuated. Similarly, Rydell, Bohlin, and Thorell (2005) found that shy 5-year-olds who had an avoidant attachment style demonstrated the lowest levels of social initiative 1 year later. Finally, Chen and Santo (2016) reported that insecure attachment moderated the association between shyness and negative peer interactions among older children. Specifically, both avoidant and ambivalent subtypes of insecure attachment exacerbated peer victimization and peer rejection among shy children.

Although limited, the results of these studies suggest that attachment security may be an important moderator in the links between shyness and socio-emotional outcomes. Parents who provide consistent and responsive care may foster feelings of security in the shy child as they explore their social environment, thus providing the child with important opportunities to develop social and emotional competencies throughout their development.

Putting It All Together: A "Best-Case Scenario" in the Development of Childhood Shyness

In this chapter, we proposed a conceptual model of protective factors that might serve to reduce risk and ameliorate outcomes in the life sequelae of shy children. Our review of the literature provided at least some preliminary support for different components of this model. Integrating these findings into a narrative description, the following represents a "best-case scenario" of the *Shy but Getting By* model.

As with the *Temple of Doom* (or worst-case scenario) described earlier in the chapter, this exemplar also begins with a child born with a shy temperament (i.e.,

tendency to respond with wariness in the face of social novelty and/or self-consciousness in situations of perceived social evaluation; Asendorpf, 1991). However, when negative emotions are evoked in these stressful social situations, the child is able to appropriately regulate and shift their attentional focus (i.e., high attentional control) and respond with less stress reactivity (i.e., better cortisol regulation). Moreover, when balanced with the child's already higher levels of behavioral restraint (that accompany shyness), relatively lower levels of inhibitory control and higher activity combine to promote appropriate risk-taking in social situations. At the same time, the child's parents further assist the child to regulate negative emotions by modeling appropriate emotional responses and engaging in rich emotion-related discussion with the child. Parents' typical interactions with their child are further characterized by warmth and support but also the setting of appropriate limits and encouragement of independence. Taken together, these setting conditions conspire to create secure parent-child relationships and, in turn, the child developing an internal working model of *felt security* (i.e., "the world is a safe, predictable, and caring place").

Viewing the world from this perspective further encourages the child to explore their social environment and initiate social contacts with positive expectations (and a friendly demeanor). Over time, a *positive feedback loop* is created, whereby positive social experiences with peers and close relationships with teachers serve to reinforce the child's positive view of himself/herself and of others, which in turn serves to gradually allay socio-evaluative concerns. As a result, and even in the face of any lingering feelings of social wariness, the child's continued positive social exchanges provide a continuing context for the acquisition and development of critical social, socio-emotional, and socio-communicative skills. These competencies continue to facilitate positive social exchanges, which further elicit positive responses from peers and teachers and so on. In this model, the shy child is placed on a trajectory of positive socio-emotional development and healthy well-being.

Of course, this model should be considered as speculative in nature. There is still much work to be done in terms of more robustly empirically testing many of our assumptions. Moreover, we have yet to consider possible gender effects. For example, peers tend to respond more negatively to shy behaviors when displayed by boys than by girls, perhaps because such behaviors violate male gender stereotypes regarding dominance and assertion (Doey, Coplan, & Kingsbury, 2014). It remains to be seen if gender might additionally moderate other pathways postulated in our model. Also, additional protective factors for shy children could also be integrated into the model in the future. These could include additional family factors (e.g., sibling relationships; Graham & Coplan, 2012), school factors (e.g., classroom climate; Spangler Avant, Gazelle, & Faldowski, 2011), and social experiences outside of school (e.g., extracurricular activities; Findlay & Coplan, 2008). We are hopeful that we have provided a conceptual framework that will stimulate future research related to protective factors in the development and implications of childhood shyness.

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Part III
Biological Perspectives

Inhibited Children in a Social World: Transactional and Interactive Processes

Pan Liu, Christina G. McDonnell, and Elizabeth P. Hayden

Introduction

It is axiomatic to say that children's development is complex and multidetermined, involving both within-person and environmental influences in shaping child outcomes. However, simplistic models of child and environmental influences on children's development that treat the two as independent are clearly inadequate given the person-environment correlation and interaction apparent across the lifespan. Indeed, very early in development, the impact of environmental influences on development is moderated by children's endogenous characteristics, characteristics which themselves act to change children's environments over time. Put simply, endogenous traits do not develop in a vacuum; as noted by Rutter (1997, p. 336), "Genetic effects have to be manifest with respect to organisms developing in a particular environmental milieu, and environmental effects have to operate on organisms that differ with respect to genetically influenced individual characteristics." This complex interplay poses a challenge to developmental psychologists and psychopathologists hoping to understand how childhood vulnerabilities are related to negative outcomes, as well as how some at-risk children nevertheless show adaptive development.

An ample literature has focused on dynamic processes such as these in the context of childhood behavioral inhibition (BI and related traits such as shyness and trait fearfulness), a temperament trait capturing the tendency toward heightened

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vigilance, fearful affect, and behavioral withdrawal in response to novel social and nonsocial situations (Kagan, 2012). BI is an established risk factor for anxiety (Fox & Pine, 2012) and possibly depression; indeed, the defining features of BI overlap with symptoms of anxiety, rendering it potentially challenging to distinguish between the two based simply on observable features. Relatedly, contemporary models of trait-disorder associations acknowledge the shared etiological bases of traits and related disorders (Pérez-Edgar & Guyer, 2014), such that distinctions between "state" manifestations of disorder and associated "traits" are potentially limited in value, at least when considering causal factors. Put differently, a key implication of these models is that those with elevated trait vulnerability (e.g., BI) possess at least some of the causal factors for disorder (e.g., anxiety), factors which interact with other sources of risk to influence outcomes.

Consistent with these ideas, high BI in childhood shows complex relations with child outcomes, and most children high in BI do not develop internalizing problems (Liu & Pérez-Edgar, 2019; Pérez-Edgar & Guyer, 2014). Indeed, in some contexts, higher BI may be beneficial; for example, inhibited or introverted individuals tend to be more deliberate and harm-avoidant (Carver, 2005; Smits & Boeck, 2006), which may prove useful in many contexts. Like all vulnerabilities, BI has a probabilistic rather than deterministic influence on development, with context playing a key role in determining whether BI is maladaptive. Thus, although child BI is expressed within multiple sociocultural and interpersonal environments, suggesting that those who find navigating interpersonal interactions challenging are at risk, many inhibited children do not develop psychopathology, and there is tremendous variability in their developmental trajectories (Henderson, Pine, & Fox, 2015).

In this chapter, we will review the literature exploring the processes by which BI and related constructs influence children's development. Historically, observational indices of behavior have been treated as the gold standard by which BI is indexed (Kagan, 2002), with parent- and self-reported BI used as other indices of trait BI. However, we will draw upon multiple vantage points for understanding processes relevant to BI, including indices of attention and other cognitive processes, psychophysiological approaches, structural and functional neuroimaging techniques, and genetic influences, when these are thought either as reflective of concomitant processes in BI or as potentially etiologically significant. We also review contextual influences likely relevant to the ontogeny of BI. Unsurprisingly, much of the extant literature has focused on caregiving and the broader sociocultural environment of the child, but we will also consider what we refer to as *the context of the individual*, by which we mean other child factors that may interact with BI, such as biological sex, gender, and other child traits. Broadly, our goal in this chapter is to highlight the processes relevant to understanding the pathways by which BI shapes outcomes.

Caregiving, the Early Home Environment, and the Inhibited Child

Parents and other caregivers are by far the most prominent influence on the early environment in which children develop. It is, therefore, unsurprising that parenting behaviors have received a great deal of attention as potential influences that operate in conjunction with child BI to predict development. As noted by Buss and Kiel (2013), parenting can play a formative role in driving the extent to which children approach/engage with novelty. Investigators have been interested in the interplay between child BI and caregiving that promotes (or fails to promote) engagement with novelty, positing a curvilinear pattern such that parents who discourage children from interacting with unfamiliar situations and those who use coercive or insensitive efforts to promote interaction with the unfamiliar are both associated with negative child outcomes.

In line with this model, we focus on two types of parenting behaviors commonly studied in the BI literature (Buss & Kiel, 2013; Kiff, Lengua, & Zalewski, 2011), overprotection and intrusiveness. Overprotective parenting is conceptualized as parenting behaviors that restrict children's exploration in novel environments, as well as the provision of excessive comfort when child distress arises in novel contexts, thereby potentially reinforcing avoidance (Ungar, 2009). Intrusive parenting is defined as inappropriately rigid parental control of children's behaviors (Wood, 2006); for children with BI, intrusive parents typically push them to interact with unfamiliar situations in an insensitive, forceful manner. While different labels have been used to refer to the same or highly similar parenting constructs (e.g., oversolicitous parenting, oversensitivity, overcontrol, low autonomy granting, parental derision), we use the terms *overprotection* and *intrusiveness* throughout. We will review available literature on both trait-parenting interactions as well as mediating processes implicated in BI and care. Of note, although both moderation and mediation are likely possible, the majority of the BI-parenting literature has focused on one or the other.

With respect to how protective and intrusive parenting behaviors moderate the effect of BI on child outcomes, compared to equally inhibited children with overprotective parents, inhibited toddlers and preschoolers of less protective parents tend to show lower stability of BI and a decreased likelihood in developing anxious behaviors (Hastings et al., 2008; Rubin, Burgess, & Hastings, 2002). For behaviorally inhibited toddlers, lower maternal sensitivity or protection was associated with fewer child anxious behaviors both concurrently (Mount, Crockenberg, Jó, & Wagar, 2010) and prospectively (Park, Belsky, Putnam, & Crnic, 1997). Although the mechanisms underlying this interactive effect are unclear, overprotective parenting may prevent inhibited children from developing coping skills when faced with novelty; as a result, these children's inhibited and anxious responses to novelty are sustained and exacerbated over time.

Intrusive parenting shows similar patterns in moderating the effects of early child BI on socioemotional outcomes. For instance, toddlers' inhibited behaviors at age 2

predicted their social reticence at age 4, but only when mothers showed more intrusive behaviors at age 2 (Rubin et al., 2002). Inhibited toddlers of more derisive and critical mothers showed sustained inhibition and social reticence, compared to their peers with non-derisive mothers (Johnson et al., 2016; Rubin et al., 2002). For inhibited children, intrusive parenting may result in heightened negative emotional arousal in them when they are already challenged by the novel environment, which may enhance their feelings of being out of control (Chorpita & Barlow, 1998), overwhelm their coping capacities, and further disrupt their ability to self-regulate (Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996). Overall, the two seemingly very different parenting constructs, overprotection and intrusiveness, show similar effects in moderating the relations between BI and outcomes, perhaps due to the fact that both constructs prevent children from effectively learning strategies to cope with novelties. This line of studies suggests that the effects of early BI may be potentiated by variations in parenting behaviors, which constitute a primary component of the child's immediate socioemotional environment.

In addition to the interactions between BI and parenting in predicting socioemotional outcomes, recent studies emphasize the bidirectional relations between BI and parenting. For example, overprotective parenting at age 2 predicted children's fearful inhibition at age 4, with the stability of children's inhibited behaviors controlled for (Rubin et al., 2002). For preschoolers, protective parenting predicted child inhibited and fearful behaviors a year later, above and beyond the stability of child inhibition (Edwards, Rapee, & Kennedy, 2010). Over and above the stability of negative reactivity during infancy, certain "less protective" parenting patterns observed at 27 and 33 months, such as lower sensitivity, less positive affect, and greater intrusiveness, were prospectively associated with lower child inhibition at 36–37 months old (Park et al., 1997). Another study of toddlers, however, failed to observe relations between overprotective parenting at age 2 and parent-reported BI at age 4 (Rubin, Nelson, Hastings, & Asendorpf, 1999). Overall, the work focusing on mediation and moderation indicates that parental overprotection may serve to strengthen associations between BI and negative outcomes.

Relatively less work has been conducted in older children. In a longitudinal cohort of school-age children, higher parental rejection at age 9 predicted modest increases in fearful inhibition and in turn internalizing problems, at age 11, with the stability of inhibition accounted for Lengua (2006). Likewise, less consistent parental discipline at age 9 predicted greater child inhibition at age 10; however, inconsistent discipline at age 9 predicted lower child inhibition at age 11 (Lengua, 2006; Lengua & Kovacs, 2005). These inconsistent predictive patterns at age 10 and 11 may reflect changes that unfold as youth are transitioning into adolescence, such that they might perceive highly consistent parenting as overcontrolling and inconsistent parenting as more autonomy granting, resulting in decreased inhibition.

Child BI also seems to elicit certain parenting behaviors, with work focusing on the impact of child BI on protective parenting. In particular, compared with their non-inhibited peers, inhibited children are more likely to elicit protective behaviors from their caregivers, especially in contexts where BI is relevant (i.e., novelty). Longitudinal studies find that parent-reported inhibition in toddlers predicted

parents' overprotective behaviors and disencouragement of independence in the future, over and above the stability of parenting (Hastings & Rubin, 1999; Rubin et al., 1999). Overprotection may in turn maintain and reinforce toddlers' fearful inhibition and increase their risk for later anxiety, playing a mediating role in linking early BI and later anxiety (Kiel & Buss, 2009). A similar pattern of BI-to-parenting was observed in older children: with the stability of parenting controlled for, higher fearful inhibition at age 9 predicted increased parental acceptance a year later and decreased parental rejection over the next 2 years (Lengua & Kovacs, 2005).

Most of the existing literature has used parent self-reported (or child-reported when applicable) questionnaires to measure parenting behaviors. While questionnaires are an economical and efficient means of collecting data, they are subject to various reporting biases (e.g., social desirability) and contribute to spurious or inflated correlations between constructs due to shared method and mono-informant variance when the developmental outcome is also measured by questionnaires from the same respondent. Thus, independent measures of key constructs provide a more stringent test of relations between child and family factors and youth outcomes. In recent work, we used observational measures of parenting to provide novel information for BI-to-parenting associations. Structured parenting is characterized by caregiving strategies that provide consistent guidance and scaffolding for the child and regulate child behaviors and emotions by providing specific instructions and limit setting, especially when the child is facing challenging situations (e.g., Barber, 1996; Pomerantz & Eaton, 2001). Along the continuum of "encouragement to approach/engage with novelty" (Buss & Kiel, 2013), structured parenting can be mapped to the middle area of the spectrum, featured by a balance between warmth and limit setting. In our study, child BI observed at age 3 predicted more structured parenting observed at age 5, which in turn predicted fewer child internalizing and attention-academic problems at age 8 (Liu, Kryski, Smith, Joanisse, & Hayden, 2019).

These findings are somewhat inconsistent with past work showing that children high in BI elicit overprotective parenting (Hastings & Rubin, 1999; Rubin et al., 1999). This may reflect the fact that our data were drawn from low-risk, community-dwelling families who may be better equipped to manage difficult child behaviors with appropriate caregiving. However, this divergence might also reflect the fact that different measurements of parenting assess different aspects of this construct. Specifically, questionnaires tend to emphasize the parent's general attitudes toward child-rearing (e.g., "I encourage my child to be independent of me"; Block, 1981), whereas observational tasks capture more concrete parenting behaviors within a specific situation (e.g., when the parent and child are working together to complete a task). This highlights the importance of using multiple measurements to tap into multiple levels and facets of a particular construct, which may play different roles in influencing developmental pathways.

Overall, the findings reviewed above indicate that parents' caregiving behaviors play an important role in shaping BI-anxiety links. For at least some children high in BI, gentle parental encouragement to approach and engage with novel situations, alongside the provision of specific instructions and effective coping skills, may place children on a more adaptive developmental pathway toward optimal outcomes.

Accordingly, prevention and intervention efforts that promote parenting strategies of this kind may be helpful.

BI and Cognition: Attentional Bias to Threat

BI likely interacts with individual's cognitive system as well, especially the attentional processes. To the extent BI and attention are somewhat independent of one another, attentional processes may serve as a "context" that interacts with BI to predict child outcomes. Cognitive theories of psychopathology propose that altered or "biased" patterns of cognition may serve as an important causal mechanism in the development of mental health problems (Clark & Beck, 1999); for anxiety in particular, early attentional bias (AB) toward negative information is thought to play a causal role in potentiating anxiety problems (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007). This notion has been supported by empirical evidence generated by both longitudinal studies (MacLeod & Hagan, 1992) and experimental manipulation designs (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). Based on this literature, BI researchers have become interested in exploring the AB profiles of children with BI and the relations between the two anxiety vulnerabilities, BI and AB, in shaping children's developmental pathways toward anxiety.

The psychopathology literature documents that relative to healthy controls, anxious individuals are typically characterized by heightened AB toward negative, especially threatening, information (Bar-Haim et al., 2007). Along this line, BI studies have examined the profiles of AB toward threat in behaviorally inhibited children, but with mixed findings reported. In the first study of AB in children with BI, adolescents with early childhood BI, but without any clinical diagnosis of anxiety disorder, showed elevated AB toward threat compared to their peers without early history of BI (Pérez-Edgar et al., 2010). However, this is the only study that found heightened threat AB in behaviorally inhibited youth, while studies in other behaviorally inhibited samples failed to observe elevated AB on the behavioral level in youth with BI. This might be due to the fact that attention paradigm commonly used to measure AB, the dot-probe task, has suboptimal psychometric properties (Rodebaugh et al., 2016) and is not able to capture the nuanced individual differences among nonclinical, behaviorally inhibited children.

A more recent, small neuroimaging literature has emerged by combining the dot-probe paradigm with neuroimaging techniques to yield indices of the neural substrates of AB in youth characterized on BI. The fMRI measures of AB are proven to be more reliable than the behavioral measures of the dot-probe paradigm and provide new evidence for the differences in AB between BI and non-BI individuals. A recent study found that 9- to 12-year-old children with high BI displayed greater activation in dorsolateral prefrontal cortex (dlPFC) than their non-inhibited peers, when they had to shift attention away from threat (Fu, Taber-Thomas, & Pérez-Edgar, 2017). The dlPFC area supports the maintenance of executive control, such

as voluntary attention allocation to support task-required performance in the presence of threat-related distractors (Bishop, 2008, 2009; Luks et al., 2007). Young adults with a history of stable early childhood BI showed more negative fronto-amygdala connectivity in response to angry faces, compared with individuals without early BI (Hardee et al., 2013). In both studies, the magnitude of neural activation was associated with anxiety symptoms. Further, these neural activation patterns appear to parallel those observed in clinically anxious adolescents. For instance, when shifting attention away from threat, anxious adolescents show greater dlPFC activation (Telzer et al., 2008) and attenuated amygdala deactivation (Price et al., 2014) than healthy controls. That youth elevated in BI show similar neural activation to those with anxiety suggests that these shared neural patterns during attentional processing may serve as one of the potential mechanisms underlying the pathways from BI to later anxiety.

More consistent findings come from work testing the interaction between BI and AB in predicting youth's anxious symptoms and behaviors. In other words, instead of conducting between-group comparisons, these studies focus on whether the BI-anxiety association is moderated, or strengthened, by high threat AB. In a longitudinal study, early-childhood BI prospectively predicted increased social withdrawal behaviors in adolescence, but only for adolescents who also showed higher threat AB (Pérez-Edgar, Bar-Haim, et al., 2010). Toddlerhood BI was prospectively associated with greater social withdrawal at age 5, only for children with greater threat AB concurrently at age 5 (Pérez-Edgar et al., 2011). In a different longitudinal cohort, middle childhood BI prospectively predicted social discomfort during adolescence, only for youth with altered patterns of attentional processes during infancy, including low sustained attention to targets and heightened attentional vigilance toward distractors (Pérez-Edgar et al., 2010). These observed moderation patterns suggest that for youth with early BI, the presence of heightened AB may strengthen the link between BI and later anxiety, whereas the absence of threat AB may prevent them from getting onto a maladaptive developmental pathway toward anxiety outcomes. This suggests that training inhibited individuals to shift their attention away from threat might be an effective way to diminish their anxiety symptoms and reduce risk for developing clinical anxiety (Liu, Taber-Thomas, Fu, & Pérez-Edgar, 2018).

BI and Cortisol

Recent work has focused on understanding the physiological underpinnings of BI to identify biobehavioral substrates that may underlie links between BI and later psychopathology (Buss & Kiel, 2013; Fox, Henderson, Marshall, Nichols, & Ghera, 2005). The majority of this work has focused on cortisol, the end product of the hypothalamic-pituitary-adrenocortical (HPA) system response to stress. Broadly, BI-related constructs (e.g., fear, shyness, social withdrawal) have been linked with disrupted cortisol functioning, including heightened reactivity and baseline

production (see Buss & Kiel, 2013, for review of biological correlates and mechanisms of BI).

The link between BI and stress physiology, however, may be moderated by environmental factors such as parenting. For example, higher cortisol reactivity may uniquely be associated with fearful behavior in the context of disrupted parenting and/or family processes, such as insecure attachment or maternal stress (Essex, Klein, Slattery, Goldsmith, & Kalin, 2009; Nachmias et al., 1996). Similarly, children with heightened cortisol reactivity and parental social anxiety are at the highest risk for social anxiety (Poole, Van Lieshout, McHolm, Cunningham, & Schmidt, 2018). Importantly, this suggests that the association between BI and altered stress physiology is complex and influenced by complex environmental inputs (Buss & Kiel, 2013; Gunnar & Adam, 2012).

Neural Correlates of BI

Much of the early work on the neural correlates of BI was based on animal models finding that the amygdala, which becomes functional shortly after birth, is directly linked to negative reactivity (e.g., distress cries, limb movements) in response to novelty during infancy (Kagan, 2012). The amygdala is a hub-like brain structure within a distributed network that underlies a multitude of emotion-related processes across development (Scherf, Smyth, & Delgado, 2013). The direct examination of amygdala in the context of BI, however, was not possible until neuroimaging techniques, such as fMRI, became accessible (Schwartz & Rauch, 2004). Earlier work on the neural correlates of BI relied on more accessible neural measures such as EEG and ERP and startle EMG (Schmidt & Fox, 1998), which are hypothesized to be directly associated with the hypersensitive amygdalar function (White, Lamm, Helfinstein, & Fox, 2012). Investigation of the neural foundations of BI has found shared neural correlates between BI and anxiety problems, supported by evidence generated by different neural measures including EEG, ERP, and fMRI. For example, children with high BI show heightened vigilance to the behavioral errors they made indicated by the modulation of the ERP component, error-related negativity (McDermott et al., 2008); this parallels ERP findings in anxious individuals (Meyer, 2017). The shared neural correlates between BI and anxiety might serve as a potential mechanism that tethers the two along the developmental pathway. Due to space limits, the present chapter focused on research related to frontal EEG asymmetry and fMRI correlates in behaviorally inhibited children.

Frontal EEG asymmetry is typically calculated as a difference score of alpha band activity between left and right frontal regions. Right frontal EEG asymmetry (i.e., greater alpha activity in the right than left frontal region) is associated with withdrawal tendencies, while left frontal EEG asymmetry is related with approach motivations (Davidson, 2004). In the psychopathology literature, greater right frontal EEG activity has been observed in clinically and subclinically anxious and depressed individuals (Field, Diego, & Hernandez-Reif, 2009; Thibodeau,

Jorgensen, & Kim, 2006). Similar patterns have also been reported in the BI literature. Negatively reactive infants and behaviorally inhibited children show greater right frontal EEG activity at rest (Finman, Davidson, Colton, Straus, & Kagan, 1989; Hane, Fox, Henderson, & Marshall, 2008) or when performing tasks designed to evoke fearful and withdrawal responses (Theall-Honey & Schmidt, 2006). Right frontal EEG asymmetry at 9 months prospectively predicted the stability of inhibition from infancy to age 4 (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001); in another sample of inhibited children, stability in right frontal asymmetry from age 3 to 10 accounted for stability of their inhibited behaviors (Davidson & Rickman, 1999).

The right frontal EEG asymmetry found in inhibited children may reflect ipsilateral projections from the right amygdala, which is presumed to receive greater visceral inputs than the left amygdala (Kagan, 2002). When inhibited children show heightened bodily responses when facing novel stimulations, their right amygdala became more activated, which then leads to higher alpha activity in the right frontal regions. EEG source modeling research shows that frontal EEG asymmetry is localized in, and thus directly reflects, dorsolateral prefrontal cortex (dlPFC) activity (Shackman, McMenamin, Maxwell, Greischar, & Davidson, 2009). Neuroimaging evidence supports the functional lateralization of dlPFC that the left dlPFC is involved in approach, goal-related, motivational processes and right dlPFC in withdrawal-related tendencies (Spielberg, Stewart, Levin, Miller, & Heller, 2008). Activation of right dlPFC during withdrawal-related processes might further support threat-related vigilance (Davidson, 2004). These patterns yielded by different measures converge to support the functional lateralization of dlPFC in relation to approach-inhibition behavioral tendencies, including child BI.

As neuroimaging technology has become increasingly accessible, recent work has more directly examined the hypothesized amygdala-based neural substrates of BI, documenting heightened amygdalar activation in inhibited individuals in response to novel or emotional stimuli, especially when stimuli are negative in valence. Again, these patterns parallel what has been observed in clinical anxiety (e.g., Monk et al., 2008). For instance, young adults identified as behaviorally inhibited during toddlerhood showed exaggerated bilateral amygdalar activation in response to novel faces, compared with their peers without a history of early BI (Schwartz, Wright, Shin, Kagan, & Rauch, 2003). Similar evidence for atypical amygdalar activation in young adults characterized with early BI includes faster latency in response to novel faces (Blackford, Avery, Shelton, & Zald, 2009) and difficulty in habituating to repeatedly presented faces (Blackford, Allen, Cowan, & Avery, 2013). When 12-year-old adolescents had to subjectively rate their feelings of fear in response to emotional faces, those with a history of early childhood BI showed greater amygdalar activation than their peers without BI (Pérez-Edgar et al., 2007). Collectively, these findings support the initial proposal of the amygdala as the primary neurobiological basis of BI and highlight its role as a shared neural foundation between BI and anxiety (e.g., McClure et al., 2007; Monk et al., 2008; Stein, Goldin, Sareen, Zorrilla, & Brown, 2002; Thomas et al., 2001). For individuals with a history of early childhood BI, the atypical amygdalar function may help

sustain their early temperamental risks over time and contribute to the later emergence of maladaptation.

Another line of recent neuroimaging studies suggest that BI may also be associated with neural functions that are implicated in reward processing, such as striatal function (Caouette & Guyer, 2014). Overall, this literature suggests that behaviorally inhibited youth of different ages show reward-related striatal hypersensitivity. For example, in a stratified incentive task, while adolescents with or without early BI showed similar behavioral performance, inhibited adolescents showed heightened striatal activation in response to incentives compared with their non-inhibited counterparts (Guyer et al., 2006). When the reward outcome was irrelevant to participants' task performance, adolescents with or without early BI showed comparable striatal activation; when the reward was contingent upon performance, adolescents with early BI showed heightened striatal activation than the non-inhibited group (Bar-Haim et al., 2009).

Adolescents with early BI also showed greater striatal activation in response to immediate negative feedback for their behavioral performance than their non-inhibited peers (Helfinstein et al., 2011). Further, heightened striatal activation was found in 10-year-old children with early BI in comparison with their non-inhibited peers; for inhibited children, the magnitude of striatal activation was further related with their social anxiety symptoms, both concurrently and prospectively (Lahat, Benson, Pine, Fox, & Ernst, 2018). The reward-related hypersensitivity may reflect the participants' worry regarding uncertain outcomes, concern over their performance being evaluated, or excessive motivation to avoid losses (Guyer, Masten, & Pine, 2013). Again, parallel patterns of heightened striatal response to incentives have been reported in adolescents with clinical social anxiety, which is associated with dysfunctions in the striatal dopaminergic system (Guyer et al., 2012). In addition to hyperreactive amygdala, atypical striatal function may constitute another shared neural correlate between BI and anxiety, serving as an additional neurocognitive vulnerability to anxiety for children with BI.

In addition to serving as neural correlates of BI, specific patterns of activity within these areas may also moderate developmental pathways between BI and later outcomes. Similar to the moderating role of threat bias discussed earlier in this chapter, extreme patterns of neural dysfunction may sustain the stability of BI and strengthen its link with later anxiety. These moderation patterns suggest that the coupling of more than one vulnerability may create a "richer" context of risk, which potentially increases the probability of developing maladaptive pathways. A recent study of 9–12-year-old children characterized by early BI found that the association between BI and anxiety symptoms was strongest for those who also showed higher AB toward threat (cognitive marker of risk) and right frontal EEG asymmetry (neural marker of risk). On the other hand, inhibited children with greater left frontal alpha activity and attentional avoidance of threat showed lower anxiety symptoms (Vallorani et al., Unpublished manuscript). These findings again emphasize that BI, as a temperamental risk alone, does not necessarily lead to negative developmental outcomes; rather, specific developmental pathways and outcomes are shaped by the

interrelations between factors from different systems within the individual, as well as between the individual and the environment (e.g., parenting).

Genetic Underpinnings of BI

Consistent with the developmental psychopathology tradition, genetic underpinnings of BI have been investigated in efforts to identify genetic markers of BI and genetic contributors to multifinality. This work has implicated genetic markers related to the serotonin (e.g., 5-HTT serotonin transporter) and dopamine (dopamine receptor D4 gene, brain-derived neurotrophic factor gene) systems. We acknowledge that concerns have been raised regarding the replicability of this literature (Hewitt, 2012); however, we provide an overview here with the goal of informing efforts at replicability and future hypothesis testing of genetic mechanisms using methods more robust than those currently widely available. Nevertheless, we encourage the reader to evaluate the findings we present critically and in light of the broader literature.

Serotonin Transporter

The majority of extant research on the serotonin system has focused on a functional polymorphism in the promoter region of the serotonin transporter (5-HTT), which consists of a short and long allele. The short allele is associated with reduced serotonin uptake and 5-HTT transcription (Hariri et al., 2002; Lesch et al., 1996) and has been associated broadly with negative emotionality in adults (Munafo et al., 2003; Munafò, Durrant, Lewis, & Flint, 2009). Regarding BI specifically, the short alleles of the 5-HTT promoter region polymorphism confer increased vulnerability for behavioral inhibition (Whisman, Richardson, & Smolen, 2011). In particular, Whisman et al. (2011) found among undergraduates that having one or two copies of the low-expressing alleles was uniquely associated with stronger endorsement of the behavioral inhibition system on the BIS/BAS self-reported scales (Carver & White, 1994), a construct with considerable conceptual overlap with BI.

Findings regarding the 5-HTT promoter region and BI in children are equivocal. For example, some studies have not found associations between the 5-HTT gene and BI (Schmidt, Fox, Rubin, Hu, & Hamer, 2002). Considering related constructs such as shyness, some work has found that the long form of the 5-HTT gene is associated with questionnaire measures of shyness (Arbelle et al., 2003), whereas others have found that short-short 5-HTT allele status is associated with heightened shyness indexed via questionnaire and behavioral observation (Battaglia et al., 2005). Hayden et al. (2007) demonstrated that preschool-aged children with one or more long alleles of the 5-HTT gene were more nervous during observational laboratory tasks, whereas children homozygous for the short alleles were rated as significantly

shyer via maternal report. More recently, these equivocal findings have been extended by results implicating the 5-HTT in gene-environment interactions.

Multiple studies now support that the link between the 5-HTT gene and BI may be moderated by social factors. Fox et al. (2005) demonstrated that children with the short 5-HTT allele only had increased risk for BI in middle childhood in the context of low social support. Similarly, others have found that children with the short allele demonstrated less continuity in BI over time, suggesting that the short variant increases plasticity to contextual influences (Johnson et al., 2016). This is consistent with a growing literature documenting the 5-HTTLPR gene in differential susceptibility to environmental input, such that children with the short allele may be particularly sensitive to positive and negative environmental factors.

Brain-Derived Neurotrophic Factor (BDNF)

Brain-derived neurotrophic factor (BDNF) is a protein that underlies neural plasticity (Schinder & Poo, 2000). The BDNF val66met polymorphism involves a substitution at codon 66 that is associated with reduced secretion of the BDNF protein that has been associated with risk for anxiety disorders (e.g., Suliman, Hemmings, & Seedat, 2013), perhaps due to associated changes in neural architecture (e.g., Gatt et al., 2009). Regarding BI in particular, the BDNF met allele is uniquely associated with endorsement of behavioral inhibition scales (Johnson, Carver, Joormann, & Cuccaro, 2016). The BDNF met allele may also influence the consistency of BI across development, as Vandermeer et al. (2018) found that children with the met allele had less stability in BI from ages 3 to 6. It is essential for future research to specify how multiple genes interact with environmental input in order to identify how BI changes and confers risk for psychopathology across development (e.g., Green et al., 2017).

Conclusion and Future Directions

We revisit our initial and widely accepted assertion that children's development is highly complex, involving person-environment interactions and correlations. The simplicity of this statement, as well as its widespread acceptance in the field, belies the challenge of effectively unpacking influences on children's development, specifically behavioral inhibition and social factors in the current context. Here, we highlight a few future directions we think will be of benefit to the field in terms of meeting this challenge.

Moving forward, the complex role of BI in development necessitates longitudinal approaches toward understanding the natural progression of the trait, as well as how it may both elicit and interact with context in nonrandom ways. It is not as though longitudinal studies of BI are lacking; however, as we have noted elsewhere

with respect to child development more broadly (Hayden & Harkness, 2020), research aimed at understanding the development of BI necessitates developmentally sensitive yet equivalent indices of the construct for use during childhood and adolescence. Thus, we encourage psychological scientists to revisit popular measures of BI toward the goal of establishing their equivalence when applied to different developmental stages. While we understand that work such as this is much easier to do with questionnaire assessments, given the potential limitations of these, we also encourage investment in developing and validating observational measures of BI that function equivalently across childhood. Put simply, the construct validity of our assessment tools places constraints on the strength of any conclusions we might draw with respect to development, whether BI or other child factors are the construct of interest.

We also acknowledge that no single methodological approach (e.g., naturalistic longitudinal methods) will suffice with respect to answering questions about the interplay between BI and contextual influences. Given the nonrandom associations between BI and contextual variables, experimental designs that contrast children who vary in BI in terms of reactivity to experimentally manipulated stimuli will continue to prove useful in understanding the interactions between causal forces that shape BI and its relation to adaptive and maladaptive outcomes (e.g., Pérez-Edgar et al., 2011). Controlled studies that aim to better unpack the mechanisms and processes by which BI renders some children vulnerable to anxiety will also prove useful in this regard. For example, there is evidence from experimentally controlled studies to support the effectiveness of attentional bias modification (ABM) in youth at risk for anxiety based on elevated BI (Liu et al., 2018). However, despite the potential efficacy of the approach in terms of ameliorating symptoms, it is unclear whether attention, the purported mechanism of risk, actually changes as a result of ABM (Price et al., 2016). This may stem from the use of psychometrically problematic yet widely used indices of attentional bias (e.g., the dot-probe paradigm; Rodebaugh et al., 2016). Hence, even controlled experimental studies will benefit from close scrutiny of measures, including those which have become standard in the field given that the extent to which an assessment tool is widely used does not necessarily indicate adequate psychometric properties or construct validity (e.g., Kotelnikova, Olino, Klein, Kryski, & Hayden, 2016). Controlled studies manipulating change in putative causal mechanisms (biological or otherwise), when equipped with rigorous assessment tools, will continue to prove useful for informing developmental theory with respect to BI, as well as potentially informing preventative measures.

Understanding the pathways by which BI might foster positive outcomes merits further research attention. Certainly, avoidance of harm and attention to threat are useful in dangerous environments, fostering health and even survival, but BI may also foster superior outcomes even in more typical contexts for child development (e.g., school competence and peer liking; Chen, Chen, Li, & Wang, 2009). Ties between child BI (and related constructs; Aron, Aron, & Jagiellowicz, 2012) and outcomes may follow a pattern referred to as *differential susceptibility* (in which an individual difference factor serves to increase sensitivity to an array of positive and

negative environmental factors, such that individuals with this "susceptibility" are not only more vulnerable to stress but are also more likely to thrive in enriched environments; Boyce & Ellis, 2005). However, as we have noted elsewhere (Hayden & Durbin, 2018), testing such models requires the psychological scientist to be mindful of the distinction between the absence of negative outcomes and the presence of superior functioning. This is critical in light of the small effect sizes and probabilistic nature of most putative markers of susceptibility, including BI, whereby most with the hypothesized vulnerability do not develop disorder, yet also may not show especially positive outcomes. Similarly, contextual factors thought conducive to especially superior developmental outcomes cannot merely index the absence of "risky" environments (e.g., the absence of negative caregiving) if the goal is to adequately test differential susceptibility.

Many scientists interested in BI are likely to self-identify as developmental psychopathologists; thus, it is perhaps unsurprising that the field has embraced a multilevel approach to understanding and assessing BI. Such an approach will continue to enhance the field and also has implications for training. Collaboration across fields and transdisciplinary approaches to graduate training are essential toward understanding the complex and multidetermined processes that account for the diverse developmental trajectories of children with BI. We note that it is not unusual for psychological scientists interested in BI to specialize in behavioral, psychophysiological, and neuroscientific methods. This tendency to choose methodologies and collaborations based on available data, rather than on familiarity, is laudatory. However, we also encourage scholars to avoid choosing research tools based on which methods are perceived to be the most important or sophisticated (Hayden & Harkness, 2020; McFall, Treat, & Simons, 2015). For example, the long tradition of laboratory-based behavioral assessments has yielded important insights into the nature of BI, even though there might be a tendency to view such approaches as primitive compared to the tools available for neuroimaging. Given the paucity of evidence to support reliance on one "level of analysis" over another, it is important to validate newer approaches against those which have already been fit within nomological networks (Cronbach & Meehl, 1955).

In closing, those who study BI are fortunate to do so during a time when cutting-edge tools are available and increasingly affordable and collaboration and replication are increasingly seen as essential toward fostering true progress in psychological science. These factors, considered as a whole, leave us well poised to shed new light on how, when, and for whom vulnerability related to BI leads to maladaptation. We eagerly await the continued growth of this rich area of developmental science.

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The Biology of Shyness and Adapting to Threat

Kelley Gunther, Elizabeth Youatt, and Koraly Pérez-Edgar

Introduction

Shyness is both a common colloquial term and a ubiquitous biobehavioral phenomenon that can be seen at all points along the developmental timeline. Shy individuals may be hypersensitive to signals of threat, particularly when the perceived threat is social in nature (Tang et al., 2016). In response to social threat, shy individuals show a distinct behavioral profile compared to non-shy individuals, marked by sensitivity and reticence to engage with social cues and concern with social evaluation (Coplan & Rubin, 2010). These responses are often accompanied by a preoccupation with self-well-being within these social contexts (Schmidt & Poole, 2019). These distinctive behaviors are associated with, and potentially driven by, underlying biological factors.

Markers of shyness, such as enhanced attention to social threat, differences in approach and avoidance behaviors, and preservation of childlike traits both behaviorally and neurally (i.e., neoteny), reflect processes that are evolutionarily conserved, early appearing, and primed to help individuals navigate their social environments. Shyness-linked overt behavioral responses to perceived social threat may be coupled with distinct responses at the physiological level, including hypervigilance to threat stimuli, increased brain activity in fear circuitry, and other fear-related behaviors such as freezing or avoidance. These responses may in part make up the etiology of shyness. Depending on environmental context, these mechanistic responses may also prove adaptive or maladaptive for an individual.

In the current literature, the construct of shyness is often associated with maladaptive developmental outcomes (Heiser, Turner, & Beidel, 2003; Nelson et al., 2007; Page, 1989; Rubin, Coplan, & Bowker, 2009; Van Ameringen, Mancini, & Oakman, 1998).

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For example, there is a large overlap between shyness and the temperament trait behavioral inhibition (BI) (Rubin et al., 2009; Schmidt, Fox, Schulkin, & Gold, 1999; Wolfe & Bell, 2014). BI is characterized by wariness and reactivity in the face of novel stimuli in early childhood (Kagan, Reznick, & Snidman, 1988), which often is most prominent in social situations (Kagan et al., 1988; Rubin, Burgess, & Hastings, 2002). By middle childhood, BI is often associated with heightened social withdrawal (Pérez-Edgar et al., 2010, 2011) and increased risk for social anxiety in adolescence (Chronis-Tuscano et al., 2009; Clauss & Blackford, 2012; Hirshfeld et al., 1992; Van Ameringen et al., 1998). Although there are evident similarities between BI and shyness, they are not one in the same—this distinction will be more thoroughly discussed subsequently.

That being said, shyness, like BI, is also a risk factor for anxiety (Van Ameringen et al., 1998), as well as other internalizing disorders (Nelson et al., 2007). Shyness also has been associated with social withdrawal (Rubin et al., 2009), social anxiety disorder (Heiser et al., 2003), poorer quality of interpersonal relationships (Nelson et al., 2007), and higher rates of substance abuse (Page, 1989). However, despite these previous associations with maladaptive outcomes, emerging research suggests that shyness is a multidimensional characteristic rather than a static label for a homogenous group. As such, emerging work is aimed at distinguishing subtypes of shyness, some of which are indeed developmentally adaptive.

In order to delve into the biological underpinnings of adaptive shyness and the way in which responses to threat may be adaptive, it is important to consider previous studies that have used a variety of neuroimaging methods to examine neural correlates of shyness, including magnetic resonance imaging (MRI), electroencephalography (EEG), event-related potentials (ERP), eye tracking, and respiratory sinus arrhythmia (RSA). These common techniques provide insight into both baseline and task-relevant structural and functional connectivity, the physiological differences between shyness and sociability, cognitive factors that interact with shyness, and the relations between shyness and regulation in emotional and social situations. Evidence of a biological basis of shyness is also seen in hormonal measures, particularly cortisol (Tang, Beaton, Schulkin, Hall, & Schmidt, 2014).

The current review focuses on threat sensitivity, approach/withdrawal tendencies, and neoteny as possible biological mechanisms that may be particularly helpful in teasing apart the broad term of "shyness" into multiple dimensions and further understand where on these dimensions specific forms of shy behavior may be adaptive. In addition, environmental context and individual patterns of attention may also interact to moderate the relations between shyness and adaptive development, helping to determine the specific processes that help support positive outcomes. Borrowing from the attention and executive functioning (EF) literature, both shyness and adaptation to threat allow individuals to flexibly respond to their environment to maintain positive goal-oriented behavior. More specifically, individual differences in goal-directed attention interact with trait-level attention biases to threat as either risk or protective factors for maladaptive developmental outcomes. A better understanding of the underlying mechanisms behind shyness and adaptation to threat across multiple contexts will help provide a more multidimensional and nuanced view of shyness across development.

Subtypes of Shyness: The Case of Adaptive Shyness

Shyness can be organized into several different subtypes. These subtypes are associated with adaptive and maladaptive outcomes depending on an individual's environment, as well as individual differences in temperament, EF, and biological processes. We will refer to several of these shyness subtypes throughout this chapter. Most readers are likely more familiar with maladaptive shyness, as shyness has been typically linked with negative outcomes such as social anxiety. In contrast, adaptive shyness refers to forms of shyness that are linked to adaptive outcomes and positive well-being (see also Poole and Schmidt; Chapter "Adaptive Shyness: A Developmental Perspective" this volume). It is important to note that because the display of shyness itself can change developmentally over an individual's lifespan, there is variability in the contexts in which shyness can be adaptive. Moreover, as an individual's social milieu changes with development, their behavioral presentation of shyness may also change over time. While the shy 5-year-old may hide behind the parent at the prospect of a social interaction, the equally shy 15-year-old may proclaim that they are not interested in a specific social invitation. The 25-year-old, now enjoying greater autonomy over the social world, can structure his or her environment such that distressing social bids simply rarely occur.

A wide assortment of terminology has been used in the literature in attempting to differentiate among different types of shyness and their level of adaptability, but there is little consensus on the boundaries of these divisions. Agreement emerges in the idea that some subtypes of shyness are early-emerging and other are later-emerging. Earlier-emerging forms of shyness are more apt to predict maladaptive developmental outcomes, and later-emerging shyness is *generally* more adaptive. Colonnesi, Bögels, de Vente, and Majdandžić (2013) and Colonnesi, Napoleone, and Bögels (2014) as well as Nikolić, Colonnesi, de Vente, and Bögels (2016) suggest a distinction between positive and negative shyness. Behaviorally, positive shyness is identified by a gaze, head, or body aversion away from threat accompanied by a "coy smile" (Colonnesi et al., 2013), while negative shyness is marked by the same aversion but in the absence of a smile (Colonnesi et al., 2013, 2014; Nikolić et al., 2016). In this formulation, positive shyness is typically later emerging than negative shyness.

Buss (1986) posed a differentiation between a fearful shyness, an early-emerging form of shyness, and a self-conscious shyness, which appears later in development. Fearful shyness is characterized by early-appearing discomfort that is most focused on wariness in the face of social novelty, while self-conscious shyness emerges later and is focused on social evaluations (Eggum-Wilkens, Lemery-Chalfant, Aksan, & Goldsmith, 2014; Schmidt & Poole, 2019). Conceptualizations of shyness subtypes also include conflicted shyness, which is operationalized as a later-emerging shyness marked by temperamental factors, such as fearful reactions to social stimuli, in combination with a desire for social belongingness (Schmidt & Poole, 2019; Tang, Santesso, Segalowitz, & Schmidt, 2016). Thus, the individual displays both heightened motivation to avoid social interactions (shyness) and increased motivation to engage in social interactions (sociability).

Finally, another label for an early-emerging shyness is temperamental shyness (see Schmidt et al., 1999; Schmidt & Miskovic, 2013). Consistent with the broad definitional umbrella for temperament traits (Fu & Pérez-Edgar, 2015), temperamental shyness may be characterized by having an identifiable biological basis as well as stability across development and is also conceptually similar to operationalizations of the BI temperament (Rubin et al., 2009; Schmidt et al., 1999).

Sensitivity and Attention to Threat

External Threat

Shyness, as an observable behavior, often emerges in response to a social interaction. Shyness, as a cognitive and emotional response, often results when the social interaction is perceived as a potential threat. This threat bias, in turn, may be a prototypical marker of shy children, as they often also display a hypervigilance to threat across contexts, reflected on both a behavioral and neural level. Attentional biases to threat are a common area of study in socioemotional development, as they may act as a mechanism or marker of anxiety (Tang, Beaton, et al., 2016). In this literature, there are two levels of analysis frequently used in examining threat biases. These levels include a microlevel of processing, collecting temporallysensitive measures in highly controlled tasks, and a more macro-level of processing, emphasizing larger-scale behaviors in more ecologically valid tasks.

Microlevel processing is evident in classic task-based measures. These paradigms include the dot probe tasks, emotional Stroop tasks, emotional visual search tasks, and emotional spatial cueing (e.g., Posner) tasks, in which participants must respond to a cognitive demand in light of emotionally valenced stimuli, often faces (Burris, Buss, LoBue, Pérez-Edgar, & Field, 2019; Fu & Pérez-Edgar, 2019). Because of the nature of these tasks, which often present stimuli on computer screens, they assess attention and responses to threat mostly within the scope of visual attention. Responses to the task may vary as a function of where visual attention is deployed in relation to an emotional stimulus, thus assessing biases in attention to salient cues.

It is important to note that most of these tasks have been used extensively in the context of BI and less so in the context of shyness. Generally, these studies have found that children high in BI show an attentional bias to threat on paradigms such as the Posner task (Morales, Taber-Thomas, & Pérez-Edgar, 2017) but less reliably on the dot probe paradigm (Morales et al., 2017; Pérez-Edgar et al., 2010, 2011). Where performance on the dot probe task may not directly characterize BI children, an attention bias to threat as measured by this task moderates the relation between BI and maladaptive developmental outcomes such that a greater attentional bias to threat is related to higher report of behaviors such as social withdrawal (Pérez-Edgar et al., 2010, 2011). Among the few studies that have specifically examined

shy children, findings suggest that children high in shyness may display an attentional bias to threatening stimuli (LoBue & Pérez-Edgar, 2014; Pérez-Edgar & Fox, 2005). Broadly, patterns of attention biases to threat in shy children mirror those seen in BI children. These task-based assessments are able to provide high levels of precision in measurement, collecting data such as button-press latency and metrics of visual attention using eye tracking technology. However, these same tasks may be criticized as lacking in ecological validity.

In addition to preferentially attending to threatening cues in computer tasks assessing threat biases as a function of visual attention or reaction time, shy individuals may also display a hypersensitivity and hypervigilance to perceived threat on a neural level. Previous work has suggested that shyness may be associated with differential arousal and regulation of the fear system, implicating hypersensitivity of the amygdala in response to threat cues (Jetha, Zheng, Schmidt, & Segalowitz, 2012). Shy adults also show a memory bias toward negatively valenced social stimuli, as well as greater neural activation of brain areas associated with affect-based processing in response to negative stimuli (Tatham, Schmidt, Beaton, Schulkin, & Hall, 2013). More specifically, research suggests increased activation of both the inferior frontal cortex and the middle temporal cortex while viewing negative social stimuli (Tatham et al., 2013). Additionally, shy adults show a greater response in the rostral anterior cingulate cortex (ACC) while viewing faces with moderate levels of emotion intensity. The same shy adults also show increased activation in areas of the brain traditionally associated with face processing, such as the superior temporal sulcus and inferior parietal cortices, in response to pairs of faces showing incongruent affect. These patterns of increased neural activation are thought to reflect both increased salience and emotion regulation in the face of social cues, suggesting that shy individuals are more receptive to facial stimuli and have higher vigilance for emotional threat detection as compared to non-shy counterparts (Tatham et al., 2013).

Other work, more frequently used in relation to the construct of shyness, examines on a macrolevel how an individual may respond to broader sources of threat, focusing less on moment-to-moment attention to threat and instead measuring how these responses may unfold more globally in paradigms emphasizing ecological validity. These paradigms often focus on social threat and are more interactive for the individual, directly targeting the centrality of social interaction in the conceptualization of shyness. As with the computer-based tasks, the interactive tasks are designed to be age-appropriate for the participant, since the form and function of shyness may change over time. For example, paradigms have been used as young as infancy, where 4-month-olds in a study by Colonnesi et al. (2013) viewed either themselves, another individual (parent or stranger), or both themselves and the other individual in a mirror, tapping into more "self-conscious" aspects of shyness at this early age. Toddlers in Colonnesi et al. (2014) were asked to name and imitate animal noises to an experimenter. Similarly, Nikolić et al. (2016) asked the same children at 4.5 years of age to perform a song in front of an audience, including their father, the experimenter, and a stranger. These different paradigms capture age-appropriate situations of social discomfort or threat in a more true-to-life scenario for the child. Metrics acquired may include behavioral measures such as aversion from the threat

or smiling behavior (Colonnesi et al., 2013, 2014; Nikolić et al., 2016), as well as physiological measures like blushing (Nikolić et al., 2016).

Peer tasks also represent a more naturalistic form of social threat among shy children. Fox, Schmidt, Calkins, Rubin, and Coplan (1996) utilized quartets of age- and gender-matched 4-year-olds to assess variations in sociability as a risk factor for internalizing problems, as children participated in free play, a cleanup task, a ticket-sorting task, and a speech task. Similarly, Walker, Degnan, Fox, and Henderson (2013) paired shy children with age- and gender-matched peers in longitudinal dyadic visits, assessing how shyness related to social problem-solving over time. These studies found that shyness in these social scenarios interacted with physiological profiles, specifically right frontal EEG asymmetry, to relate to heightened internalizing and externalizing problems (Fox et al., 1996). Behavior in these social scenarios was also related to developmental trajectories of social competence over time, such that shyness with a peer at 24 months predicted a shallower increase in social problem-solving over time, as compared to children with non-shy peer dyad interactions (Walker et al., 2013). Negative peer relations for shy children may be particularly problematic as negative social feedback may mediate the relations between early shyness and later patterns of self-conscious emotions and withdrawal (Howarth, Guyer, & Pérez-Edgar, 2013; Sette, Baldwin, Zava, Baumgartner, & Coplan, 2019).

Biased attention to threat, measured both by behavioral metrics and neural processing, is commonly noted as a maladaptive behavior. Broadly speaking, attention biases to threat are considered a characteristic of both pediatric and adult anxiety disorders (Roy et al., 2008) and may be part of the etiology of anxiety disorders (Lonigan, Vasey, Phillips, & Hazen, 2004). However, a threat bias may act as a protective factor in higher risk environments. Vigilance to threatening cues may prepare an individual to combat potential hazards to one's well-being. Children living in contexts marked by high levels early-life stress, such as low socioeconomic status (Dufford, Bianco, & Kim, 2018) or institutionalized care (Troller-Renfree, McDermott, Nelson, Zenah, & Fox, 2014) may display heightened threat biases.

While the literature frequently refers to threat biases as maladaptive (Roy et al., 2008), it may also be the case that threat biases emerge in truly threatening environments as a protective mechanism (Dufford et al., 2018; Troller-Renfree et al., 2014), minimizing exposure to early-life stressors embedded in the social environment (Hicks, South, DiRago, Iacono, & McGue, 2009; Ronald, Pennell, & Whitehouse, 2011). This idea again emphasizes the importance of considering environmental context in evaluating any adaptive value of shyness, as the imminence of actual threat may vary by environment. For example, children in high-quality neighborhoods show a negative association between resting RSA and shyness (Zhang & Spinrad, 2018). In this sample, lower RSA suggests a lower emotion regulation capacity among shy children in low-threat contexts (Zhang & Spinrad, 2018). In safe and cohesive contexts, RSA also predicts trajectories of children's shyness over time.

In particular, children's shyness upon entering elementary school can be predicted by RSA regulation when their environment is supportive and enriching. The opposite is true of children in lower-quality neighborhoods, where RSA is positively related to shyness. This association suggests that RSA may indicate an adaptive

regulatory capacity for these shy children. The modulation of the relation between physiological markers of regulation and shyness as a function of environmental threat shows the flexible and adaptive quality of shyness (Zhang & Spinrad, 2018). Shyness in high-threat environments may work to protect children from environmental forces that may constitute sources of stress and harm (Zhang & Spinrad, 2018). As such, shyness and its biological correlates may be protective to promote less deleterious outcomes.

Internal Threat

Threat may be in the form of an external, tangible detriment to an individual's well-being, but for a shy individual threat may also take the form of a more abstract worry. Shy individuals may display increased "internal focus" and a general self-preoccupation, which could be to the detriment of performance on external tasks (Sylvester et al., 2018). This behavior may be associated with higher resting state functional connectivity in the default mode network (DMN) found in shy individuals as compared to non-shy individuals (Sylvester et al., 2018). Broadly, the DMN is thought to reflect an absence of focus on external stimuli and is engaged during tasks such as retrieving autobiographical memories, planning, and perspective-taking (Buckner, Andrews-Hanna, & Schacter, 2008). Typically, there is a negative slope in DMN connectivity over time, associated with normative adolescent pruning (Sylvester et al., 2018). However, in shy individuals, this slope is flattened (Sylvester et al., 2018). In addition, behaviorally inhibited children show an increase in connectivity to default network hubs, coupled with alterations in salience network connectivity (Taber-Thomas, Morales, Hillary, & Pérez-Edgar, 2016). This combination may bias processing toward personally relevant information during development, heightening the impact of social encounters.

Top-Down Control Over Threat Attention

The preoccupation with both egocentric well-being and external sources of threat seen in shy individuals may also operate to the detriment of cognitive task performance. Henderson and Wilson (2017) suggest a dissociation between stimulus-driven attention and goal-directed attention, where heightened levels of stimulus-driven attention, like biased attention to both internal and external threat, may detract from goal-directed attention, reflected in EF. Based on accuracy metrics, shy individuals often perform comparably to non-shy counterparts on cognitive tasks, like EF paradigms (Eysenck, Derakshan, Santos, & Calvo, 2007; Wolfe & Bell, 2014). However, group differences may emerge on a neural level in metrics of task efficiency (Eysenck et al., 2007). For example, Wolfe and Bell (2014) found that in a sample of preschoolers, high performers on EF tasks show increases in medial frontal EEG

power, regardless of shyness level. However, among children who score low on these same EF measures, shy children show a similar increase in medial frontal power but without corresponding high cognitive task performance. Wolfe and Bell (2014) refer to this phenomenon as "cognitive busyness." This busyness reflects the fact that a shy child may be balancing intrusive or anxious thoughts concurrent with a task, so they must exert greater cognitive effort to overcome these extraneous thoughts. As such, they show enhanced activation but still underperform on the task. The power increase without associated task performance is thought to capture neural inefficiency (Wolfe & Bell, 2014).

Differences in levels of goal-directed attention may also interact with shyness-related differences in the processing of threat-related information, modulating behaviors in response to these perceived threats. Typically, high cognitive control and regulation is broadly considered advantageous, supporting adaptive socioemotional functioning. However, these regulatory processes may act differently in shy children, instead operating as a risk factor for maladaptive developmental outcomes. In work with BI children, higher levels of attention shifting may act protectively against developing anxiety disorders, helping children flexibly navigate their social environments even in the face of attention-capturing threat (Henderson & Wilson, 2017). However, in these same children, higher levels of inhibitory control may act as a risk factor for anxiety disorders (Henderson & Wilson, 2017).

Similarly, the ability to engage higher levels of EF or proactive control may differentially lead to adaptive or maladaptive outcomes for shy children. The P300 event-related potential component is broadly associated with attentional processes and working memory (Tang, Santesso, et al., 2016). Tang, Santesso, et al. (2016) found that children high in conflicted shyness showed heightened P300 amplitude in response to an "auditory oddball" task, suggesting greater cognitive effort during the task. Moreover, frontal P300 amplitude mediated the relation between conflicted shyness and neuroticism, such that greater frontal P300 amplitude explained exacerbated risk for neuroticism among children displaying high levels of conflicted shyness.

Differences in response inhibition and attention shifting in shy and non-shy individuals may constitute another controlled aspect of attention associated with broad developmental outcomes. Shyness has been associated with poor outcomes particularly among children with enhanced N2 responses during a Flanker task, again suggesting that cognitive and attentional control can be "too good" in shy children (Henderson, 2010). Differences in the N2, as well as the error-related negativity (ERN) ERP, may reflect increased sensitivity of the ACC to anticipate conflict and uncertainty in some shy children, which may in turn reflect high levels of behavioral rigidity for the individual and moderate the relation between shyness and socioemotional development (Henderson, 2010).

This work suggests that individual differences in elements of cognitive control may further identify shy children who may or may not display adaptive developmental outcomes. Whereas shy children may show a hypersensitivity to threat across multiple processing contexts, elements of top-down control may help to modulate these attentional biases. Potentiating attention biases to threat may encourage negative cognitions characteristic of anxiety disorders like rumination and

apprehension, which may prolong feelings of social malaise and impede social interactions (Henderson, Pine, & Fox, 2015; Henderson & Wilson, 2017). On the other hand, attention shifting may assist a child in directing attention away from distressing cues, thus reducing levels of arousal and distress (Henderson et al., 2015; Henderson & Wilson, 2017). Collectively, both neural and behavioral measures of cognitive control are essential in understanding how shy children may adapt to a hypersensitivity to threat, helping capture patterns of rigidity and flexibility as the child confronts shifting environments and associated developmental challenges.

Approach/Avoidance Behavior

Studies using a variety of neuroimaging techniques may distinguish shyness and sociability as distinct phenomena, even early in development (Schmidt, 1999; Tang, Santesso, et al., 2016). These differences are important contributing factors for social and cognitive performance and have implications for the different subtypes of shyness. Dimensions of shyness and sociability, reflected on a biological level, suggest again that shyness is not a homogenous construct, but rather a broad term encompassing a subset of behaviors along a number of continuums.

It is important to clearly identify shyness and sociability as two biologically separate traits. Since shyness and sociability may colloquially be considered foils of the same construct, parsing them apart with biological markers can clarify subtypes of shyness as well as help to understand when each of these behaviors may have adaptive value. Distinguishing these two dimensions allows for a more specific focus on the mechanisms specifically underlying shyness, to determine how it manifests as a unique and potentially adaptive trait, and to explicitly examine any influencing effects of sociability on the understanding of shyness. For example, high levels of approach and withdrawal (or sociability and shyness, respectively) suggest the presence of conflicted shyness, which is present in individuals high on both shyness and sociability. This lays the groundwork for understanding conflicted shyness (Schmidt & Poole, 2019), one of several subtypes of shyness that vary in adaptive outcomes across contexts.

Traditional theoretical models of frontal brain activation suggest that left frontal asymmetry, traditionally measured by EEG power in the alpha band, is consistent with higher levels of "approach" behaviors, while right frontal asymmetry is consistent with higher levels of "avoidance" behaviors (Coan & Allen, 2003). Moreover, higher levels of right frontal asymmetry are frequently associated with higher levels of maladaptive outcomes such as anxiety and depression (Coan & Allen, 2003). In the context of shy individuals, higher levels of shyness are associated with higher resting right frontal cortical brain activity, while measures of sociability are associated with the left frontal activity (Schmidt, 1999).

As previously noted, a body of research suggests that shyness is not necessarily synonymous with unsociability and may be associated with distinct neural mechanisms (Tang, Santesso, et al., 2016). Individuals with positive shyness are distinguished

by a concurrent experience of positive affect while also demonstrating some degree of withdrawal behavior, compared to other subtypes of shyness that may be primarily marked by negative affect and withdrawal (Schmidt & Poole, 2019). Despite a lack of exact consistency in terminology, potentially adaptive forms of shyness are unified in that they display greater levels of approach behavior allowing for environmental engagement and learning (Pérez-Edgar, 2018), whereas less adaptive forms of shyness are higher in avoidance behaviors.

There are also identifiable physiological differences for individuals varying along the dimensions of shyness and sociability, further suggesting the importance of distinguishing between these constructs in operationalizing and understanding shyness. Schmidt and Fox (1994) found differences in resting frontal EEG asymmetry as a function of levels of sociability, but not shyness. Low-sociable young adults showed right frontal asymmetry, while high-sociable participants showed left frontal asymmetry. These patterns suggest that young adults displaying conflicted shyness show higher neural sensitivity to stress and lower emotional and attentional control overall. In the same sample, adults who self-reported high on both shyness and sociability showed a higher, less variable heart rate than individuals high in shyness and low in sociability, as well as individuals low on shyness and high on sociability (Schmidt & Fox, 1994). These patterns suggest higher sensitivity to stress and lower emotional and attentional control overall for individuals conflicted shy adults.

Further differentiating biological correlates of shyness and sociability, variations in morning cortisol may relate to different patterns of brain activation during social threat processing, suggesting an adaptation of the neuroendocrine system for dealing with any associated stress of being shy (Tang et al., 2014). In particular, shy adults with relatively lower resting cortisol and higher activation of areas of the brain associated with social behavior (left amygdala, right posterior cingulate gyrus, insula, bilateral inferior, medial, and middle frontal gyri) reported lower levels of sociability (Tang et al., 2014).

These data suggest that, perhaps in evaluating shyness, sociability is equally critical to evaluating adaptive capabilities in shy individuals. Differences seen in heart rate and heart rate variability relate to socioemotional regulation, suggesting a possible mechanism underlying discomfort and/or anxiety for shy individuals during social situations (Schmidt & Fox, 1994). Measures like cortisol, while perhaps less widely used, also facilitate understanding of social approach and withdrawal related behavior (Tang et al., 2014). Prior research has found that shy individuals may display both relatively high and relatively low levels of waking morning salivary cortisol, such that individuals with high waking morning salivary cortisol are more likely to be more sociable. Thus, cortisol levels may be a driving force for some high shy individuals to navigate the socioemotional world in addition to managing their own emotional experience during social challenges (Tang et al., 2014). These hormonal differences represent slower-acting manifestations of the physiological background of shyness and may help to supplement more temporally sensitive measures, such as EEG, in better understanding adaptive shyness.

Behaviors like coy smiles, a definitional characteristic of positive shyness, reflect approach behaviors that often relate to more adaptive behavioral and psychological outcomes (see also Colonnesi et al., Chapter "Development and Psychophysiological Correlates of Positive Shyness from Infancy to Childhood" this volume). Colonnesi et al. (2013, 2014), as well as Nikolić et al. (2016), suggest that a smile accompanying a physical aversion to a social threat leaves the individual able to still engage with the environment and less closed-off than negative shyness, marked as a physical aversion without a smile (Colonnesi et al., 2013). Children displaying positive shyness to social threat often display fewer maladaptive outcomes than children displaying negative shyness. This includes lower levels of anxiety and increased levels of sociability, relative to children displaying more negative reactions (Colonnesi et al., 2014; Poole & Schmidt, 2019).

Additionally, the adaptive value of approach and avoidance behavior may vary as a function of environmental context and risk. Broadly, children reared in adversity such as instances of institutionalized care display greater levels of right EEG asymmetry at baseline over time, reflecting greater avoidance tendencies (McLaughlin, Fox, Zenah, & Nelson, 2011). As noted, greater relative left frontal asymmetry and higher avoidance behaviors may relate to psychopathology such as internalizing disorders (Coan & Allen, 2003; McLaughlin et al., 2011). However, in situations of adversity, such as unreliable caregiving, higher levels of avoidance behaviors and accompanying neural correlates may arise as an adaptation to an environment in which general avoidance may be more apt to preserve well-being in the short term (McLaughlin et al., 2011).

Although early internalizing symptoms are often associated with negative outcomes, such as anxiety (Roy et al., 2008), it may also act as a protective factor against other maladaptive sets of behaviors, such as externalizing problems (Willner, Gatzke-Kopp, & Bray, 2016) which may be associated with stressful early life contexts (Hicks et al., 2009; Ronald et al., 2011). Willner et al. (2016) found that while we typically see comorbidity between internalizing and externalizing behaviors in early childhood, kindergarteners who only display internalizing behaviors were less prone to the emergence of externalizing behaviors. They were also most likely to see a normalization of internalizing problems as well over time. This pattern is in line with adult studies demonstrating that reported shyness lowers the probability of experiencing externalizing behaviors (Nelson et al., 2007). This buffering effect may be particularly beneficial in environments marked by adversity.

Overall, there is differential adaptability in shyness and sociability based on individual differences in approach and avoidance characteristics, and as a function of environment. High levels of both approach and avoidance may be adaptive in certain circumstances to aid shy social individuals in cautiously navigating their social world while still adaptively engaging with social stimuli (Pérez-Edgar, 2018). Borrowing from the ethology literature (Reader, 2015), children who can move from shyness to sociability with relative ease may be able to engage in "low-cost sampling" of the environment, which provides them needed information without overtaxing emotional and cognitive resources.

Neoteny

Individual differences in shyness are seen from early on in development (see Schmidt & Buss, 2010, for a review). One theory suggests that structural and functional differences in the psychophysiology of shy individuals are explained by their relatively protracted development of "social" brain structures (Schmidt & Poole, 2018, 2019; see also Schmidt et al., Chapter "The Study of Behavioral Inhibition and Temperamental Shyness Across Four Academic Generations" this volume). Evolutionarily, a more protracted developmental timeline is unique to humans compared to other species. Brain development into the postnatal years is associated with larger brain volumes which allow for additional learning while the brain is most highly plastic, which in turn supports the development of higher-order cognitive processes (Schmidt & Poole, 2019). Schmidt and Poole (2019) argue that conflicted shyness may enable an individual to have more time to learn about complicated social environments in the human world. In both familiar and unfamiliar social environments that may be perceived as threatening, a higher level of reticence allows a shy child buffer time to process and infer other's intentions and motives before responding (Schmidt & Poole, 2019). They posit that conflicted shyness, where an individual may display childlike expressions such as coy smiles, in part retains a more youth-like appearance past sexual maturity, thus extending the amount of time that an individual has available to learn about their social environment before being fully independent. The buffering provided by positive signals coupled with reticence serves as a contrast to children who display indiscriminate friendliness, often as a result of early deprivation (Gleason et al., 2013).

Childlike features associated with forms of shyness may be noted behaviorally, as in coy smiles, as well as neurally. Delayed frontal brain maturation underlies some emotional and behavioral profiles associated with social inhibition and anxiety (Schmidt & Poole, 2018). Recent work suggests that children high in shyness display consistently smaller frontal alpha power/delta power ratios over time, as measured by EEG, suggesting delayed frontal brain maturation as compared to children low in shyness (Schmidt & Poole, 2018). On the other hand, children low in shyness also show a significant increase in the ratio of overall frontal alpha power to delta power longitudinally (Schmidt & Poole, 2018). Thus, neotenous traits sometimes noted in shy children may be associated with a less steep maturational trajectory of the prefrontal cortex which may, in turn, indicate a wider window for plasticity in development. Early plasticity may provide for an increased window of time during which a child can learn to appropriately react to challenging elements of environmental threat.

It is also critical to consider environmental context in assessing the adaptability of neoteny in shyness. Whereas protracted development of brain areas such as the frontal lobe may be advantageous for cognitive development and social learning in the general population, this may not be the case in circumstances of early-life stress. Regions of the frontal lobe, such as the medial prefrontal cortex (mPFC), play a large role in emotion regulation, with projections to the limbic system (Gee et al., 2013).

Negative connectivity in adulthood between the amygdala and mPFC suggests that, over development, the mPFC may downregulate the amygdala in situations of non-threat (Gee et al., 2013).

However, in instances of early-life stress, like maternal deprivation among previously institutionalized children, individuals may display accelerated maturation of connectivity between the mPFC and the amygdala (Gee et al., 2013). In rodent work, rat pups exposed to forms of early-life stress generally will show faster threat conditioning than nonstressed pups (Callaghan & Tottenham, 2016). This suggests the possibility of an early adaptive role of more mature brain structure and function in high-risk, high-stress scenarios, but perhaps at the expense of later-life psychopathology (Callaghan & Tottenham, 2016). Thus, it may be the case that neotenous features of shyness are adaptive in low-risk environments in that they prolong periods of learning and development but may act in a deleterious nature in high-risk environments where more adultlike brain function and rapid learning are initially to the benefit of one's survival.

Conclusion

A diverse body of work at multiple levels of analysis suggests that shyness is a multifaceted construct, with a great deal of heterogeneity among children described as "shy." These subtypes of shyness may be differentiated on both behavioral and neural levels, giving rise to different profiles that may vary in adaptability. Multiple methods can inform the structural and functional mechanisms involved in adaptive forms of shyness, giving insight into how different profiles of shy individuals may differentially process information relative to non-shy individuals. These differences, in turn, allow for the identification of social and emotional differences that can lead to adaptive or maladaptive outcomes. As reviewed, using neuroimaging and physiological measures may help note differences in attention to threat between shy and non-shy children, distinguish shyness as a construct independent of sociability, and understand the potential evolutionary value in the elements of neoteny associated with shyness.

Multimodal assessments of biological underpinnings of shyness also allow for a more in-depth understanding of cognitive factors that play a role in protecting shy individuals from maladaptive outcomes, as well as the role of environmental context in how these traits may operate adaptively. The level of perceived and actual threat in an individual's environment may influence how adaptive shy behaviors may be, such that forms of early-life adversity are also critical to consider in examining adaptability.

Traditionally, shyness is regarded as a negative trait-like behavior. However, taking a biological and multimethod approach redefines shyness as a multidimensional trait with multiple biologically influenced subtypes that may act adaptively in a number of developmental contexts. Future work will need to integrate longitudinal studies examining patterns of shyness subtypes, across environments, to better delineate the developmental consequences of early individual variation in the biological, social, emotional, cognitive, and behavioral response to social interactions.

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Shyness, Adaptation, Human Contact

Jay Schulkin

Introduction

A number of colleagues of mine are quiet; now that does not make them shy. But a number of them are also shy. Social shyness can render navigation into new vistas in the social milieu at times burdensome. Like the larger literature, social shyness is not the same as social anxiety, though a subtype of individuals have both (see Jones, Schulkin, & Schmidt, 2014; Kagan, 1994; Schmidt & Schulkin, 1999). And having both is no fun under circumstances in which anxiety runs high. And anxiety is expensive; it takes a toll on bodily tissue, including the brain (McEwen, 1998, 2017).

But human ingenuity is central to our evolutionary ascent. We figure out how to compensate for where we are vulnerable, or at least we can. And perhaps an exaggerated behavioral inhibition might slow an impulsive response and delay it to promote more rumination and reflection. Adaptive alternatives are rooted social viability. The shy person may be forced to reflect and perhaps search for alternatives to promote social comfort.

But shyness is not one thing (Schmidt & Schulkin, 1999). There are diverse kinds of shyness, though behavioral social inhibition to unfamiliar events is a generic feature of social shyness (Kagan, 1989). Indeed, there are several subtypes of shyness. But my interest, like others, is tied to behavioral inhibition and the navigation of the social milieu (Kagan, 1989, 2002; Schmidt & Schulkin, 1999).

I have always thought since I was introduced to this phenomenon by Jerome Kagan that there probably are diverse ways in which shyness is a rather nice feature, not a detriment, and a positive attribute as I conveyed over many years to my friend and colleague Louis Schmidt. Our first book together (Schmidt & Schulkin, 1999) was on the extreme version of shyness that leads to fear, social duress, and

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debilitation. But I worried about the overselling certain features, the anxiety that pervades the anticipation of social performance, presentation, and novel events.

Shy individuals like the rest of us are rooted in the world of objects and transactions with others from birth. A primary adaptation is towards getting coherence in a social world; social cognitive dispositions predominate among other cognitive/physiological predilections essential for adaptation and coherence of action. Making sense of others is thus a core adaptation (Cacioppo, Visser, & Pickett, 2006; Kunda, 1999).

We come prepared to make sense of the objects around us—particularly conspecifics. Shy individuals are no different in this fundamental adaptation. And perhaps even better in certain capabilities. In this essay, I begin with social evolution and human social competence, social tracking, neural and social sensibilities, and finally human well-being.

Human Evolution of Social Capability

Human evolution placed social knowledge and social context at a premium. Prosocial behavior underlies the sensibility that pervades human experience resulting in significant human contact (Darwin, 1859/1958, 1872/1998). There are many ways in which to facilitate social contact, and by definition, human contact almost always has a social component.

Two features stand out about human adaptation: good enough fit of capabilities suited to social context and flexibility. Shy individuals are no different. Without the excessive pathology of the extremely debilitated individuals, shy individuals are no different than the rest of us (Jones et al,. 2014; Kagan, 1994, 2002; Schmidt & Schulkin, 1999).

Darwin, a noted shy and introverted person (Browne, 1996/2003) like many other thinkers, understood that we are social animals. What has emerged in *Homo sapiens* has been an elaboration of social contact, the expansion of individual responsibility manifested in specific types of the division of labor in the service of group safety and human viability, adaptability, and productivity. Technical expansion like modern apps to our machines expands our capabilities. Our modern era shows how these tools can aid or not social interactions. Innovative use of resources expanding one's capabilities comes through in the use of technologies. That is one form of adaptation in the social domain.

For sheer physical amelioration (e.g., touch), bodily sensibility is another primary adaptation. Perhaps, and it would not be surprising, if shy children like others seek diverse forms of social cooperative behaviors (and deceptive) to facilitate social contact, social viability. One key adaptation is simple; social grooming behaviors, comforting others (Cheney & Seyfarth, 1990, 2007). This can lead to social cooperative behaviors; but it is no panacea, and it might not.

We are also a vulnerable species; our ontogeny is long and labored and greatly dependent on others. We look to others to gain that important ladder into the social

milieu. The long dependency on others is a fundamental feature of our species. The social knowledge we gather in ontogeny represents a critical part of our armament for gaining a foothold in the larger social world, a world in which recognizing others' intentions (e.g., Jaspers, 1913/1997; Kagan, 1984; Schmidt & Poole, 2018; Tomasello, Kruger, & Ratner, 1993) and gathering practical knowledge are critical. In other words, we come into life prepared to interpret our surroundings as defined by the social milieu, and the degree to which we succeed in this task determines to a great extent our success in coping, achieving, and thriving. The fact that we come prepared to recognize others and learn from their experiences is thus a fundamental social behavioral adaptation.

We know that socially shy children get a foothold in the larger world; they learn from others and learn well and with the same distribution of capabilities. And there seems no developmental delays in most of these capabilities in shy individuals so essential for long-term viability.

Some common themes in our cognitive development, particularly that of social development, in Table 1 (adapted from Tomasello et al., 1993), are depicted in the following.

Exaggerated Social Shyness: Some Biology

Of course, in shy children for which the social anxiety interacts with breakdown in capability, the results are not good, both in the short term and in the long run (Raglan, Schmidt, & Schulkin, 2017). And shy children have this burden, or perhaps not.

Shy children tend to secrete, for instance, less cortisol as they grow in maturity. They start with a tendency of an exaggerated cortisol response (Kagan, Resnick, & Snidman, 1988; Schmidt et al., 1997; Schmidt, Fox, Schulkin, & Gold, 1999; Schmidt, Fox, Sternberg, et al., 1999). Cortisol is the major adrenal steroid vital for

Table 1 Some developmental capabilities

Infancy: Understanding others as intentional
1. Following attention and behavior of others: Social referencing, attention following, imitation of acts on objects
2. Directing attention and behavior of others: Imperative gestures, declarative gestures
3. Symbolic play with objects: Playing with "intentionality" of object
Early childhood: Language
1. Linguistic symbols and predication: Intersubjective representations
2. Event categories: Events and participants in one schema
3. Narratives: Series of interrelated events with some constant participants
Childhood: Multiple perspectives and representational redescriptions
1. Theory of mind: Seeing situation both as it is and as other believe it to be
2. Concrete operations: Seeing events or object in two ways simultaneously
3. Representational redescription: Seeing own behavior/cognition from "outside" perspective

the organization of action and energy resources. But as shy children develop, they tend to display less cortisol secretion (Beaton et al., 2006, 2008; Schmidt, Fox, & Hamer, 2007; Tang et al., 2015). Over time, perhaps, one adaptation is to under secrete cortisol (Raglan et al., 2017). Hypersecretion of cortisol and inability to reduce its circulation is detrimental to bodily tissue (McEwen, 1998, 2017). Of course, it is all about cephalic/bodily regulation, turning on physiological/behavioral capabilities in suitable contexts and turning them off. Extreme version of shyness is a vulnerability. The issue is adaptation in the face of adverse conditions.

More generally, one adaptive role of cortisol in the maintenance of bodily tissue and in the organization of action in response to novel or unfamiliar events. One feature that can be difficult for shy, social wary events, people etc. And we come prepared often to be wary of novel events, that might be dangerous, disruptive, potentially debilitating (Kagan, 1994, 2002; Rozin, 1976, 1998). One cognitive adaptation is to make the unfamiliar familiar; we flavor the unfamiliar with the familiar (Rozin, 1976). Moreover, inhibited and shy children are more likely to demonstrate exaggerated responses to unfamiliar events (Kagan, 1989; Schmidt et al., 1997; Schwartz, Wright, Shin, Kagan, & Rauch, 2003) that can be predictive into early adulthood (Schwartz et al., 2003).

In other words, it also might be the case that shy individuals feel this extra burden to form contact, and adaptation is an enhanced capability. Perhaps those individuals less likely to be socially anxious are those seeking contact (Gunnar, 1998; Gunnar, Mangelsdorf, Larson, & Hertsgaard, 1989). Indeed, socially fearful individuals can ameliorate some of the internal discomfort by seeking bodily/social contact with others. And the ability to regulate cortisol secretion is present early on in the development (Gunnar & Quevedo, 2007; Schmidt & Schulkin, 1999).

Cortisol is the molecule of energy metabolism; excitement like social anxiety can be expensive; the issue is always about regulation of the internal milieu; and cortisol secretion is part of the internal milieu. Cortisol is elevated in energetic children and socially withdrawn and fearful children in response or anticipation of social presentation: one out of excitement under some conditions and the other social anxiety and social judgment (Gunnar, 1998; Gunnar et al., 1989; Schmidt et al., 1997; Schmidt, Fox, Schulkin, et al., 1999; Schmidt, Fox, Sternberg, et al., 1999). The adaptive side for one is to ameliorate anxiety/fear through social amelioration, while for the other, to not exhaust capability. The adaptive route is many sided; flexibility through rumination may be one side of a shy individual.

And perhaps this rumination preparation keys into other capabilities in the adjustment they make up the social milieu (Schmdit & Schulkin, unpublished manuscript). Moreover, what is distinctive about us, although our species is not alone, is the degree to which we share and participate towards common ends; shared intentions linked to the considerations of others is one of our most important cognitive adaptations (Kagan, 1994; Tomasello et al., 1993). We look at others; it is not surprising that vision, shared visual space, and recognition that we are both looking at the same objects would come to be important cognitive resources (Tomasello, 1999). But it is not simply a cognitive detached event; it is affectively rich, reassuring, and rewarding. The motivation to form meaningful contacts is essential for

development and for life. Shy individuals reach others; too basic to us for this subset of individuals not have this capability. The issues are the varied ways in which this can be accomplished (Tomasello, 2014).

Perhaps, one nice feature of shyness is introversion. It is one feature associated with shyness for some individuals. The expansion of rumination (or not) may lead to reflective equilibrium (Rawls, 1971), solution seeking adaptation that enhances human meaning, social contact, and social solidarity. Shy individuals may be in a better position for such contact. Indeed, one interesting recent hypothesis (Schmidt & Poole, 2018; Schmidt, Fox, Schulkin, et al., 1999; Schmidt, Fox, Sternberg, et al., 1999) suggests that delayed maturation of frontal cortical expression may underlie two things: (1) on the one hand, emotional tension in approach avoidance computational assessment of events (Schmidt & Schulkin, 2000), greater conflict, and more inhibition in adjusting and adapting to the social milieu, but (2) on the other hand, possibly a plus side, namely, a more varied adaptive skills, greater rumination and greater pedagogic possibility, alternative strategies. One reflects proximate evolution, the other more ultimate impacts of social shyness.

Predictive Capability and Social Tracking

Shy individuals track social events. Such tracking pervades our expectations. Diverse cognitive adaptations, including our ability to predict the behaviors of others (Dennett, 1987), are a function of the fact that we tag our fellow humans in terms of their beliefs and desires. This, of course, is a higher order cognitive function. And we use that adaptation to, in part, predict what other human beings do in our social world, as well as their intentions (Dennett, 1987; Premack & Premack, 1995; Tomasello et al., 1993, Tomasello 2014).

A cognitive resource is this ability to track others by what we think they desire and believe. Of course, we track many behaviors that are simpler, for instance, what someone is looking at; joining eye contact on a common object, rooted together in a coordinated fashion, is at the heart of pedagogy. We learn from one another and manipulate one another and predict behaviors by what the focus is on, where the eyes are rotating towards, both externally and literally telling us something about beliefs and desires (Premack & Premack, 1995; Tomasello, 2014).

We come prepared with an arsenal of cognitive adaptations rooted in social discourse and commerce with one another and the construction of objects that we use, our tools. And our evolution is knotted to social groups working in unison across diverse terrains. Key abilities include discerning the wants and the desires of others (a core feature of our adaptations), along with cognitive adaptations such as recognizing the kinds of objects that are useful or affordable (Gibson, 1979) and avoidable (Rozin, 1976), coupled with a wide array of inhibitory capacities that contribute to social cooperative behaviors. Shy individuals are no different (Tsui, LeHat, & Schmidt, 2017).

Cephalic expansion set the stage for technological creations, expanding our sensory systems. Seeing by magnifying became an evolving theme as our capacities were extended, and we turned from managing nature towards understanding nature—tool use, which was critical for this development. The Internet is an outlet, an expansion, and a modern tool for social contact, and it provides one venue for shy individuals to interact. It is perhaps less threatening in some contexts (Schmidt & Poole, 2018).

One result is social contact and a context for cooperative behaviors. And social cooperative behaviors (Dewey, 1925/1989; Greene, Sommerville, Nystrom, Darley, & Cohen, 2001; Greene, Nystrom, Engell, Darley, & Cohen, 2004; Moll & Schulkin, 2009; Moreno, 1995; Tomasello et al., 1993), in addition to an evolutionary arms race of cognitive capabilities, lie at our evolutionary base. Many core capabilities are depicted, such as numerical, spatial, and theory of mind (predicting behaviors on the basis of their beliefs and desires), which are well-known ingredients of the human mind and to some extent other primates (Premack & Premack, 1995). But when the issue turns to social events, young children early on outdistance our closest primate relatives (Tomasello et al., 1993).

The cognitive architecture is linked to making sense of our work. It is reflected in quite different kinds of events important to adaptation. Diverse cognitive systems are involved in the organization of action (Gallistel, 1992; von Holst & von St. Paul, 1963). Cognitive systems were, in part, selected to organize actions that underlie perception (Lakoff & Johnson, 1999; Schulkin, 2000); cognitive systems are not divorced from action but endemic to it.

But these ideas are not in a vacuum; they are in a context that is bodily in nature, struggling to learn something, persevering to acquire something such as knowledge as a contact sport with others, getting linked to others, enjoying the solitude of one's self enclosure amidst the safety of others, or, despite others, forming boundaries of protective parlance. Cognitive adaptation is in the doing of things for coherence of action in complex social environments (e.g., Barrett, Henzi, & Dunbar, 2003; Dewey, 1925/1989; Lakoff & Johnson, 1999; Schulkin, 2003) and for diverse cognitive adaptations to ecological conditions and social communicative functions (Barton et al., 2003; Dunbar, 1992).

Core cognitive architecture is mostly about kinds of objects (Lakoff & Johnson, 1999). As social animals, we are oriented towards diverse expressions of our conspecifics that root us in the social world (Hinde, 1970; Humphrey, 1976; Jolly, 1966), for example, a world of acceptance and rejection and of approach and avoidance towards one another and towards social and ecological objects rich with significance and meaning (Cheney & Seyfarth, 1990, 2007; Schneirla, 1959).

The social world is full of signals of cognitive/behavioral significance (Tinbergen, 1951/1969) that serve as an orientation in the organization of action. And it is the adjudication of the complexity of the social terrain that sets the conditions of approach/avoidance behavioral options (Schneirla, 1959) for which there are different in the neocortical laterality in shy/fearful children (Schmidt, Fox, Schulkin, et al., 1999; Schmidt, Fox, Sternberg, et al. 1999). People with greater right frontal activity exhibit an increased reactivity to negative stimuli, demonstrated as behav-

ioral inhibition and vigilant attention—a withdrawal response. Greater left frontal activity is associated with greater positive affect and greater behavioral activation and goal approach behaviors—an approach response (Schmidt, Fox, Schulkin, et al., 1999; Schmidt, Fox, Sternberg, et al. 1999).

A broad-based set of findings in non-primates has been the link between social complexity and larger brain size (Byrne & Corp, 2004). The metabolic investment of larger brained animals is expensive; neural tissue is a high-energy organ; brains expand while other tissues do not, or at least not to the same degree. Interesting correlations have been suggested between neocortical size and social cognitive skills—Machiavellian skills (Byrne & Corp, 2004; Byrne & Bates, 2007; Whiten, 1991, 1997). Detection and deception amidst cooperation and social prediction is a common occurrence that utilizes diverse cognitive systems (Byrne & Bates, 2007).

Children, shy children included (Kagan, 1994), are oriented within the first few months of life to form social contact through the visual system, to track events in a manner of joint attention (Kagan, 1994, 2002). These events are like social glue, facilitating future transactions with one another and determining social adaptation. The social roots of our diverse cognitive capabilities are pervasive (e.g., Humphrey, 1976; Vygotsky, 1934/1979). Shy children may have exaggerated responses under some conditions to facial and other bodily responses (Tang et al., 2015), but this can be ameliorated. The developmental trajectories are not frozen at the core in most individuals and over time cognitive/behavioral serve to ameliorate. And that is a core factor in our evolutionary capabilities.

The demands of our long postnatal period are essential for pedagogy (Premack and Premack, 1995), during which sets of core cognitive capabilities are expressed (Perner, 1991). One core feature is the ability to determine whether an object is alive or not, or intentional or not, or animated or not. Most, if not all, end organ systems have computational capabilities (e.g., kidney functions) in the maintenance of the internal milieu; but for our purposes, in this context, we are talking about the integration of information from the external world, translated into coherent adaptative functions. This later suggestion of a developmental lag to compensate for greater conflict in navigating may be an advantage over viability later in life.

Cognitive categories figure in our recognition of social and live objects (Tomasello 2014). There is much unresolved debate with regard to the range, innateness, and developmental expression of these capabilities. What is not debated is the fact that they are anchored to our social milieu, getting oriented to others, to the ecological and social surroundings. Shy children figure out ways to do this, and this enhanced capability may be an expanded capability over time.

Early on the social capability is clear in our species. The orientation of the child to a physical domain of objects, and this can appear quite similar on some tasks to the common chimpanzee or orangutan in the first few years in development (Herman, Call, Hernadez-Lioreda, Hare, & Tomasello, 2007); when given problems concerning objects in space, quantities, or drawing inferences in very young humans, chimpanzees and orangutans look similar. What becomes quite evident early on in ontogeny is the link to the vastness of the social world in which the neonate is trying to get a foothold for action (Tomasello, 1999, 2014).

Shy individuals do this quite well, and perhaps the greater conflict in development might serve over time (Schmidt & Poole, 2018). Survival depends upon social capability; viability demands social competence, which entails getting others to participate in the life blood of human activity, from the small to the large. Shyness can be a feature of behavioral inhibition (Kagan, 1994, 2002) which under some conditions might enhance cautiousness in social and unfamiliar contexts and which can be adaptive or not.

The issue for long-term viability is social intelligence. And shy children are not different here. Social intelligence, particularly in primates, is importantly knotted to reproductive success (e.g., Silk, 2007); the alliances formed by mammalian females in a number of species, for instance, are vital for this (e.g., baboons (Silk, 2007)). A premium is set on cognitive evolution, an expression of diverse cognitive/behavioral adaptations coupled with cephalic expansion (Byrne and Corp, 2004; Byrne and Bates, 2007; Whiten, 1997). Behavioral inhibition and social shyness certainly as a single factor probably do not impact this core evolutionary feature. Social collations are essential for survival in our species.

Diverse factors underlie the link between corticalization of function and both social and ecological factors in primate life, life span, group size, terrain adaptation (detection of predation, approach behaviors, foraging behaviors, etc. While shyness as a feature can change over the lifetime of an individual, group size is probably not a factor. And group size is linked to neocortex expansion in hominoids, as is longevity, as depicted subsequently. The pressure on coming into touch with others, creating alliances, and tracking lineages no doubt required more cortical mass (Barton et al., 2003; Byrne & Corp, 2004; Cheney & Seyfarth, 1990, 2007; Dunbar & Shultz, 2007).

Evolution and Adaptation: Neural/Social Sensibilities

We search for the stable amidst the precarious (Darwin, 1859/1958; Dewey, 1925/1989). The search requires diverse cephalic and cultural resources and results in punctuated and gradual cultural epicenters; the human condition remains more precarious, our weapons much more dangerous, and the level of potential destruction much greater. The precarious shifts towards the more stable by cephalic adaptation. Core needs are always a common function satisfied by food, water, sensual contact, sport, explorations, etc. The diverse motivations that underlie these needs are quite broad—as we are broad in potential for expression (e.g., Hofer, 1973; Keverne, 2004; Kagan, 1989). Shy individuals initiate diverse forms of social contact and ameliorate the internal milieu (Gunnar & Quevedo, 2007).

What evolved in our species are long-term social bonds, plasticity of expression, and corticalization of function. And as our cortical visual functions increased dramatically, standing up and looking and forming eye contact began as an evolutionary expansion in many primates. Human social contact, representation of objects, and

use of objects are core cognitive capacities; technology is an extension of ourselves, expanding what we explore.

In addition, regions of the amygdala essential for social attachment and avoidance also demonstrate significant changes in us: for instance, enlargement of the lateral amygdala which is closely tied to neocortical function (Aggleton, 1992/2000; Emery, 2000; LeDoux, 2015; Swanson, 2011/2015). The largest nuclear region is the basal lateral region. In one comparative study of apes and humans (e.g., human, chimpanzee, bonobo, gorilla, orangutan, gibbon), investigators found that the size of the lateral division of the amygdala expands quite a bit in *Homo sapiens* compared to the expansion in other primates (Barton, Aggleton, & Grenyer, 2003).

Since our evolutionary ascent is knotted to our social ability, in addition to tool making and the onset of linguistic competences. This is coupled with a long gestational period (Gould, 2002) and the massive amount of learning that takes place early in ontogeny with a long lactational period and long period of dependency. In addition, there is also a link between our longevity and the evolution of our problem-solving capabilities; our species had a greater opportunity to solve problems over time (e.g., Kaplan & Robson, 2002) and longer more varied for shy individuals to develop alternative strategies of adaptation and adjudication. Of course, that is empirical and we need to know that.

The degree of cognitive competence and social gesture, bipedal organization communicative engagement, diverse tool use, and pedagogy are clearly linked to an expansion of the range of social contact (Dunbar, 1992). For example, the more grooming-related behavioral responses, reconciliation, and social contact, the greater the degree of neocortical expansion, which may be particularly pronounced in females, in whom social contact is obviously linked to reproduction (Jolly, 1966).

The important point in our evolution is the combination of not just deception, but trust and cooperation as important cognitive and regulatory adaptations (Barrett & Henzi, 2005; Byrne & Bates, 2007). Of course, trust and cooperation can enhance the use of deception. Competition is often overstated at the expense of cooperation; we readily cooperate to the benefit of our short- and long-term interests. With corticalization of function came an enhanced capacity to regulate the diverse competing social interests that interact with various motivational systems.

A social brain is distributed across a wide array of neural structures and functions (Barton et al., 2003; Dunbar & Shultz, 2007; Frith & Wolpert, 2003; Greene et al., 2001, 2004; Moll et al., 2006; Moll & Schulkin, 2009) devoted to negotiating complex social interactions. And social attachment is a primary adaptation; evolved sets of neural systems are designed to facilitate social contact. Distinct sets of neurons in diverse regions of the cortex are active when one performs an action and when one watches others do so; this is pristinely shown in studies in macaques (Perrett & Emery, 1994; Rolls, 1999). That does not mean that there is no overlap in neurons that fire to mirroring others and in performing the action (Decety & Jackson 2006); it is just so that we come prepared to respond to others.

Prosocial sensitivity allows humans to quickly apprehend the moral implications in a social situation depending on context, agency, and consequences of one's choices. These sentiments are intrinsically linked to daily social interactions, and

there are several regions in the brain which provide a context for social flexibility. One virtue moral is in "deciding together" (Moreno, 1995). Recognizing the intentions of others is a critical feature in prosocial behaviors. This cognitive capacity begins early in ontogeny and is tied in to visual sensibility (Premack & Premack, 1995; Tomasello et al., 1993).

Recognizing the intentions is knotted to a broad array of cephalic tissue that underlies perspective taking and human social judgment (Adolphs, 1999; Moll et al., 2006). Individuals who are excessively inhibited demonstrate increased reactivity to fearful faces and social events (Tang et al., 2015). Behaviorally inhibited children demonstrate increased vigilance and uncertainty as well as heightened reactivity to novelty, which are accompanied by an increased amygdala response (Schwartz et al., 2003). This region of the brain, in addition to the hippocampus, habituates less in individuals with inhibited temperamental features (Blackford, Allen, Cowan, & Avery, 2013).

And the amygdala is critical for a variety of social behaviors, including play behavior in development (Lewis & Barton, 2006). The vulnerability for a hyperactive amygdala, long thought to contribute to behavioral inhibition towards social events in shy children (Kagan, 1989), is with some empirical support. One key neuropeptide, corticotrophin-releasing hormone or CRH (Schulkin, 2017), may be altered in amygdala function in behavioral inhibited macaques (Kalin, Shelton, & Davidson, 2000). More generally, we know that CRH, in addition to other information molecules, is altered in extreme social wariness in this primate (Erickson et al., 2005; Habib et al., 2000; Kalin et al., 2000, 2016) and probably with our species (Schulkin, 2017).

Of course, CRH interacts with diverse neurotransmitters in the regulation of social shyness. For instance, serotonin or dopamine expression and regulation is tied to adapting to the social milieu, social judgment, social approach, and avoidance and temperamental shyness (Furmark, unpublished; Schmidt et al., 2007). And changes, for instance, in the serotonin gene structure (long and short version of the 5-HTT receptor and dopamine) region has been suggested to be linked to shyness and behavioral inhibition (though the link to behavior does not account for much of the variance). The same information molecule is tied to altered frontal neocortical lateralization of function (Schmidt & Poole, 2018).

Importantly, regions of the brain rich in information molecules are tied to social assessment. In the instance of social unfairness, manipulations of 5-HTT function to influence the sense of unfairness; lower levels are reported to increase retaliation towards others; pharmacological depletion of serotonin increases responses to perceived unfairness (Moll & Schulkin, 2009).

Serotonin, like other broad neurotransmitters, underlies diverse behavioral adaptations, and deviations of normal gene function can tip the balance towards devolution depending upon the social context (Schulkin, 2017): the tone of a response as serotonin, the attentional requirements as central dopamine for response to incentives, and the organization of action. Interestingly, serotonin transporters variation is linked to amygdala function and the regulation of social fear (Hariri et al.,

2002). The enhanced conflict about approach avoidance to the social milieu may gain key access consideration over the long run for shy individuals.

Interestingly, there is some evidence that striatal dopamine and perhaps the prediction of reward may be more enhanced under some conditions for shy inhibited individuals (Guyer et al., 2006), may be perhaps to savor the reward, and may respond to enhanced incentive value.

Prediction of reward and/or incentive value is a fundamental feature of cephalic sensibilities (Berridge, 2007; Schultz, 2002). The findings that there might be greater sensitivity would be a nice adaptation and consistent with greater rumination about possibilities for shy individuals.

Conclusion

Shyness: Being Alone and Being with Others

This edited book is an important reminder of the adaptive value of social shyness, short-term conflict, and perhaps longer-term prosocial values. Reaching out to others is but one a prosocial response that we all share, even though it varies quite a bit across cultures in its expression. The life blood of humanity, after all, is our social bonds (Fromm, 1947; Humphrey, 1976) and the way we enjoy and manage our solitariness. Shy individuals are situated for just such capabilities.

Our brains are designed for social cooperative behaviors and social deception, among other forms of contact. Social contact, meaningful close relationship, is an important factor in well-being. The enhanced rumination that might facilitate some who tend to be introverted, and might be an asset as one grows older, becomes more alone. Meaningful social contact, on the other hand, is an ameliorative biological adaptation (Jaspers, 1913/1997).

Social contact is at the heart of ontogenetic development, a long-noted piece of epistemological history, differently expressed across diverse cultures. Family and group structure through meaningful contact are essential for our mental health. Supportive social contact is not an absolute prophylactic but a helpful ameliorative in combating disease and breakdown. Perhaps one feature of a delayed maturation of neocortical tissue is further room for pedagogic development (Schmidt & Poole, 2018).

We are social animals, as Aristotle noted; anticipatory mechanisms evolved with the social forms of adaptations, taking account of one another, foraging for food, building alliances of social cooperation, deception, and confrontation in group formation. Shyness might blunt some forms of emotion over the life span (Kagan, 1994, 2002; Schmidt & Poole, 2018) and enhance reflective rumination, important for human well-being. Shyness just might provide some advantage of being alone, something essential in life, along with being with others.

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Part IV
Social Perspectives

The Shy Child Adapting to the Challenges of School

W. Ray Crozier

Introduction

Schooling of the form practiced in much of the world presents many challenges to students from the outset. It is a highly social undertaking, requiring from an early age interpersonal interactions outside the home with, initially, unfamiliar adults and other children. To be sure, children who attend nursery or preschool settings have some experience of this before attending school, and their behavior in these settings has been the focus of a substantial body of research, including systematic research into behavioral inhibition (BI), shyness and social withdrawal. Nevertheless, formal schooling poses many challenges over and above those faced during free play with same-age peers. The schoolchild spends a substantial proportion of daily life attending an institution where he or she will participate alongside their peers in settings that include up to 30 or so other children. Effortful engagement in learning is expected and attainments are tested in various ways. Tasks are set and children's performance will be regularly monitored and evaluated. All of this will be overseen by a teacher and perhaps other adults based in the room. Adults will praise, express disappointment, and punish. Certain kinds of rule following and demands upon focused attention will be made. Some activities will be shared with classmates, whereas others will be undertaken alone. Talking and silence will be regulated and children will be socialized into the context-specific rules governing talking.

Students are often expected to speak up in front of the rest of the class, to answer a teacher-directed question, to respond to a point made by another student, or to volunteer information, and the teacher's responses to these contributions are often public. Indeed, the use of spoken language is a crucial area in learning, in conceptual development, the acquisition of knowledge and skills, and demonstration of their acquisition. Answers spoken aloud facilitate formative assessment, providing

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the teacher with an indicator of students' progress, their answers revealing what they know and understand and what they do not, and helping the teacher plan future lessons. In much schooling, learning in classrooms is primarily a public affair.

Out of the classroom and in the playground, the novice student will encounter fellow students who are perhaps 6 years older than he or she is. Cohorts will move up through the school annually, encountering new teachers, until children are among the oldest and will face the challenges of starting a new school, where once again they will be among the youngest. Social relationships and friendships are important in all of this. We know from personal experience, anecdotal evidence, and educational research that friendships form a significant part of school life as are more unpleasant kinds of relationships such as bullying that can include physical aggression, social ostracism, name-calling, and so on.

This is all so familiar that we may pay insufficient attention to the acculturation that is entailed and the extensive, ongoing adaptations that are required of all students. Furthermore, while in some roles students are passive participants in school-generated procedures, in many other respects, they contribute to shaping their experience through the attributes they bring with them and the reactions they elicit from teachers and their peers. They do so within a preexisting culture. Individual teachers will be known by reputation for their strictness, fairness, kindness, and so on, knowledge that is passed through the school and may be available to the student prior to joining a class for the first time. Some preexisting classroom roles are available to be filled: the bright child, the "swot," the "nerd," the lazy child, the scruff, the chatterbox, the joker, the "clown," the bully, and so on. Social identities are constructed; thus, for example, nicknames—pleasant or cruel—are assigned when children come to learn more about one another, their family background, and circumstances. Classmates' skills, aptitudes, and sporting prowess will become evident and form part of their identity within the group. A child's experience of school will help shape his or her identity in diverse ways, but it in turn will also be influenced by their developing sense of self.

Silence and Participation

One of the key features of this acculturation is the management of talk and silence. Silence has diverse functions in social interaction, including serving as a communicative device in its own right. It is an element of turn-taking in conversation that the teacher has to manage so that the class will pay attention to her or him, to ensure that unwanted talk does not interfere with learning and that not everyone speaks at once, and to provide every individual with an opportunity to contribute. Pauses during a speech turn can have various meanings, indicative of ongoing thinking or uncertainty about the appropriateness of continuing a line of conversation.

When we discuss the silence in the context of shyness, we imply that shy students speak less than is appropriate. However, the reticence characteristic of shyness can be due to many causes; thus, it may reflect failure to understand the material

under discussion or the student's disengagement from it. Cultural factors play a role. For example, due to increased social mobility and immigration into Western countries, it is common to find children in school for whom English is not their first language and who may not hear it or speak it at home; difficulties of comprehension and competence or confidence in spoken language can result in shy-like behaviors in school (Schultz, 2009, p. 53).

Disengagement is another reason for silence. It can be either temporary or reflect an enduring means of coping with school. For example, Pye (1989) writes of "invisible children" who conceal themselves from teachers' view. It is their way of adapting to the demands of school and the perceived attitudes of teachers toward them by adopting a self-protective tactic of passive withdrawal. It takes the form of "assiduously maintained mediocrity in work of just sufficient quantity to escape rebuke, lowered gaze, making your presence as unrewarding as possible when contact with a teacher is finally unavoidable" (Pye, 1989, p. 38). Silence can be chosen and be strategic, a form of coping with the circumstances in which the child or young person finds him- or herself. This can include emotions and mental states such as truculence, sulking, boredom, defiance, and anger. These states are distinguishable by accompanying facial expression, gesture, and posture, and can be further subdivided, for example, Gilmore (1995, p. 148) distinguishes submissive and non-submissive silent subordinate displays. Children are socialized into the constraints on emotion displays as well as the appropriateness or otherwise of silence, such that, for example, an angry face after being reprimanded by a teacher can result in further punishment as will a silence or gaze aversion that is perceived as insolent. A student might use silence in confrontation with a teacher as an attempted display of power, a challenge to the teacher that he or she does not "hold all the cards."

These examples dwell on the unwanted use of silence in the classroom from the teacher's perspective but quietness can have positive, adaptive value. It has many meanings and serves several functions. Ollin (2008) identifies 14 uses of silence in the classroom that can be observed, including the extent to which the teacher uses silent "slow time" to enable students to absorb material with which they have been presented; it can provide space for reflection, for listening. It can also serve as self-protection, not only as a form of disengagement, hiding ignorance, lack of preparation, lapse in concentration, or low self-confidence; Schultz (2009) provides the example of a gay student whose reticence helps her avoid the anticipated censure of classmates.

How do shy students in particular adapt to the classroom? Are there specific areas of school life that are especially challenging? From a different perspective, are there areas where shy students have positive qualities to offer? To what extent do children bring their shyness to school with them and to what degree does reticence represent a coping mechanism for what they find there? Addressing these questions through empirical research requires some consensus on the nature of shyness, and this remains problematic given the term's status as both an everyday concept and as a technical construct within psychology.

This chapter continues with consideration of this issue before surveying research into aspects of the school experiences of shy children. We shall see that the

correlations between shyness and measures of educational outcomes tend to be negative, implying that, in aggregate, shy students encounter greater difficulties in these learning environments than do their less shy peers. Nevertheless, the coefficients are modest; while there are many possible reasons for this, one that has the potential to add significantly to our understanding is that other factors serve to either attenuate or amplify the relation between shyness and educational outcomes.

This chapter emphasizes adaptation, but we should keep in mind that this is a two-way process: Schools are obliged to adjust to the individual needs of their students. In pursuit of this goal, individual teachers adapt their pedagogic strategies in order, for example, to get the most out of students who are hesitant about contributing to classroom interactions. This obligation poses challenges to busy teachers who have to manage a group of up to 30 individuals and where the greater emphasis in effective classroom management is on minimizing disruptive behaviors of various forms and degrees. Nevertheless, there is evidence that teaching style can make a difference to shy students (Coplan & Rudasill, 2016; Evans, 2010, provide overviews).

The Nature of Shyness

One of the problems facing research in this area is the diversity of constructs in use—shyness, conflicted shyness, BI, social reticence, social withdrawal, anxious solitude, and social anxiety (Coplan & Rubin, 2010)—and this is heightened by researchers', teachers', and students' use of the terms "shy" and "shyness," which are current in everyday vocabulary and, like many widely used words, have no precise referent. It is helpful to make distinctions between state and dispositional shyness, between observed and inferred shyness, and between shyness as description and explanation.

State shyness is evident in expressions such as "she looked at me shyly," "I was suddenly overcome with shyness." It refers to a transient experience that typically takes the form of reticence, volunteering few contributions to social interactions and keeping in the background on social occasions. It may also be displayed by bowed head, failure to make eye contact, and signs of unease and anxiousness such as blushing or stammering. We can also experience feelings of shyness that go unnoticed by others. There are unresolved issues here for research. What is the relation between shyness and embarrassment? Both share many characteristics: feeling self-conscious, fluster and uncertainty how to behave, blushing, and avoidance of eye contact. Both can be subjectively unpleasant states, but whereas the prosocial benefits of embarrassment and blushing for the individual and for the group have been extensively studied, little research has, until recently, and as reflected in this volume, approached shyness from this perspective. Recent studies of the positive expression of shyness draw upon designs and experimental manipulations that are commonly used in research into embarrassment, for example, presenting a speech (Poole & Schmidt, 2019) or singing (Colonnesi, Napoleone, & Bögels, 2014) in

front of an audience. Where this research has not included dispositional shyness in its design, it is difficult to conclude whether participants' experience under these conditions is better described as shyness or embarrassment. State shyness also implies that shyness is context-dependent. There are situations where most of us feel shy and others where the shyest of us come "out of our shell."

Shyness is a label that we apply not only to a state but also to an individual's disposition. We use it to explain behavior. This is bidirectional: "She's quiet because she's shy"; "he's shy because he's quiet." Self-attributed shyness takes an explanatory form. Individuals who describe themselves as shy attribute their reticence to their own characteristics, not to the constraints or challenges of the situations they are in. They explain it in terms of inhibition, that is to say, they are willing to participate but find it difficult to decide upon the appropriate words; they over-rehearse possible contributions or track the conversation but are unable to find an opportunity to interject and make themselves heard. They feel anxious, fearful that what they say will be thought foolish or reveal their ignorance, so they avoid attracting the attention of others. This pattern often entails the distinctive psychological state of self-consciousness, the salient awareness of oneself as a social object, and this acts as a restraint on spontaneous involvement. Sometimes, others present notice silence and attribute it to shyness; alternatively, they may attribute it to indifference to other people or failure to make an effort to join in. Or their silence may not be noticed in the ongoing hubbub of school life.

Despite its ubiquity, dispositional shyness is a complex phenomenon and psychologists identify cognitive, physiological, and behavioral components (see Chapters "The Study of Behavioral Inhibition and Temperamental Shyness Across Four Academic Generations" and "Adaptive Shyness: A Developmental Perspective", this volume). It may therefore be an oversimplification to assume that it necessarily takes the same form at different ages and in all shy individuals or that its correlates are consistent. For example, one shy child makes contributions to classroom discussions despite feeling anxious about doing so, whereas another student is regarded by their teachers as shy but is quite comfortable with their quietness. I return to this point after an overview of research into shyness at school.

A distinction that is increasingly made, and is represented in this volume, is between positive and negative aspects of shyness. The predominant emphasis in psychological research has been on shyness as a form of anxiety that can have unfortunate consequences for the shy child and is predictive of the clinical condition of social anxiety disorder (SAD). From this perspective, shyness is something to overcome, to grow out of, and to be helped with. Nevertheless, shyness can be associated with positive qualities such as good listening skills and willingness to get along with fellow students, and its expression can produce social benefits. For example, its positive expression in early childhood can help regulate anxiety and serve a useful social function (Colonnesi et al., 2014; Poole & Schmidt, 2019). The display of shyness might serve a protective function in students: discouraging a sensitive teacher from calling upon him or her to contribute. Shyness may be a socially acceptable reason for reticence. Indeed, a focus on helping quiet children to

overcome their shyness might neglect the positive functions that reticence serves for the individual learner and for the class.

Treating shyness as homogeneous can be misleading in that different varieties of positive and negative shyness can have differential outcomes in terms of school adjustment. Furthermore, other characteristics of the child or particular features of the situation may moderate the influence of shyness upon adjustment or act as a buffer against the stresses of school life.

This draws attention to a further distinction, between shyness and introversion. Extraversion–introversion is a dimension of personality that has consistently emerged in multivariate analyses of personality questionnaires, from the pioneering work of R.B. Cattell and H.J. Eysenck to the currently dominant Big Five model of personality structure. Eysenck and Eysenck (1969) distinguished between introverted shyness and neurotic shyness, a distinction that anticipated later classifications such as social preference (non-fearful preference for solitude) and social withdrawal due to fear and anxiety (Coplan & Rubin, 2010). The latter form is distinguished in terms of motivation, conflict, and subjective feelings rather than with reference to overt behaviors. Research into positive aspects of shyness ought to be aware of this double meaning of shyness if confusion is to be avoided, but there is another reason for referring to introversion in this chapter. Two studies with very large samples undertaken with the Eysenck personality measures in the 1960s showed that extraverts had higher attainments on nationally set tests at elementary school but that introverts fared better at secondary (high) school (see Crozier, 1997, for a brief overview). There was also a significant interaction effect involving neuroticism: Among girls in the sample, only 9% of introverted girls high in neuroticism passed the national examination that selected the top 25% for a grammar-school education compared to 23% of girls high in both extraversion and neuroticism (Entwistle, 1988). Extravert students performed better than their introvert peers in primary school, but this relationship was reversed when they changed school around the age of 11 years and the superiority of introverts persisted through university. This pattern has been interpreted in terms of the change in forms of teaching and learning from emphasis on social interaction in the classroom in elementary school to assessments that draw more upon on private study and written work (Eysenck, 1978). These studies indicate the importance of taking into account changes in the form of pedagogy across the school years.

Although the factors of extraversion and neuroticism "live on" in the Big Five model, they have not figured much in studies of shyness and school adjustment; Tõugu and Tulviste (2017) provide an exception, reporting findings from a study of 3- to 6-year-old children in Estonia that indicated that extraversion and emotional stability were significantly, albeit moderately, associated with a measure of expressive vocabulary. I return to shy children's vocabulary test performance in a later section. A study by Ash, Rice, and Redwood (2014) illustrates the significance of distinguishing between shyness and low sociability in their study of withdrawn behavior among children aged between 6 and 13 years whose first language is not English (ELL) and who are learning the language in American schools. ELL students' shyness was context dependent—they were rated by mothers and rated

themselves as shyer in the English context than in their native language—but there were no equivalent differences on ratings of unsociability. This study shows the importance of taking social context into account when interpreting children's withdrawn behavior.

One final distinction is between difficulties in encountering strangers and fear of negative social evaluation as triggers of shyness. Kagan's influential construct of BI to the unfamiliar (Kagan, 1994; Kagan, Reznick, Clarke, Snidman, & Garcia-Coll, 1984) stresses the role of novel experiences and unfamiliar people. However, apart from when starting a new school or encountering a new class teacher, many children continue to show shyness even in familiar settings when they move through the school in tandem with the same cohort of classmates. Their anxieties relate to social evaluation concerns rather than to unfamiliarity. This distinction is reflected in schoolchildren's conceptualizations of shyness (Crozier & Burnham, 1990; Yuill & Banerjee, 2001) and ought to be kept in mind when considering shyness across the school years.

Shyness and the Experience of School

A substantial body of research has built up a picture of the mostly negative correlates of childhood shyness. At least three kinds of research areas can be identified: educational attainments, adjustment to school and the factors that mediate between shyness and adjustment, and shyness as predictive of social anxiety.

Shyness and Attainments

Despite the diversity of conceptualizations, there are consistent findings indicating that shyness, however defined and measured, can be a problem in school. Shy children obtain relatively lower attainments in primary/elementary school (Bayram Özdemir, Cheah, & Coplan, 2017; Crozier & Hostettler, 2003; Evans, 2001, 2010; Hughes & Coplan, 2018). Evans (2010) reviewed 26 studies published between 1972 and 2009 that incorporated a range of measures of shyness including self-reports, classroom observations, peer and teacher nominations, and teacher and mother ratings on standardized checklists. Measures of attainment relied on scores on standardized tests and eschewed teacher ratings, since there is evidence of teachers' tendency to underestimate shy students' ability relative to their performance on standardized tests (Hughes & Coplan, 2010). Evans (2010) concluded that while the correlations between shyness and attainments are consistently negative, "the association, when found, is generally modest, with correlations indicating between 5% and 12% of shared variance in the domains of both literacy and numeracy" (p. 195).

As an illustration of research not included in the review, Kirsten Hostettler and I (Crozier & Hostettler, 2003) constructed a sample to serve as a comparison group to

students identified by their teachers as shy. We selected students solely based on their location on the same classroom register as the shy students (to avoid comparing extreme groups on the shyness dimension, which makes interpretation of differences uncertain). Teachers did not choose these participants nevertheless rated them for shyness. The correlations within this sample between shyness and scores on nationally administered educational attainment tests were $r = -0.43$ for English and $r = -0.34$ for Mathematics (both ps < 0.01; $n = 122$). These findings suggest the consistency of the relation between shyness and attainments, given that the sample presumably excluded the shyest children, who had already been identified by the class teachers.

Given the connection between shyness and reticence, it is unsurprising that there is a substantial literature relating shyness to measures of language development. Evans (2010) reviewed 47 published reports, dating from 1948 to 2009. Again, the sample of studies included diverse measures of shyness. Measures of language performance included analysis of spontaneous speech, for example, the number of spontaneous comments and the mean length of utterance during free play, in interaction with researchers or peers, or in speaking up in front of classmates and teacher in "show and tell" sessions in the classroom. Measures also included standardized assessments of language development such as expressive vocabulary, receptive vocabulary, and language comprehension. Once more, the direction of findings is consistent, the correlations are negative but modest, and the scores of shy children are close to test norms. However, the studies do not encompass the range of school ages. The majority of studies (26 out of 47) involve children below 6 years. Eight of the remaining 19 studies involve participants diagnosed with selective mutism, which ought to be distinguished from shyness. There is a dearth of studies with high school students, and we have no longitudinal designs that follow children through the school years. To my knowledge, there are no published systematic reviews that include estimates of effect sizes. When I was preparing an earlier article for publication (Crozier & Hostettler, 2003), I computed effect sizes for 20 data sets provided in 10 publications that were available to me at the time. The ages of participants in these studies ranged from 2 to 10 years, with a median of 6 years. (These publications are marked in the reference list with an asterisk). The mean value of r (Rosenthal, Rosnow, & Rubin, 2000) for vocabulary tests was 0.296, $s = 0.14$, range from 0.11 to 0.52. Separate analyses for expressive and receptive tests produced $r = 0.313$ ($s = 0.13$) for expressive tests and $r = 0.246$ ($s = 0.14$) for receptive tests. These data are consistent with the conclusion that shy children tend to obtain lower scores, but the differences are small overall and are somewhat larger for expressive tests.

One unresolved issue is whether shy children's relative underachievement on the standardized test scores reflects their underlying competence or is influenced by performance factors such as anxiety about being tested. Coplan and Evans (2009) propose four explanations of reported differences briefly summarized as follows: (1) the shy child's reticence restricts opportunities to develop language skills; (2) social-evaluative anxiety about giving incorrect answers in the presence of others; (3) risk aversion; (4) studies have compared extreme scorers on the shyness

dimension, making it unclear whether differences are due to shy participants' deficiencies or the superior performance of the least-shy children.

Arguments for an explanation in terms of competence draw upon findings that the differences in performance are obtained within the same sample on measures of reticence during social interaction, on tests of expressive vocabulary where a spoken response is required, and on tests of receptive vocabulary, where less anxiety might be expected. Hostettler and I (Crozier & Hostettler, 2003) approached the issue of performance anxiety directly by testing 10-year-old shy and less shy children under three conditions: Standardized one-to-one testing requiring oral response; standardized one-to-one testing requiring written response; printed questions and written responses. The predicted interaction was found, and shy scores were significantly lower in the one-to-one testing condition. There were no parallel differences on tests of arithmetic ability in equivalent conditions. Evans (2010) speculates that our finding may reflect the fact that the participants were older than those typically investigated and who perhaps have more pronounced social-evaluative concerns. This hypothesis deserves to be tested, but in itself it adds weight to the argument that the language test performance of older students ought to be assessed.

The complexity of associations between shyness and vocabulary is evident in a more recent study of preschool children reported by Rudasill et al. (2014). The authors report correlations of $r = -0.25$ ($p < 0.05$) and -0.18 (*n.s.*) between teacher ratings of shyness and children's scores on receptive and expressive tests, respectively, although correlations between shyness and both forms of tests were significant when parental ratings of shyness were also incorporated in a multilevel model. It is difficult to work out why this should make a difference. It is worth pointing out that the expressive test was administered after the receptive test for all children, so they might have become more comfortable with the test situation. A factor analysis (albeit with sample size of only 104) of the shyness measure (the Children's Behavior Questionnaire; Ladd & Profilet, 1996) identified two factors, which they labeled shyness and low sociability, respectively. When these factors were added to the multilevel model, the only significant predictor of language performance involved parent-rated low sociability, which was positively associated with expressive vocabulary. There are so many factors of definition, sampling, and measurement in this body of research that it is difficult to obtain a clear understanding of the influence of shyness upon children's language development.

In an attempt to distinguish performance and competence explanations of language test scores, Smith Watts et al. (2014) employed a longitudinal, latent growth model design with a large sample (n = 816) of toddlers tested at 14, 20, and 24 months, concentrating on measures of BI provided by observers and parents. Measures of expressive and receptive language development were administered at all three ages, and the aim was to test competing hypotheses about the connections between BI and development. The significant negative correlation found between BI and language test scores replicated previous research findings, but the relation was stronger and more consistent on expressive measures than on receptive measures and the overall pattern of results provided stronger support for a performance

explanation in terms of shy children's reticence in the test situation rather than language deficits or delay.

A single set of findings is insufficient to rule out explanations in terms of competence given the consistency in findings across different forms of test summarized earlier. Ideally, we would decide on the basis of insight into the processes involved. Do developmental experiences associated with children's reticence result in their having a smaller vocabulary and if so what are these experiences and what are the specific processes involved? Hilton and Westermann (2016) have investigated psychological processes involved in vocabulary acquisition. They examined the performance of thirty-two 24-month-old children on a "fast mapping" task where participants have to match a pseudo-word to a novel object when this object is presented alongside familiar objects that have known names. Performance of young children on fast mapping tasks has been shown to illustrate the processes involved in vocabulary acquisition. Shy children in this study performed significantly less well on the mapping task, and they were less successful in retaining the novel pseudo-word. Hilton and Westermann (2016) defined shyness in terms of a temperamentally based aversion to novelty, and they reasoned that because performance on the fast mapping task is known to be subject to novelty bias shy children's aversion to novelty results in reduction of the effect of novelty bias. Again, this is a single study with very young participants, and we do not know whether novelty aversion is sufficient to explain consistent findings about language development and about the difference in older children's performance on expressive and receptive measures.

The correlations reported in the literature are modest, but we must take into account the substantial population variation that exists on measures of educational attainment and language development due to factors such as socioeconomic status, parental education, gender, and even maturity differences within a single classroom; one would expect correlations with personality variables to be modest if these factors are not taken into account. We should also note that even when shy students obtain statistically significantly lower scores than their less shy peers, they obtain scores within the expected range on standardized tests. Their language development is not a problem in itself.

Nevertheless, differences have educational implications. As we noted in the Introduction, students' active verbal participation is a key element of the teaching and learning process and factors that impede this participation ought to be addressed in research into classroom management. Psychological analysis has a contribution to make here and helpful advice for teachers is available in publications by, for example, Evans (2010) and Coplan and Rudasill (2016). However, these recommendations, perhaps necessarily, tend to be "broad brush" and lack detail at a practical level. We require more observational research into classroom interactions.

Finally, language and communication competence can serve as a protective factor for shy children. For example, Coplan and Armer (2005) reported support for the hypothesis that competence, as represented by expressive vocabulary test scores, moderated the influence of shyness upon teacher-rated social behavior and need for teacher attention. This hypothesis requires further investigation: The participants were preschool children. Will the buffer effect be found in school? Is the finding specific to expressive vocabulary, or to linguistic competence more generally, or to

the kinds of cognitive abilities that lead to success in school? Do the findings imply that practice on communication skills would help shy students adjust better to school?

Shyness and Adjustment to School

A substantial body of research investigates shy children's experience of school in terms of quality of social relationships, assessed by measures such as peer acceptance, popularity and susceptibility to rejection or victimization. Shyness implies psychosocial challenges in peer relationships: It is associated with having a limited number of friends; a shy child may have one stable friendship, which may be with a child who experiences similar psychosocial difficulties (Rubin, Coplan, & Bowker, 2009). They may also be at risk of "passive victimization" by their peers (children nominated by their peers as both victimized and low in aggression; Hanish & Guerra, 2004), which they can trigger by presenting themselves as physically and emotionally weak and unlikely to retaliate (Rubin, Kennedy Root, & Bowker, 2010). They may then use social withdrawal as a strategy to cope with victimization (Gazelle & Rudolph, 2004), creating a transactional cycle where an initially shy child is victimized and responds by withdrawal which is followed by further victimization (Rubin et al., 2009).

Research also investigates adjustment to school, defined in terms of liking of school, avoidance and absences, cooperative participation in the classroom, capacity for independent work, and need for extra teacher attention (see Evans, 2001, 2010, for overviews). Mediating and moderating factors on adjustment include other characteristics of the child such as inhibitory control (Sette et al., 2018), loneliness (Bayram Özdemir et al., 2017), vocabulary test scores (Coplan & Armer, 2005), and aspects of the school environment such as teacher–child relationships (Arbeau, Coplan, & Weeks, 2010) and classroom emotional climate (Gazelle, 2006). In general, significant interaction effects have been identified in this research, showing that there are factors that mitigate (vocabulary; teacher relations, classroom climate) and accentuate (inhibitory control; loneliness) the negative implications of shyness. Once again, this research is restricted by a concentration on younger children, including preschool children. Coplan and Rudasill (2016) note that quality of teacher–student relationships is a protective factor in the personal interactions that preschool allows but that shy students are less likely to attract the teacher's attention in later years.

Shyness and Social Anxiety

Shyness in early childhood is predictive of social difficulties later in life; nevertheless, it is important to keep in mind that the relations are correlational and much of the variance in outcome measures is unaccounted for. There is moderate stability

from early childhood into toddlerhood and later childhood in BI; nevertheless, only a minority of children show high stability of BI and shyness over time. Degnan et al. (2014) identified different trajectories from BI at ages 2 and 3 to social reticence, including with an unfamiliar peer and during free play at ages 2, 3, 4, and 5 years. Children with a high-stable social reticence trajectory (reticence at 2 years that was consistent over time) comprised 16% of the sample and obtained significantly higher scores on a measure of internalizing problems than did members of the other trajectories groups. A similar picture is evident when we consider the relations between shyness and social anxiety: Measures of shyness taken in the early years predict subsequent social anxiety, shyness, and internalizing problems, but the correlations are modest (see Crozier, 2014, for a review).

Similarly, although longitudinal studies conclude that infant and childhood shy and withdrawn behaviors are statistically significant risk factors for SAD (for reviews, see Gazelle, 2010; Rapee, 2010), large numbers of children diagnosed with SAD had not previously displayed BI and equal numbers of BI and non-BI children were later diagnosed with SAD (Gazelle, 2010). Furthermore, a separate line of enquiry finds that only a minority of adults who meet diagnostic criteria for SAD report having been either shy or extremely shy as children (Burstein, Ameli-Grillon, & Merikangas, 2011; Cox, MacPherson, & Enns, 2005). A meta-analysis of longitudinal studies predicting SAD in later childhood and adolescence from BI undertaken by Clauss and Blackford (2012) reported a strong relation within the seven studies that met their inclusion criteria, namely, a highly significant odds ratio of 7.59 relative to control groups. Overall, 43% of BI children across the studies met diagnostic criteria for SAD, compared with 12% of non-inhibited children. The odds ratios include two discrepant values of 41.53 and 24.21 obtained when participants in two of the studies were assessed for BI and SAD only 2 years apart (on average). BI is a predictor of SAD; notwithstanding this finding, 57% of BI did not meet diagnostic criteria of SAD.

Retrospective and prospective research designs face methodological difficulties. Shyness is measured in different ways at different ages, and there are moves from observational studies of behavior in the laboratory in infancy and early childhood to reliance during the school years on teacher and parent rating scales and checklists and eventually to incorporation of children's self-reports on questionnaires and in interviews. The concerns of shy children change over time just as the nature of their fears change with growing maturity (Crozier, 2014). Social-evaluative concerns come to the fore and reach a peak at adolescence. Furthermore, shy, inhibited, and reticent behaviors will be influenced by parental attitudes and behaviors in various ways, including the adoption of parental protective strategies such as colluding with the child in avoidance of novel social situations, speaking up for their children if this is not feasible, or making the excuse that the child is shy. Evans and Ennis (2017) provide a relevant illustration of this. They identified protective practices that parents adopted when helping their child read difficult words during shared reading: Shyer children were less likely than their less shy peers to make a guess at a word and more likely to pause for or ask for assistance; their parents were less likely to encourage their child to try again or provide the child with clues, and they showed

a greater tendency to supply the answer to the child. Such an approach fails to increase the child's confidence and denies practice in the use of strategies for word identification.

To complicate the picture, there are age-related changes within the child in his or her ability to regulate behavior, to develop strategies in order to overcome, reduce, or disguise difficulties, and to reflect on themselves and their difficulties. For all of these reasons, not to mention the issue of the reliability and validity of assessments made by teachers, parents, and children, there are limitations on the magnitude of correlation coefficients that can be expected.

There is a dilemma here for schools and parents. On the one hand, shy behaviors are regarded as predictive of SAD and the child may benefit from some kind of preventative intervention; on the other hand, it can be argued that normal behaviors are being pathologized. To what degree is identifying shyness as a problem helpful for the child or for the school? Shyness can be an unpleasant experience that impacts upon development into adulthood, being associated with loneliness, difficulties in forming friendships, social and academic problems at school, and so on. These should not be underestimated. Shyness that persists over time does give grounds for concern since such children are at risk for developing internalizing disorders. The school years are significant for children both at the time and for the future, and reticence and adoption of self-protective strategies may interfere with their learning and adjustment. However, there is a risk of overemphasizing the negative when talking about young children's shyness and withdrawn behavior. A balance needs to be drawn, and this will be assisted by research into the factors that mediate and moderate shy children's adjustments to school.

Volunteering an Answer in Class

One common pedagogical technique in a teacher's repertoire is to pose a question to the class and either choose a student to answer or invite members of the class to volunteer an answer, typically by asking them to raise a hand. Shy children are often reluctant to do so, even when the teacher believes that the child knows the answer. This is intuitively understandable as an illustration of social reticence, but it may be useful to analyze this more closely by adopting the child's perspective and construing his or her reluctance in decision theoretical terms. This approach might also throw light on other aspects of shy children's reticence including their apparent underachievement on tests. In addition to the student's confidence in an answer—or the subjective probability of being correct—we need to take into account the values or "utilities" of the outcomes, that is, the gains and losses associated with volunteering. This can be analyzed in terms of signal detection theory (Bateson, 2016) or in terms of classical subjectively expected theory or prospect theory (Kahneman & Tversky, 1979). The costs of not volunteering are negligible in a social sense since either other students will do so or, if no one does, the shy student will not be in a

different position from anyone else. However, there may be educational costs for the individual as I discuss in the following.

Gains and losses would apply to all students but here I concentrate on shy students, hypothesizing that social costs are more prominent for them. Lack of confidence is not restricted to them but they are more concerned than their less shy peers about the consequences of public failure. Social costs can also be associated with correct answers; by drawing attention to yourself you may be called a "swot" or "nerd" or show-off: "Who does she think she is?"

What determines the subjective probability of correct and incorrect answers? Memory is accessed by a process of "bringing into consciousness" and a potential answer that is retrieved can be accompanied by a "feeling of knowing" that varies in strength from doubt to certainty. Feelings accompanying a candidate answer may be clearly either strong or weak in the matter of factual questions requiring brief answers. However, some answers require an element of judgment or approximation, which can add uncertainty (I may not remember the exact year that Neil Armstrong set foot on the moon but guessing nowhere near the year would be a conspicuous error). They might also require the composition of a lengthier answer or some element of computation. More generally, there is always some uncertainty surrounding any question: Have I heard or understood it correctly? Is it as easy as I think it is or am I missing something here? I might look to the teacher or classmates for cues to this: Do the teacher's mannerisms suggest it is a hard question? Do other students look puzzled or are some hands raised already? Some students will answer a question impulsively but others will be more circumspect, often rehearsing a possible answer subvocally before committing to utter it.

Subjective probability is not only a matter of the specific question that is posed; it is also influenced by one's past experiences of success and failure in answering questions in class and, more generally, one's confidence in the subject matter being studied. Here, we must also take into account attributions for success and failure. Shy individuals tend to attribute their social difficulties to their own characteristics rather than to the difficulties inherent in the situation, and this bias can undermine confidence in public performance. Failure to credit oneself for successes and a tendency to accept the blame for failures both undermine confidence and contribute to continuing anxiety in class. This bias will also influence the appraisal of benefits and costs of responding and indeed costs can also feed into the mental calculation of probability: High costs might exaggerate the chances of failure occurring.

The utility of a successful outcome resides in the response of the teacher and possibly fellow students. It also resides in the sense of achievement and the sense of an obstacle overcome. What are the costs? How serious a wrong answer is will be a function of several factors. Ought you to have known the answer? Has the class just covered this topic so that your incorrect answer will reveal your lack of attention or failure to understand something that has recently been explained? Are you expected to know the answer in the sense that it ought to be within the grasp of someone at your stage of learning? Another factor is the response of the teacher, which can be tolerant or generous but can also be sarcastic, critical, punitive, or show you up in

front of the class. There will also be the response of classmates who might laugh or groan or tease you afterwards.

Decision theory proposes a threshold or response criterion that has to be attained before an answer is uttered. This criterion takes into account both the "feeling of knowing" that the possible answer that is generated is the correct one and the utilities associated with correct and incorrect spoken responses. Decision-making is a dynamic process; values assigned to subjective probabilities and utilities are not fixed and will be influenced by contextual factors. From this perspective, there are four possible outcomes: A correct answer is uttered; an incorrect answer is uttered; a correct answer is withheld—a missed reward; an incorrect answer is withheld—a loss avoided. The location of the criterion influences the relative frequencies of these outcomes. A pessimistic bias (Bateson, 2016)—that we can assume characterizes a shy student—sets a high criterion that results in a bias toward not making a response. The student experiences a low rate of failure but pays for this with a high rate of missed rewards. In social comparison terms, a feeling of regret might be higher if a fellow student provides the answer that the shy student had in mind and she sees the other student receiving praise or congratulation. However, the bias might have more serious educational implications if, as many psychologists argue, an active response followed by personal, focused feedback is more important for learning than a passive response followed by generalized feedback.

Setting a high criterion is effectively similar to adopting what in cognitive behavioral treatment for SAD is termed a safety behavior, a self-protective defensive strategy that functions to cope with anxiety in social settings. It minimizes social failure but carries the costs of forgoing essential practice and restricting opportunities for positive feedback. In the long term, the strategy is a losing one because it isolates the anxious individual from the benefits that socializing can bring, impeding learning socially effective behaviors, the lack of which forms a large of part of the subjective experience of shyness. It prevents the anxious individual from learning that the costs of social failure are much smaller and rarer than imagined. All of this can apply to the consequences for learning of withholding contributions in the classroom. The bias can readily become habitual in the absence of reinforcement of alternative ways of behaving.

I have concentrated here on the example of volunteering an answer in class. A decision model can also be applied to test taking, for example, the expressive vocabulary tests where shy children consistently obtain somewhat lower scores than their less shy peers. Pessimistic bias can result in lower test scores if potential answers are rejected or suppressed and can be costly if it is a timed test where hesitations impact upon scores. Does the child utter the response that first comes to mind or do they hesitate in order to weigh up the likelihood of it being the correct answer? Do they look to cues from the examiner? As Coplan and Evans (2009) suggest, shy students are risk aversive in such situations.

In principle, this model is testable by means of response time measures and video recording of mouth movements or, for older children, interviews about their performance. The hypothesis would be that there would be a significant interaction between shyness and the social context of testing. Crozier and Hostettler (2003)

obtained support for this, finding that the context of testing did affect shy and comparison-group participants differentially; such a design could be adapted to incorporate outcome variables over and above test scores. It is also possible that differences between shy and less shy respondents will be associated with item difficulty, where risk aversion may be more prominent in more challenging questions.

The model proposes a hypothetical process and does not assume that children consciously weigh up costs, benefits, and probabilities. Yet it is consistent with the fears that are expressed in questionnaires and interviews with older children and adult participants when they are questioned about factors influencing contributions to group conversations, where references to social costs and inhibition are prominent. Participants express fear of being laughed at or thought to be stupid or they fear being perceived as arrogant. They become self-conscious. To quote one 11-year-old, "I feel a lot more shy now than when I was younger … you're not really bothered about anything when you are younger, you don't really care if people are watching you, or what they might be thinking of you" (Crozier & Burnham, 1990, p. 183). Another example comes from literature: "She does not speak in class and on the rare occasions when she is required to answer a question or recite a poem her insides contract, and she is rigid with fear that she will say something foolish and shame herself" (Costello, 2014, p. 42).

The kinds of explanations that shy people construct about their behaviors help sustain the pessimistic bias proposed here. They also contribute to performance deficits by creating anxiety and associated rumination that can interfere with the cognitive resources necessary for answering questions. More generally, anxious self-preoccupation generates greater interference with retrieval from memory or task focus.

Shyness and Adaptation to School

There is consensus from empirical research that shyness is somewhat disadvantageous at school. Studies regularly identify statistically significant differences between shy children and their less shy peers on measures of attainment and on standardized tests of language development. Observational studies show that they participate less in class and that when they do so their utterances are shorter than are those of their classmates. There are also findings using a variety of measures that shy students are less well adjusted to school and that they are at greater risk of social anxiety in later life. In short, shy students give cause for concern. An additional worry is that the low profile that shy children tend to adopt in social situations can result in their difficulties going unnoticed in the school system.

There are limitations in the conclusions that can be drawn from the empirical research. These are aggregate data and much of the variance in outcome measures remains unexplained. There is also emphasis on the youngest children with few studies of high school students and a dearth of longitudinal research. Research is

ongoing into moderating and mediating factors and this promises to explain more of the variance in outcomes and provide insights into the processes involved.

In this chapter, I have aimed to provide a context for consideration of the reticence that characterizes shy students in the classroom and is frequently the principal basis for teachers concluding that a student is shy. Educational researchers, for example, Schultz (2009), argue that silence is an important ingredient in the life of the classroom and a quiet student is not necessarily at risk merely because he or she is reticent. Silence takes various forms and serves many functions, including acting as a form of communication; too readily, as Scollon (1995, p. 21) points out, "studies of communication have tended to look at silences as absence—as absence of sound and therefore as absence of communication". It is easy to neglect it as merely the background, assuming that the important action is elsewhere. Silence can communicate mental states and emotions and it plays various roles in classroom interaction. The researcher, like the class teacher, can ask several questions about it: Is there something about the specific circumstances that leads the student to behave in this way? What does acting in a shy way mean to the student? What functions are served in these circumstances for this student? Is the shy behavior being reinforced—or even constructed—by others including teachers and fellow students? In my outline model of the shy child facing the challenges of speaking up in class or taking a test, I have attempted to view the challenge from the student's perspective, assuming that silence does not mean that she is disengaged but that she is coping with a degree of conflict that she experiences in this specific context. Silence is a choice that the shy child and the academically unconfident student are making; it is their form of adaptation.

The analysis here has implications for teacher interventions. The teacher ought to create an environment that emphasizes acceptance, encouragement, and praise. The shy child needs to know that he can place trust in the teacher. Research into classroom climate supports this point. A well-structured classroom that has a positive, encouraging climate, assessed on the basis of standardized observational methods, and the degree of shy children's observed engagement in the classroom have both been shown to moderate the effect of shyness on academic attainment (Hughes & Coplan, 2018) and function as protective factors. Here, I suggest more specifically that teachers can be aware of three factors influencing the student's likelihood to contribute in class, namely, her confidence that she knows the answer, the strength of her fears about getting the answer wrong, and the threshold she prefers to adopt for choosing to contribute. Each of these constitutes a source of reticence that the teacher can target. Phrasing of questions should be clear in order to encourage confidence in understanding what the question means; negative reactions by the teacher, particularly public ones, should be avoided; praise should be given for having the courage to contribute; positive elements of the answer highlighted. The aim is not to have the shy child speak more but to give him or her confidence to do so when he or she wishes to; the goal is to reduce the factors that inhibit contribution.

Reticence and the anxieties that underlie it form only part of the difficulties that shy children face. The quality of peer relationships and the risk of loneliness are also important to take into account. These difficulties may not be restricted to school; nev-

ertheless, children spend much time there. The school setting is an important arena for research into social interactions with peers and we need more research with older students; the early years are critical for development but research should investigate which difficulties persist over time. We also have to take into account changes in shyness and the impact of children's growing awareness of social evaluation and the concerns this raises for them. Finally, research should investigate more closely the meanings that shyness has for students and teachers. A current project in Oslo, Norway, in which I am involved, draws upon both qualitative and quantitative designs to investigate these meanings and to analyze the circumstances in which teachers adopt particular strategies to encourage greater participation among shy, reticent students in the classroom (Mjelve, Nyborg, Edwards, & Crozier, 2019; Nyborg & Mjelve, 2017). Construing reticence in strategic terms is one approach, as is taking into account the student's appraisal of the costs and benefits of particular courses of action, but these deserve to be investigated in depth.

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Shyness and Sociability Revisited

Kristie L. Poole and Louis A. Schmidt

Introduction

Over three decades ago, Cheek and Buss (1981) observed that some people were quiet and reserved in social situations. Cheek and Buss asked whether these individuals behaved this way because they felt inhibited and anxious in social situations (i.e., they are shy) or because they preferred to be alone (i.e., they are introverted). Cheek and Buss then further questioned whether shyness and sociability were so interrelated that expressing high levels of the one trait necessarily implies having low expression of the other. They suggested that the answer to this question was yes, by definition, if shyness was defined as nothing more than the tendency to avoid people. If, however, shyness and sociability were defined as conceptually independent, then the extent to which the two traits were related was an empirical question. They developed short self-report measures of shyness and sociability to address this question and found that the two measures were only modestly inversely related, suggesting independence of the two personality traits.

Cheek and Buss (1981) then asked: If a person was shy, did it make any difference to their behavior whether they were high or low in sociability? To address this question, they selected individuals who scored high and low on shyness and sociability, to comprise a total of four groups (i.e., high shyness and high sociability, high shyness and low sociability, low shyness and low sociability, low shyness and high sociability), and had them interact with unfamiliar peers. Cheek and Buss found that individuals who were high in shyness *and* sociability exhibited higher amounts of behavioral anxiety than adults in the other three groups. Presumably, this group exhibited a strong desire for social interaction with others, but these individuals

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were inhibited in approaching such situations by their social fearfulness. Thus, these individuals experienced conflicting social motivations.

Since the original publication, the Cheek and Buss (1981) measurement approach on the relative independence of shyness and sociability has been replicated across ages and populations, including toddlers (Trautman, Meyer-Bahlburg, Postelnek, & New, 1995), children (Asendorpf & Meier, 1993; Coplan et al., 2013; Coplan & Armer, 2007; Coplan, Prakash, O'Neil, & Armer, 2004; Tang, Santesso, Segalowitz, & Schmidt, 2016), adolescents (Mounts, Valentiner, Andrerson, & Boswell, 2006; Page, 1990), and healthy adults (Dhaundiyal & Coughlan, 2016; Eisenberg, Fabes, & Murphy, 1995; Miller, Schmidt, & Vaillancourt, 2008; Sheeks & Birchmeier, 2007; Tang, Santesso, Segalowitz, Schulkin, & Schmidt, 2016; although see Bruch, Gorsky, Collins, & Berger, 1989) as well as clinical adolescent (Wadman, Durkin, & Conti-Ramsden, 2008) and adult (Goldberg & Schmidt, 2001; Jetha, Schmidt, & Goldberg, 2009; Jetha, Schmidt, & Goldberg, 2007; Xu, Poole, Van Lieshout, Saigal, & Schmidt, 2019) samples.

As well, the independence of shyness and sociability has been demonstrated across cultures, including German (Czeschlik & Nurk, 1995), Portuguese (Neto, 1996), and Asian (Hussein, Fathy, Mawla, Zyada, & El-Hadidy, 2011) samples. Similar findings have been reported in nonhuman animals, as reflected by individual differences in overt timid and bold behavior (for a review, see Réale, Reader, Sol, McDougall, & Dingemanse, 2007). The ubiquitous manifestation of shyness and sociability across development, cultures, and phylogeny suggests that these two personality traits may be rooted in our evolutionary history.

In this chapter, we first review how shyness and sociability have been conceptualized in the past using an approach and avoidance motivational framework as a heuristic. We then review empirical research that has elucidated correlates of shyness and sociability across psychological, biological, and cognitive levels of analysis. Finally, we review recent work that has examined the life span developmental trends of shyness and sociability.

An Approach and Avoidance Heuristic for Understanding Shyness and Sociability

Approach and avoidance are fundamental motivational dimensions that are observed behaviorally and conserved across human and nonhuman animals, including invertebrates (see Wilson, Clark, Coleman, & Dearstyne, 1994, for a review). Two personality traits that are particularly salient to study approach and avoidance motivations are shyness and sociability, given their opposite social motivations. Shyness is characterized by inhibition and anxiety, and the perception of threat during social situations or anticipation of social situations, and is presumed to be maintained by an avoidance motivation (Cheek & Buss, 1981). Sociability is characterized by a desire to engage and interact, with the experience of positive emotions in social situations or anticipation of social situations, and is presumed to be maintained by an approach motivation (Cheek & Buss, 1981).

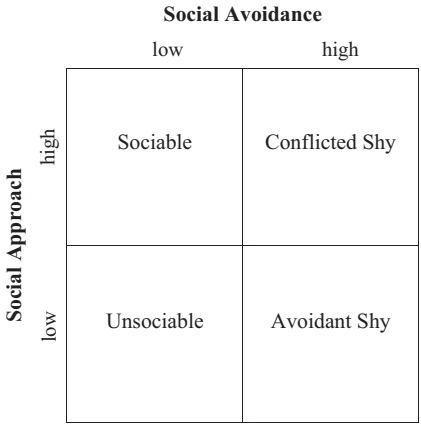

Fig. 1 An approach and avoidance heuristic framework for understanding shyness and sociability. The interaction of social approach and social avoidance dimensions and resulting four social behaviors (adapted and modified from Asendorpf, 1990)

There have been attempts in the past to use an approach and avoidance motivational framework as a heuristic to conceptualize and understand shyness and sociability (Asendorpf, 1990, 1993). Asendorpf used the interaction of social approach and social avoidance dimensions as a heuristic to understand individual differences in social behavior. In doing so, there are at least four resulting behaviors and types of individuals (see Fig. 1). The first type is *sociability* (upper left quadrant). Sociability results from high approach–low avoidance motivation tendencies. Individuals in this quadrant have a high need and desire to affiliate with others, seek out others, and find other people more stimulating than anything else. These individuals are highly outgoing, sociable, and purely extroverted. The remaining three quadrants characterize different types of socially withdrawn behaviors: (1) *conflicted shyness* (upper right hand quadrant) results from high approach–high avoidance motivational tendencies. These individuals are highly socially inhibited. They desire to interact with others but feel too inhibited and anxious in social situations to do so. Given the conflicting social motivations underlying these individuals, they are defined as socially conflicted; (2) *avoidant shyness* (bottom right hand quadrant) behavior results from low approach–high avoidance motivational tendencies. Unlike people with conflicted shyness, although avoidant individuals also experience discomfort in social situations, they have little motivation to interact with others and actively avoid social situations entirely; and (3) *unsociability* (bottom left hand quadrant) results from low approach–low avoidance motivational tendencies. These individuals do not have a high need to interact with others, but are not bothered by doing so. They are pure introverts.

Correlates of Shyness and Sociability

Shyness, sociability, and their interaction has been examined and distinguished on a range of behavioral, psychophysiological, and cognitive measures. The findings from this work have not only illustrated the relative independence of shyness and

sociability but have also illustrated that individual differences across each of these traits can produce highly different developmental outcomes. In a series of studies over the last two decades, we and others have used an approach and avoidance framework as a platform to examine the independence of shyness and sociability and to better understand the correlates and mechanisms underlying different subtypes of shyness (see Schmidt & Buss, 2010; Schmidt & Fox, 1999, for reviews). Subsequently, we review empirical research that has examined the correlates of these shyness subtypes across development.

Behavioral and Psychological Correlates

A number of empirical studies have used the approach and avoidance heuristic model to understand individual differences in social behavior, including shyness in children (Asendorpf, 1993; Coplan, 2000; Coplan et al., 2013; Coplan & Armer, 2007; Coplan, Prakash, et al., 2004; Coplan, Rubin, Fox, Calkins, & Stewart, 1994; Kopala-Sibley & Klein, 2016; Rubin & Asendorpf, 1993). Coplan and his colleagues have found that shy children display unoccupied and onlooking (passive watching of other children) behaviors in unfamiliar social situations (Coplan et al., 1994), as well as reticence during the first day of preschool (Coplan, 2000) and several months into the school year (Coplan, Prakash, et al., 2004). Among adult samples, conflicted shy and avoidant shy individuals also display distinct behaviors. For example, conflicted shy adults perceived themselves to contribute less to social interactions during everyday mealtime settings (Arkin & Grove, 1990), whereas avoidant shy individuals rated themselves as the least talkative during a dyadic social interaction with an unfamiliar social partner relative to individuals with other combinations of shyness and sociability (Schmidt & Fox, 1995).

Conflicted shyness is also predictive of adjustment problems during development, including poorer social competence during the preschool years (Coplan, Findlay, & Nelson, 2004) and loneliness, emotional instability, lower self-worth, and social anxiety during childhood and into adolescence (Crozier, 1995; Eisenberg, Shepard, Fabes, Murphy, & Guthrie, 1998; Tang, Santesso, Segalowitz, & Schmidt, 2016). Recently, a longitudinal study by Kopala-Sibley and Klein (2016) found that conflicted shyness in preschool-aged children was predictive of internalizing and externalizing behaviors in later childhood. As well, adolescents (Page, 1990), young adults (Santesso, Schmidt, & Fox, 2004), and adults (Poole, Van Lieshout, & Schmidt, 2017b) with conflicted shyness are more likely to use and abuse illicit substances compared with their peers.

Relatively less work has examined the corelates of avoidant shyness. Some work has reported that socially avoidant children reported higher levels of depressive symptoms relative to conflicted shy and unsociable children (Coplan et al., 2013). Similar findings were reported in adolescents, with social avoidance being correlated with depressive symptoms, whereas conflicted shyness and unsociability were unrelated (Bowker & Raja, 2011).

Conflicted shyness during emerging adulthood has been shown to be associated with increased social distress, increased fear of negative evaluations, and more social comparisons with peers (Nelson, 2013) relative to the socially avoidant shyness subtype (i.e., high on shyness but low on sociability). These traits are comparable to the symptoms associated with social anxiety. Indeed, we have also demonstrated that beyond emerging adulthood, adults with conflicted shyness are at an increased risk for experiencing the cognitive, behavioral, and somatic symptoms underlying social anxiety disorder (Poole, Van Lieshout, & Schmidt, 2017a). We have also found that shy (i.e., socially conflicted) adults exhibited a higher incidence of mixed handedness (a risk factor for psychopathology; Spere, Schmidt, Riniolo, & Fox, 2005) and poorer adjustment in adulthood across demographic, psychological, social, and health domains of adaptive functioning (Poole et al., 2017b).

Psychophysiological Correlates

One primary focus of our work has been examining the independence of shyness and sociability on a psychophysiological level using measures that index central and peripheral nervous system activity at rest and in response to social challenge. In one study (Schmidt, 1999), we noted that shy adults exhibited greater relative right frontal brain electrical (EEG) activity at rest (i.e., a pattern reflecting a predisposition toward avoidance behavior and negative affect), while social adults exhibited greater relative left frontal EEG activity at rest (i.e., a pattern reflecting an increased tendency for approach behavior and positive affect). Although conflicted shy (i.e., high approach–high avoidance) and socially avoidant (i.e., low approach–high avoidance) adults both exhibited greater relative right frontal EEG activity at rest, the former group exhibited more absolute activity in the left frontal brain region compared to the latter group. More recently, we reported a relation between shyness and greater relative right frontal EEG activity at rest and sociability and greater relative left frontal EEG activity at rest in adults with schizophrenia when their symptoms were statistically controlled (Jetha et al., 2009).

In an earlier study (Schmidt & Fox, 1994), we reported that conflicted shy adults also exhibited a higher heart rate and lower vagal tone (i.e., stress vulnerability correlate) during anticipation of an unfamiliar social encounter with a peer than adults in the other three approach–avoidance groups. This autonomic pattern in conflicted shy individuals indicates they have high stress and sympathetic reactivity and poor emotion regulation. Finally, in a sample of adults, we have also reported a higher cortisol awakening response among conflicted shy individuals, which may reflect the fact that these individuals require more energy resources to be socially outgoing (Tang, Beaton, Schulkin, Hall, & Schmidt, 2014).

Cognitive Correlates

Recently, we wished to extend the psychophysiological findings to possible perceptual-cognitive and neurocognitive mechanisms implicated in the origins and maintenance of conflicted shyness. In one study, we tested if individual differences in shyness and sociability were related to the processing of emotional stimuli, guided by an opponent process theory of emotion (Poole et al., 2019). The opponent process theory of emotion posits that affective states are modulated by opposing reactions (Solomon & Corbit, 1974). That is, there are two components of the emotional experience: a) *the primary process*, which is the affective state determined by the emotion-eliciting stimulus, and b) the resulting *opponent process*, which is the emotional state that is *opposite* in affective valence of the primary process (Solomon & Corbit, 1974). According to the opponent process theory, the function of the opponent process is to bring the individual's affective system to equilibrium after the experience of an emotional event. With repeated exposure to, or experience of, a specific primary process, researchers have argued that the opponent process becomes stronger across time (Comer, Harrison, & Harrison, 2015; Solomon & Corbit, 1974).

To index opponent processes, we used a visual afterimages task. During this task, participants adapt to an individual face emotion for 45 s (i.e., primary process), then the emotion face stimulus is immediately replaced with a neutral face for 800 ms, and then participants were asked to label the perceived afterimage emotion (i.e., opponent process).

Results revealed that individuals scoring high on shyness *and* sociability (i.e., conflicted) were more likely to perceive a negative emotion afterimage after adapting to happy faces and a positive emotion afterimage after adapting to angry faces, compared to other individuals scoring high and low on shyness and sociability. That is, individuals classified as *conflicted* shy experienced an increased likelihood of reporting the expected afterimage to both positive *and* threat-related emotional stimuli (Poole et al., 2019). We speculated that individuals who are characterized as shy *and* sociable (i.e., conflicted) may have increased experiences with negative, withdrawal-related emotions (i.e., angry) and positive, approach-related emotions (i.e., happy), and consequently an enhanced expected opponent process to the presentation of both negative, withdrawal-related, *and* positive, approach-related primary processes (Poole et al., 2019).

In a second study, we examined the neurocognitive correlates of shyness and sociability in children during the processing of novel tones (Tang, Santesso, Segalowitz, & Schmidt, 2016). We found that shyness was positively correlated with increases in target P300 amplitudes (an event-related potential associated with arousal, attention allocation, and cognitive resources). There were no significant relations between sociability and P300 responses. Interestingly, we also found that P300 amplitude in the frontal region mediated the relation between conflicted shyness (i.e., high shyness and high sociability) and emotional instability. These results suggest that shyness and sociability are distinguishable on neurocognitive measures in children and that there may be neurocognitive mechanisms underlying risk for emotional instability in children characterized by conflicted shyness.

Developmental Stability of Shyness and Sociability

In addition to examining the relative independence and distinct correlates of shyness and sociability, researchers also have been interested in examining the developmental stability of these two traits. Typically, shyness and sociability have been regarded as relatively stable constructs across development, particularly among extreme groups and particularly as one reaches young adulthood. However, there have been very few long-term longitudinal studies that have examined mean-level changes of shyness and sociability from early childhood into late adulthood. Thus, it remains somewhat unclear how these two traits follow similar or different developmental trends across the life course.

When examining shyness, the majority of research has assessed predictors or outcomes of different shyness trajectories (e.g., Caspi, Elder, & Bem, 1988; Grose & Coplan, 2015; Schmidt et al., 2017; Tang et al., 2017) and has not examined mean-level changes across time. A recent study attempted to take a lifespan perspective on shyness by examining a construct related to shyness (a composite using neuroticism and introversion) using a large sample of individuals between the ages of 17 to 70 (Van Zalk, Lamb, and Rentfrow, 2017). These researchers reported trends that males tended to have decreases in shyness from early adulthood to late adulthood. In contrast, females had higher mean levels of shyness overall as compared to males and that these levels remained constant across age. Recently, we reported that shyness (and conflicted shyness specifically) decreased from age 20 to 30 (Xu et al., 2019). We also found that greater decreases in conflicted shyness from age 20 to 30 were predicted by establishing a relationship, or being male.

We have also recently examined mean-level differences in shyness across the lifespan from ages 4 to 86 using a repeated cross-sectional design. (Brook & Schmidt, 2019). In the adult samples, results revealed that mean levels of shyness were significantly higher in late emerging adulthood to middle adulthood (i.e., 26–55 years) than in comparison to the other age groups (i.e., ages 17–25 and 56–86). The highest levels were found in young adulthood (i.e., ages 30–39) and the lowest levels were found in late adolescence and early emerging adulthood (i.e., ages 17–22). In the child samples, we found mean levels of shyness were relatively high in the preschool years but declined during middle childhood and increased again in late childhood/early adolescence. Caution needs to exercised when interpreting the data from the child samples as measurement invariance was not established for the child ages, so the interpretation of the mean levels of shyness in childhood may not be reliable and are only for descriptive purposes. Collectively, the trend in average levels of shyness across the lifespan appeared to follow an inverted U-shaped curve.

With respect to sociability, one study reported that sociability increased during adolescence, decreased during later adolescence into mid-adulthood, and then increased during late adulthood (Ashton & Lee, 2016). A separate study reported that sociability did not change between age 16 and 66, though this was based on two time points (Damian, Spengler, Sutu, & Roberts, 2019). We also found that sociability decreased from age 20 to 30 among both typically and atypically developing adults (Xu et al., 2019).

We have also recently examined mean-level changes in sociability across the life course from ages 3 to 86 again using a repeated cross-section design (Brook & Schmidt, 2020). Among the sample of children/adolescents, the lowest mean levels of sociability occurred during late childhood to early adolescence, relative to other childhood developmental periods. Among the sample of adults, the highest levels of sociability were seen between the ages of 17 and 22 years, whereas the 30–39 years group had the lowest levels of sociability. A final observation was that females tended to have significantly higher levels of sociability on average than males over the entire sample.

Benefits of Shyness and Costs of Sociability

In the spirit and theme of this edited volume on adaptive shyness, a final comment is warranted regarding the potential benefits of shyness and costs of sociability. Although shyness is often viewed in popular culture and the research literature as a "negative" trait and sociability as "positive" trait, are there any benefits to shyness and costs to sociability? There are accounts in the literature that suggests shyness is associated with positive aspects such as creativity (Kwiatkowska, Rogoza, & Poole, 2019) and lower risk-taking behaviors (Addison & Schmidt, 1999). As well, there are other suggestions that higher levels of sociability are not always associated with adaptive behaviors and outcomes (see, e.g., Buss, 2012; Cohen, 2004; Emmons & Diener, 1986; see also Chap. 10, this volume).

In a recent study by our group, we examined whether there were any benefits to children's shyness (Chow et al., 2017). To this end, we investigated the association between children's temperament and anxiety in an ecologically salient and stressful environment: the surgical context. We found that temperamentally shy children, paradoxically, were consistently less anxious than sociable children in response to impeding elective surgery across two visits: a preoperative visit and the day of surgery. We speculated that temperamentally shy children may be relatively less anxious than their socially outgoing counterparts because they may be more experienced with coping with anxiety in their everyday environments and perhaps have learned how to regulate their emotions better in this highly stressful context.

Conclusion

Overall, theoretical and empirical work have illustrated that shyness and sociability are fundamental and distinct personality traits that are distinguishable across a range of measures, ages, populations, and cultures. The studies reviewed earlier have been guided by the use of an approach and avoidance heuristic to understand shyness and sociability. The interaction between shyness and sociability can result in at least four social behaviors, yielding two shyness subtypes in particular. Each of these

shyness subtypes has unique behavioral, psychological, psychophysiological, and cognitive correlates across development. As well, shyness and sociability each follow unique developmental trajectories. A consideration of shyness and sociability as distinct traits can aid in our understanding of some of the reasons for different types of social withdrawal and adaptive and maladaptive outcomes associated with each of these traits.

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Quiet Strengths: Adaptable Introversion in the Workplace

Sanna Balsari-Palsule and Brian R. Little

Introduction

Naturally quiet and reserved individuals might act out of character in their workplaces by leaning in, speaking up, and engaging with others. Sometimes the reverse happens: a naturally outgoing and extraverted person may go quiet—holding back, withdrawing from the distraction of others, and working alone. Is there empirical evidence of this counter-dispositional behavior? If so, what impels it? What benefits might accrue? What costs might be suffered? If there are costs, how might a person recover after acting out of character? This chapter reviews contemporary theory and research that sharpens these questions and provides some provisional answers to them.

Recent research in personality science is exploring what happens when individuals act counter-dispositionally. Particular attention has focused on the enactment of extraversion and how it can shape important life outcomes for dispositional introverts. For example, a large body of research in laboratory-based settings has identified causal relations between enactments of extraversion and increases in positive affect for dispositional introverts (Jacques-Hamilton, Sun, & Smillie, 2018; Leikas & Ilmarinen, 2017; McNiel & Fleeson, 2006, McNiel & Fleeson, 2010; Zelenski, Santoro, & Whelan, 2012). However, how and why individuals may act out of character in multiple daily contexts is yet to be fully investigated. We therefore pay attention to the adaptiveness of introversion in the workplace—a social ecology that represents a dynamic and complex interplay of social norms, expectations, and situational demands. We use this examination to add richness to our understanding of how introverts adapt themselves and how this may manifest into benefits and costs in their lives. Although introversion is theoretically and empirically distinct to shyness, we see this as an opportunity to leverage a deeper understanding of introversion

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to provide a more well-rounded view on the adaptiveness of shyness in contexts such as the modern workplace. We will also review some provisional evidence about the same adaptational processes that occur when extraverts adopt introverted behavior in their workplace.

Compared to introversion, shyness emerges predominantly from social anxiety, which is considered a difficult condition due to its tendency to manifest in negative thoughts such as fear of judgment (Miller, 2009). Introversion, on the other hand, is commonly known as one of the five traits within the five-factor personality inventory that consists of Extraversion, Agreeableness, Openness, Conscientiousness, and Neuroticism (McCrae & Costa, 1987). Introversion falls on the extreme of the introversion-extraversion spectrum and is associated with traits such as being quiet, reserved, and introspective. Indeed, in popular media, introverts are known for characteristics such as their need for alone time to recharge, their reflectiveness, and preference to listen carefully than speak up first (Cain, 2012).

The Current Climate for Introverts

In the last decade, a growing body of research has established clear links between the mutability of personality and consequences on well-being (Gallagher, Fleeson, & Hoyle, 2011; Jacques-Hamilton et al., 2018; Leikas & Ilmarinen, 2017; McNiel & Fleeson, 2006, 2010; Zelenski et al., 2012). Rooted in prominent theoretical frameworks such as free-trait theory (Little, Salmela-Aro, & Phillips, 2007) and density distributions theory (Fleeson, 2001), the majority of this research has used laboratory-based experimental methods to examine the short-term consequences of "acting out of character." Across the majority of these studies, researchers have focused on extraversion and found compelling causal evidence of the positive effects of acting extraverted for introverts. Yet, despite strong theoretical predictions, they have reported weaker evidence of the costs (Fleeson, Malanos, & Achille, 2002; McNiel & Fleeson, 2006, 2010; Zelenski et al., 2012). In recent years, the consistency of the finding that introverts report greater well-being (as measured by positive affect) when they invoke extraverted behavior across numerous studies has given rise to a larger debate as to whether enacting extraversion may, in fact, be a beneficial strategy for introverts who act extraverted less often (Smillie, 2013; Zelenski et al., 2012). This has particularly important practical implications in contexts such as the workplace, where the experience of positive affect could be advantageous and increase multiple outcomes in well-being, motivation, and performance (Wilmot, Wanberg, Kammeyer-Mueller, & Ones, 2019). However, recent findings have added a layer of complexity. Researchers have surfaced novel evidence of the delayed onset of the costs of acting extravertedly and the conditions in which costs manifest (Jacques-Hamilton et al., 2018; Leikas & Ilmarinen, 2017). This leads us to consider, in light of theoretical predictions and recent evidence, what are the dynamics of adapting to extraversion for introverts in the workplace? We can assess these dynamics in terms of the potential costs and benefits.

Although we acknowledge that research on acting out of character in the workplace is in early stages in personality science literature, we choose to examine the workplace for a number of reasons. First, the demands on introverts to be extraverted are likely to be amplified in the workplace. Across decades of research, extraversion has been related to numerous work outcomes (e.g., career success, career life span) and linked to specific motivations and attitudes (Wilmot et al., 2019). Extraverted behavior carries a powerful normative value in Western society (Little & Joseph, 2007) and is regularly deemed a socially desirable trait (Dunlop, 2015). In the popular press, Susan Cain recently argued that there is an "extrovert ideal" in Western society, based in the "omnipresent belief that the ideal self is gregarious, alpha and comfortable in the spotlight" (Cain, 2012, p. 3). Indeed, in Western contexts, individuals are socialized from an early age to view extraverted behaviors positively, which can manifest in biases in the design of classrooms to workplaces (Cain, 2012). For example, the open-plan office environment uses social prompts toward extraverted behavior by creating extensive opportunities for interaction during the workday (Cain, 2012).

Researchers have found that of the Big-Five traits, extraversion is the easiest to enact, even on demand (Leikas, Verkasalo, & Lonnqvist, 2013). Extraversion is also most easily inferred from visual cues (e.g., a smiling face) of the Big-Five traits (Borkenau & Liebler, 1992; Borkenau, Mauer, Riemann, Spinath, & Angleitner, 2004). Indeed, many individuals carry strong internal representations of extraversion and how to act extraverted, which further bolsters the ease of enacting extraverted behavior when demanded by a situation or a context (Semin & Krahe, 1987).

The need to examine the workplace additionally stems from the increasing value being placed on dynamism and agility in the modern organization. Individuals are much more likely to experience demands to flex and adjust their behaviors to novel situations and tasks (Huang, Ryan, Zabel, & Palmer, 2014). Jobs and career trajectories are no longer defined by clear-cut descriptions, and instead, many juggle more complex and multiple roles (Rothbard, 2001). Within such a context, many introverts may flourish, while others may experience increasing psychological strain in the face of a constant pressure on adaptiveness, which may translate into feeling drained and stressed, and costs for well-being and health. We, therefore, can draw on existing and novel evidence to form predictions of consequences and how they may translate into the workplace in terms of impact on emotional and physical well-being, as well as performance.

We recognize that in the context of this volume, although introversion and shyness are commonly interwoven and used interchangeably in popular language, shyness is conceptually and theoretically distinct from introversion (Briggs, 1988, Crozier, 1995). However, research has predominantly prioritized the introversion-extraversion spectrum, especially due to the media attention that introversion has received in recent years. We therefore base this review on the assumption that while shyness and introversion are distinct constructs, there may be parallels that add value to shyness. Aspects of extraverted behavior, such as assertiveness and intensive sociability, may be draining, albeit to different degrees, for both shy individuals and dispositional introverts. Shy individuals may share some common episodic

experiences to dispositional introverts, such as triggers of social discomfort in the workplace, from situations requiring assertive action and behavior, unstructured social settings such as networking events (D'Souza, Gowda, & Gowda, 2006), and evaluative contexts such as performance reviews (Russell, Cutrona, & Jones, 1986). Although we do not make definitive predictions for shyness, we hope to offer a perspective that has important implications and deepens an understanding of shyness in a daily context.

Theoretical Underpinnings of Acting Out of Character

Research on the consequences of acting "out of character" has drawn on several theoretically relevant models and arguments in the last decade. Many of these frameworks have propagated the benefits of acting in line with one's traits across different contexts. For example, the behavioral-concordance model posits that individuals are more likely to experience pleasant affect when engaged in trait-congruent behavior (Moskowitz & Côté, 1995). Specifically, this model assesses momentary behavior, that is, the pleasant and unpleasant affective states that arise from an interaction between traits and temporary behaviors (Côté & Moskowitz, 1998). For example, researchers find that disagreeable individuals report more pleasant affect when being disagreeable and more unpleasant affect when being agreeable (Côté & Moskowitz, 1998). From this perspective, introverts may experience more unpleasant affect when engaged in extraverted behavior at work. Similar to the behavioral-concordance model, the person-environment fit framework suggests that individuals are more likely to benefit from a fit between their personality characteristics and traits, as well as their environment (Lewin, 1935; Murray, 1938; Pervin, 1989). An underlying premise is that a congruence between individuals' personality characteristics and their environment results in fewer demands on personality (Roberts & Robins, 2004).

The trait-consistency hypothesis (Fleeson & Wilt, 2010) similarly posits the benefits of behaving in accordance with one's traits forms a sense of authenticity. This hypothesis suggests that individuals are most authentic when they are acting in line with their traits. Indeed, in recent years, researchers have explored the multifaceted nature of *subjective authenticity* that relates to one's true or core self (Kernis & Goldman, 2006). The behavioral component of subjective authenticity is concerned with whether an individual behaves "in accord with one's values, preferences and needs as opposed to acting 'falsely' merely to please others or to attain rewards" (Kernis & Goldman, 2006, p. 209). Research within authenticity has shown that behaving out of accordance with one's character could hinder one's overall social functioning and well-being, especially when in conflict with environmental norms (Kernis & Goldman, 2006). These theoretical postulations are particularly interesting in the context of the workplace where individuals may face daily demands to adapt and behave out of character, which, in turn, may impact their subjective authenticity if they view their behavior as deviating from their "true self."

These feelings of inauthenticity may also have an impact on well-being. Additionally, they may impact important career outcomes as inauthenticity is known to trigger both reputational confusion and imposter syndrome (Clance & Imes, 1978; Craik, 1993; Little et al., 2007).

While these theories and frameworks address the potential costs associated with a discordance or lack of consistency with one's traits, other perspectives suggest that acting "out of character" does not necessarily mean acting "against" one's character. Specifically, individuals may act out of character in service of goals and personal projects (Little et al., 2007; McCabe & Fleeson, 2012). Personal projects, for example, are "extended sets of personally salient action in context" (Little et al., 2007, p. 25) that both influence and are shaped by external phenomena in daily life. Personal projects can be wide-ranging in their breadth and content and range from daily concerns to meaningful lifelong projects. In light of the social and societal value of extraversion, personal projects are often explicitly centered on extraversion. For example, "be more extraverted" is often one of the most commonly listed personal projects, at least in North American contexts (Little & Joseph, 2007). Similarly, Hudson and Roberts (2014) report that more than three-quarters of participants who have low scores in extraversion listed a desire to increase their extraversion in their goals. These goals often involve the pursuit of being a leader, connecting with others, or trying to convey information more effectively (Heller, Komar, & Lee, 2007; McCabe & Fleeson, 2012).

A Free-Trait Perspective

Free-trait theory reconciles the perspective that behaving in accordance with one's traits can negatively impact individuals, but also that it can bring benefits (Little, 1996, 2000; Little et al., 2007). According to free-trait theory, when individuals pursue personal projects, they may act discrepantly in order to advance that project. This behavior involves adopting "free traits," which are "culturally scripted patterns of conduct that are carried out as part of a person's goals, personal projects, and commitments, independent of that person's 'natural inclinations'" (Little, 2000). For example, an individual may put on an extraverted show at work by engaging in free-trait extraversion (i.e., behave as a *pseudo-extravert*). This behavior may be in the pursuit of getting noticed by their manager or to fast-track their chances of getting promoted (Little et al., 2007). If pseudo-extraversion is successfully deployed and a personal project progresses, it may bring positive consequences such as a sense of accomplishment and well-being.

Although free-trait theory suggests that flexing extraversion may be beneficial and an attractive strategy in the pursuit of personal projects, a key tenet of this framework is that this conduct can, under certain conditions, entail psychological and psychological costs such as stress and emotional exhaustion. If introverts experience a protracted demand to engage in extraverted behavior and cannot nurture their first nature (i.e., their biological and physiologically based introversion), over

time, their pseudo-extraversion may turn costly. For example, over time, extraverted behavior can take the form of a chronic stressor that, as with any transitory or chronic stressor, depletes an individual's finite, adaptive energy and self-control resources (Baum, Singer, & Baum, 1982; Joseph, 2002). Any additional stress may act as a further drain on an individual's energy resources and leave an individual in a depleted state.

According to free-trait theory, however, when these costs are felt, they may be mitigated. If individuals have access to "restorative niches," it may allow them to restore their depletion and tiredness from acting out of character (Little et al., 2007). Restorative niches are places, spaces, activities, and states of mind that allow individuals to indulge in their first nature and be their natural selves (Little et al., 2007). While these will differ across individuals and be idiosyncratic in nature, they can also provide individuals with a form of a coping mechanism, both from the perspective of problem-focused and emotion-focused coping (Lazarus & Folkman, 1984). With the former, restorative niches provide individuals with a respite from the potential stress associated with acting out of character, and in the latter, reduce the emotional distress associated with acting out of character (Joseph, 2002). Therefore, for introverts who protractedly enact extraversion, they may benefit from restorative niches that allow them to lower their stimulation and reduce any stress or physiological impact from the sustained enactment of extraverted behavior (Little et al., 2007). While certain environments may present opportunities for restoration, others may require individuals to seek out ways of reducing the strain felt from acting out of character.

In sum, free-trait theory and related perspectives in personality science present a strong case for exploring the benefits and costs of extraverted behavior in daily life. Given the workplace setting is rife with situational and role demands and the pursuit of personal projects that involve trait extraversion, we now turn to examine the potential benefits and costs of extraverted behavior in the workplace, with a focus on dispositional introverts.

Benefits of Enacting Extraversion

An established and evidenced relation in personality science literature is the positive relation between trait extraversion and positive affect (Clark & Watson, 2008; Costa & McCrae, 1980). Intriguingly, researchers have discovered that the link between extraversion and positive affect holds at both trait and state levels. In other words, individuals who engage in momentary enactments of extraversion experience greater positive affect and feel happier as a result. Across numerous experience-sampling studies (ESM), individuals report feeling more positive affect after acting extraverted, irrespective of their level of trait extraversion (Gallagher et al., 2011; McNiel & Fleeson, 2006; McNiel, Lowman, & Fleeson, 2010; Zelenski et al., 2012). This phenomenon generalizes across cultures (Ching et al., 2014) and can manifest from momentary positive affect to enduring positive affect

(Wilt, Noftle, Fleeson, & Spain, 2012). These studies are grounded in a density distribution approach that assumes that introverts differ in their mean level of extraverted behavior, but can enact both introverted and extraverted states at a given moment. The frequency with which individuals enact these states creates a density distribution that forms a trait (Fleeson, 2001). The studies in question adopt a between-subjects study design in which participants are randomly assigned to "act introverted" (i.e., quiet, shy, and unadventurous) and "act extraverted" (i.e., bold, assertive, and adventurous) conditions. In these conditions, participants are required to comply with their acting instructions in short tasks, such as a group discussion or interview task. For example, Zelenski et al. (2012) used this approach to explore the effects of acting extraverted on affect and cognitive fatigue for dispositional introverts. Surprisingly, researchers found little evidence of the effects of acting extraverted on negative affect and cognitive performance. Instead, as with previous studies, they reported an increase in introverts' positive affect after acting extraverted. When researchers have probed this finding further, it appears that extraverted behavior mediates the relation between trait extraversion and trait positive affect (Wilt et al., 2012). In other words, both introverts and extraverts experience positive affect because of what extraverted behavior entails in action, i.e., what extraverts "do." These linkages would suggest that introverts experience positive affect when enacting aspects of extraverted behavior, such as being sociable in a group setting.

In the workplace, the positive affect associated with extraverted behavior can translate into a direct advantage for introverts. A recent meta-analysis revealed that extraverts are at an advantage in the workplace due to their tendency to experience greater positive affect. This advantage manifests in a number of outcomes, such as interpersonal skills, leadership emergence, performance, and emotional well-being (Wilmot et al., 2019). We would therefore expect that these advantages also manifest in benefits for introverts who engage in extraverted behavior.

First, as extraversion is characterized by interpersonal skills and fluency in social interactions and experiences, extraverts often receive more social attention (e.g., recognition, approval) than others (Ashton, Lee, & Paunonen, 2002). They also have higher ratings of the quality of friendships and rate their social experiences as more rewarding (Smillie, 2013; Wilson, Harris & Vazire, 2015). Introverts who successfully exhibit extraverted behavior may find themselves at an interpersonal advantage, both in terms of getting noticed by their colleagues and senior leaders and experiencing greater enjoyment from their social experiences such as with their colleagues over lunch. Indeed, recent evidence suggests that positive social experiences associated with extraverted behavior can explain its effect on positive affect (Smillie, Wilt, Kabbani, Garratt, & Revelle, 2015). Here, researchers found that both in laboratory-based studies and in daily life, differences in the quality of a social experience mediate the relation between trait extraversion and trait positive affect.

This behavior may, in turn, have the salutary effect of making them perform better at work (Wilmot et al., 2019) and be more likely to receive positive feedback and elicit more positive responses from co-workers, supervisors, and managers. It is

plausible that if introverts receive social reinforcement and reward for their behavior, it may serve to further amplify their feelings of positive affect and translate into other positive outcomes such as job satisfaction and a stronger motivation to achieve and drive their goals to fruition (Wilmot et al., 2019). Indeed, meta-analytic studies consistently report that trait extraversion is a predictor of job satisfaction due to extraverts' greater opportunities for socialization and more time spent in rewarding situations (Judge, Heller, & Mount, 2002).

Although there is mounting evidence of the link between extraverted behavior and positive affect, researchers offer alternative explanations for why introverts may experience a rise in positive affect from enacting extraverted. From a free-trait theory perspective, the experience of positive affect is partly due to project progression or achievement (Little et al., 2007; McCabe & Fleeson, 2012). For example, if an introvert enacts extraversion to push forward the progress of a personal project, such as connecting with their colleagues in a firm whose values are deeply aligned with their career aspirations, their ability to successfully enact extraversion may give them a sense of competence and self-esteem to the individual. Another perspective is that the positive affect that arises from engaging in extraversion protects individuals against the costs associated with having to stretch and adapt oneself (Wilmot et al., 2019; Zelenski et al., 2012). The positive affect from enacting extraverted may be enough to reduce the costs of adaptiveness for some, or, for others, act as a buffer until a delayed onset of the costs finally occurs.

At first glance, therefore, while the association between enacted extraversion and positive affect may seem clear-cut, it is clear that it is more complex. An important nuance here that runs across these perspectives is that while introverts experience positive affect when they engage in extraverted behavior, research suggests that introverts can underestimate or affectively "misforecast" the hedonic benefits of acting extraverted. Zelenski et al. (2013) reported that introverts tend to overestimate the unpleasantness that extraverted behavior will bring. In a workplace setting, this may result in tangible setbacks for introverts as research suggests that negative forecasting can lead to a lower likelihood that introverts emerge as leaders due to their lack of confidence around their ability to assert themselves (Spark, Stansmore, & O'Connor, 2018).

Enacting Extraversion and Career Success

Across numerous studies in organizational literature, extraversion has long been a predictor of performance and extrinsic success at work (e.g., performance, number of promotions) (Seibert & Kraimer, 2001). For example, researchers have reported compelling evidence of the positive association between extraversion and salary (Harrell & Alpert, 1989; Judge, Higgins, Thoresen, & Barrick, 1999; Melamed, 1996). Along with salary, extraversion is consistently reported to be a predictor of greater progression into leadership and managerial positions (Dunn, Mount, Barrick, & Ones, 1995; Judge, Ilies, Bono, & Gerhardt, 2002; Melamed, 1996; Rawls & Rawls, 1968).

Part of this faster progression lies in extraverts being rated as better performing and higher in perceptions of status and leadership potential (Bendersky & Shah, 2013; Judge, Ilies, et al., 2002). In fact, meta-analytic research has found that extraversion is associated with higher ratings of work performance across numerous ratings (e.g., supervisors, colleagues) and different types of performance (e.g., technical performance, contextual performance) (Wilmot et al., 2019). Researchers postulate that a large part of this advantage stems from the capacity of extraverts to be more proactive and take charge and influence others (Grant, Parker, & Collins, 2009). We draw on similarities to shyness here, which, similar to introversion, has been stereotyped to be a hindrance to career success, social capital, and relationships (Crozier, 2001). This is likely to be even more rampant in a work setting where shy adults may feel a similar pressure to introverts to engage in extraverted behaviors to both get along and get ahead.

In light of this evidence on extraversion, enacting extraversion may be an important career strategy for some introverts (and perhaps shy adults) who can successfully engage in extraverted behavior as pseudo-extraverts at work. These individuals may end up setting themselves for chances of greater success in receiving positive rewards such as promotions and higher performance ratings. Such rewards are likely to reinforce their behavior and lead introverts to be more likely to repeat their extraverted behavior in the future. However, when making this claim of the benefits of acting extraverted, there are additional factors to consider.

In today's challenging and dynamic work environments where individuals are co-located and navigate multiple roles and hierarchies, competencies around adaptiveness and flexibility are increasingly advantageous. In fact, some researchers have long posited the benefits of interpersonal flexibility for psychological adjustment and success (Leary, 1957), which may be even more pertinent today. Neighboring psychological constructs such as self-monitoring have heralded the benefits of this adaptiveness. In self-monitoring theory, researchers have found that high self-monitors (i.e., those who adapt their behavior to a situation/role or context) progress through an organization at a faster rate and are more likely to receive promotions than low self-monitors (Kilduff & Day, 1994). While high and low self-monitors may not differ in their performance on specific tasks, high self-monitors tend to perform better when it is related to "contextual performance." Contextual performance refers to individuals who are successful in adapting to their roles and environments and being more central to information networks (Kilduff & Day, 1994). Within the workplace, contextual performance is arguably an increasingly important competency. One may therefore expect that introverts who are able to flex their behavior and be agile across different works may have a unique interpersonal and leadership advantage, even compared to "real" extraverts.

This is especially true in light of a mounting evidence that while extraversion is associated with leadership emergence, it is not necessarily related to leadership effectiveness (Ames & Flynn, 2007; Bendersky & Shah, 2013; Grant, Gino, & Hofmann, 2011; Judge, Woolf, & Hurst, 2009). Indeed, researchers in organizational and personality literature have identified new boundary conditions of the association between extraversion and leadership. For example, Martin, Liao, and

Campbell (2013) reported that while a directive, assertive leadership style can enhance proactive behaviors in individuals who exhibit satisfaction with their leaders, empowering leadership, which is much less directive and "extraverted," is more important for boosting the proactivity of those who are less satisfied with their leaders. Grant et al. (2011) similarly reported that introverted leadership is, at times, more efficacious than extraverted leadership, especially for employees who are proactive. Extraverted leaders are more likely to attempt to assert their dominance over proactive employees rather than incorporate their input (Grant et al., 2011). In fact, even in professions that may favor extraverts such as sales, individuals who are able to balance the strength of both introversion and extraversion are more successful due to their ability to adopt the "best of both worlds" (Grant, 2013).

Within organizational literature and the popular media, the tide is slowly turning. The traits associated with introversion are increasingly been recognized as assets to the modern workplace in both psychological literature and the popular press (Cain, 2012). While the strengths of extraversion can be advantageous in the workplace and a bias toward extraversion still exists, whether it be the value of assertiveness, sociability, and making quick decisions, the strengths associated with introversion, including the ability to listen carefully and receptivity to input and feedback, are increasingly important (Grant et al., 2011). Individuals who behave pseudo-extravertedly may therefore find it advantageous to enact extraverted behavior but be cautious not to overriding the strengths of their natural tendencies and stay behaviorally agile.

The Costliness of Enacting Extraversion

Despite the strong theoretical underpinnings and plausibility of claims of the cost of enacting extraversion, until recently, experimental studies have largely failed to surface evidence that enacting extraversion can impact tiredness or increase negative affect in introverts. Instead, researchers have uncovered the positive association with enacting extraversion across numerous studies, and even surfaced the costs for extraverts. Intriguingly, Zelenski et al. (2012) reported that while introverts experienced an increase in positive affect from acting out of character, it was extraverts who reported greater negative affect and exhibited poorer cognitive performance after being instructed to act introverted. Gallagher et al. (2011) corroborated these asymmetrical findings between introverts and extraverts and reported that extraverts often find it more effortful to engage in "contra-trait behavior" and often lose the motivation to maintain this behavior compared to introverts. In our own research, we found initial evidence that while introverted employees did not experience any impact of extraverted behavior on their well-being (as measured by positive affect, emotional exhaustion, and turnover intentions), at a junior level, extraverted employees who were required to engage in introverted behavior reported higher emotional exhaustion.

This asymmetrical evidence has been particularly surprising, both in the face of theoretical predictions and in light of theories from adjacent disciplines such as emotion regulation that has found strong evidence of the psychological costs of suppressing or feigning emotions for individuals. Although theoretically distinct to acting out of character, suppressing and feigning one's emotions as in emotion regulation involves similar regulatory mechanisms as acting out of one's natural traits and behavior. In fact, considerable research on emotion regulation has reported that people instructed to suppress their emotional expression perform worse on self-regulatory tasks than those who can act in accordance with their natural traits (Goldberg & Grandey, 2007). Additionally, research finds that introverts struggle more with feigning emotions than extraverts and find it more challenging and less rewarding in the workplace (Chi, Grandey, Diamond, & Krimmel, 2011; Judge et al., 2009). Taken together, this growing body of research raises new questions as to whether there are in fact costs for introverts who act out of character.

Recent studies have shed important light on this question. A study examining free-trait theory found initial evidence that introverts only experience the costs of acting extraverted on well-being when the behavior is of a protracted or long-term nature, and when they are already experiencing stress (Little & Joseph, 2007). Delving deeper, research has focused less on defining the temporal aspects of what constitutes protracted; however, this evidence offers a plausible explanation for why previous studies fail to surface the costs for introverts. As laboratory-based studies assess momentary changes in extraversion, they may not be long enough in duration for the costs of engaging in extraversion to manifest into actual consequences. In the context of the workplace, this has important implications. Individuals who pursue long-term personal projects that involve extraverted behavior may be at a disadvantage to those who engage in short-term projects, even if they involve intense bouts of enacting extraverted behavior such as sociability or assertiveness. For example, the project to "be more extraverted" at work is perhaps more draining and stress-inducing than short-term projects that demand extraversion such as "give a strong presentation" or "network effectively." "Be more extraverted" falls into the category of an "intrapersonal project," which in personal project literature has been associated with a range of negative outcomes (Little, 1989, 1996; Salmela-Aro, 1992). Past research has found that individuals who pursue intrapersonal projects experience a lower sense of control; lower likelihood of success; and more stress, anxiety, and difficulty in their project pursuit (Little et al., 2007). Introverts particularly are less efficacious in their intrapersonal project pursuit than extraverts, partly because they may lack the necessary behaviors (e.g., assertiveness) for their completion (Little et al., 2007).

Given the close relation between well-being and performance, we may expect that engaging in extraverted behavior over long periods of time for project pursuit may increase both tiredness and stress, which may spill over into a negative impact on work performance. Stress at work may be a critical factor here—if pseudo-extraversion interacts with additional, existing job stress, it may give rise to detrimental consequences for emotional and physical well-being. In the context of the workplace, this raises an important risk factor for introverts who engage in extraverted behavior.

Research in organizational psychology has frequently found that modern organizations are sources of acute and chronic job stressors that cut across various categories, from task-related stressors (workload, time pressure, etc.) to role and job stressors (e.g., job insecurity), to stressful change processes (e.g., restructuring, mergers and acquisitions (M&A)), and social stressors (e.g., team dynamics) (Sonnentag & Frese, 2012). We can expect that the reality of the risk is even greater for shy adults, whose experience of social anxiety partly underscores shyness.

Indeed, this tenet is indirectly supported by Jacques-Hamilton et al. (2018) who recently reported that the benefits of enacting extraversion for introverts are dependent on the level of introversion. In this study, introverted individuals were instructed to behave extraverted (i.e., "act in a bold, talkative, outgoing, active and assertive way") over a period of 1 week. They then completed measures of affect, authenticity, and tiredness. As with previous studies, acting extraverted increased positive affect and feelings of authenticity for both dispositional introverts and extraverts. Significantly, individuals with average levels of trait extraversion found it beneficial to act extraverted in their daily life, but introverts who were at the extreme end of the introversion spectrum experienced tangible costs in terms of increased negative affect, tiredness, and feelings of inauthenticity.

Researchers also found that introverted individuals reported retrospective tiredness and negative affect. This finding supports the view that often introverts may experience the costs of tiredness, but in the form of a delayed onset, once the positive feelings from acting extraverted dissipate. Additional research bolsters this finding that introverts do experience tiredness, but after a 3-h delay (Leikas & Ilmarinen, 2017). This provides support for the free-trait tenet that introverts can restore their depletion and tiredness through alleviating their overstimulation and allowing them to indulge their introverted nature.

Practical Implications of Adaptiveness

The above findings have particularly important implications in the workplace, where work environments may differ considerably in the degree to which they afford restoration. Some work environments may unknowingly constrict introverts' access to restoration (e.g., offices without doors that close), while others may provide ample opportunities for introverts to combat the strain of acting out character in the form of quiet spaces, or even a meeting room that can be booked, and allow introverts to recharge in solitude. The importance of restorative niches in the workplace has been recently advocated in empirical and popular press (Cain, 2012; Little, 2005; Little & Joseph, 2007).

In other cases, it may be less about the environment but more about the comfort in the knowledge that they have agency and autonomy in choosing their form of recovery. For example, a recent study on resource recovery found that individuals' degree of autonomy during the lunch break determined the extent to which social and relaxing activities reduced fatigue (Trougakos, Hideg, Cheng, & Beal, 2013).

Researchers found that when *integrative choice* was high (i.e., having the autonomy to choose to go to lunch with colleagues), engaging in social activities during the lunch break reduced fatigue. However, when *identified choice* was high (i.e., having low autonomy in decision-making), having social activities impeded recovery by increasing fatigue. It is plausible that a large proportion of fatigued individuals with low integrative choice were introverts who were overstimulated by engaging in social activities during the lunch break. These introverts would be much more likely to recover if they engaged in activities that served to reduce their stimulation, such as relaxation or access to a quiet room.

Along with agency, individuals may also benefit from a positive, supportive, organizational climate. Although this research does not specifically examine introversion or extraversion, research on emotional regulation has found that employees who report a "climate of authenticity" at work, and are able to express their real emotions when interacting with co-workers, experience less burnout from emotional labor (Grandey, 2000). From a self-regulation viewpoint, being able to express themselves naturally affords a self-regulatory break from monitoring their emotions. Further supporting this notion, studies have found that perceptions of the organization climate as supportive and prosocial can compensate for a lack of self-regulatory resources (Cropanzano, Howes, Grandey & Toth, 1997; Muraven & Slessareva, 2003). Although there is a lack of empirical research on acting out of character for introverts, these findings allow us to draw important implications of the need to reduce the risks of introverts who enact extraversion, make room for the benefits, and mitigate the costs when they occur.

Future Directions

It is evident that research on the adaptiveness of extraversion in the workplace is complex. While there is a strong empirical reason to believe that it is likely to be a beneficial career strategy, it carries equal risks and poses a potential threat to introverts' well-being and performance at work. Factors such as stress, the duration and longevity of extraverted behavior, and the level of introversion can compound this risk and strain, while others, such as positive affect and restorative niches, may protect and mitigate.

We are looking toward a new and exciting direction of research with a focus on adaptiveness. As researchers continue to explore the dynamics of acting out of character and how they play out in daily lives, there will be a number of opportunities for future research; for example, longitudinal studies that identify at which point in "protractedness" a cost to well-being or performance at work may manifest. Researchers could also consider integrating a mixed-methods approach to existing experience-sampling methods by conducting observational studies in the workplace using co-workers and supervisors as observers (Judge, Klinger, Simon, & Yang, 2008). An observational method would be particularly useful for measuring enacted extraversion to triangulate with a survey format. In addition, researchers could

expand the scope to different work environments and industries, to identify the change in impact across organizations with stronger or weaker demands and pressures on individuals to be extraverted, as well as the access and freedom to restorative niches that may mitigate them. In so doing, we hope this research provides a stepping stone for multiple avenues of examination of both introversion and shyness.

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Part V
Cultural Perspectives

Shyness and Adaptation Across Cultures

Wai Ying Vivien Yiu, Jung Hwa Choi, and Xinyin Chen

Introduction

Developmental theorists and researchers have long believed that peer interactions constitute an important social context for children to learn various skills and appropriate behaviors that are necessary for achieving success and socioemotional adjustment (Hartup, 1992; Rubin, Bukowski, & Bowker, 2015). The activities during peer interactions provide opportunities for children to develop social-cognitive abilities, such as perspective-taking and organization of strategies to solve interpersonal disputes (e.g., Piaget, 1932). Peer interactions also help children understand social standards and expectations and display self-regulatory behaviors in social settings. Moreover, social relationships formed and maintained through peer interactions are conducive to the attainment of feelings of affiliation and belongingness, which may serve to reduce psychological distress, such as loneliness and depression (Rubin et al., 2015; Sullivan, 1953). Given this background, it is reasonable to argue that children who withdraw from peer interactions, due to social fear and anxiety, a lack of social interest, or other reasons, are likely to be at risk for developing social and psychological problems (Coplan & Weeks, 2010; Rubin, Coplan, & Bowker, 2009).

As a major type of social withdrawal, shyness in childhood and adolescence has received much attention from researchers in the past several decades (e.g., Asendorpf, 1993; Coplan, Prakash, O'neil, & Armer, 2004; Schmidt & Buss, 2010). Findings of studies in North American and West European societies have shown that shyness is associated with, and predictive of, low social status (Bohlin, Hagekull, & Andersson, 2005; Rydell, Bohlin, & Thorell, 2005), peer victimization (Buhs, Rudasill, Kalutskaya, & Griese, 2015; Dill, Vernberg, Fonagy, Twemlow, & Gamm, 2004), academic underachievement (Hughes & Coplan, 2010), and internalizing problems (Eggum-Wilkens, Valiente, Swanson, &

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Lemery-Chalfant, 2014; Nelson et al., 2008; Sette, Zava, Baumgartner, Baiocco, & Coplan, 2017). However, cultural norms and values are likely to affect social perceptions and evaluations of shy behavior. As a result, culture may play a significant role in shaping the display and development of shyness and determine, in part, its relations with adjustment outcomes.

The focus on this chapter is on shyness and adaptation among children and adolescents in different cultures, especially Western and Eastern cultures. We first discuss some conceptual issues, such as those concerning the constructs of shyness and related behaviors. Then, we review research on social attitudes of parents and peers toward shyness in different societies, followed by a section on the role of culture in affecting the relations between shyness and adjustment. During the discussion, we pay particular attention to the implications of macro-level social changes and associated individual acculturation processes. The chapter concludes with some suggestions for future research.

Shyness and Related Constructs

Social withdrawal refers to the process in which individuals remove themselves from opportunities for social interactions and frequently display solitary behaviors in social contexts (Rubin et al., 2009). As a type of social withdrawal, shyness is concerned with wariness, unease, vigilance, and self-consciousness in contexts of social novelty or perceived social evaluation (Crozier, 1995). According to Asendorpf (1991), shyness represents a personality trait that derives from an internal conflict of approach and avoidance motivations in social interactions. Shy children often have the desire to interact with others and demonstrate interest in social activities. However, their approach motivation is hindered by a high level of fear and anxiety in the face of novel or challenging situations (Coplan & Armer, 2007).

Shyness is distinct from some other forms of social withdrawal, such as unsociability or social disinterest. Whereas shyness reflects a combination of conflictual social approach and social avoidance motivations, unsociability is driven by a low approach motivation to interact with others (Asendorpf, 1990; Coplan & Armer, 2007). Unlike shy children who display anxious and fearful feelings in challenging social situations, unsociable children often express a nonfearful preference for solitude (Coplan et al., 2013; Coplan, Ooi, & Baldwin, 2019; Goossens, 2013). The conceptual differentiation between shyness and other forms of social withdrawal, particularly unsociability, has important implications for cross-cultural research. In Western individualistic societies, unsociability or social disinterest may be considered an expression of personal choice, autonomy, or a self-oriented action, and therefore may be associated with less maladaptive outcomes than shyness (e.g., Larson, 1997; Leary, Herbst, & McCrary, 2003; Liu et al., 2015). In some group-oriented cultures such as the traditional Chinese culture, however, shyness appears to be relatively benign and acceptable, but unsociability is regarded as

anti-collective, selfish, and problematic and is thus related to heightened socioemotional difficulties (e.g., Chen, Wang, & Cao, 2011).

Compared with unsociability, behavioral inhibition seems to be more conceptually and empirically linked with shyness. Behavioral inhibition refers to a dispositional trait of temperamental reactivity to unfamiliar social and nonsocial situations in early childhood (Fox, Henderson, Marshall, Nichols, & Ghera, 2005; Kagan, 1998; Stevenson-Hinde, Shouldice, & Chicot, 2011). When presented with novel stimuli, infants who show high behavioral inhibition tend to be physiologically reactive and exhibit a high level of negative affect such as distress, fear, and crying (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001; Garcia-Coll, Kagan, & Reznick, 1984). Inhibited toddlers are hesitant to approach a stranger, retreat from unfamiliar objects, and engage in little vocalization during free play in unfamiliar places. They are also likely to display reticent behaviors in peer groups (Coplan et al., 2004; Coplan, Rubin, Fox, Calkins, & Stewart, 1994). For example, inhibited toddlers tend to observe their peers' play activities without joining (i.e., onlooking behavior). From a developmental perspective, behavioral inhibition is considered an antecedent of children's anxiety-based shyness in reaction to novel objects or social circumstances (e.g., Asendorpf, 1991; Coplan & Armer, 2007; Rubin et al., 2009). Relative to behavioral inhibition, shyness may be more susceptible to cultural influence because the emergence of shyness is more closely related to the social interaction context (Chen, 2018).

Researchers have proposed other constructs focusing on relatively adaptive aspects of shyness, including positive shyness (Colonnesi, Bögels, de Vente, & Majdandžic, 2013; Colonnesi, Napoleone, & Bögels, 2014) and regulated shyness (Xu, Farver, Chang, Zhang, & Yu, 2007; Xu, Farver, Yu, & Zhang, 2009; Xu & Krieg, 2014). Positive shyness, suggested by Colonnesi et al. (2014), refers to the positive expression of shyness during infancy (i.e., coy smile) as a way to regulate emotions in anxiety-provoking situations. Positive shyness may serve an adaptive function in regulating fear and arousal, which in turn may enhance prosociality and trust (Colonnesi et al., 2013; Reddy, 2000, 2005; see also Chap. 3 this volume). Xu et al. (2007) introduced a concept of regulated shyness, which is characterized by nonassertive and unassuming shy behaviors (e.g., "someone who does not show off," "someone who behaves modestly") that are associated with self-control and social restraint. Regulated shyness is differentiated from anxious shy behaviors, in that children who exhibit regulated shyness do not avoid social contact (Xu & Farver, 2009; see also Chap. 12 this volume). Given the nonassertive nature of regulated shyness, which reflects a child's desire to fit in with the group (Leary & Buckley, 2001; Xu et al., 2007), regulated shyness is consistent with group-oriented values that are emphasized in traditional Chinese culture and is shown to be related to peer acceptance in Chinese children (Xu et al., 2007). Cross-cultural research on shyness-related constructs, including positive shyness and regulated shyness, is limited. It will be interesting to explore their meanings and functions in different cultures.

The Biology of Shyness

Children's shyness is associated with various biological processes. For example, biological studies in Western samples have revealed a link between heart period (the interval between heartbeats or one cardiac cycle) and shyness. Inhibited children exhibited shorter heart period (i.e., faster heart rate) in response to unfamiliarity than uninhibited children (Garcia-Coll et al., 1984; Henderson, Marshall, Fox, & Rubin, 2004). Although comprehensive research on biological correlates of shyness has been conducted with Western samples, little cross-cultural comparative studies on the biology of shyness have been conducted (Khan, Schmidt, & Chen, 2017). Xu et al. (2009) examined biological reactions of shy Chinese elementary school-age children and found that when exposed to an interaction with an unfamiliar adult, shy children displayed shorter heart periods (i.e., higher heart rates) than non-shy children. This exploratory study suggests that shyness involves a similar process of autonomic nervous system in both Western and Chinese societies.

Research conducted in Western societies has revealed that the serotonin transporter genetic polymorphisms are associated with shyness (e.g., Fox et al., 2005; Lesch et al., 1996). Despite mixed results (Munafo et al., 2003; Schmidt, Fox, Rubin, Hu, & Hamer, 2002), in general, individuals who carry short alleles of the 5HTT-linked polymorphism (5-HTTLPR) tend to exhibit more fearful and anxious reactivity in response to unfamiliarity than individuals who carry long alleles of 5-HTTLPR. However, a recent study showed that the long allele of the 5-HTTLPR gene was related to behavioral inhibition among Chinese children (Chen et al., 2014). In this study, children with the long allele of the 5-HTTLPR exhibited more inhibited behaviors in the unfamiliar situation than children with the short allele of the 5-HTTLPR. This pattern was different from most of the results in Western children. Several studies have shown differences in the relative frequencies of the 5-HTTLPR alleles between East Asian and Western individuals; higher proportions of Chinese and Japanese people carried the short allele compared to Western people (Kumakiri et al., 1999; Nakamura et al., 1997; Tsai, Hong, & Cheng, 2002). Chen and colleagues' (2014) study indicated not only the differences in relative frequencies of the 5-HTTLPR alleles but also different relations between the short allele of the 5-HTTLPR and behavioral inhibition. The results seem to suggest that cultural contexts may play a role in regulating the processes underlining the links between biological factors and behavioral inhibition. Further research is needed to clarify the issue.

Cultural Values and Meanings of Shyness

Researchers have explored the meaning of shyness in different cultures, mostly through the assessment of individual perceptions and beliefs using self-report methods (e.g., Rubin, Nelson, Hastings, & Asendorpf, 1999). Weisz, Suwanlert,

Chaiyasit, Weiss, and Jackson (1991) asked parents and teachers in Thailand and the United States to make judgments about children who displayed overcontrolled behaviors, including shyness and fear. The results showed that Thai parents and teachers rated behavioral problems less serious and less worrisome than their US counterparts. Weisz and colleagues argued that Thai adults may tolerate broad variations in child behaviors, which is related to the values of avoiding strong emotional reactions in Thai Buddhism.

A method that is more commonly used in the study of cultural meanings is examining individual responses to hypothetical vignettes describing shy behavior (e.g., Cheah & Rubin, 2004; Coplan, Girardi, Findlay, & Frohlick, 2007). In a study of cultural norms and social anxiety, Heinrichs et al. (2006), for example, presented to participants several vignettes involving socially withdrawn behavior and asked them to provide judgments about how appropriate the behavior was in their culture. The results showed that socially withdrawn behavior was more accepted in collectivistic societies (Japan, Korea, and Spain) than in individualistic societies (Australia, Canada, Germany, the Netherlands, and USA). A similar method was used in other cross-cultural studies (e.g., Bowker, Ojo, & Bowker, 2016; Cheah & Rubin, 2003) in which adults or youth were asked to respond to vignettes portraying a child being withdrawn among peers (e.g., standing alone and not playing at preschool). The results of these studies were often mixed in terms of cultural differences and similarities.

Based on Heinrichs et al.'s study (2006), Rapee et al. (2011) further explored cultural meanings of shyness in East Asian and Western cultures by asking youth to report their expected social impact of the behavior. Specifically, after the vignette was presented, the participants rated the extent to which they would expect the person in the vignette to be socially liked and to succeed in their careers (e.g., future relationships with colleagues and bosses). The study showed that Western youth viewed shy behavior as clearly less desirable than outgoing behavior. However, youths in East Asian countries, including China, Japan, and Korea, viewed them as less different, which suggested that youth in East Asia were more accepting of shy behavior than youth in the West.

Chen and colleagues (e.g., Chen, 2012, in press) argued that cultural meanings of shyness may be examined from a contextual-developmental perspective. According to this perspective, cultural influence on individual behaviors or behavioral characteristics is an interactive process that is mediated by mutual evaluations and responses in social activities. In such processes, culture provides guidance for interpreting and evaluating individual behaviors (Benedict, 1934; Chen & French, 2008). During social interactions, socialization agents, such as parents and peers, evaluate children's behaviors according to cultural expectations, norms, and values, and express acceptance, approval, or rejection toward children who display these behaviors. Adults' and peers' evaluations and responses in turn promote or suppress the development of behaviors. Children also play an active role in endorsing, transforming, and constructing cultural norms and values in their interaction with adults and peers. In the following sections, we focus on how shyness is evaluated and responded by parents and peers in different cultural contexts.

Parental Attitudes Toward Shyness

Parental beliefs and socialization practices are likely to reflect cultural influences on children's development and adjustment (e.g., Super & Harkness, 1986; Whiting & Edwards, 1988). Parents in different societies prescribe to different cultural norms and value systems. During child development, parents hold different socialization goals and express different culturally guided judgments and responses toward children's behaviors. In Western societies, parents' socialization goals focus on individual autonomy, competitiveness, and self-expression (Maccoby & Martin, 1983; Marjoribanks, 1994). In contrast, many non-Western societies place a strong emphasis on group-oriented values. Achieving and maintaining group harmony is a primary concern in many Asian societies, where individuals are expected to restrain personal desires and control expression of emotions. Parents in these societies may display positive attitudes toward children's shy behavior (e.g., Chen, 2010).

Findings from research with parents and children in Western societies have consistently indicated that shyness is viewed as socially immature, incompetent, and maladaptive (e.g., Rubin, Burgess, & Coplan, 2002) and is related to parental disappointment, concern, embarrassment, and rejection (e.g., Kyrios & Prior, 1990; Tani, Ponti, & Smorti, 2014; van Zalk, van Zalk, & Kerr, 2011). Low parental approval and acceptance of children's shyness in Western societies are manifested in parents' use of high-power socialization strategies in response to shyness (e.g., Rubin et al., 1999). Parents of shy children are found to be overprotective, intrusive, and controlling of their children's behaviors, such as taking over and telling the child what to do (e.g., Hane, Cheah, Rubin, & Fox, 2008; Miller, Tserakhava, & Miller, 2011). In a longitudinal project with a Canadian sample, Hastings and Rubin (1999) examined toddlers' inhibition through observation and assessed mothers' reported socialization strategies in reaction to children's social withdrawal. The results indicated that toddlerhood behavioral inhibition predicted parent-reported directiveness and overcontrol in later years, suggesting that parents attempted to change toddlers' inhibition through redirection of their children's behavior in a power-assertive fashion.

Differences in attitudes toward shyness between Chinese parents and North American parents have been reported in a series of cross-cultural studies (e.g., Chen, Dong, & Zhou, 1997; Rubin et al., 2006). In traditional Chinese culture, children's vigilance and wariness are considered virtuous qualities that may indicate maturity and accomplishment (Chen, 2010). Children who are shy are likely perceived as well-behaved because behavioral restraint and submission that they display may contribute to group functioning (e.g., Ho, 1986). In an observational study using the Behavioral Inhibition Paradigm (Garcia-Coll et al., 1984), Chen et al. (1998) examined the relations between maternal attitudes and toddlers' behavioral inhibition. Chinese mothers and Canadian mothers completed a measure of child-rearing attitudes that assessed their acceptance, rejection, and punishment orientation. Toddlers were observed for their reluctance to approach a stranger and to explore new toys. The results showed that Canadian mothers expressed higher levels of rejection and punishment toward child inhibition, compared to Chinese mothers, who showed higher levels of acceptance of child inhibition.

Research with Latino parents suggested that children's shyness also tended to be related to positive parental attitudes. For example, Varela, Sanchez-Sosa, Biggs, and Luis (2009) found that in Latino families, children's shyness was positively associated with maternal warmth and negatively associated with paternal power assertion and hostile control. Other cross-cultural empirical findings showed that shyness, across different developmental periods, was perceived as less problematic in Asian societies, such as Korea and Thailand, than in North American societies (e.g., Kim, Rapee, Oh, & Moon, 2008; Weisz et al., 1991).

Peer Attitudes Toward Shyness

Peers are important socialization agents whose attitudes toward shyness may vary across cultures (Chen & Schmidt, 2015). In social interactions, peers may demonstrate acceptance or rejection in reaction to specific individual temperament and personality characteristics and behaviors (Chen, 2018). In Western societies, shy children tend to experience peer rejection and isolation (e.g., Rubin et al., 2009). As peers exclude them from social activities, shy children begin to actively withdraw from peer interactions and develop social anxiety and other internalizing problems (Burgess, Wojslawowicz, Rubin, Rose-Krasnor, & Booth-LaForce, 2006; Gazelle & Ladd, 2003; Harrist, Zaia, Bates, Dodge, & Pettit, 1997; Zakriski & Coie, 1996).

Relative to the negative attitudes expressed by peers in Western societies, peer attitudes toward shyness in Asian countries were found to be more positive (e.g., Chen, Rubin, & Li, 1995). For example, Chen, DeSouza, Chen, and Wang (2006) conducted a cross-cultural study of peer interactions among 4-year-olds in China and Canada, and found that social interactions initiated by shy children resulted in different peer reactions in different cultural environments. Specifically, when shy children in Canada initiated social interactions, their peers tended to express overt rejection, disagreement, and intentional ignoring of the initiation. However, in China, peers showed more positive responses and support, such as compliance and cooperation. As Chen et al. (2006) indicated, peers in Canada perceived passive and shy behavior as an indication of incompetence, whereas in China, peers perceived shyness as an appropriate indication of a desire for social interaction. Similar positive peer attitudes toward shyness have been reported in studies conducted in other Asian societies. For example, Rapee and colleagues (Heinrichs et al., 2006; Rapee et al., 2011) found that, compared to youth in Western countries, youth in East Asian countries were more approving of shy and unassertive behaviors.

The Display of Shyness Across Cultures

Cultural norms and values provide guidance for individuals to express certain temperamental characteristics (Chen, 2018). According to Rothbart and Bates (2006), individual experiences in socialization and social interaction may

reinforce or inhibit the display of certain characteristics. Cross-cultural studies have shown that children and adolescents in different societies differ in their display of shyness and related behaviors. For example, according to parental reports, East Asian children were rated as more shy and fearful in stressful settings and less likely to approach unfamiliar situations compared with their Western counterparts (Gartstein et al., 2006; Porter et al., 2005). Studies that examined peer-nominated shyness (e.g., Chen & Tse, 2008) showed that among Canadian-born children, Chinese Canadian children scored higher than European Canadian children on shyness-related traits.

Results of parental and peer reports were consistent with those from observational studies. Compared with European American children, Korean American children displayed more shy behavior and fewer self-expressive behaviors in preschool settings (e.g., Farver, Kim, & Lee, 1995). Asian and Western children also differed on reactivity in toddlerhood and the preschool years. For example, Rubin et al. (2006) observed Chinese, Korean, Australian, Canadian, and Italian toddlers in novel laboratory settings and found that Chinese and Korean toddlers exhibited more fearful and anxious reactions than Western toddlers. Specifically, Asian toddlers remained close to their mothers during free play sessions and were more reluctant to explore the novel environment. When a female stranger entered the room, Asian toddlers waited longer to approach the stranger and to touch the toys when they were invited to do so.

There are different views about shyness in Latino children. For example, Polo and López (2009) argued that cultural values such as social connectedness and group orientation are emphasized in Latino societies as in many East Asian societies, which may enhance children's self-consciousness, concerns with social evaluations, and sensitivity in social situations. On the other hand, some scholars (e.g., Schreier et al., 2010) argued that Latino societies promote values such as sociability, self-expression, and discouragement of criticism and rejection, which may help reduce children's reactivity in social settings. Existing results (Gudino & Lau, 2010; Polo & López, 2009; Varela et al., 2004) tend to support Polo and López (2009)'s argument, but more studies need to be conducted on this issue.

Shyness and Adaptive Development: The Role of Cultural Context

Cultural contexts may exert influence on the manifestation of temperamental traits as well as their functional meanings in development, which may be indicated by their relations with adjustment outcomes. In societies where assertiveness and self-expression are valued and encouraged, shy behavior is likely to contribute to the development of adjustment problems. However, in societies where individualistic values are not emphasized, shy behavior may be associated with more positive outcomes or less negative outcomes.

Relations Between Shyness and Adjustment

Cross-cultural variations in the relations between shyness and adjustment outcomes have been reported in the literature. In Western societies, shyness has been consistently found to be associated with difficulties in social relationships (e.g., Asendorpf, Denissen, & van Aken, 2008; Coplan et al., 2004; Rydell et al., 2005), learning problems (e.g., Crozier & Hostettler, 2003; Hughes & Coplan, 2010), negative self-perceptions of social competencies and general self-worth, and other internalizing problems (Boivin, Hymel, & Bukowski, 1995; Findlay, Coplan, & Bowker, 2009; Gazelle & Rudolph, 2004; Prior, Smart, Sanson, & Oberklaid, 2000). The associations are both concurrent and longitudinal, suggesting that shy behavior may lead to social and psychological problems in a short period and have enduring undesirable effects on adjustment in Western societies. Interestingly, in a Swedish sample, shyness has been linked with negative outcomes, but the associations were weaker, compared with the findings in the United States (Kerr, Lambert, & Bem, 1996). The difference may be due to the relatively egalitarian values in Sweden, which may make shy youth and non-shy youth less different in their life adjustment (Kerr et al., 1996).

On the other hand, studies conducted in China have provided evidence for adaptive significance of shyness. The results of these studies showed that shyness was positively associated with indexes of social, emotional, and school adjustment (e.g., Chen et al., 2011; Chen, Rubin, & Sun, 1992). Shy children in China not only gained peer approval, but also succeeded academically and were perceived as competent by teachers (Chen et al., 1995). In addition, shy children were more likely than non-shy children to acquire leadership status and the award of distinguished studentship. In terms of psychological adjustment, shy children rated themselves low on loneliness or depression. The positive relations between shyness and children's adjustment are also found in longitudinal studies, which showed that childhood shyness predicted social competence, academic achievement, and psychological well-being in adolescence (e.g., Chen, Rubin, Li, & Li, 1999). Taken together, these results suggest that whereas cultural disapproval of shyness may impede children's development of well-being, cultural endorsement of shyness may help shy children develop positive adjustment outcomes.

As we mentioned earlier, shyness is different from other aspects of social withdrawal, such as social solitude, unsociability, and social disinterest (e.g., "Kids who would rather be alone"; Coplan et al., 2004). According to Asendorpf (1990), unsociability is driven by a low approach motivation. Unlike shy children who may be accepted by others and adjust well, unsociable children, who are not motivated to engage in social interactions, are often regarded as anti-collective and experience adjustment problems in China. This argument has been supported by findings of some studies in Chinese samples (e.g., Liu et al., 2014). In addition, Xu and colleagues have investigated the functional meaning of regulated shyness in Chinese and other non-Western societies. The results suggested that regulated shyness was associated with more positive outcomes in a sample of Chinese children (Xu et al., 2007) and Turkish

children (Özdemir, Cheah, & Coplan, 2015). These results may be attributed to the cultural endorsement of unassuming behaviors that are thought to promote social harmony because unassertiveness is perceived to demonstrate a desire to fit in with the larger group. What is unclear is how regulated shyness is associated with adjustment in Western societies. Researchers should study relations between regulated shyness and adjustment outcomes in Western children and adolescents to better understand its adaptive meaning across cultures.

Social Change, Acculturation, and Shyness

According to the socioecological perspectives (e.g., Bronfenbrenner & Morris, 2006; Greenfield, 2009; Kağıtçıbaşı, 2012), macro-level changing contexts are likely to affect the beliefs, attitudes, and behaviors of children and parents. As many traditional agricultural societies become industrialized and urbanized, the requirements of competitiveness and initiative-taking in commercial and other social activities may result in a greater endorsement of individual independence and autonomy. Accordingly, the adaptive value of shy behavior, which impedes individual exploration and self-expression in challenging settings, is likely to be undermined by the social change.

The impact of social change on children's shyness has been demonstrated by a series of studies that Chen and colleagues have conducted in China over the past decade (e.g., Chen, Cen, Li, & He, 2005; Liu et al., 2015). China has carried out a full-scale reform toward a market economy, particularly in urban regions, since the 1980s, which has resulted in an increase in individual and family income, privatization of industries, and rapid rise in competition (e.g., Zhang, 2000). Along with the social and economic changes that took place in the past few decades, Western individualistic values and ideologies, such as individual freedom and autonomy, have been introduced into the country (e.g., Kulich & Zhang, 2010). In contemporary China, the socialization goals of many parents and schools have expanded to cultivate children's social and behavioral qualities that are required for adaptation in the competitive society (e.g., Way et al., 2013). Children are now encouraged to express personal opinions and demonstrate self-assertiveness, which are qualities that have been neglected in traditional Chinese culture (Chen, Bian, Xin, Wang, & Silbereisen, 2010; Chen & Li, 2012).

Social change in China has been found to have an effect on the ways in which shyness contributes to children's adaptive and maladaptive development. Chen et al. (2005) examined the relations between shyness and adjustment in different phases of the social change in China. Although shyness was positively associated with social competence, leadership, and academic achievement in the 1990 cohort, the relations were generally nonsignificant or mixed in 1998. Furthermore, by 2002, as China transitioned rapidly into a market economy, shyness was positively associated with various problems in social and psychological domains; shy children were perceived as incompetent by teachers and peers, displayed school problems, and

reported high levels of depression. Differences in the relations between shyness and adjustment in the three cohorts in China suggest that, when shyness becomes incompatible with the demand of assertiveness in the society, shy children may experience difficulties in social and psychological adjustment.

The impact of macro-level contexts on shyness also has been demonstrated in urban-rural differences in China. Chen, Wang, and Wang (2009) reported that whereas shyness was associated with social and school problems and depression in urban children, it was associated with leadership, teacher-rated competence, and academic achievement in rural migrant children. Ding, Chen, Fu, Li, and Liu (2020) recently found that shyness was associated with fewer adjustment probems in rural migrant children than in urban children. It will be interesting to examine relations between shyness and adjustment in rural Chinese children as rural regions of China become urbanized.

Similar to the experience of rural-to-urban migrant children in China, children from immigrant families in North America display lower levels of shyness as a result of acculturation. For example, Chen and Tse (2010) found that, among Chinese children who immigrated to Canada, proficiency in English and length of residence in Canada were negatively related to peer-nominated shyness, suggesting that Chinese children who were more socialized with Western cultural values displayed less shy behavior. In a longitudinal study, Huntsinger and Jose (2006) found that second-generation Chinese American adolescents reported higher levels of shyness than their European American counterparts. However, in a follow-up study that was conducted 5 years later, differences in shyness between the two groups largely disappeared due to the acculturation experience of Chinese American youth. Similar results have been reported in immigrant Mexican American youth and Hispanic/Latin American children (e.g., Gudino & Lau, 2010; Polo & López, 2009), indicating that socialization and acculturative experiences in the North American context may contribute to decline in shyness. An important issue that remains to be examined is how acculturation is involved in shaping the adaptive meaning of shyness among immigrant children. Research on the adjustment of shy immigrant children who accept new cultural values and who maintain traditional values will provide valuable information about processes of cultural influence on individual development.

Issues and Future Directions

From the evolutionary perspective, shyness in unfamiliar or challenging settings is likely to serve adaptive function in protecting individuals, especially children, from potential risks when interacting with others may pose threats or harms. Anxious reactions in these settings allow individuals to be vigilant to and avoid the risks and, at the same time, maintain social connections. In many contemporary Western societies, however, shyness is viewed as indicating social incompetence and immaturity because it impedes the exploration, initiative-taking, and self-expression, which are

required to achieve success in competitive commercial and industrialized social environments. As a result, the adaptive value of shyness is substantially reduced or diminished, and the display of shy behavior is associated with social disapproval, rejection, and lack of opportunities to learn various skills, which in turn contribute to social and academic difficulties and psychological problems (Rubin et al., 2015).

Rapid social changes toward industrialization and modernization are occurring in many traditionally agricultural societies in the world (Greenfield, 2009; Kağıtçıbaşı, 2012). How the social changes impact the relation between shyness and adaptation is an important and interesting question for developmental researchers. Greenfield (2009) argues that a consequence of the social changes in these countries is the cultural shift from emphasis on collectivistic values to emphasis on individualistic values in socialization, which facilitates the development of independent behaviors in children. Accordingly, shy behavior becomes increasingly maladaptive, leading to pervasive social and psychological problems. The research findings from some developing countries and regions (e.g., Chen et al., 2005; Kağıtçıbaşı & Ataca, 2005) appear to support this argument. However, Chen (2012, 2015) and Tamis-LeMonda et al. (2008) argue that the ongoing social changes in both developing and developed countries are likely to bring about coexistence and integration of mixed, even conflictual, cultural values. As a result, the exposure to, and experience of, diverse values are an important part of human development. How shy children adapt and develop in this context should be investigated systematically.

According to the contextual-developmental perspective (Chen, 2012), social interaction in group and larger settings is a main mechanism through which culture and its change influence individual development. Culturally directed social evaluations and responses in interaction define adaptive and maladaptive meanings of behaviors and, at the same time, serve to regulate their development. During the process, children play an active role through their reactions to the social influences and through participating in the construction of norms for group interaction. There is little research on the role of social interaction in "mediating" the link between culture and shyness. It will be interesting to investigate social interaction experiences of shy children and cultural involvement in shaping these experiences.

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The Many Faces of Shyness in Childhood Across Cultural Contexts

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Introduction

Shyness represents a common yet diverse experience across cultures. Some shy individuals are highly wary of novel and uncertain social situations, exhibiting shyness mostly toward strangers. Others are often concerned about being negatively evaluated by others, and as a consequence afraid to interact with even people they have known for a long time. Still others tend to engage in nonassertive, unassuming, and polite behavior, particularly in conspicuous and potentially conflictual situations. These distinct experiences of shyness may serve important adaptive functions, yet manifest differently across cultural contexts. The purpose of this chapter is to elucidate adaptive roles different forms of shyness may play and how cultural influence may shape the expression of shyness and its relation to psychosocial adjustment.

Definition of Shyness

As a socially devised lay term, shyness has been used to refer to a wide range of experiences. Interviews with children and adults from different cultural contexts (Bayram Özdemir, Cheah, & Coplan, 2015; Crozier, 1995; Crozier & Burnham, 1990; Xu & Farver, 2009; Xu, Farver, Chang, Zhang, & Yu, 2007; Xu, Farver, Yang, & Zeng, 2008; Zimbardo, 1977) have shown that shyness may be manifested in varying manners such as reticent, wary, and unassuming behaviors, and related to distinct feelings,

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including concerns about negative evaluations and self-consciousness of public attention, formal situations, and breaches of privacy.

The diverse experiences of shyness are reflected in the various ways of how shyness is defined in the research literature. As seen in Table 1, a review of two edited books on shyness by leading researchers in the field (Rubin & Asendorpf, 1993; Rubin & Coplan, 2010), as well as the most recent journal articles devoted to shyness, clearly shows that research definitions of shyness vary in scope and emphasis, ranging from a narrower focus on inhibited behavior and anxiety (e.g., Cheek & Buss, 1981; Leary, 1986) to a wider range of wariness, self-consciousness, and

Table 1 Examples of definitions of shyness

Definition	Year	Researchers
Tension and inhibition when with others	1981	Cheek & Buss
A heightened state of individuation characterized by excessive egocentric preoccupation and overconcern with social evaluation … with the consequence that the shy person inhibits, withdraws, avoids, and escapes social interactions	1982	Zimbardo
Inhibited and awkward behavior when with casual acquaintances or strangers, with feelings of tension and distress, and a tendency to escape from social interaction	1984	Buss & Plomin
Excessive and nervous attention to the self in social settings, resulting in timid and often inappropriate overt behaviors as well as emotional and cognitive distress	1986	Briggs, Cheek, & Jones
Discomfort or inhibition in the presence of others	1986	Jones, Briggs, & Smith
An emotional-behavioral syndrome characterized by social anxiety and interpersonal inhibition or avoidance	1986	Leary
A preoccupation with the self in response to real or imagined social situations leading to social inhibition and anxiety	1990	Melchior & Cheek
A form of social withdrawal that is motivated by social evaluative concerns, primarily in novel settings	1993	Rubin & Asendorpf
Apprehension about being evaluated, as well as responses to novel situations	1999	Crozier
Slow or inhibited approach in situations involving novelty or uncertainty	2001	Rothbart, Ahadi, Hershey, & Fisher
Wariness and anxiety in the face of social novelty and perceived social evaluation	2004	Rubin & Coplan
Various forms of modest, reserved, wary, inhibited, anxious, or withdrawn behaviors in social situations	2009	Asendorpf
Temperamental wariness in the face of social novelty and/or self-conscious behavior in situations of perceived social evaluation	2010	Coplan & Rubin
Anxious, vigilant, and wary reactivity in challenging social settings	2019	Chen

Note: The examples of definitions of shyness were based on two edited books: Rubin and Asendorpf (1993). *Social withdrawal, inhibition, and shyness in childhood: Conceptual and definitional issues*, and Rubin and Coplan (2010). *The Development of Shyness and Social Withdrawal*, as well as the journal articles published since 2017 with the keyword "shyness" in the field of Abstract retrieved from the database, PsycInfo

reserved and modest behavior (e.g., Asendorpf, 2009; Coplan & Rubin, 2010). Not surprisingly, Pilkonis and Zimbardo (1979, p. 133) concluded that "…shyness still remains a fuzzy concept that defies simple definition…," a remark that remains valid 40 years later.

The divergence among these definitions creates a dilemma when applying them to refer to shyness experienced by lay people. On the one hand, narrower definitions of shyness such as "tension and inhibition when with others" refer to behaviors that may not be logically necessary for inferring shyness. For instance, individuals who engage in nonassertive and unassuming behavior do not necessarily exhibit any observable tension or inhibition, but they often report being shy themselves (Xu & Farver, 2009) and are labeled "shy" by other people (e.g., Xu et al., 2007, 2008). Thus, applying a definition with a narrower focus may inadvertently "disqualify" some shy people from calling themselves "shy" (Harris, 1984). On the other hand, a broader definition of shyness such as "…modest, reserved, wary, inhibited, anxious, or withdrawn behaviors in social situations…" covers quite diverse behaviors that may only occasionally co-occur in the same individual.

There are at least two approaches that can be used to address the challenge of defining shyness. Some researchers use terms, such as behavioral or social inhibition (e.g., Asendorpf, 1990; Fox, Henderson, Marshall, Nichols, & Ghera, 2005; Kagan, 1994), social reticence (e.g., Coplan, Rubin, Fox, Calkins, & Stewart, 1994; Degnan et al., 2014), or anxious solitude (e.g., Gazelle & Ladd, 2003), so that they could avoid the use of the term "shyness" altogether. The advantage of this approach is that the phenomenon of interest can be defined without requiring an argument about whether it really represents shyness or not. For instance, Kagan, Reznick, Clarke, Snidman, and Garcia-Coll (1984, p. 53) used the term "behavioral inhibition to the unfamiliar" (BI) to refer to "…the child's initial behavioral reactions to unfamiliar people, objects, and contexts, or challenging situations…" This definition delineates two criteria for BI: it has to be initial behavioral reaction, which does not necessarily involve experiences of shyness, and it must occur in response to unfamiliar or challenging social situations, as well as nonsocial stimuli (e.g., objects) that only activate fear but not shyness (Xu & Krieg, 2015). Using this definition, Kagan (1994, p. 42) was able to distinguish the temperamental category of BI from shyness and concluded that "…most adults who say they are shy do not belong to the temperamental category favoring this quality…."

Alternatively, given its varying forms, shyness may be better treated as an umbrella term and consists of multiple subtypes, rather than as a unidimensional construct. Researchers may choose to add qualifiers to the lay term "shyness" to prescribe the boundaries of the conceptual terrains of their interest. That is, they could develop definitions of different forms or subtypes of shyness, corresponding to distinct aspects of lay people's experiences of shyness, such as fearful and self-conscious shyness (Buss & Plomin, 1984; Eggum-Wilkens, Lemery-Chalfant, Aksan, & Goldsmith, 2015), avoidant and conflicted shyness (Schmidt & Poole, 2019), negative and positive shyness (Colonnesi, Napoleone, & Bögels, 2014), and shyness toward strangers/temperamental shyness, anxious shyness, and regulated shyness (Xu, Farver, Yu, & Zhang, 2009). By focusing on specific forms of shyness

that are clearly defined, researchers are no longer guilty of *psychological imperialism*, "…in which psychologists effectively superimpose their professional definitions of psychological constructs upon those developed by the lay person…" (Harris, 1984, p. 169). Rather, they are able to map concepts of specific forms of shyness, though not necessarily exhaustively, onto different aspects of shyness experienced by lay people, an approach my colleagues and I took to understand shyness across cultural contexts.

The Multidimensional Model of Childhood Shyness

My colleagues and I have developed a multidimensional model of shyness (Xu & Farver, 2009; Xu et al., 2007, 2008, 2009; Xu, Farver, & Shin, 2014; Xu & Krieg, 2014; Xu, Zhang, and Hee, 2014; also see Asendorpf, 2009) that identified and distinguished three forms of shyness in childhood: shyness toward strangers, anxious shyness, and regulated shyness that seem to capture the most salient experiences of shyness in childhood across cultural contexts. Although all of the three forms of shyness are characterized by an "asocial" behavioral manner, manifested in relatively low frequency of social interaction, reticence, quieting of behavior, and lack of initiation attempts, they vary based on other prototypical behaviors, accompanying emotional experiences (or lack thereof), and primary eliciting situations (Xu et al., 2007, 2008, 2009; Xu & Farver, 2009). For instance, shyness toward strangers is shown as inhibited behavior accompanied by a fear of novelty or uncertainty in unfamiliar social situations (e.g., meeting someone for the first time), whereas anxious shyness is activated mostly in social evaluative situations (e.g., being criticized or expecting being criticized by an authority figure or peer) where children are anxious or nervous about real or imagined negative feedback or disapproval. In contrast, regulated shyness is not accompanied by observable fear or anxiety, but tends to involve self-consciousness about being a likely target of public attention (Xu & Farver, 2009). Regulated shyness is most salient in conspicuous and potentially conflictual situations (e.g., being complimented by others, facing disagreement with others) and is shown as acquiescent, unassuming, and polite behavior through which children refrain from assertive attempts and/or remain reticent (Xu et al., 2007, 2009).

Motivational and Executive Inhibition. The multidimensional model of shyness was partly built upon the theoretical accounts of inhibitory control processes proposed by Nigg (2000). Nigg (2000) distinguished motivational inhibition, or "… bottom-up interruption of ongoing behavior or suppression of behavioral response due to fear or anxiety in the presence of immediate novel social situation or cues for punishment…" (Nigg, 2000, p. 238), from executive inhibition that refers to "…the processes for intentional control or suppression of response in the service of higher order or longer term goals (as opposed to immediate stimulus incentives)…" (Nigg, 2000, p. 238). Drawing from Gray's (1987) model of behavioral inhibition system, Nigg (2000) argued that motivational inhibition consists of two distinct yet related processes toward different eliciting contexts: response to novelty and response to

conditioned punishment or non-reward cues; the former resembles Kagan's conceptualization of reactivity toward novelty (Kagan, Reznick, & Snidman, 1988), whereas the later may be associated with neurotic personality in adults and anxiety about being negatively evaluated by others in both children and adults. In contrast, executive inhibition seems to resemble what Rothbart and Bates (1998) referred to as "effortful control," and is associated with constraint and conscientiousness in adults and impulse control and compliance in both children and adults.

Nigg (2000) proposed that motivational inhibition may be mediated by the early developing septal-hippocampal formation and amygdaloid complex and may emerge during the first year of life. In contrast, executive inhibition seems to be supported by the later development of prefrontal cortex/anterior cingulate and thus likely emerges near the end of the first year and continues to grow into childhood and adolescence (Posner & Rothbart, 2000; Rothbart, 1989). Moreover, later developing executive inhibition, which is often related to socialization experiences and learning of cultural norms (Rothbart & Bates, 1998), represents a malleable and goal-directed top-down process that may modulate or regulate the bottom-up processes of motivational inhibitory control.

Shyness Toward Strangers. The relative strengths of executive and motivational inhibitory control processes, as well as the development of and interaction between the two inhibition systems, may represent a plausible underlying mechanism for development and divergence of the three forms of shyness in childhood. For instance, a strong early developing motivational inhibitory control in response to novel or "discrepant" events may frequently activate vigilance, quieting of behavior, and orienting to novel stimulus (Kagan, 1997), and thus predisposes some children to develop shyness toward strangers. This novelty-driven motivational inhibition system is manifested in relatively low neural activation thresholds in the amygdala and its associated circuitry and shown behaviorally as fearful and inhibited responses in unfamiliar situations (Kagan, Reznick, & Snidman, 1990). With limited socialization experiences and insufficient regulation by executive inhibition system that develops relatively late in life (Nigg, 2000; Rothbart, 1989), shyness toward strangers can be easily identified in young children as an aspect of the most salient temperamental attributes (Kagan, 1994), and thus may also be referred to as temperamental shyness (e.g., Balkaya, Cheah, Yu, Hart, & Sun, 2018; Schmidt, Fox, Schulkin, & Gold, 1999; Schmidt & Miskovic, 2013).

Anxious Shyness. With the increasing regulation of executive inhibitory control over time, a sensitive motivational inhibition system may not necessarily lead to fearful and inhibited behavior in later years (Buss & McDoniel, 2016; White, McDermott, Degnan, Henderson, & Fox, 2011). Nigg's concept of executive inhibition represents a willful or voluntary self-regulatory function in which an individual initiates, maintains, and modulates reactions in serving higher order or long-term goals. The development of executive inhibition is closely related to socialization of cultural norms (Rothbart & Bates, 1998) and shapes the way that individuals interpret the subtle aspects of environmental cues, understand social acceptability of reactions, and behave in accordance with societal expectations and social approval (Kopp, 1982, 1989). Therefore, while young children with a sensitive motivational

inhibition system are likely fearful and inhibited in unfamiliar social situations (i.e., demonstrating shyness toward strangers), they may gradually develop varying capacity of executive inhibitory control and thus differ in their ways of coping with a low threshold of arousal in later years.

In the absence of adequate regulation by executive inhibition system, for instance, children may be particularly vulnerable to negative social experiences that could further sensitize their motivational inhibition systems to not only cues of novelty, but also cues of conditioned punishment and non-reward (Asendorpf, 1990). The meanings of conditioned punishment or non-reward cues would be partly dependent on individual's cognitive construal of the self in relation to significant yet often familiar others, such as peers or school authority figures, who interact with and evaluate children based on cultural norms and societal expectations on a daily basis. When peers' or authorities' evaluations tend to be, or are perceived to be undesirable, children are likely to construe such negative social evaluations as cues of punishment or non-reward, and over time develop what we referred to as anxious shyness. Anxious shyness tends to emerge later than shyness toward strangers because it requires developing cognitive capacity of construing oneself in relation to others and accumulating experiences of being (or perceiving being) a target of repeated negative social evaluations (Asendorpf, 1990).

Regulated Shyness. Unlike anxious shyness, the development of regulated shyness may be associated with an increasingly strong executive inhibition, i.e., voluntary or intentional control on prepotent responses (e.g., fearful responses toward strangers), that is partly due to accumulating socialization experiences that help cope with stress associated with social interactions (Rothbart & Bates, 1998; Zhou, Eisenberg, Wang, & Reiser, 2004). On the one hand, similar to the other two forms of shyness, regulated shyness may be mediated by a sensitive motivational inhibition system which limits the frequency of social interactions and results in an "asocial" tendency to remain quiet and constraint, i.e., behaviors of the least risk for appearing bold or intrusive, particularly in conspicuous and potentially conflictual situations. On the other hand, unlike anxious shyness, regulated shyness may be supported by a strong executive inhibition system that modulates the function of motivational inhibition system. Specifically, aspects of executive inhibition, such as attention regulation (e.g., orienting away from potential sources of non-reward/punishment) and cognitive reappraisal of social evaluative cues, may not only help control for easily escalated emotional arousal and inhibited behavior, which are undesirable for long-term goals of maintaining harmonious social relationships, but also activate behaviors that may increase the chance of fitting in with others within the constraint of a sensitive motivation system, such as acquiescent, unassuming, and polite behavior that are characteristic of regulated shyness. Therefore, even though a sensitive motivational inhibition system may hold children back from intensive social participation, with regulation of executive inhibition, children are able to exhibit regulated shyness that would help make social encounters more manageable and less threatening by conveying an important message to peers that they desire to fit in with others.

Support for the Multidimensional Model of Shyness

Correspondence to Lay People's Experiences of Shyness. Harris commented on the use of the term "shyness" by researchers and argued more than 30 years ago that "… it is clearly nonsense for psychologists to borrow a term from the lay person and then construct a definition of that term which enables them to subsequently inform the lay person that he or she is using the term incorrectly…" (Harris, 1984, p. 174). Other researchers recommended coding and analyzing lay people's own open-ended accounts of shyness to address the problem (Cheek & Watson, 1989). Therefore, it is an imperative first step to explore whether the three forms of childhood shyness proposed in our multidimensional model tap conceptions of shyness by children themselves.

Xu et al. (2008) asked 9–10-year-old Chinese children to nominate peers whom they felt were "very shy" and then explain the reasons why they considered the peers best described as shy. This open-ended approach identified a large number of behaviors that were considered characteristic of shyness by children themselves, most of which represent prototypical attributes of the three forms of shyness. For instance, the most frequently mentioned behavior "…is embarrassed when being criticized…" reflects anxious shyness, whereas the second frequently mentioned attribute "…does not show off…" demonstrates regulated shyness. The third frequently mentioned behavior "…does not talk much…" suggests an "asocial" manner that characterizes all the three forms of shyness, and "…is afraid to talk to someone s/he does not know…," the fourth frequently mentioned attribute, represents a prototypical behavioral marker of shyness toward strangers. Thus, the most salient attributes in children's conceptions of shyness are in line with defining behaviors of the three forms of shyness, at least in the Chinese culture.

Furthermore, using cluster analysis, Xu et al. (2008) were able to identify four clusters of prototypical characteristics of shyness based on children's conceptions: fearfulness/anxiety toward novelty or challenge, fearfulness/anxiety toward negative social evaluation, nonsocial and unassuming behavior, and self-consciousness. The first three clusters consist of observable behaviors that correspond to shyness toward strangers, anxious shyness, and regulated shyness, respectively, whereas the fourth "self-consciousness" cluster represents experiences of "feeling shy" that was found to be related to both anxious shyness and regulated shyness (Xu & Farver, 2009). Moreover, consistent with the prediction of our multidimensional model that the three forms of shyness might be related differently to executive inhibition system, the results of multidimensional scaling analyses showed that the cluster "nonsocial/unassuming behavior" tended toward the "regulated" side, whereas the clusters "fearfulness/anxiety toward novelty or challenge" and "fearfulness/anxiety toward negative social evaluation" were located on the "reactive" side of the reactive-regulated dimension.

Similarities and Differences. There are three main propositions of the multidimensional model of shyness with regard to the similarities and differences among the three forms of shyness. First, a sensitive motivational inhibition system may

underlie all the three forms of shyness, but it may manifest differently, depending on eliciting contexts. In support of this proposition, studies of children from various cultural contexts have revealed moderate interrelations among the three forms of shyness, though the relations tended to be small when different forms of shyness were rated by different informants (e.g., parents and teachers) who were familiar with children's behaviors in different kinds of contexts (Xu et al., 2007; Xu et al., 2014; Xu & Krieg, 2014). For instance, informants such as parents might be more likely than teachers to witness children's experiences of interacting with strangers, whereas teachers, rather than parents, have more opportunities of observing children's interactions with familiar peers at school (Eisenberg, Shepard, Fabes, Murphy, & Guthrie, 1998). In a similar vein, an underlying sensitive motivation system may also limit the frequency of social participation associated with all three forms of shyness, and as a consequence, studies have found positive associations of the three forms of shyness with asocial and solitary behaviors at school (Xu et al., 2007; Xu & Farver, 2009; Xu et al., 2014).

Furthermore, Xu et al. (2009) found that shyness toward strangers was associated with observational ratings of inhibited behavior in Chinese children during a stranger encounter situation, whereas anxious shyness was related to observational ratings of inhibited behavior in a card-sorting task with negative social evaluative cues. Interestingly, although regulated shyness was not related to inhibited behavior in either situation, it was associated with lowered heart period (a marker of physiological arousal) in the stranger encounter situation. This inconsistency between behavior and physiology suggested that children who engaged in regulated shyness, despite not showing highly inhibited behavior, may remain susceptible to the uncertainty or unpredictability of the novel stimuli (Buss & McDoniel, 2016; Xu et al., 2009), as indicated by lowered heart period, possibly due to a sensitive motivational inhibition system that not only underlies shyness toward strangers and anxious shyness, but also regulated shyness.

Second, given the early emerging motivational inhibition in response to novelty, shyness toward strangers is expected to emerge earlier than the other two forms of shyness. In contrast, the development of anxious shyness and regulated shyness, but not that of shyness toward strangers, is expected to be closely related to experiences with familiar peers at school. Consistent with this argument, much research has shown that shyness toward strangers can be identified as one key aspect of temperament in very young children (Buss & McDoniel, 2016; Kagan, 1994), whereas the emergence of anxious shyness seems to be associated with accumulating negative experiences with familiar peers over years (Asendorpf, 1990). Furthermore, studies of Chinese, South Korean, and Asian American children have shown that anxious shyness was related to peer rejection, whereas regulated shyness was associated with peer acceptance at school (Xu et al., 2007; Xu et al., 2014; Xu & Krieg, 2014).

Third, the multidimensional model of shyness would predict that whether shyness toward strangers would later develop into anxious shyness or regulated shyness is dependent on growing capacity of executive inhibition system that is susceptible to socio-cultural influences. In line with this argument, Xu et al. (2007), Xu, Farver, and Shin (2014) and Xu et al. (2015) were able to replicate the differential relations

of anxious shyness (negative) and regulated shyness (positive) to executive inhibition, operationalized as measures of effortful control (Rothbart & Bates, 1998), in studies of Chinese, South Korean, and Asian American children. In another longitudinal study of Chinese children, Xu et al. (2009) found that while early shyness toward strangers was related to later regulated shyness among children with high or moderate effortful control, it was associated with later anxious shyness among children with low or moderate effortful control, providing support for the key role executive inhibition system may play in the development and divergence of anxious and regulated shyness over time.

The Adaptive Functions of Different Forms of Shyness

While the three forms of shyness differ in their relations to children's psychosocial adjustment, they seem to serve a similar adaptive function of appeasement that is essential for establishing and/or reestablishing cooperative social relations, though in varying social situations.

Cooperation and Appeasement. As favored by natural selection owing to direct fitness benefits (mutually beneficial cooperation) or indirect fitness benefits (altruistic cooperation), cooperative interactions are "…those in which two or more individuals incur some cost, investing time, energy, or resources, or forgoing other opportunities, in order to behave in a fashion that will benefit all involved…" (Fessler, 2007, p. 178). Natural selection also favors the evolution of appeasement displays or "…the process by which individuals placate or pacify others in situations of potential or actual conflict…" (Keltner, Young, & Buswell, 1997, p. 360), to establish and/or reestablish cooperation, because it is less costly to signal acquiescence than to engage in conflict that may escalate into a fight one may lose. Human appeasement behaviors are nonassertive in nature and often include gaze aversion, lowering the head, and postural and behavioral constraints that are also found in appeasement behaviors of animals (De Waal, 1988), as well as nonintrusive speech or reticence, self-conscious emotions, deference, politeness, and modesty that are byproducts of the unique human capacity of taking others' perspective upon the self, and in particular upon one's public appearance (Gruenewald, Sally, Dickerson, & Kemeny, 2007; Keltner, 1995; Keltner et al., 1997). These behaviors act to signal one's commitment to the social relationship and are often perceived by others as a promise to fit in and to engage in appropriate behavior worthy of others' trust and respect (Castelfranchi & Poggi, 1990; Goffman, 1967). As a consequence, appeasement behaviors often elicit cooperative or affiliative behaviors in others and reduce potential conflict and aggression (Keltner et al., 1997).

Shyness and Appeasement. Shyness, regardless of its specific form, shares the conditions, behavior, and social consequences of appeasement (Keltner et al., 1997), and a sensitive motivational inhibition system mentioned above may form the basis for dispositional appeasement that characterizes all the three forms of shyness. First, behavioral markers of an asocial manner, which are likely related to a sensitive

motivational inhibition system and shared by the three forms of shyness, include reticence or nonintrusive speech, behavioral constraint, and limited assertive attempts; these behavioral characteristics are also prototypical attributes of appeasement. Second, the primary conditions for activating appeasement behavior include interacting with strangers, authority figures, peers of higher status, as well as potential interpersonal conflict, all of which represent key eliciting situations for shyness as well (Keltner et al., 1997).

The instrumental role of appeasing others is evident for all the three forms of shyness, but may be most salient in different situations for different forms of shyness. Appeasement may occur in situations such as meeting and interacting with a stranger in which there is a significant amount of uncertainty or "risks" with regard to establishing a cooperative relationship with an "unknown" person (Fessler, 2007). By engaging in shyness toward strangers and exhibiting wariness and inhibition rather than initiating social contact right away, children recruit a conservative and nonassertive option to increase the chance of keeping peace with someone with whom they are not familiar.

In a similar vein, appeasement may also occur in situations that involve a heightened awareness of being (or imagining being) negatively evaluated by others that may indicate a disrupted social relationship, particularly by authority figures and peers of higher status. Anxious shyness often involves an exaggerated sense of social inefficacy and failure and is shown in worry about failing to meet some threshold for social acceptability and maintaining cooperative relationships with others (Shepperd & Arkin, 1990). It may, however, temporarily appease others, given that its inhibited and submissive gesture may be perceived as an intention to remain affiliative with others (Gilbert & Trower, 1990), and consequently, protecting oneself from further harsh judgment (Cheek & Briggs, 1990; Shepperd & Arkin, 1990).

Appeasement may also be activated in conspicuous situations where one's public appearance may be perceived as indicating unrestricted claims regarding the self or a discernable attempt of standing out from others, both of which may evolve into conflict or confrontation and result in disrupted social relationship. Regulated shyness, which is characterized by nonassertive, unassuming, and polite behaviors, is particularly instrumental in appeasing others in such situations (Keltner et al., 1997). It represents a social interactional strategy that resolves around regulation of untoward impulses and behaviors, especially those that encroach upon the rights of others, and that may be construed as an attempt of distancing oneself from others or as insensitivity to others' needs (Chance, 1988; Goffman, 1967). Regulated shyness bestows respect and deference on others, and would thus increase social harmony and cooperation, the ultimate goals of appeasement (Keltner et al., 1997).

Culture and Shyness: The Processes of Hyper- and Hypocognition

The three forms of shyness are not just byproducts of natural selection as key aspects of human appeasement; they are also expected to vary based on the degree to which cultures emphasize appeasement as a key interpersonal function and apply them to solve problems of social cooperation. The appeasement functions of a particular form of shyness may be differentially formalized in social institutions, which could result in either a highly elaborate conception, i.e., hypercognition, or an underrepresentation, i.e., hypocognition, of this form of shyness and its appeasement functions in various cultural contexts.

Hypercognition and Hypocognition. The terms "hypercognition" and "hypocognition" were coined by Levy (1973) in his consideration of emotions in relation to cultural structuring of emotion knowledge. Specifically, these two terms are used to refer to cultural processes of variously elaborating, i.e., hypercognizing, or suppressing, i.e., hypocognizing, conscious recognition of particular emotions (Levy, 1973; Lutz, 1986; Shaver, Wu, & Schwartz, 1992). For instance, in some East Asian cultures such as China and Japan, the emotion of shame is highlighted as one primary way of appeasement and is endorsed as a method of enforcing group norms and maintaining social cooperation (Marsella, Murray, & Golden, 1974; Wilson, 1981). Consequently, its functions as a social control strategy are formalized and elaborated in these cultures via the process of hypercognition. The process of hypercognition is manifested in early socialization of shame as a primary cultural goal (Fung, 1999), resulting in the understanding of the term "shame" among 95% of 2.5- and 3-year-old Chinese children (Fung, 1999; Shaver et al., 1992) and transmission of cultural knowledge of shame via parenting practices (Fung, 1999). This is in clear contrast to only 10% of American children of the same age group who understood the term "shame" and little socialization effort related to shame by parents, possibly because in the American culture, shame is not viewed as a common social control strategy, and thus being hypocognized as a less salient emotion (Russell & Yik, 1996; Shaver et al., 1992). While shame may still serve important appeasement functions in the American culture, it is however, not considered as a hypercognized way of fulfilling such functions (Shaver et al., 1992).

Culture and Shyness. Cultural variations in the prevalence, expression, and socialization of the three forms of shyness may be understood via the processes of hypercognition and hypocognition. Different forms of shyness may be perceived as culturally structured but personally articulated ways of appeasement in fulfilling the goal of social cooperation, via the processes of hyper- and hypocognition. The predominant cultural norms and beliefs are expected to constrain conscious recognition and evaluation of both behaviors and situations related to shyness and shape cultural views with regard to the effectiveness of each form of shyness as a strategy of appeasement, as well as the types of focal events, i.e., the events corresponding to central cultural values and concerns (Mesquita & Frijda, 1992), that are most salient in eliciting various forms of shyness.

All three forms of shyness represent important ways of appeasing others; yet, the extent to which each of them is able to fulfill the goal of social cooperation is dependent on whether it is hyper- or hypocognized in a particular cultural context. For example, strangers are often perceived as out-group members in relatively homogeneous cultural contexts such as Japan where there is a heightened awareness of the distinction between in-groups and out-groups (Gudykunst & Nishida, 1994; Itoh, 1996; Neuliep, Chaudoir, & McCroskey, 2001; Yamagishi, Jin, & Miller, 1998). In a confrontation-averse culture like Japan, wariness and hesitancy to approach/initiate contact with strangers, or shyness toward strangers, is recognized as a common and acceptable way of showing respect for not imposing oneself on others, especially when there is a great amount of uncertainty when interacting with members of out-groups (Gudykunst & Nishida, 1994). Thus, shyness toward strangers is hypercognized as an instrumental way of social appeasement in the Japanese culture and is considered functional in ensuring a peaceful first-time interpersonal exchange. In addition, meeting with strangers also represents an appeasement-related focal event defined in the Japanese culture where gaze aversion, minimal or nonintrusive speech, and postural constraint, all of which are behavioral markers of shyness toward strangers, are expected as part of the cultural norms (Krieg & Xu, 2015, 2018; Krieg, Xu, & Cicero, 2018; Sakuragi, 2004; Senju et al., 2013). In contrast, many metropolitan areas of the USA represent culturally and ethnically heterogeneous contexts where being able to proactively navigate the social relationships with out-group members, such as strangers on daily basis, is considered an attribute for social success. Shyness toward strangers is thus likely hypocognized or deemphasized as an appeasement strategy in these types of settings where the potential "cost" associated with being wary, hesitant, and inhibited outweighs the "gain" related to conveying an implicit appeasing and affiliative gesture. Consequently, meeting with strangers may be less likely to represent a focal event for activating appeasement in such cultural contexts. Social approach with warm greetings when meeting someone for the first time, rather than demonstration of appeasement, may be sought after as alternative to establish cooperation.

The hyper- and hypocognition processes could also be used to understand cultural variations in anxious shyness. In cultural settings where there is a strong emphasis on social hierarchy, anxious shyness may be hypercognized as a gesture of appeasement for individuals who are, or imagine themselves to be, at submissive social positions, when facing negative social evaluations from authority figures or peers of higher status. For example, subordinates' demonstration of anxious shyness in some collectivistic cultures such as the Japanese culture, where there are clear boundaries in the social ranking system (Krieg, Ma, & Robinson, 2018; Sakuragi, 2004), may be taken as an effort of appeasing and maintaining cooperation with authorities or peers of higher status (e.g., relatively popular children in a peer group or clique). Thus, situations that involve negative evaluations by authorities or peers of higher status represent focal events that activate anxious shyness as a hypercognized way of appeasement in the Japanese culture. Although most Western cultures do not consist of a rigid social hierarchical system as in the

Japanese culture, expression of anxious shyness is not uncommon in Western children when they are members of peer groups with varying social statuses. Studies of children's peer relationships have demonstrated that peer statuses tend to be stable, and "peripheral" members often rely on submissive appeasement strategies such as demonstration of anxious shyness to seek peace with peers of higher status and to protect themselves from additional social failure (Parker & Asher, 1987). Therefore, it seems that situations that involve negative evaluations by peers of higher status also represent focal events for activating anxious shyness in children from various Western cultures (Asendorpf, 1990, 2009). Given these cultural similarities in the hypercognition of anxious shyness and related focal events in childhood, it is not surprising that anxious shyness was found to be related to similar psychosocial adjustment outcomes in children across cultural contexts (Xu et al., 2007; Xu et al., 2014; Xu & Krieg, 2014).

Similarly, regulated shyness could also be hyper- or hypocognized across cultural contexts, depending on whether it is viewed as a prototypical way of appeasement in establishing/reestablishing social cooperation. Regulated shyness is likely hypercognized in a culture where its reciprocity is institutionalized and strictly enforced. That is, individuals are likely more willing to engage in regulated shyness and refrain themselves from standing out or acting assertively in cultures where they are socialized to believe that others will do likewise in similar situations (Gächter & Herrmann, 2008). For instance, reciprocity of acquiescent and nonassertive gestures in interpersonal relationships represents a core value in some East Asian cultures where traditional Confucianism remains influential (Gudykunst & Nishida, 1994; Singhal & Nagao, 1993), which likely hypercognizes regulated shyness as part of expectations for prospective cooperative partners. An important function of regulated shyness is to motivate reputation management behavior with regard to culturally constituted cooperative relationships. Furthermore, members of these cultures are constantly evaluating each other's command of, and motivation to conform to, cultural standards of behavior, which sensitize them to public attention and highlight conspicuous and potentially conflictual situations as focal events that activate regulated shyness. Not surprisingly, regulated shyness tends to be associated with children's positive peer relationships and psychosocial adjustment in cultures such as China and South Korea where it may be hypercognized (Xu et al., 2007; Xu et al., 2014). In contrast, in many Western cultures where there is a lack of institutionalization of reciprocity of appeasement behaviors in conspicuous and conflictual situations, regulated shyness may be hypocognized due to the risk that individuals who exhibit nonassertive and unassuming behaviors may be exploited by those who do not conform to these standards. Instead, these cultures may hypercognize assertive or even confrontational problem-solving rather than seeking reciprocal appeasement.

Summary and Future Directions

In summary, there is increasing evidence to suggest that shyness is a multidimensional phenomenon in childhood across cultural contexts, and the differentiation of three forms of childhood shyness, shyness toward strangers, anxious shyness, and regulated shyness, seems to correspond to distinct lay conceptions of shyness. Drawing from Nigg's (2000) model of motivational and executive inhibition, we argue that all the three forms of shyness may be related to an early emerging sensitive motivational inhibition system that predisposes children to dispositional appeasement and manifests as asocial and solitary behaviors, but they seem to vary in their relations to a later developing executive inhibition system. There are both within- and between-cultural differences in these three forms of shyness. Within each culture, shyness toward strangers, anxious shyness, and regulated shyness vary in their primary eliciting situations and accompanying behaviors and emotions that are associated with different peer relationships and psychosocial adjustment. Across cultural contexts, predominant values and beliefs may shape hyper- and hypocognition of the three forms of shyness, as well as their appeasement functions and focal events that activate each form of shyness. As a consequence, cultural variations are often found in prevalence, expression, and socialization of shyness toward strangers, anxious shyness, and regulated shyness.

Despite the recent effort of understanding shyness as a multidimensional phenomenon across cultural contexts, it remains unclear what might help interpret cultural similarities and differences in developmental outcomes associated with childhood shyness. Drawing from social psychological literature on interpersonal perception and relationships (Chiu & Dweck, 1997; Dweck & Leggett, 1988; Erdley, Cain, Loomis, Dumas-hines, & Dweck, 1997; Erdley & Dweck, 1993), more recently, researchers have begun to explore how cultural variations in children's implicit theories of shyness may help understand cultural differences in perception of and relationship with shy children. Implicit theories are shared by lay people and represent the way how they interpret and react to social situations (Chiu & Dweck, 1997) and can be distinguished into at least two different views: an implicit entity theory that construes traits or behaviors as fixed and immutable qualities, often resulting in a tendency to make global, rigid, and enduring judgments of others on the basis of limited information; an implicit incremental theory that focuses on changing nature of abilities or personalities over time and across situations, and that tends to lead to relatively flexible interpersonal judgment. Zhang and Xu (2019) found that in comparison to Chinese children, American children reported stronger entity theories of shyness and were more likely to view shyness as a stable and immutable trait, which in a mediation model partly explained why they had worse relationship with shy peers. Zhang and Xu (2019) speculated that cultural differences in socialization of entity and incremental views of shyness may shape the way children perceive and react to their shy peers. Although this study failed to distinguish different forms of shyness and their relations to entity and incremental theories, the findings nevertheless highlighted an important future

direction of exploring the roles implicit theories may play in understanding cultural similarities and differences in interpersonal perception of and relationship with shy children.

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Perspective on Shyness as Adaptive from Indigenous Peoples of North America

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The focus of this chapter is on perspectives of shyness and behavioral inhibition as socially adaptive among Indigenous Peoples of North America. Within the borders of the United States, American Indians and Alaska Natives are the two political designations for the Indigenous Peoples, whereas within the borders of Canada, First Nations, Inuit, and Métis are the political designations for the Indigenous Peoples. We note from the outset the enormous cultural, linguistic, geographic, religious, and political diversity—arguably greater than for all of European countries —among the thousands of nations and communities contained within these umbrella labels (Burack et al., 2017). Despite their vast differences, Indigenous Peoples generally share certain characteristics, such as greater emphasis on sociocentric, ecocentric, and cosmocentric as opposed to egocentric configurations of the self, which differentiate them from Western populations (Kirmayer, 2007). Furthermore, they share a history of hundreds of years of European colonization and oppression that has had, and continues to have, a deleterious impact on Indigenous Peoples in a multitude of broadly similar ways, including epidemic disease; loss of traditional lands; forced relocation to a system of reserves or to urban areas; attempts of cultural, familial, political, religious, and linguistic assimilation; cultural invisibility; intergenerational trauma and poverty; and pronounced health disparities (Fryberg, Covarrubias, & Burack, 2018; Gone et al., 2019). Yet, Indigenous Peoples collectively share a remarkable history of resistance, resilience, and cultural continuity in the face of the imposition of Western values and other

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forms of oppression of Indigenous values and ways of being (Burack, Gurr, Stubbert, & Weva, 2019).

With the essential goal of de-pathologizing Indigenous ways of being (e.g., Fryberg, Markus, Oyserman, & Stone, 2008), and the ways that they are addressed within Western psychological and psychiatric frameworks, we challenge the notion that behaviors indicative of shyness and inhibition that are often noted among Indigenous persons are indicative of psychiatric symptomatology or are even deleterious in any way. Rather, we highlight the role of shyness as adaptive within traditional Indigenous conceptualizations of development and socialization. This type of contextualization is particularly relevant to the study of Indigenous youth for whom the commitment to and participation in activities associated with the cultural continuity of Indigenous ancestral culture are consistently linked to positive developmental outcomes (Burack, Blidner, Flores, & Fitch, 2007; Chandler & Lalonde, 1998, 2009; Chandler, Lalonde, Sokol, Hallett, & Marcia, 2003; Fryberg et al., 2013; Hallett, Chandler, & Lalonde, 2007; Iarocci, Root, & Burack, 2009; Kirmayer, Dandeneau, Marshall, Phillips, & Williamson, 2011). With this background, we argue that mainstream conceptualizations of shyness as a precursor to adult psychopathology have questionable relevance for Indigenous communities, in which shyness and inhibition, more generally, are traditionally viewed as desirable behaviors that help to promote harmonious relations and an adaptive state of being (e.g., Brant, 1990).

Incorporating Indigenous Knowledge and Perspectives

Within collectivist societies, such as Indigenous ones, social contexts and roles are often considered to be potent determinants of behavior, whereas personality receives far less emphasis than it does in individualist cultures (Triandis, Chan, Bhawuk, Iwao, & Sinha, 1995). Accordingly, Western conceptualizations of enduring personality characteristics and traits, such as behavioral inhibition, are generally inconsistent with traditional Indigenous worldviews and cultural practices. Instead, Indigenous notions of self and personhood are framed within the contexts of community, familial, and social roles. This way of being is also reflected in certain Indigenous languages which, unlike Western ones, do not possess linguistic properties such as time markers and agentic conceptions of self, but rather depict individuals as changeable agents in a fluid environment. In this framework, the notion of inhibition is not that of a maladaptive trait, but rather that of an adaptive social skill that can reflect "good manners" and humility among all members, but especially children.

In our attempt to provide insight into how the constructs of shyness and behavioral inhibition are conceptualized and experienced within Indigenous populations differently than among the Western mainstream, we focus largely on "emic," or "insider" (Achenbach, 2014), perspectives of a Western construct. This approach is consistent with that of a two-eyed seeing approach in which Indigenous and Western

ways of thinking are both valued and utilized. For example, the First Nations Mi'kmaw elder Albert Marshall advocated that Indigenous ways of knowing can, and should, coexist with Western ones in a space in which both epistemologies are meaningfully and respectfully engaged and impactful (Bartlett, Marshall, & Marshall, 2012).

Indigenous notions of self and personhood. In order to explore Indigenous understandings of self and personhood and how they are discordant with mainstream notions of fixed personalities, we illustrate three concepts pertaining to the thriving Inuit culture in Greenland, in which Inuktitut/Kalaallisut-based renderings of personal development depict individuals as changeable as the weather. This lack of stable agentic forces operating within a person is not viewed in a negative light, but rather as a natural outgrowth of the small role that humans occupy in the natural world (Williamson, 2011). The conceptualization of human culture and personas as belonging to and within a spiritual world is an important aspect of personality development according to an Inuit/Kalalliit cosmology. As Karla Jessen Williamson, an Inuk anthropologist, recalled:

> Over the years, growing up in Greenland, my aunt continued asking me about the center of my universe and each time it filled me with wonder- I felt waves of awe. In my physicality, there were cosmic and spiritual aspects that I needed to tend to. These pre-cosmic values that the Inuit inculcate in the process of bringing up their children come to mind when Briggs talks about "pro-social" values in Inuit child rearing. The two types of values are never really disconnected. (Williamson & Kirmayer, 2010, p. 300).

Three essential constructs capture much of the cosmic and social values of the Inuit community. *Silarsuaq* is an overarching term which describes a metaphysical layer of existence, wherein Inuit reside and interact with the spiritual world at every given point in their personal history, and through which they are strongly influenced by reciprocal forces that circumscribe their engagement with the environment and help them to live out the qualities or achievements of one's ancestors (Williamson, 2011). As humans are not animated by *silarsuaq* in the same fashion as animals and the natural world, they do not possess the more clarified and higher (fluid) form of intelligence. Accordingly, they may mistakenly believe that their personal expressions, mannerisms, and behaviors are more stable/crystallized than they truly are, as though they contain an essence of their very own (Williamson, 2011).

The second Inuit concept, of *inusutuut*, serves to further highlight the transitory states of being experienced by individuals within Inuit culture. This Kalaallisut-based construct refers to a young person (in spirit or in mind), yet is associated neither with a set chronological age or state of development nor with an inborn, stable trait. Instead, *inusutuut* aligns with the notion of *silarsuaq*, taking whatever configuration it so pleases, and animating the form of a specific person; they may be preternaturally old or remain defiantly young in spite of the aging process. A person can be *inusutuut* at any age, and this implies a kind of playful exploratory nature, which is not necessarily presaged by that person's individual (stable) personality. It is a state of mind, or being, which one enters and freely exists when necessary, or when the appointed time has come.

The third Inuit concept, of the emotion-construct *Isumaluttuq*, implies "difficulty with thought processes" or "taking leave of one's intelligence or senses" (Kirmayer, 2011) that would likely be labeled as mental illness within Western cultures. Viewed as a state of mind rather than a personality trait that has no "expected course or prognosis," *isumaluttuq* can change as rapidly as a person's mind and experiences. Thus, the idea of a person being inflicted with serious mental illness (*isumaluttuq*) is conceptualized as a transitory experience, which shares common linguistic features with the way Inuit people frame the experience of emotional states, as opposed to the Western notions that often conceptualize mental illness as enduring (Kirmayer, 2011; Stevenson, 2014).

This view of humans as having ever-changeable states in their environment is further reinforced by the central animating force of Inuit cosmology, *pingortitaq*, which shapes human experience in a random fashion over which humans exert little influence (Dorais, 1991). According to Williamson (2011), "The powers and innate physical and spiritual qualities of all things, animate and inanimate, are to be respected as unique and granting autonomy. No one, including parents of children, may impose their own characteristics or qualities on another." The "powers" referred to here are numerous, but can include the personality and unique character traits of the individual, which grant the individual ultimate autonomy in how they choose to conceptualize and frame the specific constellation of behaviors and attitudes at any given moment. Inuit words are also meaningful and spiritually powerful in and of themselves, and are grounded in an understanding that "there is no way of determining what will happen next in nature. Man cannot control nature" (Williamson, 2011).

These Inuk belief systems are reflected in the Inuktitut language, which does not include time markers (Williamson, 2011), nor direct analogs to the agentic, linear, and ontologically informed trajectory of personality found in Western-scientific dialogues (Dorais, 1995, 2010). Thus, Western-style descriptions of a specific behavior, emotion-state, or set of behaviors as enduring and stable within a person across time are contrary to how Inuktitut language and epistemology depict individuals as changeable agents acting in an always-fluid external world (Dorais, 1991). Although based specifically on Inuk culture, this world view is largely consistent with that of other Indigenous systems and is essential to the ways that shyness and behavioral inhibition are portrayed and valued.

Inhibition as Normative Behavior Among Indigenous Peoples

Our discussion of shyness and behavioral inhibition as normative rather than as a predictor of pathology is largely influenced by the work of Clare C. Brant, who, as Canada's first Indigenous psychiatrist, dedicated his career to promoting a better understanding of the mental health issues and concerns of Indigenous Peoples across Canada (for a brief biography, see Wieman, 2000). Shyness and behavioral inhibition were highlighted prominently in Brant's compelling paper published in the *Canadian Journal of Psychiatry* and titled, "Native ethics and rules of behavior,"

which served as an introduction to his Canadian colleagues in psychiatry both to the ways of being of Indigenous persons and to the potential pitfalls in utilizing Western approaches with this community. This perspective is reflected in the opening statement of Brant's abstract, that "Psychiatrists assessing Native children and adolescents often find them passive, difficult to assess and not forthcoming." Brant follows up with the warning that "This behavior, which actually reflects the influence of Native culture, is often misinterpreted by clinicians unfamiliar with that culture as evidence of psychopathology."

In arguing that conflict-avoiding behavior is essential to Indigenous communities, Brant described four fundamental categories of behavior, which he termed as noninterference, non-competitiveness, emotional restraint, and sharing. Among them, emotional restraint refers to inhibitory behavior (physical and emotional) of both positive and negative behaviors. For example, Indigenous youth are typically expected to restrain themselves from expressing strong feelings such as joy, anger, and fear as well as controlling hostile and aggressive behavior (Brant, 1990). He argued that these patterns originated as techniques to ensure group unity and cohesion that are particularly essential for survival in hostile environments. As depicted in the Inuk belief system (Williamson, 2011; Williamson & Kirmayer, 2010) and as reflected in his title, the conceptual premise of Brant's comments is that shyness, behavioral inhibition, and any other behaviors need be seen within the context of ethics and rules of behavior that ensure adaptive behaviors in, or responses to, specific contexts or situations rather than as some inherent, and often maladaptive, trait.

Brant's call for increased knowledge and sensitivity among his colleagues in their work with Indigenous persons leads to several points that need to be considered in framing the notion of a North American Indigenous context for addressing shyness and behavioral inhibition. One, Indigenous Peoples typically eschew the notion of a shyness or behavioral inhibition as a pathological personality trait. Two, behaviors that appear to reflect shyness or inhibition are highly valued within Indigenous culture. Three, behaviors associated with shyness and inhibition continue to be prioritized in response to the historical and ongoing necessity for Indigenous people to avoid interpersonal conflict. Four, these perspectives must be considered within the reality of the evolution of Indigenous culture as the function of the complex meeting and transaction of ancestral and Western ways of being, with the forced imposition of the latter on the former.

These communal values of promoting shyness and inhibited-type behaviors among children in order to facilitate harmonious functioning among future generations of community members are inevitably reflected in child-rearing practices. For example, among Inuit children in Greenland, shy behavior is encouraged through the concept of *naalapoq*, described as the "traits of shyness and good manners combined with an extensive noninvolvement in adult affairs… which is the most positive thing to say of a child" (Langgaard, 1986). Similarly, among Cree First Nations, inhibition has been directly linked to the formation of harmonious peace-making behaviors, which enhances the chances of group survival in their harsh northern environments (Prince, 1993).

Arguably, the central teaching of Inuit *qaujimajatuqangit* (the concept of intelligent or adaptive qualities of thinking and behavior) which predominates across Inuit Nunangat is *piliriqatigiingniq*, which emphasizes that Inuit people build collaborative networks to work toward a shared, overarching goal that benefits the common good. This value stresses the primacy of the community over that of individual interests. Curriculum documents produced by the Nunavut government reveal the extent to which this particular teaching translates both as a key learning indicator and as a cultural imperative, which is essential to successfully maintaining one's place within the community (Tagalik, 2010). According to the *Inuqatigiit* document, this particular teaching is foundational to traditional Inuit values and should preside over all other teachings:

> (Piliriqatigiingiq is) the essential Inuit belief that stresses the importance of the group over the individual should pervade all teaching. Expectations for students will reflect working for the common good, collaboration, shared leadership and service. Piliriqatigiingniq also sets expectations for supportive behavior development, strong relationship-building and consensus-building. (*Inuit Qaujimajatuqangit Education Framework*, p. 45, Anon, 2007)

In addition, key features of this particular teaching stress that a child understand their place within the group, that they learn to develop and demonstrate leadership qualities, that they learn to advocate for a specific group or one's own community, that they are instructed in how to form an opinion in order to appropriately build consensus, and how to express and qualify judgments in terms of the common good. The essential point is that the cornerstone of this philosophy exhorts individual development with respect to a continuous striving toward group and common goals.

Similar social values are shared by the Yup'ik, or "real people" (Ayunerak, Alstrom, Moses, Charlie, & Rasmus, 2014)—a cultural grouping of Indigenous Peoples of the American Artic and Siberia who belong to the Eskimo-Aleutian language group and share recent common ancestor with the Inuit peoples (Kammler, 2000). As with Canadian Indigenous communities, the Yup'ik share a similar history of forced assimilation, sedentarization, and migration, by both American and Russian settlers who imposed their language, customs, and beliefs upon them (Krupnik & Chlenov 2013). In particular, they faced extreme adversity brought along with the influx of settlers during the "gold rush" period and its aftermath, which saw rapid and oftentimes deleterious change to local Indigenous cultures and ways of being (Gugel, 2000). However, the Yu'pik have maintained a strong connection and devotion to their ancestors' ways of living through the transcription of a rich oral literature (Ayunerak et al., 2014), parts of which are replicated here as they pertain to the shared validation of "shyness-inhibition" as examples of lived humility. In one example, a Yup'ik member describes such a scenario:

> You know sometimes we argue and call each other names, trying to outdo each other. Having that kind of relationship is noisy. It is better to be quiet and not answer back … even though you have a lot of words in your mind. The words we want to express don't come out of mouths by themselves. These are some of the things that I was taught. They said that our words don't try to come out, they do not kick. They said that keeping it inside is better… They say that a person who has this trait is referred to as a wonderful person (Fienup-Riordan, Rearden, & Meade, 2005, p. 141).

The emphasis of valuing one's community over individual interests is further highlighted in the following anecdote from another Yup'ik tribal member, who describes the proper rules of engagement and deference when meeting with an elder or novel person/situation:

> When you see someone whom you have never seen before, you cannot look directly into their faces. It is like you are afraid and respectfully shy and unable to speak to them. We were told to ask elders if we wanted to know about something, even though we were shy. They wanted us to ask questions, to have them explain the meaning…. *Takartaryaraq* (being respectful) is like *qigcikiyaraq* (honoring others)…. *Niisngayaraq* (listening obediently) is a way of adhering and not doing as one pleases but doing what's expected (Fienup-Riordan et al., 2005, p. 59).

Takartaryaraq (being respectful) and *qigcikiyaraq* (honoring others) are here implicitly defined as a soft reticence; the abilities to listen and ask questions, rather than frame one's own knowledge and attempt to dominate the conversation, are highly prized. A similar quote from a Yup'ik elder, reflecting back on their traditional upbringing in a Yup'ik community, exhorts this particular sentiment even more strongly: "You pitiful one, someday you will be a crestfallen person if you continue to behave using your own mind" (Fienup-Riordan et al., 2005).

Although Indigenous knowledge and narratives are at the essence of this chapter, we highlight one extensive empirical attempt to delineate an Indigenous perspective on shyness and behavioral inhibition and their links to developmental outcomes. In this study, West and Newman (2007) included adolescents in grades 7, 8, and 9 and their parents from the Lumbee tribe, which is located primarily in rural areas of North Carolina. With about 50,000 members in that region (United States Census Bureau, 2002), the Lumbee were, as of 2002, the largest tribe east of the Mississippi River and the ninth largest one in the United States. Their rich ancestry includes Indigenous American, European American, and African American lineages (Bryant & LaFromboise, 2005). Although they have been recognized as a tribe by the State of North Carolina since 1885 (Sider, 2003), they had remained unrecognized as a tribe at the federal level at the time of the West and Newman study (see Bryant et al., 2004). As this ongoing struggle has fostered a level of independence and autonomy from both the federal government and neighboring settler American communities (Bryant & LaFromboise, 2005), the Lumbee became largely a self-governed tribe with preponderance of local Lumbee-run institutions, such as a bank, stores, schools, and churches (Sider, 2003). West and Newman explain that the geographic and day-to-day isolation from American institutions, which impart "normative" American cultural mores, provided a unique environment in which Lumbee children and adolescents were able to connect with their heritage cultural values, leading to high levels of cultural connections, involvement, and continuity all seem particularly high (Bryant & LaFromboise, 2005).

In detailing their study that included the adolescents' self-reports on a measure of social anxiety and retrospective behavioral inhibition, West and Newman (2007) hypothesized that the links between indicators of childhood social anxiety, such as that indicated by shyness and behavioral inhibition, and later social anxiety in adolescence found in this community, would differ from those in non-Indigenous

populations due to cultural differences. In particular, they noted that the social norms and values of the Lumbee included an emphasis on being cautious and reserved in interpersonal relationships, whereas shyness and social reticence are viewed as weaknesses in mainstream society. According to West and Newman, their prediction was largely supported by the somewhat anomalous findings: Lumbee adolescents in this study retrospectively reported higher than average levels social inhibition in childhood, yet these fears did not appear to be connected with the development of social anxiety symptoms in adolescence as had been cited among a non-Indigenous group. West and Newman suggest that a certain level of social fear or shyness in childhood is probably normative, transient in nature, and, therefore, relatively non-distressing or problematic in the long term. This reflects a Lumbee cultural value in which shyness is viewed as a positive social trait, and it contours the relation between socially based fears in childhood and, later, social anxiety in adolescence, such that shame and poor self-image do not develop in the manner that is seen as pathological in other communities. Thus, the community norms that govern socialization and promote the importance of being "cautious and reserved" in interpersonal relationships may be viewed as protective against the mainstream North American norms in which extraversion and collegiality are typically prized.

Conclusions

The premise of this volume, that shyness can, and should be, viewed as adaptive in certain, if not most, contexts resonates with perspectives on socially fluid, eco- and allocentric ways of being among Indigenous Peoples of North America. In contrast to the common Western psychiatric and psychological depictions as deleterious traits that predispose to later mental illness, shyness and behavioral inhibition are portrayed by Indigenous scholars, mental health workers, researchers, and youth as culturally appropriate, socially desirable, and even essential to communal social harmony. In highlighting this point in cautioning his non-Indigenous colleagues in psychiatry against pathologizing the passive behaviors that they observe among Indigenous youth, Clare Brant argued that these types of behaviors need to be understood within the unique contexts of Indigenous cultures and history. This discourse provides insight into the complexity of interpreting Indigenous behavior as conceptualizations of shyness and inhibition seem to evolve both in relation to ancestral traditions that have been passed down from generation to generation in the individual communities and in response to the challenges and adversity of the last few centuries that emanate from the extensive experience of persecution, invasion, and ongoing colonization of Indigenous Peoples. In particular, shyness and behavioral inhibition were essential tools in minimizing interpersonal conflict, which also promotes Indigenous unity and healing that are necessary in the face of the adverse and trying conditions faced by the communities.

The commonalities regarding the value of shyness and behavioral inhibition both as adaptive for the individual and as essential for communal cohesion and well-being

are striking in the face of the vast differences with regard to culture, language, locale, and even history across the many Indigenous communities. These differences seem to diminish in the face of a relatively universal emphasis in Indigenous cultures on viewing oneself as a small part of the great universe, thereby highlighting the centrality of the pro-social values that are instilled as the individual becomes increasingly humble and considerate, less egocentric, and more aware of the social and physical surroundings. Yet, the vast disparities across the many communities that stretch across the vast land of North America necessitate even more nuanced depictions of shyness and behavioral inhibition in relation to community, tribe, or individual values and well-being, and all in contradistinction to the Western narrative of pathology.

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Part VI
Comparative and Evolutionary Perspectives

Comparative Perspectives on Temperament and Personality in Human and Nonhuman Animals

Kristine Coleman

Introduction

As anyone working with animals is well aware, individuals differ vastly with respect to their behavioral responses to stressful or novel stimuli. Exposed to the same stimulus, some individuals eagerly approach it, while others cower or freeze in response. There are many reasons for these disparate behavioral responses, including past experience, current emotional state, and the stimulus itself. However, one of the major forces underlying these different reactions is biological predisposition, known as personality or temperament. Once considered "noise" around an adaptive mean (Francis, 1990), these individual differences are now generally accepted as interesting and important in their own right (Clark & Ehlinger, 1987).

My own interest in this field started when I was in graduate school. My doctoral research examined individual differences in shyness and boldness in a population of pumpkinseed sunfish (*Lepomis gibbosus*). We found that individual fish living in a single population differed with respect to their propensity to inspect novel objects (Coleman & Wilson, 1998; Wilson, Coleman, Clark, & Biederman, 1993). Further, these differences were consistent and correlated with a host of other traits, including acclimation to laboratory conditions, choice of prey, and microhabitat usage. These studies were among the first to examine individual differences in temperament in a non-primate species.

Since these early studies in animal temperament, similar differences have been found in a variety of diverse taxa, from beetles to octopus to fish to birds and reptiles. Strikingly, individual differences in temperament have been found in every species in which they have been investigated, indicating the conserved nature of this trait. The impact of animal temperament can be seen in the wide range of academic disciplines in which it is now studied. While once studied predominantly by

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psychologists, personality is now examined by researchers in a wide range of fields, including neuroscience (e.g., Fox et al., 2015; Roseboom et al., 2014), evolutionary ecology (e.g., Réale, Reader, Sol, McDougall, & Dingemanse, 2007), and conservation biology (e.g., McDougall, Réale, Sol, & Reader, 2006). Personality is becoming a common variable in translational studies as well as applied science. Indeed, few traits have been studied as broadly as personality, both in terms of the number of species as well as range of disciplines involved.

In this chapter, I describe animal personality and some of the common tests used to assess it. I then discuss some of the current research in animal personality, with a focus on translational and applied research.

What Is Temperament/Personality?

Broadly speaking, the terms "personality" and "temperament" are defined somewhat similarly as behavioral differences that persist through time (e.g., Stamps & Groothuis, 2010). While the terms are often used interchangeably today (Capitanio, 2011), this has not always been the case. Historically, distinctions were made between the terms, with "temperament" being used to describe behavioral responses in animals and children and "personality" restricted to human adults (Watters & Powell, 2012). Researchers have previously argued that temperament reflects genetic behavioral differences, while personality reflects non-genetic differences (e.g., Buss & Plomin, 1986). Little distinction is made between the terms today; both are used to refer to an individual's basic position toward environmental change and challenge (Lyons, Price, & Moberg, 1988), which emerges early in life and remains relatively consistent throughout development (McCall, 1986). Further, both are used to describe behavioral differences in human and nonhuman animals alike. While temperament or personality are the most commonly used terms, other researchers use "behavioral syndromes" (Sih, Bell, Johnson, & Ziemba, 2004) or "coping style" (Koolhaas et al., 1999) to describe these behavioral differences. The discrepancies in use often reflect the field of study. "Behavioral syndromes," for example, is widely used in behavioral ecology studies, while "coping style" or "temperament" are more common in neuroscience. For the purposes of this chapter, I use the term "personality".

Measuring Animal Personality

There are many methods by which temperament or personality is assessed in both humans and nonhuman animals. Indeed, there are almost as many ways to assess personality as there are research groups assessing it. Even "standardized" tests such as the Human Intruder Test (HIT) for macaques (see below) are performed somewhat differently across laboratories. Still, despite the disparate methodologies

utilized to assess personality, the underlying dimensions are usually relatively similar (e.g., Bergvall, Schäpers, Kjellander, & Weiss, 2011; Konecna et al., 2008) and characterize how individuals deal with various challenges.

In humans, information regarding personality or temperament is often derived by interviews or surveys with the individual (or a parent), administration of standardized testing batteries, or from direct behavioral assessments of the individual. In many cases, comparable tests are used with nonhuman animals. The majority of the methodologies used to assess personality in animals rely on direct behavioral coding, either in the home environment (in which little is done to the animal) or in a situation in which the animal is somehow challenged (i.e., presented with a stimulus designed to elicit a response). Behavioral coding involves measuring the duration or frequency of particular variables, for example, the amount of time an individual spends inspecting a novel object or moving about a new enclosure. Personality also may be assessed using observer rating (Freeman & Gosling, 2010) in which care staff or others fill out questionnaires about the subjects. Some of the most common assessment tools are described below. It should be noted that these methods are not mutually exclusive; researchers often employ multiple approaches to assessing personality.

Home Environment Assessments

One way in which personality can be assessed is by observing subjects in their home environment and quantifying their responses to everyday, naturalistic events (e.g., interactions with conspecifics or caretakers, introduction to new situations). Individuals within a population typically vary with respect to many personality traits, including level of sociability, propensity to explore, degree of agitation, etc. This kind of assessment is often done with children, either at home or in the school setting, and has been used for a wide range of animals, including fish (Colléter & Brown, 2011), birds (David, Auclair, & Cézilly, 2011), elephants (Horback, Miller, & Kuczaj, 2013), and rhesus monkeys (Capitanio, 2011). In these studies, researchers quantify the duration and/or frequency of time animals spend in various behaviors such as social behaviors, locomotion, play, aggression, and exploration. Statistical methods such as factor analysis are then used to reduce the data into various clusters of behaviors (often called "traits"). For example, in a recent study examining elephant personality (Horback et al., 2013), researchers used this kind of behavioral coding to assess the amount of time elephants engaged in approximately 20 different behaviors, including play, social behavior, and aggressive behavior. Factor analysis on 480 h worth of data revealed three primary personality traits: "playful," "curious," and "sociable" (Horback et al., 2013).

As described above, observer rating also can be employed to assess personality in the home environment (e.g., Capitanio, 2011; Freeman & Gosling, 2010). Rating instruments typically involve two or more observers, well acquainted with the subjects, who rate them based on a number of predefined traits or adjectives.

For example, in nonhuman primate (NHP) studies, adjectives used often include "apprehensive," "active," "playful," and "curious" (e.g., Stevenson-Hinde & Zunz, 1978). Observers are typically asked to rate individuals on a Likert scale (e.g., "On a scale of 1–7, how curious is this individual?"). As with the behavioral observations, scores are analyzed with factor analysis in order to uncover various dimensions of behavior. Key dimensions in animal studies differ by study, but often include bold/shy, aggression, exploration/avoidance, sociability, and activity (Gosling, 2001). Interestingly, these factors are similar to human personality dimensions referred to as the "Five Factor Model" (Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism; Goldberg, 1990). Observer ratings are most commonly used with species that receive a great deal of attention from their caretakers, such as dogs (Jones & Gosling, 2005; Ley, McGreevy, & Bennett, 2009), horses (McGrogan, Hutchison, & King, 2008), nonhuman primates (Freeman & Gosling, 2010), farm animals (Finkemeier, Langbein, & Puppe, 2018), and zoo animals (Tetley & O'Hara, 2012), although these ratings have been used in other species as well (e.g., Gosling & John, 1999).

Home environment personality assessments are ethologically relevant to the animals and highlight naturally occurring variation. Resulting dimensions from these tests are often analogous to human personality traits, which is particularly important for translational studies (see below). However, behavioral observations tend to be highly time intensive and sensitive to potential confounds, such as time of day and time of year (Coleman & Pierre, 2014). Observer ratings tend to take less time, but require observers with a great deal of familiarity with the subjects. In both cases, interpretation of dimensions that result from factor analysis can be somewhat subjective (Réale et al., 2007). See Freeman & Gosling (2010) for a comparison of various approaches to these rating instruments.

Response to Challenge

While home environment assessments, and observer ratings in particular, are becoming more popular, for most species, personality assessments involve evaluating the subject's response to some sort of purposeful environmental perturbation. These stimuli typically involve a degree of novelty and/or risk, such as a new object or situation, or may involve something aversive, such as restraint. Unlike observer ratings, which capture several personality constructs, each test typically measures one or two dimensions, most often shy/bold and exploration/avoidance (Réale et al., 2007). Researchers often use more than one test and may combine them with home environment assessments. I describe some of the most common types of tests below. This review is by no means exhaustive; for any given species, there may be dozens of specific tests used. As an example, a relatively recent review of personality in sheep listed over 15 unique assessment tools (Dodd, Pitchford, Hocking Edwards, & Hazel, 2012).

Novel Object

Perhaps the most commonly utilized tool for assessing personality in animals is a "novel object test," which measures response to unfamiliar items. The novel objects vary with respect to perceived risk, ranging from seemingly innocuous (e.g., novel food, brightly colored toy) to potentially threatening (e.g., toy with big eyes, which can be somewhat threatening to certain species). Because there is inherent risk in inspecting any novel object, these tests typically measure an individual's boldness.

Variables examined in novel object tests often include latency to approach and/or inspect the object and amount of time spent near or with the object. Some studies quantify behavioral variables including distress behavior as well. Animals exhibit a spectrum of responses to these novel stimuli, ranging from "bold" (i.e., short latency to approach) to "shy" (i.e., long latency to approach, Fig. 1). These tests can be performed in the individual's home environment (e.g., Coleman & Wilson, 1998; Herskin, Kristensen, & Munksgaard, 2004) but are often carried out in a novel testing arena (e.g., Colléter & Brown, 2011).

Responses on this test have been ecologically validated in a variety of species (see Réale, Chap. 15 this volume). For example, pumpkinseed sunfish assessed as bold on a novel object test in their home environment had different stomach contents and parasite loads and acclimated faster to the laboratory than shy fish (Wilson et al., 1993). Wild vervet monkeys (*Chlorocebus pygerythrus*) found to be bold with respect to a novel object were more likely to engage in predator inspection behavior toward a model predator than their shy counterparts (Blaszczyk, 2017). Similarly, bold grey mouse lemurs (*Microcebus murinus*) studied in their natural environment were more likely than others to forage in a risky environment (Dammhahn & Almeling, 2012).

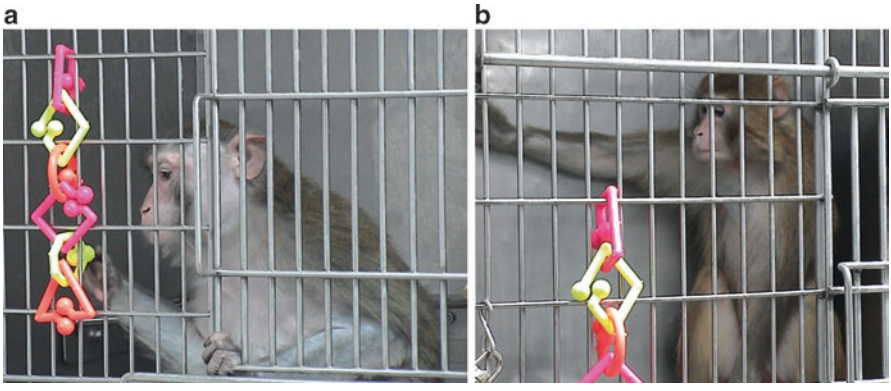

Fig. 1 Example of a rhesus macaque inspecting (Bold; **a**) and avoiding (Shy; **b**) a brightly colored bird toy placed on the cage as part of a novel object test. Republished by permission of Taylor and Francis Group, LLC, a division of Informa plc, from the *The Handbook of Primate Behavioral Management,* S.J. Schapiro (Ed), 2017

As indicated above, novel object tests are common in studies of animal temperament/personality. Variations of this test have been used in just about every species in which personality has been found, including insects (Müller & Juškauskas, 2018; Tremmel & Müller, 2013), hermit crabs (Watanabe et al., 2012), fish (Wilson et al., 1993), birds (Stowe et al., 2006), rodents (Joshi & Pillay, 2016), farm animals (Dodd et al., 2012), and nonhuman primates (Blaszczyk, 2017; Carter, Marshall, Heinsohn, & Cowlishaw, 2012; Coleman, Tully, & McMillan, 2005). A version of this test is utilized in human children as well (Kagan, 1997); indeed, many of the novel object tests used in animal species are based, at least in part, on these human assessments.

Novel Environment

Another relatively common temperament assessment measures response to a novel environment. In these tests, often termed "open field" tests (Walsh & Cummins, 1976), the subject is removed from the home environment and subsequently exposed to an unfamiliar open enclosure. In some versions of this test, the novel environment is divided into "safe" (e.g., has some sort of cover) and "risky" (e.g., exposed) areas. Novel objects may be present in the testing arena as well.

This test measures the personality constructs boldness and/or exploration. Variables assessed in this test typically include one or more of the following: latency to begin exploring (i.e., leave starting place), amount of locomotion in the environment, amount of time spent in the risky environments, and number of times animals move between safe and risky environments. Open field tests are utilized in many species, including fish (e.g., Burns, 2008; White, Wagner, Gowan, & Braithwaite, 2017), rodents (Prut & Belzung, 2003), farm animals (Dodd et al., 2012), and monkeys (Williamson et al., 2003).

Response to Human

One specific intruder test is the Human Intruder Test (Kalin & Shelton, 1989). This test, designed to measure an individual's response to the potentially threatening social stimulus of an unfamiliar human intruder, is one of the most widely used tests to measure temperament in rhesus macaques (*Macaca mulatta*) and related species. Specifically, it was designed to measure behavioral inhibition, defined as behavioral withdrawal from (Kagan, Reznick, & Snidman, 1988) or fearfulness in response to (e.g., Schmidt et al., 1997) novelty. The HIT was originally developed to assess behavior in infant macaques, but has been adapted to other age groups and NHP species (e.g., Costall et al., 1988). In general, the subject is brought to a cage in a novel room and allowed to acclimate for a period of time. The subject is then exposed to a human intruder, with whom it has no prior experience. The intruder

first stands by the subject's cage taking care to avoid eye contact (designed to represent a potential social threat), after which the intruder makes direct eye contact, a threatening posture, with the subject. While there have been various iterations of this test, they all have similar components (e.g., an unfamiliar human who makes direct eye contact with the subject). Subjects display a wide range of behavioral responses to this test. Generally, individuals who show excessive freezing behavior when the intruder is not making direct eye contact, and/or those showing excessive anxious behavior (e.g., scratching, distress behaviors) in the presence of the intruder, are considered more behaviorally inhibited than others (see Coleman & Pierre, 2014 for review). One reason for the widespread use of this test is that it has been pharmacologically validated. Behavioral responses to the intruder (including freezing, hostility, etc.) have been reduced with various anxiolytics (Habib et al., 2000; Kalin, Shelton, & Turner, 1991) and increased with anxiogenic compounds (Kalin, Shelton, & Turner, 1992).

Response to unfamiliar humans is also used to assess personality in other species. The human avoidance distance test in cattle and the human approach test in dairy cows measure the response of the animals to a human making direct eye contact (Gibbons, Lawrence, & Haskell, 2011; Parham, Tanner, Wahlberg, Grandin, & Lewis, 2019; Sutherland, Rogers, & Verkerk, 2012). Similar tests have been conducted in pigeons (Santos et al., 2015), pigs (Brown et al., 2009), and horses (Calviello et al., 2016).

Restraint

Personality assessments often measure an individual's response to an aversive stimulus. One experience that is aversive to most animals is manual restraint or handling, which can happen for husbandry or clinical purposes. For example, cattle and dairy cows or other livestock may be restrained in stalls known as cattle crushes or chutes for examinations or veterinary treatment. Some animals become agitated in response to this restraint, while others remain relatively docile (e.g., Parham et al., 2019). Because it elicits this kind of behavioral variation, researchers have utilized this restraint as part of a personality test for these species. In this test, the animal is loosely restrained in the chute for a period of time, and observers assess the animal's response to the restraint (known as chute score) as well as the response to being released from the chute (known as exit score). Responses to both include "docile," "restless," "nervous," and "aggressive" (see Parham et al., 2019). While subjective, these scores have been found to be reliable across both experienced and inexperienced observers (Parham et al., 2019). The flight speed with which the animals exit the chute may also be calculated. A similar test has been developed for pigs. In this test (the backtest), young pigs are put on their backs and gently restrained for a period of time (e.g., Hessing et al., 1993). Researchers measure the degree of struggling as an indicator of coping style (Zebunke, Repsilber, Nürnberg, Wittenburg, & Puppe, 2015), with increased struggling thought of as reactive coping. Restraint

tests are also relatively common in bird (Campbell, Hinch, Downing, & Lee, 2016; Fucikova, Drent, Smits, & van Oers, 2009) and fish (Colchen, Faux, Teletchea, & Pasquet, 2017; Ferrari, Benhaïm, Colchen, Chatain, & Bégout, 2014; Magnhagen et al., 2015) species.

Predator

For certain species (i.e., those most vulnerable to predation in the wild), response to a predatory simulation has been used to assess personality. For example, insects such as beetles are often handled with forceps to simulate a predator attack (Müller & Juškauskas, 2018; Tremmel & Müller, 2013). Insects generally respond to such handling with a period of tonic immobility, after which they begin to move again. The latency to move is used as a measure of boldness; bolder individuals spend less time immobile than shyer individuals (Müller & Juškauskas, 2018). The image of a predator (a raptor) displayed on a screen has been used to assess boldness in hermit crabs (Watanabe et al., 2012). In response to the image, most hermit crabs withdraw into their shells. Bold hermit crabs re-emerge sooner than their shy conspecifics (Watanabe et al., 2012). Response to a predator also has been used to assess personality traits in nonhuman primate species. The Predator Confrontation Test (Barros, Boere, Huston, & Tomaz, 2000) was developed to assess response to a predatory threat in marmosets (*Callithrix penicillata*). In these tests, marmosets are exposed to a taxidermized Ocilla cat (*Felis tigrina*), a natural predator, in an open field testing arena. Observers assess response to the "predator," including displacement behavior, vigilance, and exploratory behavior. Similar to the HIT, this test has been pharmacologically validated. Anxiolytics reduced displacement behaviors and increased exploratory behavior in marmosets exposed to the model predator (Barros et al., 2000; Barros, Mello, Huston, & Tomaz, 2001).

Social Isolation

For social species, isolation from the group can be highly aversive to individuals. Isolation tests are therefore used for highly gregarious species, such as sheep or horses (Lansade, Bouissou, & Erhard, 2008; Rice, Jongman, Butler, & Hemsworth, 2016). For example, in the isolation box test, a sheep is put into an opaque box for a set amount of time, and behavior and/or level of agitation is measured (Murphy et al., 1994). In addition, the speed at which animals leave the isolation chamber is also used as a measure of temperament (Plush, Hebart, Brien, & Hynd, 2011). It is worth noting that while these tests quantify response of animals to social isolation, many personality assessments necessitate that animals be removed from their social group for testing. Animals are typically tested individually on the Human Intruder

tests, Open Field tests, and restraint tests. This separation from the social group can be an experimental confound and/or a welfare concern and has been used to support the use of home environment assessments (Hopper, Cronin, & Ross, 2018).

Animal Personality Research

Recent years have seen a dramatic increase in publications on the study of animal personality (Fig. 2). A literature search on animal temperament or personality performed with PsychInfo, a database of peer-reviewed literature, revealed over 2200 articles published between 1900 and 2018. Over a third of these papers were published in the past 5 years. Importantly, this increase can be seen across a wide range of scientific fields, including psychology, neuroscience, agricultural sciences, veterinary science, and environmental science. Below, I briefly review some fields of study in which animal personality studies are found. Because animal personality studies in the fields of behavioral ecology and evolution are covered elsewhere in this book (see Réale, Chap. 15), I focus on biomedical/translational and applied ethology studies.

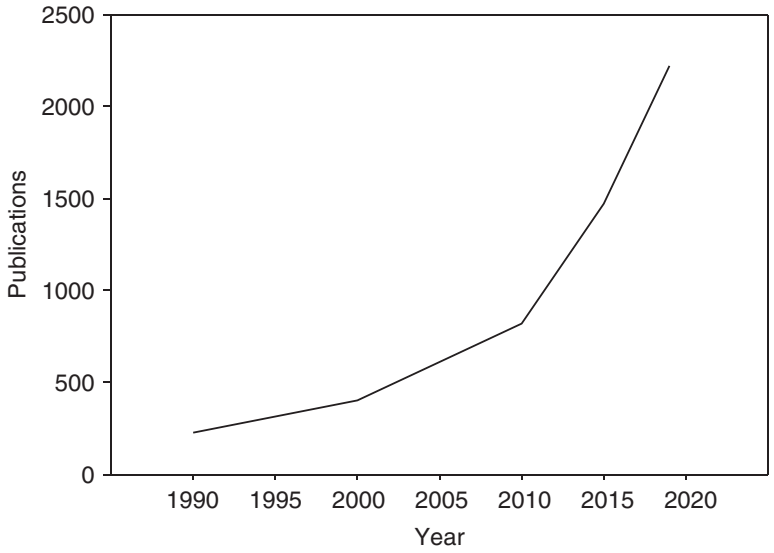

Fig. 2 Cumulative number of peer-reviewed publications on animal personality or temperament published between 1990 and 2019. There were approximately 230 publications prior to 1990. Data taken from PsychInfo

Biomedical Research

One reason for the current increased interest in personality is its role in various behavioral and/or health outcomes in humans (Capitanio, 2011; Deary, Weiss, & Batty, 2010; Mehta & Gosling, 2008; Miller, Cohen, Rabin, Skoner, & Doyle, 1999; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007). The link between personality traits, such as behavioral inhibition, and vulnerability to stress-induced behavioral problems in human populations has long been established. Several studies have demonstrated that children who consistently score as inhibited early in life are at a greater risk of developing anxiety, depressive disorders, and other psychopathologies later on in life compared to non-inhibited peers (Hirshfeld et al., 1992; Rosenbaum et al., 1993; Schwartz, Snidman, & Kagan, 1999). Inhibited children are also more likely than others to suffer from allergic disorders (Kagan, Snidman, Julia-Sellers, & Johnson, 1991) and respiratory illnesses (Boyce et al., 1995). This relation is not limited to children; personality traits have been associated with adult health-related outcomes as well (e.g., Schmidt & Fox, 1995). The personality dimension conscientiousness, which includes traits such as reliability, competence, and self-discipline, has been associated with longevity (Kern & Friedman, 2008). Conversely, studies have found a correlation between high levels of neuroticism and premature death (Roberts et al., 2007).

Similar associations between personality and illness have been found in various animal species, including nonhuman primates. Behaviorally inhibited rhesus macaque infants show greater hypothalamic-pituitary-adrenal (HPA) axis activation and behavioral responses to stresses, such as separation from peers, compared to others (Suomi, 1991) and also show impaired immune function (Laudenslager et al., 1993). They are more likely than non-inhibited individuals to develop airway hyperresponsiveness, a characteristic of asthma (Chun, Miller, Schelegle, Hyde, & Capitanio, 2013). Socially inhibited rhesus monkeys have lower antibody response to immunization and social relocation compared to highly sociable monkeys (Capitanio, Mendoza, & Bentson, 1999; Maninger, Capitanio, Mendoza, & Mason, 2003). Nervous monkeys low in confidence are also more likely than others to experience chronic diarrhea, particularly in response to repeated stressors (Gottlieb et al., 2018).

Not only are there behavioral similarities between humans and animals, there are also physiological similarities. Young rhesus macaques identified as behaviorally inhibited on the Human Intruder test show increased activity of the amygdala and bed nucleus of the stria terminalis (Kalin, Shelton, Fox, Oakes, & Davidson, 2005), structures shown to be important in behavioral inhibition in humans as well. Further, these monkeys have higher basal cortisol levels than others (Kalin, Shelton, Rickman, & Davidson, 1998); this finding is congruent with previous work demonstrating that behaviorally inhibited and temperamentally shy children have higher levels cortisol levels (Kagan et al., 1988; Schmidt et al., 1997). Further, similar genes have been found to correlate with personality traits in humans and animals.

For example, a repeat polymorphism of the dopamine D4 receptor (DRD4) has been associated with the trait novelty seeking in both humans and vervet monkeys (Bailey, Breidenthal, Jorgensen, McCracken, & Fairbanks, 2007).

Because of these similarities, animals, particularly nonhuman primate and rodent species, have been used as models for studying the relation between human personality and health outcomes. There are several reasons for why this kind of comparative approach can enhance such studies. In an interesting review, Mehta and Gosling (2008) identify four main benefits of using animal studies to better understand human personality and health, although there may be others. One of the primary benefits is that animal studies allow researchers to control variables that may have confounding effects. Factors such as access to health care, levels of social support, food intake, and exposure to substance abuse have all been found to influence various health outcomes in human populations. While difficult to account for in human studies, these factors can be controlled in animal studies. Animals within a colony tend to get fed the same food items, and most have similar access to clinical care. Controlling for these variables allows researchers to examine factors that might covary with personality to affect health outcomes. Researchers can measure and manipulate biological variables (e.g., hormones or neurotransmitters) in ways that would not be ethically possible in human studies. Further, animal studies allow researchers to observe subjects in their home environment in ways that would not be possible to do in humans. Such observations can enhance the ability to examine the relations among personality, the environment, and health outcomes (Mehta & Gosling, 2008). Finally, the relatively short lifespan of many animal species allows for longitudinal studies examining changes over development that would not be feasible with human studies (Mehta & Gosling, 2008).

Behavioral Management

Attending to the behavioral needs of animals in captivity is an integral part of animal care. Behavioral management is a comprehensive strategy for promoting psychological well-being involving factors such as socialization, nonsocial enrichment, and positive reinforcement training (PRT), as well as facilities design and positive animal-staff interactions (Keeling, Alford, & Bloomsmith, 1991; Weed & Raber, 2005; Whittaker, Laule, Perlman, Schapiro, & Keeling, 2001). The goals of behavioral management plans are to produce animals that are in good physical condition, display a variety of species-typical behaviors, are resilient to stress, and that easily recover (behaviorally and physiologically) from aversive stimuli (Novak & Suomi, 1988). It is well known that an individual's behavioral needs can differ due to a variety of factors, including personality. Therefore, it stands to reason that knowledge about individual differences in personality should help guide decisions about how to manage the care of captive animals.

Behavioral Health

Perhaps not surprisingly, personality traits have been associated with well-being and affect in humans. Studies have shown people high in the trait "extraversion" have higher positive affect compared to those low in the trait (e.g., Burgdorf & Panksepp, 2006). Similar results have been found in animals. For example, personality traits have been associated with subjective well-being in a variety of species including chimpanzees (*Pan troglodytes*) (King & Landau, 2003), orangutans (*Pongo pygmaeus* and *Pongo abelii*) (Weiss, King, & Perkins, 2006), brown capuchins (*Sapajus apella*) (Robinson et al., 2016), rhesus macaques (*Macaca mulatta*) (Weiss, Adams, Widdig, & Gerald, 2011), and Scottish wildcats (*Felis silvestris grampia*) (Gartner & Weiss, 2013). In these studies, researchers use observer ratings to assess both personality and subjective well-being. Subjective well-being ratings usually focus on questions surrounding perceived happiness of the individual, the animal's social relationships, personal control and whether the individual is meeting its goal, and how happy the rater would be if he or she were the specific animal (see King & Landau, 2003, for details). As with personality ratings, there tends to be relatively high inter-rater reliability across observers (e.g., King & Landau). In other words, despite the subjectivity of the measures, individual raters tend to score individuals in the same way.

Cognitive bias testing is another way of assessing emotional states of animals. Cognitive bias refers to the influence of affective state on information processing (Mendl, Burman, Parker, & Paul, 2009). Multiple studies have demonstrated that, in humans, self-reported emotional states can influence cognitive processes, including attention, memory, and judgment. Specifically, individuals in a negative affective state (e.g., anxiety, depression) show increased vigilance to threatening stimuli, are quicker to recall negative memories, and are more likely to have negative assumptions about future events or ambiguous stimuli compared to those in a positive emotional state (Mendl et al., 2009; Paul, Harding, & Mendl, 2005). Researchers have exploited this bias in information processing to develop cognitive bias tests to indirectly measure emotional states in nonhuman animals. These tests have been used to assess both positive and negative affect in multiple species, including rats (Harding, Paul, & Mendl, 2004; Richter et al., 2012), dogs (Mendl et al., 2010), and sheep (Doyle, Fisher, Hinch, Boissy, & Lee, 2010). Studies have shown that personality can influence emotional response to these cognitive bias tests. Pigs with a proactive (e.g., bold) personality as assessed on a novel object test and isolation test responded more optimistically on the cognitive bias tests than others (Asher, Friel, Griffin, & Collins, 2016). Similarly, dogs with a calm as opposed to anxious temperament were more likely to respond optimistically (Mendl et al., 2010). Taken together, these studies support the idea that, as with people, personality can influence well-being and affect in animals.

Although relatively few studies have specifically examined the relation between personality and affect, personality has been shown to play a role in the development of some behavioral problems, including stereotypic behavior. Stereotypies, defined as repetitive, habitual behavior patterns with no obvious function (Mason, 1991;

Shepherdson, 1993), are commonly seen in captive animals in a variety of settings. While there is much to learn about its causes, recent evidence suggests that certain personality types may be more vulnerable. Boldness, as measured by response to a novel object, was found to positively correlate with the development of stereotypic behavior in rhesus macaques, both when the monkeys were tested as infants (Gottlieb, Capitanio, & McCowan, 2013) and as adults (Gottlieb, Maier, & Coleman, 2015). Similar findings have been seen in other species, including striped mice (Joshi & Pillay, 2016), farmed mink (Hansen & Jeppesen, 2006), and horses (Nagy, Bodó, Bárdos, Bánszky, & Kabai, 2010). Further, boldness has been linked to feather damaging behavior in parrots (van Zeeland, van der Aa, Vinke, Lumeij, & Schoemaker, 2013) and certain lines of hens (Uitdehaag, Rodenburg, Komen, Kemp, & van Arendonk, 2008). In these studies, animals that engaged in the behavior were bolder or less reactive than those not displaying the behavior. These results may seem somewhat counter intuitive at first; however, stereotypic behavior and feather damage have been proposed to be a coping mechanism (e.g., van Zeeland et al., 2009). Thus, the bolder, more proactive animals may be engaging in this coping mechanism more than others. This finding is not ubiquitous. Cussen and Mench (2015) found that extraverted parrots had a less pronounced increase in stereotypy following the removal of enrichment compared to those low on the extraversion. However, in that study, authors examined stereotypy in response to a stressful event.

Environmental Enrichment

One of the most commonly utilized strategies for addressing behavioral needs of animals in captivity is to provide them with environmental enrichment, including items such toys and foraging devices (Coleman, Weed, & Schapiro, 2017). These devices are designed to increase the expression of species-typical behaviors and decrease boredom for animals. Enrichment is often provided with a "one size fits all" approach; that is, what is good for one is assumed to be good for all animals. However, personality can influence how individuals respond to various enrichment strategies. For example, Bolhuis, Schouten, Schrama, and Wiegant (2005) found an interaction between personality as measured on the backtest and enrichment use in pigs. While all of the pigs in the study displayed increased play and manipulation behavior in an enriched compared to barren environment, this increase was significantly higher in pigs that had a bolder, more proactive personality (Bolhuis et al., 2005). In other words, the bold pigs were more likely than shy pigs to utilize environmental enrichment when provided. Similar results were found in rhesus macaques given novel apps on iPad as enrichment. Some bold monkeys (as measured on a novel object test) used this enrichment device, but none of the shy monkeys interacted with it (Coleman, 2017).

Other studies have found that enrichment can actually cause stress for individuals with certain personality traits. Because animals tend to lose interest in items with continuous exposure (e.g., Lutz & Novak, 2005), enrichment is often rotated with

the goal of promoting novelty. While exposure to novelty has been found to promote well-being for most animals, it can be potentially anxiogenic for highly inhibited individuals. A study of orange-winged Amazon parrots (*Amazona amazonica*) found that highly fearful birds showed increased anxiety in response to rotating enrichment compared to non-fearful birds (Fox & Millam, 2007). Similarly, Yamanashi and Matsuzawa (2010) examined the behavior of chimpanzees while they were performing various cognitive tasks (e.g., Numerical Sequence Task in which the chimpanzee chooses numerals in ascending order and a Masking Task in which the chimpanzees have to memorize numerals). Cognitive tasks such as these have been utilized as enrichment (Washburn & Rumbaugh, 1992). Half of the chimpanzees in the study were labeled as "stress sensitive" because they displayed self-directed behaviors such as scratching while performing the tasks. The stress-sensitive chimpanzees were more likely than others to become agitated when they got an incorrect response on the cognitive tasks (Yamanashi & Matsuzawa, 2010). Together, these studies suggest that enrichment may not confer the same benefits to all individuals and may even increase distress in some individuals.

In addition to promoting species-typical behaviors and reducing boredom, enrichment also can be used as a mitigation strategy to reduce stress in animals. Personality can affect how individuals perceive these mitigation efforts. For example, lavender oil has been found to be anxiolytic in several species (e.g., Cline et al., 2008; Hawken, Fiol, & Blache, 2012), including humans (Woelk & Schlafke, 2010). Researchers investigated the anxiolytic effects of lavender in female sheep selectively bred to have either a "calm" or "nervous" personality (Hawken et al., 2012). In this study, sheep were exposed to a mask containing either lavender oil or a control (peanut oil) for 30 min, after which they were isolated from their group for 5 min. Not surprisingly, calm sheep showed less agitation during the isolation stress than nervous sheep, regardless of whether they received the lavender or the control. However, the authors found an interaction between personality and the effects of the lavender. Lavender had an anxiolytic effect for calm sheep; compared to controls, sheep that received the lavender showed less agitation and lower plasma cortisol concentration. In contrast, nervous sheep given lavender showed higher agitation and plasma cortisol in response to the isolation stress compared to controls (Hawken et al., 2012). Results such as these are not only relevant to behavioral management of sheep, but may adapted to other species, including humans.

Compatibility

Another component of behavioral management is socialization. Socialization, or housing animals with compatible conspecifics, has been shown to be an important factor in promoting psychological well-being of a variety of species (Coleman et al., 2017). However, socialization can result in aggression or even trauma if the partners are not compatible. Therefore, finding compatible partners is important. There is evidence that humans tend to choose partners with similar personalities to their own (Dijkstra & Barelds, 2008). This relation recently has been explored in nonhuman

primate species as well. Studies in rhesus macaques (Capitanio, Blozis, Snarr, Steward, & McCowan, 2017; Coleman, 2017) have found that female, but not male, monkeys were more likely to be successfully pair-housed with partners that had similar personality traits. Pairs in which the partners had similar personalities engaged in more affiliative and less aggressive behavior than pairs consisting of partners with dissimilar personalities. Similarly, in capuchins (*Sapajus* sp.), dyads with similar personalities (particularly in the traits Neuroticism and Sociability) had higher quality relationships than those with differing personalities (Morton, Weiss, Buchanan-Smith, & Lee, 2015). The authors also found that monkeys high in Neuroticism and low in Sociability tended to avoid social relationships in general. While more work needs to be done in other species, these results highlight the role of personality in relationships.

Positive Reinforcement Training

Positive reinforcement training (PRT) is another component of many behavioral management programs. PRT is a form of operant conditioning in which the subject is presented with a stimulus (e.g., a verbal command), responds by performing a specific behavior (e.g., present a body part for injection), and is provided with reinforcement (e.g., food treat). Several studies have demonstrated that positive reinforcement training can reduce behavioral and physiological indices of stress associated with common management procedures (Bassett, Buchanan-Smith, McKinley, & Smith, 2003; Schapiro, Bloomsmith, & Laule, 2003). For example, Lambeth and colleagues (2006) found that chimpanzees trained to voluntarily accept an injection of anesthetic (Ketamine HCl) have lower hematological indicators of stress (e.g., neutrophils and white blood cells) than chimpanzees who were not trained for this task.

While positive reinforcement training is generally considered to enhance well-being, there is a great deal of variation among individuals with respect to training. Some subjects are relatively easy to train and learn tasks quickly, while others do not appear to learn tasks as easily. Personality has been found to play a role in training success. For example, in a series of studies (Coleman, 2017; Coleman et al., 2005), we found that shy, fearful macaques were less likely than bold monkeys to successfully learn tasks including touching a target and presenting a body part. Similarly, reactive macaques were found to be less likely to cooperate with voluntary restraint than calm monkeys (Bliss-Moreau & Moadab, 2016).

Results of these studies suggest that personality assessments can identify individuals that may be difficult to train. However, it is not practical, or in many cases desirable, to restrict training to those animals with certain personality traits. Thus, there is a need to develop alternate training techniques for fearful or reactive animals. Nonhuman primates and other animals are known to imitate the actions of others (e.g., Subiaul, Cantlon, Holloway, & Terrace, 2004); thus, one potential alternate training technique is to have subjects watch a conspecific train various tasks, in the hopes that the observer would learn through social learning or imitation, a process by which observers (i.e., subjects) can learn from skilled "teachers" or demonstrators.

There is evidence to suggest that personality may play a role in an individual's propensity to engage in social learning. In an interesting study, Carter, Marshall, Heinsohn, and Cowlishaw (2014) assessed two personality traits, shy/bold (as measured on a novel object test) and anxious/calm (as measured by response to a model predator) in wild baboons (*Papio ursinus*). They then examined the propensity for the animals to engage in social learning to solve a task (finding either a novel or familiar food item). Both boldness and anxiety were found to be associated with social learning. Bold, anxious baboons were more likely to perform the task after watching a conspecific perform that task than shy/calm individuals (Carter et al., 2014). These animals were not necessarily more likely to watch the demonstrators, but rather seemed to have an increased propensity for learning. Studies along these lines could serve as a model for other species.

Farming Community

Another field in which personality is often used as a tool is in agricultural science. Indeed, it is not uncommon for the farming community to selectively breed for particular temperamental traits, including docility in cattle (Haskell, Simm, & Turner, 2014) and reduced aggression in pigs (Turner et al., 2008). This has been done both for the safety of personnel as well as for welfare and productivity reasons. Highly reactive livestock tend to have decreased growth rates and increased susceptibility to illness than less reactive animals (Dodd et al., 2012). In addition, calm personality has been associated with production measure such as meat tenderness in cattle (Coutinho et al., 2017), enhanced milk production in cows (Sutherland et al., 2012), and higher wool growth in sheep (Plush et al., 2011). It is thought that these differences might be due, in part, to the circulating corticosteroids (Plush et al., 2011). Not only do these findings have practical implications, but they can also affect the welfare of the animal. The welfare of stress-sensitive animals may be compromised due, in part, to their inability to cope with stress (Finkemeier et al., 2018; Gibbons et al., 2011; Sutherland et al., 2012). For example, highly reactive cattle may injure themselves in the weigh chutes.

Conclusions

In recent years, there has been a sharp increase in published studies of animal personality. This trend underscores the importance of this trait across a wide range of fields. Studies of animal personality can provide insight into studies of human personality, but are also important in their own right. Personality affects many aspects of animals' lives, including their factors important to welfare and how we can appropriately manage their needs.

Personality also can be an unintended confound in scientific studies. For example, we have shown that it is more challenging to train shy rhesus macaques for vari-

ous tasks than their bolder counterparts (Coleman et al., 2005). Thus, it is possible that shy animals may be disproportionately removed from studies in which subjects must be trained for a particular task, such as getting blood drawn, leading to sample bias. This kind of sample bias may be particularly problematic for studies in which the animals voluntarily cooperate with tasks. In these scenarios, animals with particular temperamental traits (e.g., shy) may be less likely than others to participate, which could skew resulting data. In a recent study, zoo-housed squirrel monkeys rated on personality assessments as "low caution" and "high gentleness/affection" were more likely than others to voluntarily participate in training (Polgar, Wood, & Haskell, 2017). This bias also may be present in cognitive studies. In a recent study (van Horik, Langley, Whiteside, & Madden, 2017), researchers found that neophobic pheasants (as measured on a novel object test) were less likely to participate in voluntary cognitive assessments than bolder group mates. The authors point out that this differential participation can lead to misinterpretation of cognitive performance. Even if participation in cognitive testing is not voluntary, performance may be affected by personality. This may be particularly valid in situations in which a human tester is present. Inhibited or shy individuals may have more difficulty performing the task not because of diminished cognitive ability, but rather because of an inherent wariness of the human.

Similarly, capture methods can also introduce sample bias in studies in which subjects are removed from the natural environment. Capture methods that involve a degree of novelty seeking may be more likely to attract bold members of the population. For example, Wilson et al. (1993) captured pumpkinseed sunfish from a pond with one of the two methods, a novel object (empty minnow trap) or a seine net. Fish caught in the trap were bolder than those caught in the net in a number of variables (Wilson et al., 1993). In that study, the minnow trap served as a novel object test. However, had the trap had been the sole capture method, the population of fish used in subsequent studies would have been disproportionately bold. In field studies, shy fish may be more likely to hide or flee, while bold animals might be more likely to approach human observers, resulting in sample bias. Researchers should be cognizant of these potential biases and account for them when possible.

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Evolution of Adaptive Individual Differences in Non-human Animals

Denis Réale and Pierre-Olivier Montiglio

Introduction

For a century, personality has been an important concept and research domain in psychology. In contrast, only at the beginning of the twenty-first century have ecologists and evolutionary biologists started studying personality differences among individuals of a species. Potentially because animal personality was an appealing and intuitive concept at first sight, it became attractive to many animal behaviorists and behavioral ecologists. Others have criticized the concept, either because they considered the term too anthropomorphic or because they regretted the descriptive, a-theoretical nature of this novel field. Over the last two decades, though, several thousand studies have been published on this topic (see Coleman, Chap. 14, this book), leading to novel theoretical and empirical developments and making animal personality one of the most important and dynamic research topics in current studies on animal behavior. In this chapter, we have decided to focus on the advances in the study of non-human animal personality from a biological point of view, to provide the reader a perspective that may differ from what psychologists have used to focus on. We hope our chapter shows the differences and similarities between this body of work and the approaches used in human personality psychology.

Tinbergen's (1963) influential paper on the causes of behavior has guided research on animal personality over the last 20 years. Research has focused on three of the four causes proposed by Tinbergen. First, the neuroendocrinological mechanistic/proximal causes of personality differences have been explored and represent a major research field (Groothuis & Carere, 2005; Groothuis & Schwabl, 2008; Koolhaas et al., 1999; Koolhaas, de Boer, Buwalda, & van Reenen, 2007). Second, personality differences may find their sources during ontogeny (Groothuis &

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Trillmich, 2011; Sachser, Hennessy, & Kaiser, 2011; Stamps & Groothuis, 2010). Third, behavioral traits may be compared among species and linked to specific ecological conditions or explained by historical (i.e., phylogenetic) contingency. Phylogenetic studies of behavior in a personality context are still the least developed field of study. The rarity of studies using a phylogenetic approach may come from the difficulty of standardizing personality tests and measures among species (Réale, Reader, Sol, McDougall, & Dingemanse, 2007). Phylogenetic analyses of behavior are also less considered because of the very definition of personality, which emphasizes differences among individuals within populations (discussed later in the chapter). Can we actually compare behavior among species as differences in "personality" if personality is the feature of populations (Réale & Dingemanse, 2012)? Finally, ultimate (i.e., evolutionary) causes may explain personality differences observed currently in wild animal populations, and these differences may have ecological or evolutionary consequences for these populations. Animal personality represents individual variation that explains part of the measured, phenotypic variation, and that is the substrate on which selection can act to produce evolutionary change. This has naturally led scientists to argue for a more prominent use of a quantitative genetic framework when studying animal behavior (Dingemanse & Réale, 2005; Dochtermann & Roff, 2010; Réale et al., 2007) and human personality (Penke et al., 2007; Réale, 2007; Réale & Dingemanse, 2011; Réale & Weiss, 2013). Quantitative genetics have four objectives: to estimate the components (e.g., genetic or parental) of the phenotypic variance of a trait and the covariance between traits, to examine the factors affecting this (co)variance, to estimate the shape and strength of selection pressures acting on these traits, and to analyze the role of (co)variance components on the evolutionary response of traits to selection (Lynch & Walsh, 1998). A quantitative genetic approach to the study of behavior had been underexploited in the past (Boake, 1994; Fairbairn & Reeves, 2001). After two decades of research, animal personality could, thus, be considered as a mature field of research with ramifications in physiology, neuroendocrinology, ecology, and evolution.

In this chapter, we first provide a quick history of the evolutionary and ecological study of animal personality. We then discuss the differences and similarities of terminologies and approaches used by evolutionary biologists/ecologists and by psychologists. Finally, we review the consequences of personality differences for ecology and evolution at the successive stages of an organism's life.

A Brief History of the Evolutionary and Ecological Study of Personality

Psychology has a long tradition of research on personality (Dumont, 2010). In the nineteenth century, pioneers such as Galton and Pearson became interested in the heritability of personality in humans, whereas Janet, Freud, Jung, or Adler developed the foundation of personality research with their work on mental pathologies. In the meantime, a few other scientists, among whom Pavlov, Yerkes, and Hebb,

started analyzing animal personality (Gosling, 2008), although psychologists' interest only started in the 1970s (Gosling, 2001).

In comparison, ecological and evolutionary studies of animal personality started 30 years later in the 2000s. The delay may seem surprising since the study of within-population phenotypic variation, including behavioral variation, is central to evolutionary biology (Darwin, 1859, 1872). By the late 1970s, ecologists and evolutionary biologists started showing the first signs of an interest for individual differences in behavior and for the associations among the behavior of individuals across multiple ecological contexts (a.k.a. personality and behavioral syndrome, respectively, as we will see in more details below). For example, Chitty (1967) argued that individual (genetic) differences in social behavior (i.e., aggression and spacing), which rapidly change in frequency under natural selection pressures, could play a role in the self-regulation of rodent populations. Myers and Krebs (1971) presented some evidence for a dispersal syndrome in two species of voles (Microtus ochrogaster and M. pennsylvanicus). Hutingford (1976) showed a positive link between aggression toward conspecifics and risk taking toward potential predators in three-spined sticklebacks (Gasterosteus aculeatus). Armitage and Svendsen estimated individual variation in social behavior in yellow-bellied marmots (Marmota flaviventris; Armitage, 1986a, 1986b; Svendsen & Armitage, 1973). Arnold and Bennett (1984) and Brodie III (1993) have analyzed anti-predator behavioral variation among garter snakes (*Thamnophis* sp.). Clark and her colleagues examined the ecological consequences of individual differences in behavior of pumpkinseed sunfish (Wilson, Coleman, Clark, & Biederman, 1993).

The 1970s period also witnessed the first reviews putting individual behavioral variation within an ecological context. Bekoff (1977) provided evidence for individual behavioral variation in mammals and hypothesized that individual differences in their propensity to disperse result from differences in the rate of social (agonistic) interactions within a litter during their ontogeny. Clark and Ehlinger (1987) reviewed the evidence for individual behavioral differences and behavioral syndromes in animals. Wilson, Clark, Coleman, and Dearstyne (1994) was probably the first review paper that triggered the vibrant interest for personality in the early twenty-first century.

The study of personality in ecology, however, really began at the turn of the new millennium. In 2003, a summer Association for the Study of Animal Behaviour conference, organized in Grünau (Austria) by Kurt Kotrschal, was probably one important starting point in the development an international research field in animal personality. Among the first to start, Drent and his colleagues have initiated a thorough research project on the great tits, combining work in the laboratory and in the field (see, e.g., Dingemanse, Both, van Noordwijk, Rutten, & Drent, 2003; Drent, Oers, & Noordwijk, 2003; van Oers, Drent, Dingemanse, & Kempenaers, 2008; Verbeek, Drent, & Wiepkema, 1994). To date, the great tit personality project counts among the most complete cases of the ecological study of wild animal personality. Reviews on the topic have flourished in the early millennium and helped in developing the field (Dall et al., 2004; Dingemanse, Kazem, Réale, & Wright, 2010; Dingemanse & Réale, 2005; Réale et al., 2007; Sih, Bell, Johnson, & Ziemba, 2004;

Smith & Blumstein, 2008). In the meantime, other papers have reviewed the quick progresses done on the neuroendocrinological mechanisms of individual behavioral differences (e.g., Groothuis & Carere, 2005; Koolhaas et al., 1999). Others have encouraged the development of ontogenetic studies of personality (e.g., Stamps & Groothuis, 2010) or of the genetics of personality (e.g., Réale et al., 2007; van Oers et al., 2005) and evidence of selection acting on personality (e.g., Dingemanse & Réale, 2005). More recently, studies have been linking personality differences with metabolism or life history traits (Biro & Stamps, 2008; Careau, Thomas, Humphries, & Réale, 2008; Réale, Dingemanse, Kazem, & Wright, 2010; Réale, Garant et al., 2010). Since then, there has been an explosion of papers on animal personality, both from a mechanistic and from the evolutionary and ecological point of view.

Differences and Similarities in Terminology and Approaches Between Research on Human and Non-human Animals

Terminology. Work in behavioral and evolutionary ecology considers the role of behavioral traits—anything that we can measure about the behavior of an organism—within its ecology. It also analyzes how differences in traits among individuals covary with differences in their fitness (i.e., whether the trait is under selection). Variation is key here. Without differences among individuals in their behavior, selection cannot generate any evolution. Researchers have been interested in parsing out the variation that exists in any behavioral trait into (1) differences that exist among individuals (i.e., so called among-individual differences) and (2) the differences that exist in the behavior of these individuals when they are measured repeatedly over time or in different contexts (e.g., in the presence or absence of a predator, so called within-individual variation; Dingemanse & Dochtermann, 2013).

After years of discussions, biologists have reached a consensus over their definition of personality. For most of them, the term "personality" refers to the presence of *consistent individual differences in behavioral traits over time and across situations* (see e.g., Réale et al., 2007). In other words, individuals' mean behavioral trait values deviate systematically from each other and from the average value of their population. The shyest individual in a given year or context is still the shyest in another year or context. Importantly, consistent individual differences, personality, are a property of a group of individuals; it is not possible to define the personality of an individual without any reference to its population. Consistent individual differences are possible even when individuals' behavior is not consistent itself. For example, all individuals could plastically change their behavior to changes in their environment (e.g., increase or decrease their aggressiveness as a function of the size of their opponent), while preserving their behavioral differences (e.g., the individuals that are the most aggressive when facing a smaller opponent are still the most aggressive when facing a bigger one).

A widespread measure of the importance of consistent among-individual differences is the repeatability or the proportion of the total phenotypic variance in a trait that is observed among individuals. The repeatability of a behavioral trait is thus the ratio of among-individual variance over the sum of among- plus within-individual variance (Boake, 1989; Hayes & Jenkins, 1997; Lessells & Boag, 1987). Interpreting a repeatability estimate requires to consider the temporal scale over which the measurements were collected (Réale & Dingemanse, 2012). An individual can plastically adjust its behavior in response to immediate environmental effects or temporary variation in an individual's hunger state (Dingemanse, Dochtermann, & Nakagawa, 2012). Over a short time, part of the among-individual behavioral differences may thus be caused by state differences or environmental conditions experienced temporarily. At a larger time-scale, though (i.e., a period of a month or a year), an individual's hunger state or body condition will likely change and thus should not create consistent among-individual differences. This is why repeatability declines with the time between the measurements (Bell, Hankison, & Laskowski, 2009, Réale & Dingemanse, 2012). Note that personality questionnaires should be exempt from this issue, as the raters are generally asked to evaluate their actions, attitudes, and emotions over a large range of situations spreading over a long period. However, questionnaires hardly capture the within-individual variance component.

Consistent differences in behavior among individuals also have been studied as behavioral syndromes (Sih, Bell, & Johnson, 2004). Behavioral syndromes emphasize the presence of an association between the behavior of an individual within a given ecological context (i.e., during mating interactions) or at a given time (i.e., as a juvenile) and its behavior in another ecological context (e.g., when foraging) or at another time (e.g., as a sexually mature adult). Researchers have quantified the presence and strength of behavioral syndromes as correlations between pairs of measurements taken on organisms' behavior. The major difference between the concept of personality and that of behavioral syndrome is about the way we quantify consistent differences: personality indicates that a significant portion of the variance in behavior is observed among individuals (i.e., it uses a variance ratio). Behavioral syndrome indicates that any two measurements of organisms' behavior are linked (i.e., it uses a correlation). A behavioral syndrome approach can be more far intuitive to many researchers because it does not build on a complex quantitative genetic framework. A personality approach can be more flexible because it can consider more than two measurements or ecological contexts within a single analysis.

From an ecological or evolutionary perspective, personality is, therefore, the repeatable dimension of a behavior trait. However, we think it is preferable to use the term "behavior trait" rather than "personality trait," as any trait has both a repeatable and a non-repeatable dimension of respective influences. Note that any other type of trait can also have such a dimension; for example, researchers have studied the personality dimension of parental behavior, risk taking, social behavior, or exploration. Among-individual differences in that trait could be called personality phenotypes. However, phenotypic differences in the trait should be called behavioral phenotypes.

Personality and behavioral syndromes, as defined from an evolutionary and behavioral ecology perspective, encompass temperament and coping styles (Gosling, 2001; Réale et al., 2007). There are a few nuances between these terms. Psychologists define temperament as the inherited and biological basis for behavioral tendencies. Temperament appears early in life and serves as a foundation for personality. They differentiate temperament from personality itself, which is built on the experiences (e.g., physical, cultural) accumulated by the individual during its whole life (Gosling, 2008). People who work on the behavioral and neurophysiological reaction of animals in response to a stressful situation talk about coping styles (Koolhaas et al., 1999). However, from a biological standpoint, there is no need to separate temperament, coping style, and personality, particularly for the study of the evolutionary and ecological consequences of this phenomenon (Réale et al., 2007).

Approaches. Psychologists often quantify animal personality using a scoring approach: they observe individuals in a natural setting to quantify the frequency of particular behaviors or their intensity (Uher, 2008; Weiss & Adams, 2013). This approach presents the advantage of quantifying behaviors in their natural context. Many behaviors are only expressed in response to conspecifics, mates, or conditions that are difficult to recreate experimentally. We can thus only study them using the scoring approach. Unfortunately, the scoring approach does not allow us to control for all the potential effects artificially generating behavioral differences among individuals. For example, individuals may behave more boldly than others because they were observed in a safer environment. Animals also often select their environment to match their phenotype through niche picking. For example, bold and shy individuals can settle in different parts of the habitat, which could then further exacerbate their differences in boldness (or any other behavioral trait). It thus becomes impossible to separate the cause from the consequence; do bolder individuals live in a safer environment or do individuals that live in a safer environment behave more boldly?

Alternatively, personality can be quantified using a rating approach: researchers design questionnaires to score behavior in a series of situations or contexts (Costa Jr. & McCrae, 1992). Personality dimensions are then extracted using multivariate analyses (Crocker & Algina, 1986; Nunnally & Bernstein, 1994). This approach when applied to non-human animals is usually restricted to captive or domestic animals, where keepers can rate different individual animals (Uher, 2008; Weiss & Adams, 2013). The rating approach has proven to be highly reliable in these conditions (Weiss & Adams, 2013). Nevertheless, it is seldom applicable to wild animals that are not as easily observable for long periods as captive or domestic animals (Réale & Dingemanse, 2012).

Biological studies quantify animal personality using an etching approach: They experimentally subject individuals to standardized, often stressful conditions to observe their reaction. This approach also has been proposed by comparative psychologists with a series of tests such as the open-field test, the novel-object tests, the startle test or the mirror or the dyadic encounter test. With each of these tests, we

can only grab a facet of the whole personality of an individual (Carter, Feeney, Marshall, Cowlishaw, & Heinsohn, 2013), and it is thus clear that we could not get the level of information that other methods will provide. However, it remains a very robust way of measuring personality in animals. Its undeniable advantage is that measurements are collected in standardized conditions, thus minimizing uncontrolled effects on behavior and through repeated measures of different traits in time to provide a way to analyze the among- and within-individual dimensions of phenotypic variation.

Using different approaches, biologists have studied the processes generating consistent differences among individuals. Consistent individual differences can first be caused by genetic differences. Inbreeding can alter behavioral traits (Meffert, Hicks, & Regan, 2002), and thus individuals with distinct levels of inbreeding may differ consistently in their behavior. Parents affect the behavior of their offspring permanently through behavioral interactions, parental care, hormones transmitted through the egg or the placenta, or the modification of the natal environment (Arnold, Ramsay, Donaldson, & Adam, 2007; Champagne, 2008; Groothuis & Carere, 2005; Groothuis & Schwabl, 2008). Environmental conditions early in life can also have persistent effects on the behavior of an individual. For example, competition with offspring in a nest can modulate the aggressive behavior of individuals later in life (Carere, Drent, Koolhaas, & Groothuis, 2005). During ontogeny, the environmental conditions experienced by an individual affect its behavior and bias the probability that it experiences similar conditions later in life. Thereby, a series of feedback loops between personality at one development stage and experience or state can modulate the development of personality throughout time (Groothuis & Trillmich, 2011; Sih et al., 2015; Stamps & Groothuis, 2010). Furthermore, an individual can learn to select the most appropriate conditions for its personality, a process called niche picking (Stamps & Groothuis, 2010). Psychologists have been aware that niche picking can maintain heritable behavioral variation for some time (Penke et al., 2007). In many species, repeated social interactions with conspecifics have an important effect on the development of personality and can lead to the development of specialized social roles (Bergmüller & Taborsky, 2010; Montiglio, Ferrari, & Réale, 2013). For biologists, this phenomenon generates genotype(individual)-environment correlation (individuals are not distributed randomly according to the environment).

The genetic, parental, and early environmental effects translate into behavioral variation through several proximate, physiological processes. For example, it has been shown that personality is linked to variation in the activity of the hypothalamus-pituitary-adrenocortical (HPA) axis, the main nervous system in charge of dealing with stress (Koolhaas et al., 1999), or the production of stress hormones (Atwell et al., 2012, Koolhaas et al., 1999; Montiglio, Garant, Pelletier, & Réale, 2015; Øverli et al., 2007) or testosterone (Baugh et al., 2012; While et al., 2010). However, that link is not observed systematically in the wild (Dosmann, Brooks, & Mateo, 2014; Ferrari et al., 2013). Consistent individual differences in behavior are also generated by differences in the activity and reactivity of the sympathetic and

parasympathetic nervous systems (Koolhaas et al., 1999, 2007) or by differences in the turnover rate or the expression of dopamine and serotonin (Coppens, de Boer, & Koolhaas, 2010; Munafò et al., 2003; Reif & Lesch, 2003; van Oers & Mueller, 2010; but see Korsten et al., 2010).

Developments in mixed-model statistics have also prompted a thorough and quantitative investigation of the contribution of each source of variation, shaping behavior within populations (Class, Kluen, & Brommer, 2014; Dingemanse & Dochtermann, 2013; Dingemanse & Araya-Ajoy 2015; Wilson et al., 2010). These models can reach high levels of complexity, including the estimation of genetic and permanent environmental effects on individual differences or individual by environment interactions. Individual by environmental interactions represent individual differences in plasticity, and can in turn be composed of genetic by environment interactions or the genetic differences in plasticity among individuals. In accordance with some of the work on coping styles (Koolhaas et al., 1999), differences in plasticity among individuals within populations can also covary with the average behavior (i.e., the personality) of individuals (Dingemanse & Wolf, 2013). Further developments have also allowed researchers to dissect the residual variation, unexplained by genetic effects. In accordance with some of the predictions from the coping style model (Coppens et al., 2010), it now appears that some individuals are less predictable than others (Stamps, Briffa, & Biro, 2012).

The reasons for the variance in within-individual variance are not well understood at the moment. Part of these differences could arise from individual differences in plasticity (reaction norms) in response to unmeasured environmental effects or from individual differences in the range of conditions encountered by individuals that are unmeasured (Brommer, Karell, Ahola, & Karstinen, 2014; Réale & Dingemanse, 2010). Alternatively, they could reflect an adaptive strategy. For example, it is often beneficial for prey to behave unpredictably to predators. Conversely, repeated social interactions can lead to the coexistence of consistent and inconsistent individuals within populations (e.g., Wolf, Van Doorn, & Weissing, 2010). Such developments are very beneficial because they have allowed researchers to integrate more fully the study of behavioral plasticity, behavioral consistency, and behavioral differences at the individual level. Accounting for plasticity and individual consistency will also allow for robust and precise estimates of personality in free-ranging animals, where environmental conditions cannot be controlled but instead need to be accounted for by statistical models.

Finally, several evolutionary processes can provide an ultimate explanation for the maintenance of individual behavioral variation in natural populations, among which are frequency-dependent selection, temporal or spatial heterogeneity in selection patterns, sexual antagonistic selection, correlational selection, and trade-offs between traits (Dingemanse & Réale, 2013; Penke et al., 2007). Interestingly, not many of these processes have yet been investigated empirically and provided strong evidence for a link between selection patterns and behavior variation.

Consequences of Individual Personality Differences for Ecology and Evolution

Over the last 15 years, a growing number of studies have accumulated evidence for links between personality differences and ecologically relevant traits and characteristics of many species. We now know that almost every life stage of an organism can be considered under the light of personality differences, and we can now say that personality has important implications for both the ecology and evolution of species. We consider that this is where animal personality has made its biggest progress. Below we provide some of the most striking examples where researchers have found links between personality differences and some facets of an organism's life, suggesting that personality affects an individual's decisions during its life.

First Steps in Life. In species providing parental care, offspring have to go through a stage during which they are dependent on the care provided by the parents (Clutton-Brock, 1991; Royle, Smiseth, & Kolliker, 2011). That situation has led to the evolution of conflicts between parents and their offspring, and among siblings, over the care that should be provided to each offspring (Trivers, 1974). It is hard to imagine that personality differences among offspring do not play a role in parent-offspring dynamics and sibling conflicts (Roulin, Dreiss, & Kölliker, 2010). However, few studies have been published on the question. For instance, Roulin et al. (2010) discussed the role of aggressive behavior in begging and sibling competition in altricial birds. The proportion of aggressive offspring in the brood may have serious consequences on the differential growth of offspring and interactions among offspring. Furthermore, food shortage may reduce the average body mass at fledging for a brood of lowly aggressive offspring but lead to high variance in survival within a brood of highly aggressive offspring. For precocial species, such as many ungulate species, where the offspring is mobile a few hours after birth, differences in personality may play an important role in the dynamics of emancipation and the socialization of the offspring. Mothers surely play a role in that dynamic too as we see below. The explorative offspring may go too far from the herd and get caught by predators, which means that environmental conditions may lead to selection for specific behavioral types in offspring. Note that as for many traits (Wilson & Réale, 2006), personality differences at a younger age can be mainly attributed to genetic or parental effects. In the case of genetic effects, we can expect that depending on their personality, different parents have to deal with different brood dynamics, and that this may affect their reproductive success. In the case of parental effects, parents have a way to manipulate the personality of their offspring to fit with the environmental conditions in which their offspring will live. We will discuss this more in the section on parental care.

Dispersal, Habitat Selection, and Space Use. There comes a point when offspring have to leave their parental environment to establish themselves in a new place. At this point, individuals disperse, and several researchers have considered that some traits such as exploration or boldness could influence the propensity to disperse and the distance of dispersal (Bekoff, 1977; Clobert, Le Galliard, Cote,

Meylan, & Massot, 2009; Cote, Clobert, Brodin, Fogarty, & Sih, 2010). There is now numerous evidence that, among vertebrates, fast explorers, highly aggressive, lowly neophobic, or lowly sociable individuals, are more likely to disperse and are also long-distance dispersers (Cote & Clobert, 2007; Dingemanse et al., 2003; Fraser, Gilliam, Daley, Le, & Skalski, 2001; Quinn, Cole, Patrick, & Sheldon, 2011).

During dispersal, animals have to select the habitat in which they will live and reproduce. The habitats available to a dispersing animal may differ in their characteristics, such as their level of food abundance or quality, in the level of predation risk, or in the density of refuges available. Habitats may also differ in the social environment they will offer to the dispersing animal. The density, the sex ratio, or even the general personality distribution of conspecifics may also change from one place to another. The personality of an individual can determine the particular habitat it chooses during dispersal. For example, juveniles of the common lizard (species) differ in how attracted they are to the odor of other members of their population. Some juveniles are sociable and will consistently be attracted to this odor, while others that are lowly sociable will be repulsed by it (Cote & Clobert, 2007). At low lizard density, the sociable juveniles had a higher probability of dispersing than less sociable ones. In contrast, at high density, lowly sociable juveniles had a higher probability of dispersing than sociable ones. Hence, at low density, sociable lizards may disperse and go to densely populated habitats, whereas at high density, lowly sociable individuals disperse to lowly populated habitats. Individual personality can also determine how choosy the animal is when selecting a new habitat. Juvenile eastern chipmunks, Tamias striatus, select a burrow in a habitat that is like their natal habitat, and slow explorers are pickier than fast ones in their choice of a habitat around their burrows (Réale et al., unpublished data).

Once established, individuals use their home range in different ways according to their personality. For example, Boon et al. (2008) found that in North American red squirrels (Tamiasciurus hudsonicus), fast explorers tend to be caught more often outside their territory and at longer distances from their territory than slow explorers. Larger home range use and higher rates of captures were also found in Siberian chipmunks (Boyer, Réale, Marmet, Pisanu, & Chapuis, 2010). Roe deer use a variety of habitats from forested areas to open agricultural fields. Using GPS data from individuals with known personality, Bonnot et al. (2015) have been able to show that bolder individuals (propensity to take risks) used open habitats more frequently. Such differences in habitat use can have consequences for survival when the risk of mortality varies with the habitat. Elks (Cervus elaphus) with a higher rate of movements, and using open terrains close to roads more frequently, had a higher probability of being killed during the hunting season (Ciuti et al., 2012).

Mating. The personality of an animal can affect its mating success and thus be the target of sexual selection (Schuett, Tregenza, & Dall, 2010). Being more active, or more aggressive, allows males to acquire more mates in some systems (Patterson & Schulte-Hostedde, 2011; Sih, Chang, & Wey, 2014). An individual's personality could also be associated with its mating tactics. That association raises the possibility that variation in personality is maintained by the selective and evolutionary mechanisms, maintaining alternative mating tactics within populations (frequency

or condition dependence, see Andersson, 1994; Oliveira, Taborsky, & Brockmann, 2008). For example, in the great tit (Parus major), fast exploring males sire more offspring out of their nests, while slow exploring males sire a greater proportion of the chicks in their nest (Patrick, Chapman, Dugdale, Quinn, & Sheldon, 2012; van Oers et al., 2008,).

Because part of the traits is consistent over time or across situations, personality could also act as a sexual signal used by individuals to assess whether mating with a partner is beneficial or not. The level of choosiness expressed by males or females also can be associated with their personality. In zebra finches (Taeniopygia guttata), exploratory females prefer to mate with males that are more exploratory, while less exploratory females do not exhibit any preference (Schuett, Godin, & Dall, 2011). Interestingly, pairs of more exploratory individuals produce heavier offspring that reach independence in better condition (Schuett et al., 2011, b). Surprisingly, in great tits (Parus major), males expressed a similar pattern of mate preference. Fast explorers exhibited a preference for fast exploring females, while slow explorers did not express any preference (Groothuis & Carere, 2005). These studies hint that the necessity for parents to coordinate their behavior during territory defense and parental care might both favor individual behavioral consistency and allow different personalities to have equal mating success.

Social Interactions and Social Roles. Many animals have to interact repeatedly with their conspecifics, either because they live in social groups or because they establish territories and defend them against their neighbors. The particular tendency of an individual to be aggressive or sociable varies consistently in many animal species. Guppies (Budaev, 1997), and marmots (Armitage, 1986a, 1986b) exhibit consistent differences in their tendency to seek out and tolerate conspecifics. Personality can also determine who interacts with whom, within a social group. In the Trinidadian guppy (Poecilia reticulata), individuals tend to interact preferentially with conspecifics of similar sociability, while bolder individuals had fewer social ties with their shoal members (Croft et al., 2005, 2009). In captive sticklebacks (Gasterosteus aculeatus), bolder individuals maintain more social connections more evenly distributed across group members, than shyer individuals (Pike, Samanta, Lindstrom, & Royle, 2008). Animals with different personalities differ in their tendency to interact with conspecifics and vary in with whom they prefer to interact. Thus, the particular "mix" of personalities present in a group or society might have an impact on the social dynamics of the group (Krause, James, & Croft, 2010). In water striders Aquarius remigis, rare but unusually aggressive males can affect the general mating dynamics of a whole mating group of individuals by harassing and driving both males and females into hiding (Sih & Watters, 2005). The presence of such unusually aggressive males could decrease the intensity of sperm competition experienced by individuals in the population (Wey, Chang, Fogarty, & Sih, 2014).

The particular personality of individuals within groups or populations can also impact the group performance and behavior. Individual great tits (Parus major) differ consistently in the speed at which they explore a novel environment (Verbeek et al., 1994). The exploration tendencies of individuals predict their position in

flocks when they forage for ephemeral and clumped patches of food (e.g., beech mast, Krebs, MacRoberts, & Cullen, 1972). Fast exploring individuals form weak bonds with many conspecifics, but those bonds are less stable over time. Fast exploring individuals are also more likely to be observed in multiple foraging flocks over the winter. In contrast, slow exploring individuals form fewer but stronger bonds that are more stable over time (Aplin et al., 2012, 2013). These relations between an individual's personality and its position within the social structure are likely to originate from different social preferences among individuals, associated with their personality (Aplin et al., 2012, 2013). Because of their position within the social structure of foraging flocks, fast explorers are more likely to discover novel food patches than slow exploring individuals (Aplin et al., 2012).

Parental Care. Parental behavior can typically include caring for the eggs (e.g., incubation, oxygenation, or insulation) or the offspring, but also defending the nest, burrow or the offspring directly against predation and cannibalism (Clutton-Brock, 1991). Personality has been linked with parental care in two ways. First, some studies have shown individuals can differ in their level of parental care as a function of their personality expressed in another context. For example, in blue tits (Cyanistes caeruleus), males that are more aggressive feed their nestling at a lower rate than less aggressive males (Mutzel, Dingemanse, Araya-Ajoy, & Kempenaers, 2013). Many of these aspects of parental behavior have been found to vary consistently among males or females. For example, Westneat, Hatch, Wetzel, and Ensminger (2011) found repeatable differences in the rate at which males and females of house sparrow (Passer domesticus) provision their offspring, even after accounting for environmental differences during parental care. Some studies also report that males express a higher consistency in provisioning rates than females (Nakagawa, Gillespie, Hatchwell, & Burke, 2007, but see Westneat et al., 2011). Such differences among individuals, however, did not seem to be associated with additive genetic variation, meaning that these cannot respond to selection pressures (Wetzel, Hatch, & Westneat, 2015). Interestingly, individuals also showed different levels of plasticity and adjusted their provisioning rate differently, depending on brood size and age (Westneat et al., 2011). Such differences in plasticity in provisioning rates could arise if, in response to the increase in food needed, some individuals raised chicks' provisioning rates, while others switched to bigger food items (Westneat et al., 2011). In contrast, the time spent incubating the eggs did not vary consistently among parents (Nakagawa et al., 2007). An important question is what determines which aspects of parental care exhibit most consistent variation among individuals in a system. In species with biparental care, a major question is how individual consistency in parental behavior can affect the way males and females negotiate their effort either in real time or over evolutionary time (Nakagawa et al., 2007, see also McNamara et al., 1999).

While most of the evidence for consistent differences in provisioning rates among parents come from bird species (Bell et al., 2009), fish with parental care also show consistency. In three-spined sticklebacks, Gasterosteus aculeatus, males differ in the time they spend fanning their clutch (Stein & Bell, 2014), which oxygenates them and clears the carbon dioxide (Wootton, 1984). Parental care also

includes territory and nest defense in many species, and males also differ consistently in their willingness to defend their offspring against potential predators or other sticklebacks (Stein & Bell, 2014). Interestingly, males that fanned more of their eggs are also more willing to defend their offspring, suggesting that males exhibit a clear behavioral syndrome linking multiple aspects of parental behavior (Stein & Bell, 2014). Parental care in sticklebacks is not only necessary for offspring survival (Wootton, 1984) but can also act to "program" offspring phenotypes. Fathers decrease the time they spend fanning the eggs when exposed to predation threat (Stein & Bell, 2014). Interestingly, offspring that experienced such a reduced parental care hatch at smaller sizes and express a decrease in their activity under predation threat to a greater extent than offspring with normal parental care (Stein & Bell, 2014). Such findings parallel extensive laboratory studies in rodents. In these animals, mothers differ in the grooming and licking behavior they provide to the offspring during the first few days after birth (Meaney, 2001). Pups that were less groomed or licked grow to differ in many ways from pups that received more maternal care.

Dealing with Predators. Eating and being eaten is the fate of many animals, and recent studies indicate that personality difference can have strong implications for the way they perceive predation risk and for predator-prey relationships. However, to date, it is still not clear which behavioral type is favored by selection from predators. In a study on bighorn sheep (Ovis Canadensis), Réale and Festa-Bianchet (2003) discovered that during years of high predation by cougars, bolder and more docile adult ewe had a higher survival. Surprisingly, no difference was observed in survival among ewes with varying boldness and docility during years of low predation by cougar. We still do not understand why bolder and more docile ewes are less susceptible to predation than shy and non-docile ones.

Predation is also suspected to affect the correlation between behavior traits. Bell (2004) compared two stickleback (Gasterosteus aculeatus) populations with and without predation and found that activity, aggression, and exploration were phenotypically and genetically correlated in the predated population but not in the naïve population. Using two groups of six populations each with and without predation, Dingemanse et al. (2007) confirmed the hypothesis that predation could lead to correlations among behavior traits. Bell and Sih (2007) experimentally tested the effect of predation on the association between behavior traits and found that predation pressures were favoring combination of traits that could generate positive correlation between them.

Getting Old. There are two ways to see potential links between behavior traits and age. The first one is purely developmental: at each stage of their life, the costs and benefits associated with expressing a particular personality may change, and thus, the average personality phenotype may change with age (Niemelä, Vainikka, Hedrick, & Kortet, 2011). The second potential link occurs through differential survival of individuals with different personality types, which leads to changes in the abundance of different personalities among different age classes. In both cases, differences in personality types with age may inform biologists about the functional role of behavior on life history decisions.

Differential survival among individuals with different personalities has been the topic of recent developments following the observation that personality was linked to life history strategies (Biro & Stamps, 2008; Réale, Gallant, LeBlanc, & Festa-Bianchet, 2000, Réale et al., 2009, Réale, Dingemanse, et al., 2010; Réale, Garant, et al., 2010; Stamps, 2007; Wolf, van Doorn, Leimar, & Weissing, 2007). In their theoretical model, Wolf et al. (2007) played with the idea that behavioral decisions affect an individual's reproductive assets, and that behavior plays a functional role in both survival and reproduction. Based on these two assumptions, fast personality phenotypes (i.e., high aggression, high boldness, fast exploration) should coevolve with a fast life history (early life reproduction and short life). In contrast, slow personality phenotypes (low aggression, shyness, and slow exploration) would associate with a slow life history (late reproduction and long-lived type). Following the seminal paper by Ricklefs and Wikelski (2002) on the pace of life and the link between physiology and life history, Réale, Dingemanse, et al. (2010) and Réale, Garant, et al. (2010) proposed a general conceptual framework, according to which a whole suite of personality, physiological, or immunological traits were expected to be associated with the position along the slow-fast life history continuum. Furthermore, they showed that these links were observed for individuals within a population, for populations within a species, or for different species. An increasing number of studies have tested that framework, either completely or partially, with mixed results. One reason for mixed results may be that studies have not verified the two basic assumptions behind Réale, Dingemanse, et al. (2010); Réale, Garant, et al. (2010) framework or Wolf et al. (2007) model. First, a trade-off should be found between early reproductive effort and survival or late reproduction. Second, behavior or physiological traits should have a functional role either in terms of survival or reproduction. For example, bold or aggressive types should grow faster and mature earlier in life but die younger than shy, lowly aggressive types. Unfortunately, studies have rarely tested for the presence of these two assumptions. More work is needed on the link between personality and life history decision, growth rate, age at maturity, or senescence.

Conclusion

Over the last couple of decades, we have seen an unprecedented increase in studies in non-human animal personality. Personality is without contest a strong field of research in animal behavior. Recent studies have demonstrated how considering individual consistent behavioral differences has changed the whole field of animal behavior by linking several disciplines such as psychology, physiology, development, ecology, and evolution together to provide answers about this phenomenon. Animal personality research has built up bridges between biology, ecology, and psychology. It participates in the current trend in the development of integrative biology. The most important contribution of personality to progress in behavioral ecology has been to help people clarify what they measure when they measure

behavioral phenotype, and what they are talking about when they interpret phenotypic differences. It also has forced us to nuance and refine what we see as adaptive in an organism's behavior and nudged a better integration of behavioral ecology within evolutionary biology as a whole. Considering individual differences in behavior has allowed researchers to gain insights into when and where a behavioral trait can be subject to selection and whether this trait can respond to selection.

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Why Do People Have Painful Feelings? An Evolutionary Tale of Misery and Woe

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Introduction

There are many types of painful feelings that humans normally experience. There is the pain of heat, the pain of cold, the pain of flesh that has been crushed, the pain of flesh that has been cut, the pain of a chemical burn, the pain of electric shock, the pain of hunger, the pain of eating something distasteful, the pain of being sick with an infection, the pain of a noise that is too loud, the pain of fear, the pain of anger, the pain of disgust, the pain of jealousy, the pain of guilt, the pain of shame, the pain of anxiety, the pain of sadness and depression, and so on. It should be clear from this list that I am using the term "pain" in a rather broad sense to refer to any unpleasant, aversive feelings.

Why do we have painful feelings? Evolution has imbued our nervous system with the capacity to experience painful feelings to help us avoid problems or threats that—over evolutionary time—were associated with decreased reproductive success (fitness). These feelings are ancient—we share them with many other organisms, including fish and invertebrates. There are many different types of painful feelings because there are many different types of problems and threats that organisms have evolved to avoid.

In this chapter, I provide an overview of evolutionary accounts of painful feelings, including the pain that accompanies tissue injury and painful emotions or feelings that accompany social problems. I further demonstrate the utility of this perspective in the context of depression. I focus on this feeling state because it is usually considered pathological in the mental health fields. In other words, depression represents a feeling state where an evolutionary perspective provides novel insights. However, the principles are generalizable to other feelings of clinical interest, such as anxiety, which I also briefly discuss.

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The Evolution of Painful Feelings

In the field of evolutionary psychology, most researchers explicitly or implicitly propose that emotions have two related functions (Andrews & Thomson Jr, 2009; Buss, 2000; Nesse, 1990; Sznycer et al., 2016; Tooby & Cosmides, 1990; Tybur, Lieberman, Kurzban, & DeScioli, 2013). First, emotions have a motivational function in which the organism gives precedence to some problem or threat relative to other competing goals. Second, all emotions have a coordinating function. The body is composed of multiple systems (e.g., circulatory, musculoskeletal, pulmonary, integumentary, digestive, immune, and nervous systems), each of which perform crucial functions. To produce an adaptive response to environmental contingencies, these systems must be regulated in a coordinated fashion.

The motivational and coordination functions of emotions are really two sides of the same coin. To give priority to one problem or another in the environment requires that body systems be differentially regulated. For instance, fear will increase the priority given to avoiding a predator above other goals, such as foraging, mating, and immune defense, but this can only be accomplished by differentially regulating the digestive, musculoskeletal, and immune systems. The emotion of disgust motivates behavior involved in avoiding a potentially contaminated food source and upregulates immune defense, while downregulating the systems involved in foraging and mating (Tybur et al., 2013).

Researchers interested in whether fish and invertebrates have the capacity to feel pain have reached similar conclusions (Sneddon, 2015; Sneddon, Elwood, Adamo, & Leach, 2014). A normal pain response has two major features. First, painful feelings are necessarily aversive, and it is their aversiveness that gives them motivational power. “The key function appears to be that the aversive experience of pain creates a strong and lasting motivation that enables the animal to avoid getting into a similar situation in the future” (Sneddon et al., 2014, p. 202). Thus, the injured organism is motivated to engage in avoidant learning and avoidant behavior.

At this point, it is useful to distinguish between two uses of the term “avoidant” in psychology. Avoidant learning is typically viewed as an adaptive process by experimental psychologists who study how behavior is shaped by experience. In this research tradition, the emphasis is on how the organism learns to avoid some noxious situation or stimulus, which are external events. However, within clinical psychology, “avoidance” often refers to how individuals avoid aversive thoughts or feelings, which are internal states. In this context, avoidance is thought to be maladaptive because it inhibits the processes that allow negative moods to resolve, such as reappraisal and habituation (Clark, 1999; Foa & McLean, 2016; Hunt, 1998; Litz & Keane, 1989). In this chapter, I discuss both concepts. However, I will only use *avoidant behavior* and *avoidant learning* to refer to the adaptive avoidance of noxious external stimuli. To maintain conceptual clarity, I will use the term *analgesic behavior* to refer to distraction, thought suppression, rubbing of injured tissue, self-medication, or other behaviors that attempt to avoid or soothe aversive internal feelings. Of course, the aversive properties of painful feelings motivate

both avoidant behavior and analgesic behavior. However, the evolved function of painful feelings is to motivate avoidance of noxious external stimuli. Below, I show an example in which the administration of an analgesic can lead to maladaptive outcomes by impairing the organism's ability to avoid noxious external stimuli. Consequently, analgesic behavior is a property of a normally functioning pain mechanism (Sneddon, 2015; Sneddon et al., 2014), but it is not the evolved function of pain mechanisms. Analgesic behavior is more properly termed a *byproduct* or a *spandrel* (Andrews, Gangestad, & Matthews, 2002).

The second major feature of painful feelings is that they must involve a whole-body response, which is related to the idea that emotions have a coordination function. Put another way, the concept of a whole-body response implicitly recognizes that multiple systems in the body must be regulated in a coordinated fashion to produce adaptive motivational changes.

Pain in Fish and Invertebrates

Lynne Sneddon and her colleagues have thoroughly reviewed the evidence that fish and many invertebrates meet both the motivational and coordination criteria for a normal, evolved pain response to physical injury (Sneddon, 2015; Sneddon et al., 2014). In this section, I briefly review a few relevant findings to demonstrate the proposition that painful feelings motivate the organism to avoid noxious stimuli.

In an elegant experiment, Robyn Crook and her colleagues demonstrated how painful feelings help longfin inshore squid avoid predators (Crook, Dickson, Hanlon, & Walters, 2014). They randomly assigned the squid to either injury or no-injury conditions and crossed that with an anesthetic treatment or no anesthetic treatment in a 2x2 experimental design. In the injury conditions, they clipped the end of one of the squid's tentacles during surgery; some squid received a transient local anesthetic treatment during surgery whereas others did not. Then the squid were placed into a tank with a natural fish predator of the squid—black sea bass. Interestingly, the sea bass appeared to be able to detect the injuries, because they preferentially targeted the injured squid. Moreover, the injured squid were more likely to be caught by the fish. However, the squid that were at the greatest risk of capture were those that had been injured and received the anesthetic. The injured squid that had not received the anesthetic were less likely to be caught because they took evasive maneuvers sooner, taking greater efforts to maintain distance from the predator. In other words, the pain of the injury motivated the squid to take extra precautions that helped it to avoid predation by the sea bass. These extra precautions were not taken by the anesthetized squid.

Another set of experiments have shown that goldfish are capable of learning spatial and visual cues that are associated with electrical shock, that they use these cues to avoid the shock, and that a local anesthetic inhibits this learning (Dunlop, Millsopp, & Laming, 2006; Millsopp & Laming, 2008; Yoshida & Hirano, 2010). In one of these experiments, goldfish were trained to feed in a certain area of the tank

(Millsopp & Laming, 2008). Subsequently, the researchers introduced an electric shock when the fish came to the feeding area. The fish avoided the feeding area in a dose-dependent fashion—the more intense the shock, the more they avoided the feeding area. In a follow-up experiment, the shock in the feeding area was kept constant, but the researchers varied the amount of time that the fish were deprived of food. Again, they found dose-dependent effects—the longer the fish were deprived of food, the more time they spent in the feeding area and endured the shock.

These results effectively demonstrate the point of this chapter. The electric shock is aversive, and the fish are motivated to learn that the feeding area is associated with the shock. Consequently, they spend more time avoiding the feeding area when the shock is more intense. The motivational nature of aversive feelings is further highlighted by the follow-up experiment. In that experiment, the fish are put in a dilemma in which they are deprived of food, and they must endure a severe shock in order to feed. The fish integrate their need for food with the aversiveness of the shock, and they are motivated to avoid the more severe problem. When they have recently been fed, they avoid the shock and the feeding area, but when they have been deprived of food for several days, they endure the shock in order to feed.

The Painful Feeling Triggered by Inescapable Shock

The evolutionary view of painful feelings can provide novel insight into the depressive-like state that rats experience when they are exposed to repeated, inescapable shock (Maier & Seligman, 2016). In the typical inescapable shock experiment, animals (usually rats) are randomized to one of three conditions. In the first condition, the rats are simply restrained (R). In the second condition, the rats are exposed to shocks that they can learn to terminate by spinning a wheel or pressing a lever. This is often called the escapable shock (ES) condition, because the shock is under the rat's control. The third condition is called inescapable shock (IS). The IS condition involves tethering the rat to another rat in the ES condition such that they both receive shocks of the same intensity and duration at the same time. The difference between the IS and ES conditions is that the IS rat is unable to terminate the shock through its own efforts. Thus, the IS rat lacks the ability to control the shocks that the ES rat has.

After going through one of these three conditions, the rats are then given a task, which I will refer to as a *secondary task*, because it is secondary to the shock paradigm. In the original experiments, the secondary task involved learning to jump over a hurdle in a shuttle box in order to escape a shock (Maier & Seligman, 2016). While the rats in the R and ES conditions easily learned how to avoid the shocks by jumping over the hurdle, the IS rats had great difficulty learning this. Because the ES rats experienced just as many shocks as the IS rats, the slower learning by the IS rats must have been attributable to their inability to control their shocks. The learning deficits following inescapable shock (IS) have been demonstrated in a number of organisms, including dogs, cats, and fish (Abramson, Seligman, & Teasdale, 1978; Maier & Seligman, 2016; Seligman, 1975), but the paradigm has been most widely studied in rats.

The learning deficits following IS also generalize to a number of secondary tasks, a fact which was important in the development of the *learned helplessness* hypothesis (Maier & Seligman, 2016). The essence of the learned helplessness hypothesis is that exposure to IS leads the organism to believe that nothing it does matters (Maier & Seligman, 2016). The learned helplessness hypothesis requires that organisms have the capacity for developing the expectation that outcomes are uncontrollable, a proposition that—when applied to non-human animals—was quite radical in the 1960s when the hypothesis was first proposed (Maier & Seligman, 2016). Additionally, the learned helplessness hypothesis proposes that IS produces a motivational deficit. Specifically, that the organism loses the motivation to try to control its environment. Finally, the learned helplessness hypothesis proposes that IS triggers depressed affect. Animals exposed to IS exhibit a number of behavioral changes that correspond to the symptoms of depression in humans, and IS has become an important non-human animal model of depression (Maier & Seligman, 2016). Put simply, the learned helplessness hypothesis proposes that the IS rat experiences aversive feelings (i.e., depression), and it lacks motivation to avoid noxious stimuli.

The evolutionary account introduced above suggests that these two elements of the learned helplessness hypothesis cannot both be correct. Specifically, if the IS rat has truly lost motivation for avoiding noxious stimuli, then it should not feel any pain. The function of painful feelings is to motivate avoidance of noxious stimuli. Thus, if the IS rat does have painful feelings, it will be motivated to avoid noxious stimuli. In other words, the evolutionary account suggests that the learned helplessness hypothesis is wrong in one of two ways: (1) the IS rat does experience painful feelings, but it has not lost motivation to control its environment; or (2) the IS rat has lost motivation to control its environment, but it does not experience painful feelings.

In the rat, IS triggers behaviors that closely map onto many of the symptoms of depression in humans (Maier & Seligman, 2016). In humans, depression is aversive, but is it possible to tell whether the IS rat also experiences this state as aversive? IS rats exhibit an increased preference for analgesic substances, such as alcohol and morphine (Volpicelli, Ulm, & Hopson, 1990; Will, Watkins, & Maier, 1998). Moreover, the preference persists after the shocks have stopped, and it does not develop in ES or R rats (Volpicelli et al., 1990; Will et al., 1998). The preference for analgesia is an important attribute of organisms having normal pain responses (Sneddon et al., 2014), so the analgesic behavior of the IS rat strongly suggests that the depressive-like state is aversive.

Precisely because this state is aversive, it should have motivational effects. The fact that IS rats feel enough distress to seek out analgesia suggests that their pain does have motivational properties. What is their distress motivating them to avoid? Following IS, the rat shows an enhanced ability to learn which cues are associated with noxious stimuli, otherwise known as fear conditioning (Shors, 2004; Shors, Weiss, & Thompson, 1992). In other words, IS rats are motivated to identify cues associated with threats, which suggests that they may not have given up avoiding threats such as shocks after all.

We suggest that IS rats may simply have switched strategies for trying to avoid the electric shocks. In the literature on human cognition, it is generally recognized that there are two major information processing styles (Evans & Stanovich, 2013). Type 1 processing tends to be fast, associative, and automatic, while Type 2 processing is slower, attentionally demanding, rule-based, analytical, and controlled. Perhaps the defining characteristic of Type 2 processing is the use of working memory (Evans & Stanovich, 2013), which is a type of memory in which information is kept in an active state because it is used in ongoing processing (Baddeley, 2007). Moreover, there is some evidence that rats are capable of both processing styles (Beckers, Miller, De Houwer, & Urushihara, 2006; De Houwer, Hughes, & Barnes-Holmes, 2016). In the non-human animal literature, the rapid, simple processing style most like Type 1 is termed *associative*, while the slow, complex processing style most like the analytical Type 2 style is sometimes termed *propositional* (Boddez, De Houwer, & Beckers, 2017).

The distinction between Type 1 and Type 2 processing styles can help explain some otherwise puzzling findings in the literature on IS. For instance, the shuttle box experiment is probably best solved with a quick, simple Type 1 processing style, since it only requires the animal to figure out that it needs to jump over a hurdle once to avoid the shock. Rats previously exposed to IS often solve the shuttle box task equally well as the ES and CR rats (Maier, Albin, & Testa, 1973; Maier & Testa, 1975). To elicit performance deficits in the shuttle box test by IS rats, the researchers must make the task more complicated by requiring the rat to cross the hurdle at least twice to stop the shock. However, the more complex the behavioral response required of the rat to stop the shock, the more likely it is that other extraneous events will occur (sounds, visual cues). Indeed, the IS rat is more likely to perceive multiple environmental cues that could potentially be associated with the termination of the shock (Minor, Jackson, & Maier, 1984; Shors, 2004). Thus, another potential explanation for the performance deficits on complicated versions of the shuttle box task is that IS rats—by virtue of increased Type 2 processing—consider and test more hypotheses about the causes of the termination of the shock.

Moreover, many of the learning deficits associated with IS—such as the slower learning in the shuttle box task—are due to the fact that IS rats are less physically active. When the second task does not require much physical activity to solve, IS rats tend to learn *more* rapidly than rats in the ES or R conditions (Glazer & Weiss, 1976). Because Type 2 processing is more effortful and attentionally demanding than Type 1, it may require organisms to be less physically active so that fewer attentional resources are devoted to navigating the environment (Andrews & Thomson Jr, 2009).

The Type 2 processing that rats are capable of has been demonstrated in a fear conditioning paradigm in which the rats are trained to associate a foot shock with auditory or light cues (Beckers et al., 2006). In this paradigm, the rats have been shown to engage in propositional reasoning about the causal relations between the cues and the shocks. In short, rats are capable of slow, analytical Type 2 reasoning about causal relationships if sufficiently motivated by a painful stimulus.

With this as background, I review an important set of experiments conducted by Thomas Minor in Steve Maier's lab (Minor et al., 1984). They involved the typical IS protocol discussed above followed by performance on a Y-maze task. In the Y-maze, rats start off at the base of the Y, and they receive foot shocks through the floor of the maze. The shock usually motivates the rats to move, but the shock continues as they move and come to the junction in the maze. If the rat goes down the correct arm of the maze (left or right) the shock terminates, and the shock continues if the rat goes down the incorrect arm. Previous research in Maier's lab had shown that IS rats, but not ES or R rats, were slower to learn the correct arm to terminate the shock (Jackson, Alexander, & Maier, 1980). However, other researchers who had employed a similar paradigm had failed to find a learning deficit in IS rats (Irwin, Suissa, & Anisman, 1980).

Minor et al. (1984) wanted to investigate reasons for the discrepancies, and they identified two possible reasons. First, Jackson et al. (1980) had used a variable delay in terminating the shock after the rat had entered the correct arm, while Irwin et al. (1980) had used a fixed delay. Minor et al. (1984) reasoned that the variable delay may have made it more difficult for the rats to determine that the cause of the shock's termination was their decision to go down one of the Y-maze's arms.

Second, Jackson et al. (1980) had placed an experimenter in the room when the rats were doing the Y-maze, whereas Irwin et al. (1980) had used an automated procedure that did not involve the presence of a researcher. Minor et al. (1984) considered the experimenter's presence to be an irrelevant task cue, and they suggested that perhaps the IS rats were more easily distracted by irrelevant cues. However, as discussed above, we now know that IS potentiates fear conditioning (Shors et al., 1992), and we also know that fear conditioning can promote Type 2 causal analysis in rats (Beckers et al., 2006; De Houwer et al., 2016). So, another possibility is that the IS rats may have entertained more hypotheses about the causes of the termination of the shock. After all, the rats were not privy to the design details of the experiment—they did not know that the experimenter's presence was an irrelevant cue. For IS rats—thinking more carefully about the causes of shock termination through Type 2 reasoning—the presence of the experimenter may have made the problem more complex because there were multiple causal hypotheses to consider for the termination of the shock (e.g., the rat's decision, the experimenter's behavior).

Minor et al. (1984) conducted several experiments to test these hypotheses, and they found that both the variable delay and the presence of the experimenter were required to produce the slower learning in the IS rats. It was known that IS is more likely to produce learning deficits on complex tasks (Maier & Testa, 1975), so the researchers suggested that both the variable delay and the presence of the experimenter may have contributed to the complexity of the Y-maze for the IS rats. Put another way, Type 1 processing is probably sufficient to solve the Y-maze—all the rat needs to do is figure out which arm to go down to stop the shocks. However, when a variable delay is employed and an experimenter is present, an IS rat that is primed to go through slow, careful, analytical Type 2 processing may be more likely to consider multiple causal hypotheses.

To investigate attention to external cues, Minor et al. (1984) conducted a follow-up experiment in which they first put the rats through the typical conditions of an IS experiment, then they tested them on a Y-maze where a light bulb had been added. The light bulb was either placed in the correct arm for avoiding the shock (C), the incorrect arm (IC), the same arm that the rat started in (S), or no light at all (NL). The rats were tested in five blocks, with 20 trials in each block.

In all light bulb conditions, the ES and R rats showed a pattern of declining errors across the five blocks, which means that over time they figured out which arm to go down to terminate the shocks. The IS rats also showed a declining pattern of errors for the IC, S, and NL light bulb conditions. However, the pattern for the C condition (when the bulb is placed over the correct arm to terminate the shock) showed a unique, inverted u-shaped pattern. In other words, in the first block, the rate of errors by the IS rats was low, which contrasted with the ES and R rats who had a high rate of errors. This suggested that the IS rats had learned more quickly than the ES and R rats in the first block. But the error rate increased (peaking at block 3) before declining again. This was a strange pattern, and the researchers suggested, "Perhaps yoked [inescapably shocked] subjects were more prone to test hypotheses concerning the relation of the light to correct choice responses" (Minor et al., 1984, p. 553).

Explaining why Minor et al. (1984) suggested that the IS rats "were more prone to test hypotheses" is easier if I use a bit of anthropomorphic language. The IS rats were paying attention to the light cue, and this resulted in a low error rate in the first block of the C condition. The pattern of results can be explained if the rats suspected that the light may have been helping them terminate the shock, but they were also entertaining other hypotheses. To prove whether the light was the key factor, they stopped using the light cue to guide their behavior in the second and third blocks. The increased rate of errors suggested that the light cue was in fact related to the termination of the shock, and so the rats reverted back to the use of the light cue in the fourth and fifth blocks, with a corresponding low rate of errors. In other words, when the rats used the light to guide their behavior, they had a low rate of errors; when they did not use the light as a guide, they had a high rate of errors; so the rats concluded that the light was causally related to the termination of the shock.

In summary, the evolutionary account of painful feelings suggests that the learned helplessness hypothesis for the effects of inescapable shock is inaccurate—particularly, the assumption that the IS rat lacks the motivation to avoid noxious stimuli. The depressive-like state triggered by IS is inherently motivational precisely because it is aversive. Only if the depressive-like state were not aversive would it lack motivational properties. Consistent with an altered motivational state, IS rats are more prone to analgesic behavior. What, then, is the function of this aversive, depressive-like state? What are the IS rats motivated to avoid? Most likely, they are motivated to avoid the shocks that triggered the depressive-like state. IS rats have not lost the motivation to learn cues that are associated with shocks (Shors et al., 1992), nor have they lost the motivation to avoid shocks (Glazer & Weiss, 1976). The IS rats appear to be motivated to adopt the slower, more methodical Type 2 processing style in which they consider a broader range of hypotheses about causal relations, which means they are slower to solve some tasks.

Depression in Humans

In psychiatry and clinical psychology, depression is considered an affective disorder characterized by a lack of motivation. The most important conceptual basis for this belief is the symptom of anhedonia (the loss of interest in activities that are normally pleasurable, such as sex, eating, humor, social companionship). According to the conventional narrative, the depressed person has given up the pursuit of adaptive goals—including sex and eating.

My analysis of IS, widely considered a model of human depression, suggests instead that the rat exposed to IS is simply in an altered motivational state in which escaping the shock is prioritized over other goals, including mating and foraging. If IS is in fact a good model of human depression, then the evidence should lead to similar conclusions about the motivational and cognitive effects of depression in humans. Specifically, human depression should motivate people to avoid some problem or threat in their lives, and we might expect it to be associated with Type 2 processing.

Complicating the issue is the fact that the term "depression" is a catchall phrase that encompasses multiple phenotypes (Insel & Charney, 2003). These phenotypes share in common the symptoms of sadness and anhedonia (loss of interest in activities that are normally pleasurable), but they differ in other symptoms, causes, and neurological mechanisms (Andrews, Bharwani, Lee, Fox, & Thomson Jr, 2015; Andrews & Durisko, 2017).

Elsewhere (Andrews et al., 2015; Andrews & Durisko, 2017), my colleagues and I have reviewed evidence that the symptoms produced by IS closely correspond to the symptoms associated with the melancholic type of depression, as it is usually described (Taylor & Fink, 2008). In addition to anhedonia, both IS and melancholia are characterized by decreased time spent sleeping, but a greater proportion spent in rapid eye movement (REM) sleep; there is a decrease in eating, but a relative preference for carbohydrate over protein; and both conditions are associated with chronic activation of the hypothalamic-pituitary-adrenal (HPA) axis.

Melancholia is also associated with *rumination*, which refers to distraction-resistant thoughts about the circumstances surrounding the episode (Gold, 2005; Taylor & Fink, 2008). There is some evidence that rumination involves Type 2 processing, which is an interesting correspondence with the literature on IS in rats. For instance, evidence of Type 2 processing has been shown in mood induction experiments, studies of subclinical depression, and even in some studies of clinical depression (Ambady & Gray, 2002;Andrews & Durisko, 2017 ; Andrews & Thomson Jr, 2009).

The symptoms of melancholia appear to be organized in a way that supports rumination (Andrews & Durisko, 2017; Andrews & Thomson Jr, 2009). For instance, anhedonia reduces interest in normally pleasurable activities that could disrupt the slow, methodical processing characteristic of Type 2 processing. Similarly, a loss of sleep is associated with rumination (Guastella & Moulds, 2007), which allows the individual to spend more awake time processing information.

Moreover, when the individual does sleep, the increased time spent in REM sleep should help consolidate information learned during waking hours (Rasch & Born, 2013). Finally, many studies have shown that blood cortisol levels are positively associated with rumination (Zoccola & Dickerson, 2012), and it has been argued that cortisol helps release glucose into the bloodstream that the brain uses as fuel for rumination (Gold, 2015). In short, melancholia appears to satisfy the requirement of a coordinated, whole-body response.

But what, precisely, is melancholia a response to? If we look to the IS literature as a guide, it is clear that it is the loss of control over the shock—not the shock itself—that triggers depressive-like symptoms in the rat (Maier & Seligman, 2016). The literature on human depression suggests that loss of control over the environment is a contributing factor to depression (Abramson et al., 1978). However, people do not get depressed over problems or stressors they believe were impossible to avoid (Abramson & Sackheim, 1977; Garber & Hollon, 1980). Paralleling my analysis of IS, to become depressed, people must experience a problem or stressor that they believe they could have avoided. Painful feelings motivate avoidant learning and behavior. If there is nothing that could have been done to avoid a problem, there is no adaptive value in producing aversive feelings.

Is there any evidence that melancholia motivates avoidant learning and behavior? Melancholia can be triggered by a variety of stressors (Taylor & Fink, 2008). In principle, this could cause variability in the precise way in which avoidant learning and behavior is instantiated. For this reason, it is important to control for the type of stressor that triggers the episode. In this context, a strong case can be made that physicians who get depressed after making a serious medical error exhibit avoidant learning and behavior.

Physicians commonly agonize over medical errors they have made, and the reasons are understandable. Medical errors cause harm to their patients, and they can put the physician in a position where they are concerned for their reputations and careers. Because errors are often avoidable, it is not surprising that physicians commonly experience depressive symptoms after making a serious medical error. In a study of 114 residents in internal medicine, 81% reported feelings of remorse after making a serious medical mistake, 79% felt angry at themselves, 72% felt guilty, and 60% felt inadequate (Wu, Folkman, McPhee, & Lo, 1991). Two large studies have found that making a medical error put residents at substantial risk of clinical levels of depression (Sen et al., 2010; West et al., 2006). In one of these studies, 63% of residents who reported having made a major medical error in the last 3 months screened positive for clinical depression, compared to 33% who did not report any errors (West et al., 2006).

After making an error, physicians commonly make *constructive changes* to their practice that probably reduce their chances of making a similar error again in the future. In a classic study, 82% of internal medicine residents reported paying greater attention to detail in response to their most significant medical mistake, 72% reported that they were more likely to personally confirm patient data, 62% reported seeking more advice, 54% reported reading more medical literature, and 49% reported trusting the judgment of others less (Wu et al., 1991).

The emotional distress that physicians feel is crucial to motivating constructive changes to their clinical practice. In one study, if internal medicine residents felt responsible for the error, they felt more distress and made more constructive changes to their practice (Wu et al., 1991). In another study involving nurses who made a medication error, the nurses reported making more constructive changes to their practice if they felt more anger at themselves, more guilt, or more inadequate (Meurier, Vincent, & Parmar, 1997).

A very similar response unfolds when psychiatrists have a patient who commits suicide. Patient suicide is common enough that it has been called "the most significant event in the training of a psychiatrist" (Sacks, Kibel, Cohen, Keats, & Turnquist, 1987, p. 218). Indeed, it is common for psychiatrists who have had a patient commit suicide to report feelings of depression, grief, rumination, anger, shame, guilt, and self-blame (Hendin, Haas, Maltsberger, Szanto, & Rabinowicz, 2004; Sacks et al., 1987). Again, the symptoms often reach clinical levels. In a study of psychiatric residents reporting on their emotional response to their first patient who committed suicide, 24% had clinical levels of emotional disturbance, with symptoms of depression being prominent (e.g., anxiety, loss of self-worth, intrusive thoughts) (Ruskin, Sakinofsky, Bagby, Dickens, & Sousa, 2004).

How do distressed psychiatric residents behave after a patient's suicide? (Sacks et al., 1987, pp. 218–219).

> Clinically, the resident becomes preoccupied with insuring that another suicide does not occur. On inpatient units, the possibility of another suicide seems imminent. Passes are cancelled, and more patients are placed on suicide observations. Worry is understandable since suicides have been [known] to cluster so that increased concern is appropriate, but the distinction between appropriate and excessive caution is [for] the moment blurred. In outpatient settings, patients who would otherwise be sent home are admitted. It is as if every clinical interaction with a patient is burdened by the fearful question of whether it indicates a need for suicide precautions.

Psychiatrists who have had a patient commit suicide report a number of other changes to their practice: being more vigilant for signs of suicidal thinking, more careful documentation, more detailed communication about patient records, greater use of formal suicide assessment tools to try to improve the ability to evaluate suicide risk, seeking out more medical knowledge about suicide risk, increasing personal availability to patients so they have someone to turn to when they are distressed, consulting with colleagues or team members about patients' suicide risk, and increasing efforts to understand patients' situations and feelings (Alexander, Klein, Gray, Dewar, & Eagles, 2000; Rothes, Scheerder, Audenhove, & Henriques, 2013).

These are excellent examples of avoidant behavior. Current suicide assessment tools are unable to predict suicidal behavior with any real accuracy (Large et al., 2016; Runeson et al., 2017). The distressed resident who has had a patient commit suicide realizes this brutal fact with stark clarity and errs on the side of caution, implementing changes that reduce the risk of any other patients committing suicide. From a clinical standpoint, the resident does not always make decisions that are best for the patient. But their behavior is clearly interpretable as an attempt to predict and prevent further patient suicides.

Again, the emotional distress that psychiatrists feel motivates such changes. In one study, psychiatrists who were highly distressed by a patient's suicide were more likely to reconsider how they had treated the patient and were more likely to be cautious in their approach with other patients in the future (Wurst et al., 2011). In another study, mental health workers who reported making the greatest changes to their practice (learning more about suicide, greater hospitalization of suicidal patients, greater consultation with colleagues, more attention to legal matters) also reported the highest rates of needing and seeking therapeutic support to cope with the suicide (Gulfi, Castelli Dransart, Heeb, & Gutjahr, 2010).

There are further questions that are worth investigating. For instance, what are the precise thoughts that depressed physicians have after having made a serious medical error? Do these thoughts provide evidence that the depressed physician is trying to understand how to make constructive changes to their practice?

Nevertheless, the fact that distressed physicians are more likely to make constructive changes to their practice after making a serious medical error demonstrates the utility of an evolutionary perspective. The conventional narrative recognizes the aversive nature of depression, but it inexplicably proposes that depression is a state in which motivation is lacking. This perspective is inaccurate—at least when it comes to depressed physicians who have made a serious medical error.

Anxiety-Related Conditions

The evolutionary perspective on painful feelings has also been generalized to anxiety and anxiety-related conditions, such as phobias, which I briefly review (Bateson, Brilot, & Nettle, 2011; Nesse, 2005; Ohman & Mineka, 2001; Russell, Maslej, & Andrews, 2015).

The primary symptom of anxiety is worry—distressing thoughts about an impending or anticipated problem. Put another way, anxiety is a future-oriented emotion where there is concern about a potential threat. From a clinical perspective, one of the most puzzling aspects of anxiety-related conditions is that they can be triggered by a threat that is highly unlikely to occur (e.g., "If I go to the party, everyone will laugh at me") or by something in the environment that does not seem to pose any real threat (e.g., a phobia of garden hoses). This makes anxiety-related conditions seem excessive or irrational.

However, from the evolutionary perspective I have reviewed, anxiety ostensibly evolved to avoid the threats that trigger the anxious feeling. The essence of a threat is that it is a feared problem or event that may be anticipated or impending, but it has not yet occurred. To prevent a threat from occurring is an interesting problem, because if one waits until the event occurs, it is too late to take corrective action. Thus, people must take corrective action on the basis of cues that are inherently imperfect indicators of the threat (Bateson et al., 2011; Nesse, 2005). For instance, when one suddenly comes across a long, slender object lying in the grass, it may be better to quickly jump aside before closely examining it to determine whether it is a

garden hose or a deadly snake. In situations of such uncertainty, there are two possible errors that can be made. A false positive error involves taking corrective action when the threat is not actually present, and a false negative error involves not taking corrective action when the threat really is present. But the two errors have different consequences. A false positive (jumping aside when the object is a garden hose) involves an expenditure of effort that turns out to have been unnecessary, while a false negative (not jumping aside when the object is a deadly snake) can be lethal. In such a situation, it may be better to adopt a better-safe-than-sorry approach.

The evolutionary perspective on anxiety is that it motivates a strategy of erring on the side of caution. Imagine that anxiety is controlled by a dial that goes from 0 to 10. As one turns up the dial from 0, anxiety goes from a wispy worry to an intense foreboding or trepidation. As one turns the dial up, the types of errors that one makes also change. When one has no anxiety at all (the dial is set at "0"), one will never make a false positive error (one will never confuse a garden hose for a deadly snake), but one will always make false negative errors (one will never take corrective action when the snake is actually present). And when the dial is turned all the way up to "10," one will never make a false negative error (one will always identify and avoid the snake), but one will be highly susceptible to false positive errors (one will take corrective action even when the snake is not present).

If you view the symptoms of anxiety as being controlled in this way, it is obvious that there is no point on the dial where one can definitively say that the symptoms are so severe that they must be disordered. Does anxiety become a disorder when the severity dial reaches 6? When it reaches 8 or 10? Most evolved emotional responses are regulated in a dial-like way because the brain must carefully match the emotional response to the demands of the situation. Put another way, the reason the anxiety dial goes up to 10 is because there are some situations where one simply cannot afford to miss a threat. Other threats, if missed, may only cause a slight inconvenience, so the whole range of the dial is required.

Conceptualizing anxiety as being regulated by a dial helps us to see that people will differ in where they set their dial, and these differences will often be adaptive. For instance, people who are exposed to more threats (e.g., they live in dangerous environments) or are more vulnerable to threats (e.g., they are injured or weaker) will probably have their anxiety dial set to a higher value (Bateson et al., 2011). A person who seems to have an excessive or irrational degree of worry may have good reason to err more on the side of caution.

Conclusion

The evolutionary theory reviewed in this chapter proposes that painful feelings evolved to motivate organisms to avoid problems or stressors in their environments. The reason why there are so many different kinds of painful feelings is because they evolved to motivate the organism to avoid different types of problems. Moreover, to effectively avoid a problem, each aversive feeling recruits and coordinates a different

whole-body response. I have focused on how this perspective can be employed to yield interesting and novel insights into feelings of depression and anxiety. But it has also been usefully applied to the study of disgust, jealousy, and shame (Buss, 2000; Sznycer et al., 2016; Tybur et al., 2013).

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Epilogue

Although shyness often has been regarded as a maladaptive or pathological trait, emerging views on the study of shyness have started to challenge this idea. In this volume, we assembled a group of leading experts from diverse fields of study who have each provided unique perspectives on the conceptualization of shyness spanning developmental, biological, social, cultural, and comparative and evolutionary perspectives, with an emphasis on the adaptive aspects of shyness. Contributors have illustrated that shyness is evident across both human and nonhuman animals, has different meanings across cultures, and serves different functions across development. What is clear from this collection of chapters is that shyness is not uncommon and can be expressed and experienced in a number of distinct ways. Most importantly, this volume has provided theoretical and empirical evidence to suggest that, despite common perception, shyness may in fact be viewed as an *adaptive* trait. The perspectives presented here are an important reminder that shyness may serve an important function to the human condition.

Twenty years ago, in an edited volume on shyness (Schmidt & Schulkin, 1999), in which many of the contributors of that volume also contributed to this current volume, we left a promissory note in the epilogue of that volume in which we suggested the importance of considering the positive and adaptive aspects of shyness. What does the future hold for the next 20 years in the study of shyness? We hope that over the coming decades we are able to better understand the developmental origins of adaptive shyness, the mechanisms involved in the maintenance of adaptive shyness, and the long-term outcomes of adaptive shyness by using prospective, longitudinal studies and incorporating objective behavioral and biological measures across multiple and diverse contexts.

Given that social connection is so fundamental to human existence and the systematic investigation into adaptive aspects of shyness is still in its nascent stages, it is our hope that the ideas raised in this volume will continue to ignite interest among current and future generations of students, educators, researchers, and clinicians.

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However, we would also be remiss without a further comment on this last point regarding social connection, given the current worldwide situation. Sadly, the publication of this volume coincides with the throes of the COVID-19 pandemic in which social distancing has emerged as a new term and a crucial aspect of daily behavior in order to manage the highly contagious spread of the novel coronavirus. It will be interesting to see if social distancing becomes a new kind of adaptive shyness, and if it has any lasting effects on emotional well-being.

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