Nonverbal Sensitivity in Adolescence

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Abstract

Nonverbal sensitivity is the ability to perceive and interpret social interaction cues, which is crucial in enhancing social dynamics, psychological well-being, and success in various life domains. While adults are generally believed to possess greater nonverbal sensitivity than children, the timeline for its development remains inadequately explored, particularly during adolescence. This study investigates the capacity of adolescents to infer emotional and social information from visual scenes and compares it to adults' abilities. The sample comprised 79 adolescents and 89 adults, with a balanced gender distribution (55.1% male), recruited through community advertisements. Participants were shown line-drawn images of social interactions (Teh et al., 2019) for durations of 1 second and 2 seconds, focusing on dimensions such as valence, intensity, and degree of social engagement. Accuracy scores were created by comparing gender-matched normed means (Teh et al., 2019). While accuracy scores did not differ significantly between the two viewing durations, increased accuracy was noted for intensity interpretations at the 2-second mark. Notably, age-related differences emerged in the valence condition, with adolescents demonstrating lower accuracy than adults. Additionally, gender differences were observed in both the valence and degree of social engagement dimensions, with females outperforming males. These findings indicate that even brief exposures (1 second) can yield reasonably accurate inferences, but adolescents exhibited a negativity bias, interpreting social scenes more negatively. This aligns with prevailing developmental theories on social processing during adolescence. This research contributes to a better understanding of nonverbal sensitivity in adolescents and underscores its significance for social perception.

Key words: nonverbal sensitivity, adolescence, social perception, social cognition development, and social perception accuracy

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Nonverbal Sensitivity in Adolescence

As adults enter a party and look around, they can—for the most part –identify which partygoers are dating, who are just friends, who is trying to get the attention of another, and much more. This process of "reading the room" happens quickly and effortlessly. However, a child might be unable to come to the same conclusions as the adult partygoer. Adults are thought to be better at "reading the room" than children, but what is the timeline for developing this skill? Perceiving and accurately deducing situations or intentions – or reading the room – has been widely studied and has had many names across various disciplines. These names include interpersonal sensitivity, nonverbal sensitivity, emotion recognition, decoding ability, inferential accuracy, empathic accuracy, mind reading, mental states attribution, accuracy at zero acquaintances, first impression accuracy, judgmental accuracy, and many more (for a review, see Hall, Schmid Mast, et al., 2016). To assess the ability to read various nonverbal cues as a whole with less focus on individual factors, the term "nonverbal sensitivity" fits best. The current study aims to examine the development of nonverbal sensitivity in adolescence.

What is Nonverbal Sensitivity?

Nonverbal sensitivity (NS) refers to the ability to perceive and interpret relevant cues in everyday social interactions. This can be as simple as understanding a joke aimed at someone you know; it relies on understanding the group dynamics, the relationships between the joke tellers and the recipient, whether they are being playful or harmful, etc. Not understanding the joke can lead to feelings of isolation or embarrassment and may even lead to consequences in the friendship. Developing nonverbal sensitivity may enhance social interactions, psychological well-being, and overall success in various aspects of life. Understanding and utilizing nonverbal cues can significantly impact our relationships and well-being. Adults can perceive and/or interpret even complex cues with a high degree of accuracy and can do so based on relatively little information. For example, one method researchers have used to examine this capacity is the "thin slice" paradigm. Thin slices consist of selected short, videotaped segments typically lasting less than five minutes, chosen from a longer videotape or a larger scenario. Studies have found that humans can make accurate social judgments from thin slices of information (Ambady et al., 2000; Ambady & Rosenthal, 1992; Hall et al., 2008; Wang et al., 2021). While developing an updated instrument measuring interpersonal perception – an alternative term for NS, Archer and Akert (1980) sought to understand the necessary amount of visual cues to make better-than-chance judgments. They conducted three studies using the Social Interpretations Task (SIT) – a measure composed of videotaped social scenes created to assess social interpretation accuracy. In study 1, the authors selected three scenes from the SIT, separating each scene into three equal parts for a total of nine segments. In study 2, the authors split the three selected scenes from study 1 into "its constituent channels of communication" (Archer & Akert, 1980, p. 407). Participants would be shown verbal transcripts, transcripts and audio, a photo, a silent video, or an entire scene with both visual and audio components. Finally, in study 3, the authors selected five stills from scenes and showed participants one of five conditions: only the tops of the photos, the bottoms, the right side, the left side, or the whole image. With each study, participants were asked to interpret various social cues, such as the nature of the relationship between the characters displayed.

Across these studies, participants performed above chance in interpreting accurately even when shown a single segment from a scene, a single channel of communication, and most of the photo segments. Further, they found that each segment, channel of communication, and most photo segments from each scene had above-chance accuracy ratings. Overall, these findings support the claim that a single segment, channel of communication, or image segment is enough to make an accurate interpretation and that people can perform equally well if shown as part of an interaction versus a whole (Archer et al., 2001; Archer & Akert, 1980). This corroborates the theory that adults can use smaller segments of interactions to make somewhat accurate judgments.

The range of constructs that humans may need to learn to perceive to be socially successful is varied and vast. It includes emotions, dispositions, traits, behavioural tendencies, relationship types and quality, deception, and context (Archer et al., 2001; Bernieri & Gillis, 2001; Colvin & Bundick, 2001; Hall, 2001; Malone & DePaulo, 2001; Nowicki & Duke, 2001). Murphy et al. (2019) suggested that people can relatively accurately perceive various types of social information from displays of nonverbal behaviour. The authors conducted various personality questionnaires on filmed actors and correlated these scores with coded nonverbal behaviours displayed (Murphy et al., 2019). Four hundred-one targets were videotaped for five minutes in a dyadic interaction. Following this videotaped interaction, the participants were asked to complete several questionnaires measuring personality, states, hireability, etc. Additionally, researchers coded the videotapes for six nonverbal behaviours: gaze, gestures, nods, self-touch, smiling, and speaking time. They measured correlations between nonverbal behaviours and the various attributes measured through the questionnaires. They compared the correlations between nonverbal behaviours coded for 1 minute versus the whole 5-minute interactions to assess if any predictive validity was lost by shortening the interaction. They found that there was little loss in predictive validity (with an average difference of r = .09 between averaged correlations of 1-minute segments and the whole 5-minute interactions). Speaking time showed the greatest loss, leading authors to suggest that measuring speaking time may not be as valid using thin slices when examining the ability to predict various traits. The authors also found that combining two slices (two minutes) had similar predictive validity to that of the whole interaction (five minutes) for most of the nonverbal behaviours (except for nods). These studies help us understand the mechanism behind NS, but we still need to examine what benefits we receive from being high in NS.

Nonverbal sensitivity allows for behavioural adaptivity and promotes successful interactions. This is due to the ability to read a situation correctly and anticipate needs or states in others (Schmid Mast & Hall, 2018). These successful interactions are essential to high social competence or intelligence (Sternberg & Li, 2020), which is critical to our subjective well-being and gives us the image of a well-rounded person. NS has been linked to various signs of social success (see Hall et al., 2009 for a meta-analysis on correlates). This can range from not understanding a joke to misinterpreting situations, causing social distress and potential feelings of isolation. Studies have indicated that errors in decoding others' behaviours and social situations using nonverbal cues are associated with greater depression, stress, mortality risk, and lower self-esteem (Carton et al., 1999; Eslinger et al., 2021; McCabe et al., 1999). Moreover, strengths in this skill are linked with intelligence, better psychosocial functioning and higher social competence (Archer et al., 2001; Dirks et al., 2018; Hall et al., 2009; Murphy & Hall, 2011).

By adulthood, humans are relatively good at NS. Indeed, adults can judge others' personality traits and social network characteristics with better than chance accuracy, even from observations under 5 minutes long (Ambady et al., 2000; Ambady & Rosenthal, 1992; Hall et al., 2008; Mobasseri et al., 2022). In Hall et al.'s (2008) comparison of mean levels of accuracy across tests, the authors found across 109 studies, the mean *pi* was .72 (above .50 being better than chance) of adults' accuracy in rating domains such as intelligence, personality, emotions/affect; status; and other.

Sensitivity to various constructs appears to have a developmental ordering, with some nonverbal cues being interpreted accurately in early childhood whereas others are not interpreted above chance level until adulthood. As with other complex skills, nonverbal sensitivity develops gradually over time. The constructs that children learn to perceive nonverbally differ across developmental stages. To reach this skill level, we need to examine the developmental precursors to NS and the associated social cognitive processes that may contribute to its development.

Developmental Precursors

How we process and respond to social stimuli is a core element studied under the umbrella term 'social cognition.' Theories of social development, such as Theory of Mind, should be discussed to understand better processes that contribute to nonverbal sensitivity. Theory of Mind refers to the ability to put ourselves in someone else's shoes – take others' perspectives even if they do not align with our own. This means we can imagine and understand others' states, beliefs, and intentions – in other words, meta-representation (Rakoczy, 2022). Theory of Mind explains how humans are capable of empathy and sympathy, as they would be required to imagine and take on the perspective of what another person is experiencing. This ability improves with age and is marked by achieving certain stages. Further, Theory of Mind could serve different purposes and is practiced differently depending on the developmental stage (Im-Bolter et al., 2016). Theory of Mind can be seen as an essential component of NS as it requires perspective-taking and increasing social learning.

In early childhood, infants begin to understand others through socialization, interaction and mimicry. Around nine months of age, infants begin to show a basic form of Theory of Mind;

they start to understand that others have their own goals and desires (Rakoczy, 2022). A series of tests examining seven-month-old infants' understanding of goal-directed actions found that infants displayed goal-oriented thinking (Hamlin et al., 2008). The authors did so by having a researcher grasp or reach towards one of two toys or ambiguously show the back of their hand to one of the toys. In some cases, the researcher would complete the action by touching/grasping the toy, while other times, they did not complete the action but displayed reaching towards the toy. Then, they measured whether the infant would imitate the action and grasp the target object. The authors found that the infants could imitate and grasp or reach the same toy that the researcher had touched. They could also do so when the researcher had not completed the action but indicated that reaching or grasping the toy was their goal (Hamlin et al., 2008). This study suggests that even by seven months of age, infants can analyze goal-directed actions and imitate others – which is a foundational step toward understanding others.

It is believed that at around four years of age, children reach meta-representation (Rakoczy, 2022). They begin to understand that not only do others have their own perspectives, but that this may differ from their own. They begin to be able to predict others' actions based on their understanding of the other's goal by tracking and decoding behaviour. The false belief task is commonly used to display Theory of Mind. For example, a child will be introduced to two characters, "Sally" and "Anne". Sally has a basket in front of her, while Anne has a box. Sally has placed a marble in her basket. Sally proceeds to exit the scene. Then, Anne takes the marble and puts it in her box. Upon Sally's return, the child will be asked, "Where will Sally look for her marble?" (Baron-Cohen et al., 1985). The correct answer is that Sally will look for the marble in her basket as it requires participants to imagine seeing what Sally has seen. Children who struggle with Theory of Mind will incorrectly state that Sally would look in the box (because they saw it go there). Researchers have studied various false belief tasks, and it appears that children approximately four years old tend to be able to answer the task correctly (Rakoczy, 2022). This marks an essential developmental stage in Theory of Mind; by four years of age, it is estimated that a child can take visual perspectives of others and predict their actions in simple false belief tasks.

This development continues into adolescence, and Theory of Mind becomes a more complex ability that differentiates into wider range of constructs; it continues to be refined until adulthood (Weil et al., 2013). In adolescence, researchers tend to use the term “mentalizing” to describe a more sophisticated form of Theory of Mind, which involves ongoing interpretation and reflection of both the self's and others’ mental states (Burnett & Blakemore, 2009; Frith & Frith, 2003). Symeonidou et al. (2020) found that while adolescents could display theory of mind, they were slower than adults. The authors conducted two visual-world eye-tracking studies to test whether adolescents and adults differed in the time course of predictive gaze in a simple and a higher-order Theory of Mind task. They used a standard false belief task that involved identifying a character’s perspective, as children tend to be able to complete belief tasks around the age of four successfully. For the higher-order task, the authors used a “Secrets” task in which participants had to predict how a character would behave to hide a secret. For example, if a character secretly loved the colour pink but did not want anyone to know, he would purchase a green car to hide this. This task requires more complicated higher-order thinking and perspective-taking. The authors tracked predictive gaze and found that, although adolescents could correctly predict a character’s choice, adults were faster. This study suggests that higher-order Theory of Mind is still developing in adolescence.

One well-studied component of nonverbal sensitivity is the ability to recognize emotions in facial expressions. Studies in this vein have found that there is improvement by age. Several studies have shown that children's emotion identification accuracy increases with age (between four and eight years old). By middle childhood, children tend to reach adult levels of accuracy in emotion identification (Lawrence et al., 2015). In addition, there seem to be gendered effects; females tend to be better at accurately inferring affective information from facial expressions than males (Hall, Gunnery, et al., 2016; Lawrence et al., 2015; Mobasseri et al., 2022).

Research consistently finds that the capacity to identify emotions from facial expressions correctly improves with age across childhood, though the tempo of development is faster for some emotions than others. Correct identification of anger and sadness tends to develop more slowly (Lawrence et al., 2015; Stella et al., 2022; Witkower et al., 2021). A particularly well-designed study examined improvement across age (cross-sectionally) in recognizing five "basic" emotions. In this study, which included 240 four to 18-year-olds (separated into five groups with 48 participants each), participants were presented with images of people displaying happiness, anger, sadness, disgust and fear. The intensity of the emotion was manipulated via software to portray various intensities (35%, 50%, 75%, and 100%; Montirosso et al., 2010). Each age group's performance was compared to that of 16 to 18-year-olds to assess whether the level of recognition was "adult-like." They found that recognition ability improved steadily from childhood into adolescence, except for disgust, which did not significantly improve with age. Improvement with age in accuracy was most dramatic for sadness. Regarding intensity, accuracy improved with age and as a function of the level of intensity of emotion depicted. Within the different intensity conditions, accuracy roughly peaked around age 13-15 such that by this age, it appears there were similar levels of accuracy to 16-18-year-olds. These findings highlight that nonverbal sensitivity, particularly in accurately identifying emotions from facial expressions, improves with age, peaking in adolescence, with notable differences based on gender and the intensity of emotional expressions. Reading emotions is an important element of NS, as emotions can set the tone for social interactions.

A similar developmental pattern is observed when emotion perception is studied using the thin slice methodology. In one of the earlier studies examining emotion perception from social scenes in children and adolescents, Magill-Evans et al. (1995) developed the Child and Adolescent Social Perception measure (CASP) to measure social perception in a semi-naturalistic context. They created ten videotaped scenes lasting between 19-40 seconds with two to four characters per scene. For example, in one scene, a boy is telling a story which he finds humorous to another boy while a girl sitting with them is disgusted by the story (Magill-Evans et al., 1995). Two hundred and twelve children and adolescents (M_{age} = 10.5, *SD* = 2.9, Range = 6 – 15) were asked open-ended questions about the scenes. In particular, researchers asked participants to identify how a character in a scene would be feeling and what types of nonverbal cues led them to this judgment. Answers were scored on emotion and cue scores. These scores were calculated by assessing emotion identification accuracy and the correct number of nonverbal cues provided by comparing to an answer key created through a combination of the actor's self-reported emotions, the researchers' coding of the scenes, three independent judges' responses, and responses from children in a pilot study. They found that accuracy improved with age such that 14 and 15-year-olds were far more accurate than six and 7-year-olds, yet their mean scores were still imperfect. Magill-Evans et al.'s (1995) study captured developmental increases in emotion identification accuracy through thin slices.

There is a lack of research between adolescents and adults. The few studies that have examined this transition suggest that for some constructs, NS continues to develop. Kunzmann et al. (2018) found that adolescents were not as developed as adults. They explored the ability to accurately perceive emotions in male adolescents and adults by filming a boy or a man portraying anger, sadness, or happiness elicited through recounting a memory where the target emotion was felt (Kunzmann et al., 2018). They created nine thin slices from these videos. They asked male adolescents (M_{age} = 16, *SD* = 1.04), young adults (M_{age} = 29, *SD* = 2.78), and middle-aged adults (M_{age} = 50, *SD* = 3.07) to identify the emotions portrayed. Their findings revealed significant improvements with age, indicating that adolescents' ability to perceive emotions nonverbally is not as developed as that of adults, highlighting ongoing developmental changes in emotional perception during adolescence.

In addition to studying emotion perception, a few studies have examined children’s accuracy in inferring other social characteristics. Brey & Shutts (2015) examined children’s ability to use nonverbal cues to make inferences about social power. They showed 3 to 6-year-olds thin slices of dyadic interactions where one actor held more power over the other (one of the characters was “in charge”). They manipulated conditions so the participants would view the tapes with or without sound or as static photographs. They found that older children outperform younger children in accuracy (r^2 = .44). Additionally, younger children could not accurately judge who held power in conditions without sound or when they viewed static photographs, while older children could do so in every condition. When sound was available, younger children could accurately judge who held power – albeit still at lower rates than the older children. Their studies suggest that young children rely more on verbal information to gather social cues. These findings provide further evidence that the pace of development of nonverbal sensitivity varies depending on the construct being perceived.

Some research has suggested that children and adults are equally good at accurately inferring certain personality traits and social behaviours. For example, children, teachers, and adults were shown thin slices of 18 unacquainted children (Lansu & van den Berg, 2022). The authors sought to compare accuracy in inferring likeability, popularity, prosocial behaviour, aggression, and social inclusion. They found that their participants were significantly better than chance at predicting popularity and social behaviour, significantly worse than chance at predicting aggression and social exclusion, and at chance at predicting likeability. Interestingly, there was no difference in accuracy between the children (M_{age} = 10.7) and adult (M_{age} = 22.1) judges. This could suggest that inferring likeability, popularity, prosocial behaviour, and aggression is similar in difficulty or importance to inferring basic emotions, as research found that by middle childhood, there tended to be no differences between children and adults in reading basic emotions (Lawrence et al., 2015). Yet again, females tend to make more accurate judgments than males across age (Archer et al., 2001; Brey & Shutts, 2015; Hall, Gunnery, et al., 2016). Overall, this research highlights that children and adults can accurately infer certain social traits and behaviours, with accuracy levels resembling those found in basic emotion recognition, while noting that females generally make more accurate judgments than males.

How Do We Get from Childhood to Adult Level of NS Skill?

While there is some literature on differences between children and adults, there remains a gap in knowledge on the development of nonverbal sensitivity in adolescence. Most studies compare children with adolescents or children with adults. This implies that adolescents have reached adult-like levels of accuracy in various domains of social perception. Still, we have some evidence of some adolescent development in other skills that may be relevant to NS. However, we do not have enough research examining what types of cues become newly relevant in adolescence, nor the kinds of social information that may not be as important by adolescence. This is surprising as adolescence is a unique developmental period that is much more than just a placeholder between childhood and adulthood. It is an important period for social cognition as newly salient and more complex social cues emerge, such as reputation, identity formation, peer and romantic competition, etc. (Brown & Larson, 2009; Burnett & Blakemore, 2009; Choudhury et al., 2006). These social motivations, incentives, and concerns differ in adolescence from childhood, and learning to navigate an adult landscape is important. Thus, we expect an advancement of interest in learning nonverbal sensitivity.

Adolescence as a Potential Period of Change in NS

During adolescence, studies suggest that the brain reorients to adjust to new social desires and perceived expectations as several newly relevant motivations emerge. This developmental period is marked by peer relations becoming more salient and complex (Brown & Larson, 2009). Deep friendships and betrayals emerge as peers start to play leading roles in adolescents' lives. Hierarchies begin to develop, and adolescents start recognizing others' positions in the ranks and comparing them to their own. Intimacy, romance, and sexual discovery start to develop at this age; desires for partners are no longer childhood crushes (Brown & Larson, 2009). Meanwhile, adolescents' identities are starting to form, and they will continue to go through changes as they discover what and who they like and how to fit into the identity they wish to be a part of (Brown & Larson, 2009). These emerging social motivations and expectations have been examined in conjunction with brain development.

Brain development in the prefrontal cortex and limbic system persists into one's 20s. Development during adolescence is not simply a continuation of childhood; more complex modifications occur. The prefrontal cortex, which is responsible for decision-making, planning, and inhibition, among other things, changes dramatically in adolescence. Around puberty, frontal grey matter volume peaks and is slowly pruned away as unwanted synapses are eliminated (Burnett & Blakemore, 2009). This is believed to be due to increased social interactions and fine-tuning behaviours to understand others and increase self-awareness. These changes in the pre-frontal cortex are believed to be important in social development as decision-making in the social sphere becomes more complex.

Simultaneously, this period is marked by the increased emergence of self-conscious emotions and perspective-taking (Choudhury et al., 2006; Somerville et al., 2013). Adolescents begin to notice themselves and notice others seeing them. In particular, self-evaluations and other-evaluations increase between the ages of 10 and 13 (Pfeifer et al., 2013). While this is happening, it is theorized that the brain is taking in all social information and fine-tuning based on experiences to learn how to navigate future successful social interactions. Another critical area of change is in the limbic system. During adolescence, the limbic system is hypersensitive to the rewarding feeling of risk-taking. Moreover, peer social interactions play a significant role in this rewarding feeling (Nelson et al., 2005, 2016). Experiences and decisions are coloured by peer feedback; adolescents may be more influenced by peer feedback and may engage in more risk-taking behaviour as they navigate their social interactions.

The various theories of social development suggest that a pattern of being able to recognize and process social stimuli emerges (Im-Bolter et al., 2016; Rakoczy, 2022; Weil et al., 2013). These theories suggest that this ability improves and can become more complex with age.

These abilities may play an important role in overall nonverbal sensitivity. As such, this suggests that nonverbal sensitivity may be necessary in social development and closely linked to social success.

Knowledge Gap

In summary, there is a gap in developmental studies looking at nonverbal sensitivity to cues other than emotions. From what has been studied, there does appear to be a developmental improvement such that little children rely more on verbal cues, and increased age is related to more accurate inferences. In Lansu and van den Berg's (2022) study, their results suggest that by in middle childhood, children's accuracy in perceiving certain constructs tends to be similar to that of adults. Further, there appears to be a gendered difference in ability across development. However, even though adolescence may be a sensitive developmental period for socio-emotional training, little research has focused on nonverbal sensitivity in adolescence. How do we make this leap in skill from childhood to adulthood? Are there differences in developmental timings depending on the type of cue perceived, gender, pubertal development, or other factors?

There is a need to examine nonverbal sensitivity relevant to adolescent social success. As adolescent developmental theory suggests, adolescence is a unique period with newly relevant social motivations. "Success" looks different in adolescence. However, as little research has been conducted on nonverbal sensitivity in adolescents, there remains a gap in testing adolescent-relevant constructs. Teh et al. (2018) developed a set of line-drawn images of social scenes to measure the perception of social engagement. They defined "social engagement" as a "multidimensional construct representing various situational factors that may be relevant for regulating one's behavioral or emotional responses in real-life contexts." (p. 1796). Although this is different from the constructs I would want to focus on, given adolescent theory, this novel construct serves as a good start. I propose several constructs in my Future Directions section.

The Current Study

The current study aims to test adolescents' capacity to infer emotional and social information from a scene against adults' ability to do the same. While the literature suggests a development increase in nonverbal sensitivity, research examining adolescence and the factors that could affect this skill is lacking. Methodologically, my literature review indicates that inferences can be accurate and predictive even in the absence of any personal interaction in a social scenario (Ambady et al., 2000). My first hypothesis (H1) predicts that shorter exposure duration will decrease accuracy ratings. This is based on literature looking at thin slices, which suggests that we can capture information adequately from small segments, but the shorter the segment, the less accurate the inference will be. Further, I am interested in seeing if these exposure durations' effects on accuracy differ as a function of age. Perhaps there is a developmental difference in processing speed as changes happen in the brain during this age (Burnett & Blakemore, 2009).

My second hypothesis (H2) predicts that adolescents will be less accurate than adults at inferring social information. This prediction refers to various theories of social development, which suggests that adolescents are still actively developing skills I believe are linked with nonverbal sensitivity, such as Theory of Mind. Further, adolescence is a developmental period marked by intense new changes and re-orientations. This period introduces enhanced perspective-taking and social self-evaluations as peer-related social information becomes more salient (Breiner et al., 2018; Choudhury et al., 2006; Cosme et al., 2022; Pfeifer et al., 2013). As adolescents' perspective-taking is enhanced (Choudhury et al., 2006), pursuing research examining nonverbal sensitivity during this period would be necessary. As adolescents are still developing in various social aspects, I believe adolescents would be less accurate than adults.

Finally, my third hypothesis (H3) explores the effects of sex. Previous literature suggests a slight female advantage (Hall, Gunnery, et al., 2016; Lawrence et al., 2015; Mobasseri et al., 2022), so I want to see if this will be replicated in my study and explore this in adolescents and adults. In sum, I aim to explore the development of nonverbal sensitivity in adolescence and examine methodology.

Methods

Participants

The full sample consisted of 90 adolescents and 93 adults. The adolescents ranged from 14 to 17 years old (*M* = 15.68, *SD* = 1.08) and were 53.9% male and 69.7% white. The adults ranged from 22 to 30 years old (*M* = 25.67, *SD* = 2.33). They were 43.5% male and 65.6% white (see Appendix A for full sample participant demographics). 13 participants were removed from the analytic sample as they failed more than once on the attention check, which will be described later. The final analytic sample consisted of 79 adolescents and 89 adults. The adolescents ranged from 14 to 17 years old (*M* = 15.62, *SD* = 1.08) and were 55.1% male and 67.1% white. The adults ranged from 22 to 30 years old (*M* = 25.63, *SD* = 2.30) and were 41.6% male and 67.4% white (see Table 1 for analytic sample participant demographics).

Table 1

Analytic Sample Participant Sociodemographic Characteristics by Age Group

	Adolescents		Adults		Full sample	
	n	%	*n*	%	*n*	%
Gender						
Female	35	44.9	52	58.4	88	52.4
Race						
White	53	67.1	60	67.4	113	66.9
Black	6	7.6	7	7.9	13	7.7
East Asian	8	10.1	3	3.4	11	6.5
South Asian	6	7.6	13	14.6	19	11.2
Other	6	7.6	6	6.7	13	7.7
Student						
Yes	79	100.0	24	27.0	104	61.5
Highest Level of Education						
High School or Less	79	100.0	3	3.4	83	49.1
Post-High School	-	-	86	96.6	86	50.9
Primary Parent’s Highest Level of Education						
High School or Less	4	5.1	5	5.6	9	5.3

	Adolescents		Adults		Full sample	
	n	%	*n*	%	*n*	%
Post-High School	75	94.9	84	94.4	160	94.7

The participants for this study were recruited for a larger study (Pakkal et al., In Prep). A previous component studied focused on the effect of emotion regulation on a cognitively demanding task in adults and adolescents. The present study utilizes the same participant dataset to investigate adolescents' and adults' ability to accurately infer social information from line-drawn images depicting various social scenes to index developmental differences across adolescents and adults. While the current study draws on the same pool of participants, the variables and research questions differ from those explored in the first study.

Participants were recruited through advertisements posted in community settings such as high schools and universities and through a community outreach initiative that aims to connect community members and their families to research conducted by several research labs at Brock University. To be eligible, participants had to be between the ages of 14 and 30, fluent in English, and have access to an internet-connected computer. Qualified participants were sent a virtual meeting invite to complete testing with a research assistant (RA). During the online meeting, the participant engaged with the RA in completing study tasks and answering questions on a designated website. The RA initiated the session by sharing a unique URL through the video meeting software's messaging feature. Consent forms, questionnaires, and study tasks were administered using Inquisit (Millisecond, n.d.), a software for conducting psychological experiments. After opening the link, the participant and RA could no longer see each other; they maintained an audio connection. The RA guided the participant through the consent form and provided instructions as needed throughout the session, prompting the participant for a code to progress and then supplying the corresponding instructions for each study component.

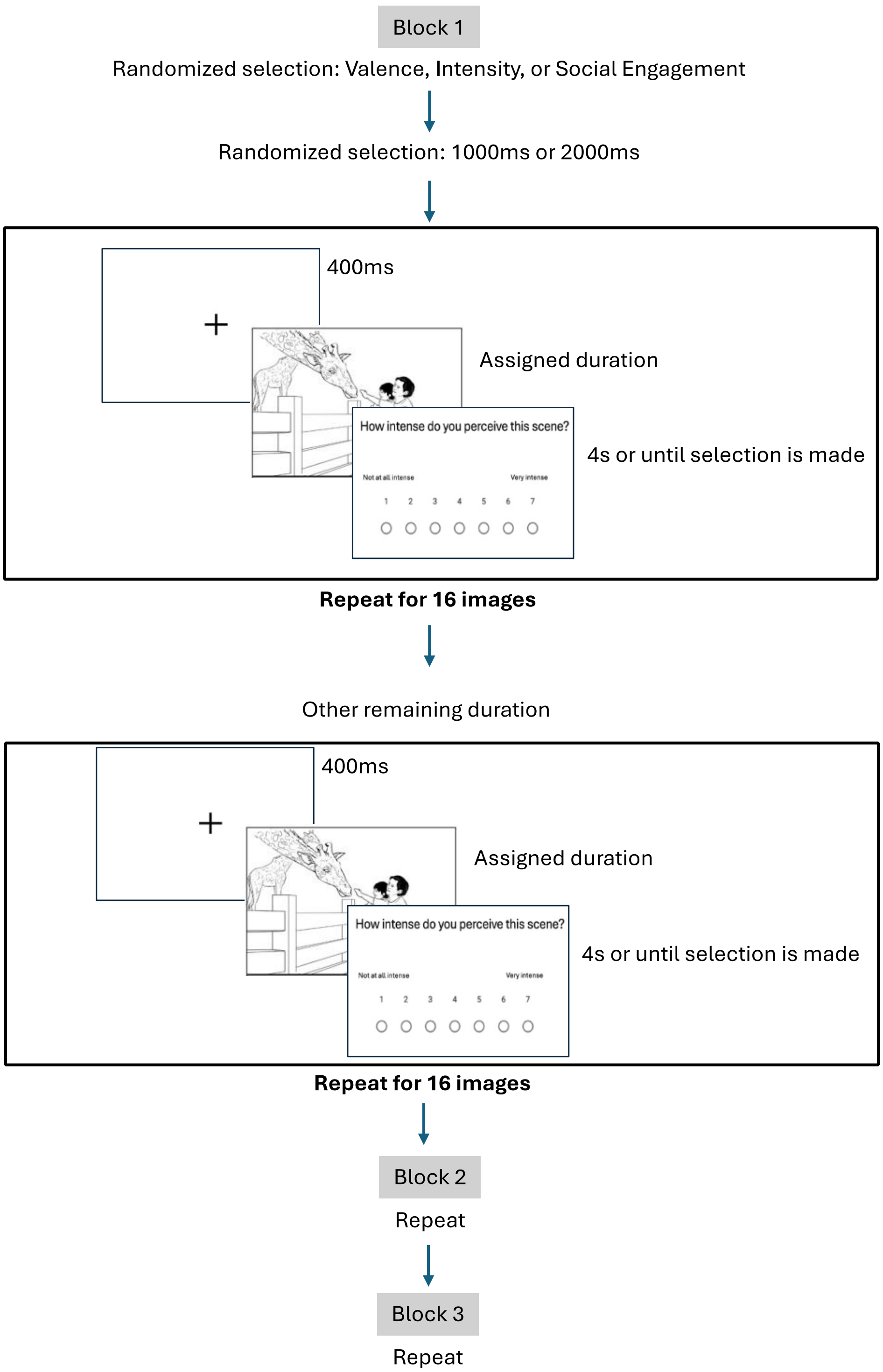
Procedure

Following their consent, participants completed a performance task unrelated to the present research question. Next, they completed a series of self-report questionnaires about demographic characteristics and traits.

For the present study, participants had to complete three blocks, one for each dimension (valence, intensity, and social engagement). Block order was randomized and counterbalanced. Within each block, participants had to view a set of 16 images (15 real and one scrambled) twice. Once for 1000ms and the second for 2000ms. The order of duration assignment was randomized and counterbalanced. See Figure 1 for protocol depiction. Participants began by seeing an HTML instruction page relevant to the assigned block dimension (valence, intensity, or social engagement). Once ready to begin, participants were prompted to press a key. The dimension name remained visible at the top of the screen during the entire block sequence. Participants then viewed a fixation point for 400ms. Then, they saw an image for 1000ms or 2000ms (whichever duration set they were randomly assigned to). Immediately after viewing an image, participants had to rate it on a graphic Likert scale of the assigned block dimension (e.g., if they are completing a "valence" block, the question following any image asked to rate the valence of the image). The question disappeared as soon as they selected their answer or after 4s. Participants did this for 16 images and then repeated this process for the other remaining duration. Then, Participants could take a break before beginning the next block. Once ready to continue, they were prompted to press a key. The second and third blocks consisted of the same tasks but with the other remaining dimensions. Following this, participants were debriefed. They were compensated $10 in a virtual gift card of their choosing and had the option of gaining volunteer credits.

Figure 1

Protocol



Materials

Pictures with Social Context and Emotional Scenes (PISCES)

The Pictures with Social Context and Emotional Scenes (PISCES) was developed by Teh et al. (2018) to address an empirical gap in studying social engagement perception. The database consists of 203 line-drawn images depicting various social scenes (see Figure 2 for an example). The authors used 62 undergraduate students comprised of 30 females (M = 20.3, SD = 1.0) and 32 males (M = 23.9, SD = 2.0) to rate the images on valence, intensity and social engagement portrayed using Likert scales of 1 to 7. Valence was measured as ‘1’ being strongly negative to ‘7’ being strongly positive. Intensity was measured with ‘1’ being extremely low intensity and ‘7’ being extremely high intensity. Social engagement was measured as a degree of perceived social engagement, ‘1’ being completely no interaction or engagement with another person, to ‘7’ as an extremely high degree of interaction or engagement with others. The authors analyzed participants’ scoring and shared in their supplementary materials the mean values and standard deviations for each image as a function of sex. This serves the function of being a normed sample.

Figure 2

Three Images from PISCES

In the present study, 39 images were chosen, though some were repeated depending on the block in which the image was presented. Image selection was done by creating low, medium, and high sets for each dimension (valence, intensity, and social engagement). This was done using percentiles of mean ratings (low: lower 20%, medium: 40% to 60%, and high: 80% to 99%).

Within these three levels, roughly 15 images with the lowest standard deviations were chosen for maximum agreement. See Appendix B for mean ratings of images selected for this study.

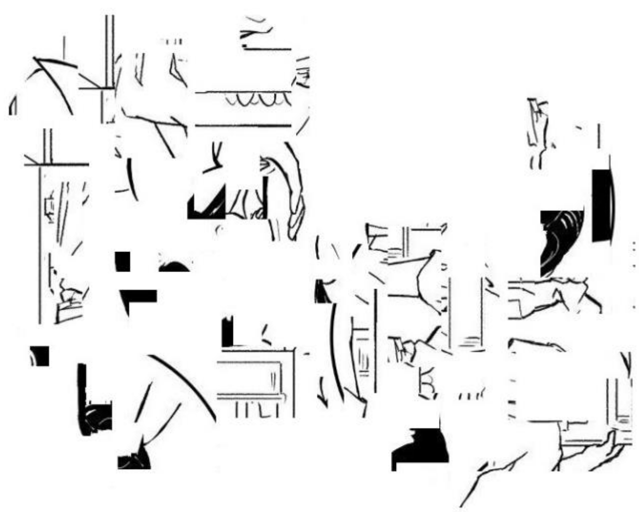
Measures

Attention Checks

In every set of images shown to participants, which contained 16 images, one served as an attention check. Participants would view a “scrambled” image which was uninterpretable (see Figure 3 for an example). As participants answered study questions, they were asked to identify when the image was a “scramble” image instead of one of the PISCES images. They could do so by pressing a button on the screen. For analysis, participants who made one or more errors during attention checks – not correctly identifying that the image was “scrambled” – were excluded as inattentive. 13 participants were removed from the analytic sample as they failed more than once on the attention check.

Figure 3

Example "Scramble" Image



Accuracy Scores

For the current study, accuracy was determined using the normed mean values for valence, intensity, and social engagement as provided by Teh et al. (2018) in their supplementary materials. Accuracy scores were calculated by subtracting the normed and gender-matched mean value (from Teh et al.'s (2018) sample) from my participants' scores for each image and the relevant dimension. Then, I used the absolute values of these new scores and reverse-coded them so that higher numbers represent higher accuracy (maximum is 4). Finally, accuracy scores were averaged by dimension per participant separately for each duration such that each participant had an average accuracy score for valence, intensity, and social engagement by duration.

Manipulation: Duration

To explore how accuracy was affected by exposure duration, participants viewed stimuli at two different durations, 1000ms and 2000ms, in the presentation phase of the procedure. This procedure is a within-subjects design, allowing participants to rate each image twice, once for each duration condition. Ratings made when exposed to images for 1000ms are expected to be less accurate than those for 2000ms.

Analytic Plan

To test whether accuracy differed as a function of duration, age group, sex, or by any interaction between these factors, I conducted three 3-way repeated measures analyses of variances for each dimension (valence, intensity, and social engagement). Duration (1s vs 2s) was measured within-subjects; age group (adolescents vs. adults) and sex (males vs. females) were between-subjects factors.

Results

Preliminary Descriptive Analyses

Prior to the main analyses, preliminary descriptive analyses were conducted on participants' mean ratings for each dimension. These were calculated by averaging participants' individual image ratings by the relevant dimension (valence, intensity, and social engagement). See Table 2 for descriptive statistics for mean ratings split by dimension, duration, age group, and sex. I ran three 3-way repeated measures ANOVAs to see if there were any differences in ratings of dimensions (valence, intensity, and social engagement) by duration of exposure, age, and sex. My within-subjects variables were duration (1000ms and 2000ms), and my predictors were age group (adolescents vs. adults) and sex (males vs. females).

There were seven outliers identified in extreme values and Q-Q plots, but an examination of the distribution of standardized scores found that > 95% of most variables' values fell within normal range ($z < 1.96$) with the exception of valence seen for 1s (94.7%), intensity seen for 1s (93.5%), and social engagement seen for 1s (94.1%). All variables met the assumptions of kurtosis and skewness. Two variables violated the Kolmogorov-Smirnov test, but a visual inspection of the histograms show relatively normal distributions, thus I will proceed with my analyses. Levene's test for Equality of Error Variances were all nonsignificant ($p > .05$), thus meeting the assumption of homogeneity of variance. For valence, Box's Test of Equality of Covariance was significant, but ANOVAs are robust enough that I will proceed with caution.

Across the three dimensions, there were no significant within-subject effects such that ratings did not differ when rated for 1s or 2s, nor were there within-subject interactions (see Appendix C).

Table 2

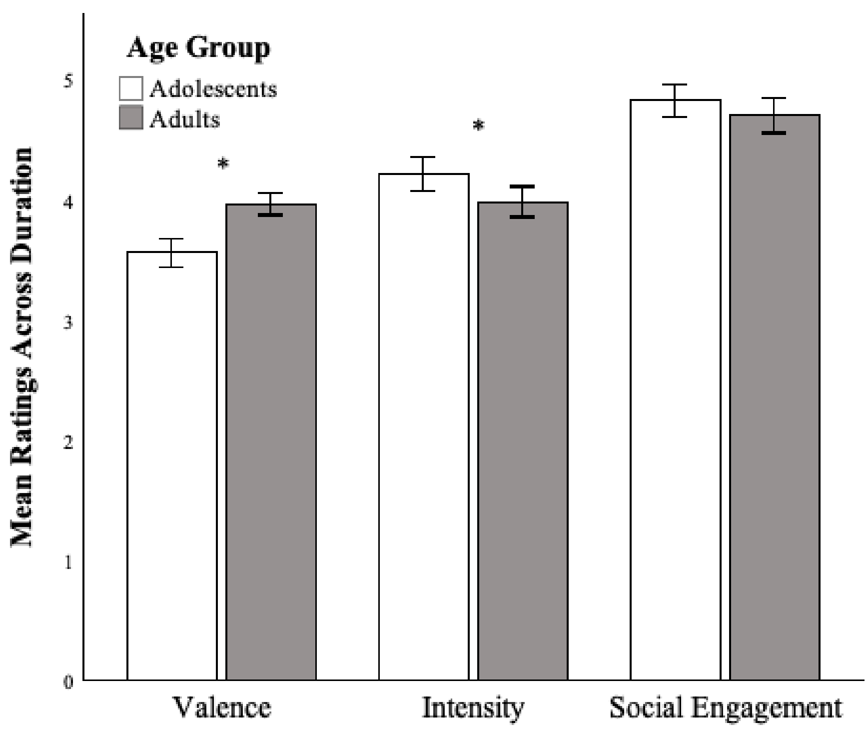
Mean Ratings for All Three Dimensions by Duration, Age Group, and Sex

	Valence		Intensity		Social Engagement	
Duration Sample	*M*	*SD*	*M*	*SD*	*M*	*SD*
1000ms						
Adolescents						
Males (*n* = 43)	3.55	0.43	4.24	0.61	4.92	0.65
Females (*n* = 35)	3.65	0.53	4.17	0.83	4.81	0.66
Total (*n* = 78)	3.59	0.48	4.21	0.71	4.87	0.65
Adults						
Males (*n* = 37)	3.90	0.48	3.92	0.66	4.80	0.69
Females (*n* = 52)	3.98	0.44	4.01	0.62	4.58	0.69
Total (*n* = 89)	3.94	0.45	3.97	0.64	4.67	0.70
Full Sample						
Males (*n* = 80)	3.71	0.49	4.09	0.65	4.87	0.67
Females (*n* = 87)	3.84	0.50	4.07	0.71	4.67	0.68
Total (*n* = 167)	3.78	0.50	4.08	0.68	4.76	0.68
2000ms						
Adolescents						
Males (*n* = 43)	3.52	0.45	4.27	0.61	4.95	0.65
Females (*n* = 35)	3.68	0.45	4.24	0.68	4.79	0.62
Total (*n* = 78)	3.60	0.45	4.26	0.64	4.88	0.64
Adults						
Males (*n* = 37)	3.90	0.45	3.97	0.63	4.83	0.68
Females (*n* = 52)	4.01	0.42	3.98	0.57	4.60	0.74
Total (*n* = 89)	3.97	0.43	3.97	0.59	4.69	0.72
Full Sample						
Males (*n* = 80)	3.70	0.48	4.13	0.64	4.89	0.66
Females (*n* = 87)	3.88	0.46	4.08	0.63	4.68	0.69
Total (*n* = 167)	3.79	0.48	4.11	0.63	4.78	0.69

In the valence dimension, there was a main between-subjects effect of age group, $F(1, 163) = 26.37$, $p < .001$, $\eta_p^2 = .139$, such that adolescents rated the images significantly more negative than adults (see Table 2 and Figure 4). There was no main effect of sex, $F(1, 163) = 2.70$, $p = .102$, $\eta_p^2 = .016$, nor was there an interaction, $F(1, 163) = 0.09$, $p = .768$, $\eta_p^2 = .001$.

Figure 4

Mean Image Ratings for Valence, Intensity, and Social Engagement by Age Group



Note. Error bars 95% CI. Significant differences are depicted by *.

In the intensity dimension, there was a main between-subjects effect of age group, $F(1, 163) = 7.13$, $p = .008$, $\eta_p^2 = .042$, such that adolescents rated the images significantly more intense than adults (see Table 2 and Figure 4). There was no main effect of sex, $F(1, 163) < 0.001$, $p = .990$, $\eta_p^2 < .001$, nor was there an interaction, $F(1, 163) = 0.26$, $p = .611$, $\eta_p^2 = .002$.

Finally, in the social engagement dimension, there were no main effects of age, $F(1, 163) = 2.60$, $p = .109$, $\eta_p^2 = .016$, of sex, $F(1, 163) = 3.07$, $p = .082$, $\eta_p^2 = .018$, nor was there an interaction, $F(1, 163) = 0.18$, $p = .672$, $\eta_p^2 = .001$.

Main Analyses: Accuracy

Accuracy scores were calculated by comparing participant mean ratings to gender-matched norm ratings from Teh et al.'s (2018) study (see Methods). Scores ranged from 0 to 4 ('0' being inaccurate and '4' being accurate). See Table 3 for descriptive statistics for accuracy score means split by dimension, duration, age group, and sex.

Tests for assumptions found three outliers in extreme values and Q-Q plots, but an examination of the distribution of standardized scores found > 95% of the values fell within normal range ($z < 1.96$), except for accuracy of valence seen for 1s (94.6%), and accuracy of intensity seen for 2s (94%). All variables met the assumptions of kurtosis and skewness. Four of the variables violated the assumptions of normality as tested via the Kolmogorov-Smirnov test, but a visual inspection of the histograms show relatively normal distributions, thus I will proceed with my analyses. Levene's test for Equality of Error Variances were all nonsignificant ($p > .05$), except for accuracy of social engagement seen for 1s (F (3, 163) = 4.35, p =.006), so I will proceed with caution. Box's Test of Equality of Covariance were all nonsignificant.

I conducted a 3-way repeated measures ANOVAs for accuracy for each dimension (valence, intensity, and social engagement) to test whether accuracy differed as a function of exposure duration, age group, sex, or by the interaction of these factors. Duration (1s vs 2s) was my within-subject variable, and my predictors were age group (adolescents vs. adults) and sex (males vs. females).

Table 3

Mean Accuracy Scores for All Three Dimensions by Duration, Age group, and Sex

	Valence		Intensity		Social Engagement	
Duration Sample	*M*	*SD*	*M*	*SD*	*M*	*SD*
1000ms						
Adolescents						
Males (*n* = 43)	3.41	0.38	3.55	0.41	2.77	0.46
Females (*n* = 35)	3.56	0.31	3.39	0.59	2.95	0.63
Total (*n* = 78)	3.48	0.36	3.48	0.50	2.85	0.55
Adults						
Males (*n* = 37)	3.60	0.32	3.39	0.44	2.92	0.61
Females (*n* = 52)	3.68	0.30	3.42	0.39	3.05	0.47
Total (*n* = 89)	3.65	0.31	3.40	0.41	3.00	0.53
Full Sample						
Males (*n* = 80)	3.50	0.37	3.48	0.43	2.84	0.54
Females (*n* = 87)	3.63	0.31	3.41	0.48	3.01	0.54
Total (*n* = 167)	3.57	0.34	3.44	0.46	2.93	0.54
2000ms						
Adolescents						
Males (*n* = 43)	3.35	0.31	3.52	0.38	2.73	0.44
Females (*n* = 35)	3.58	0.35	3.50	0.46	2.95	0.57
Total (*n* = 78)	3.45	0.35	3.51	0.42	2.83	0.51
Adults						
Males (*n* = 37)	3.62	0.31	3.44	0.43	2.88	0.57
Females (*n* = 52)	3.68	0.27	3.45	0.40	3.02	0.50
Total (*n* = 89)	3.66	0.29	3.45	0.41	2.96	0.53
Full Sample						
Males (*n* = 80)	3.48	0.34	3.48	0.40	2.80	0.51
Females (*n* = 87)	3.64	0.31	3.47	0.42	2.99	0.53
Total (*n* = 167)	3.56	0.33	3.48	0.41	2.90	0.53

Valence

The model revealed no significant within-subject effects for inferring valence (see Table 4). There were also no significant within-subjects interactions. I found significant between-subject main effects of age, $F(1, 163) = 13.37$, $p < .001$, $\eta_p^2 = .076$, such that adolescents were significantly less accurate than adults (see Figure 5). There was a significant main effect of sex, $F(1, 163) = 7.52$, $p = .007$, $\eta_p^2 = .044$, such that females were significantly more accurate than males (see Figure 5). However, I found no significant interaction between age group and sex, $F(1, 163) = 1.53$, $p = .218$, $\eta_p^2 = .009$.

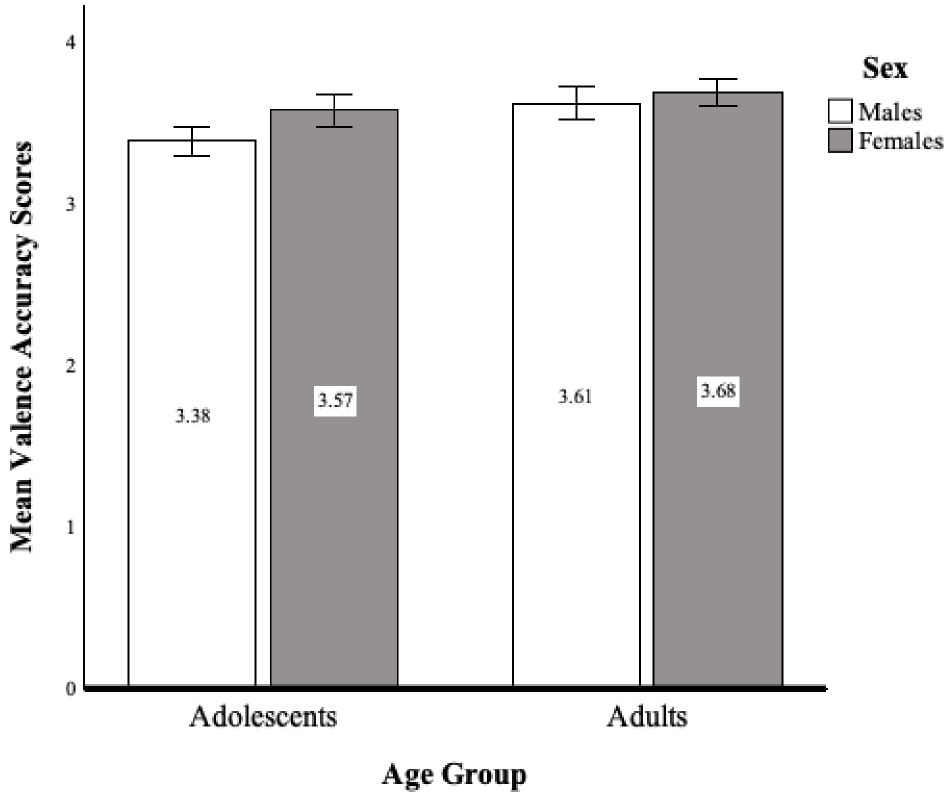
Table 4

Effects of Duration and Its Interactions with Age Group and Sex on Accuracy for All Three Dimensions

Accuracy Dimensions	$F(1, 163)$	p	η_p^2
Valence			
Duration	0.21	.647	< .001
Duration × Age Group	1.14	.288	.007
Duration × Sex	0.82	.365	.005
Duration × Age Group × Sex	2.03	.156	.012
Intensity			
Duration	4.31	**.040**	.026
Duration × Age Group	0.02	.884	< .001
Duration × Sex	2.67	.104	.016
Duration × Age Group × Sex	3.72	.055	.022
Social Engagement			
Duration	1.96	.164	.012
Duration × Age Group	0.36	.549	.002
Duration × Sex	0.33	.568	.002
Duration × Age Group × Sex	0.16	.689	.001

Figure 5

Mean Valence Accuracy Scores across Duration by Age Group and Sex



Note. Error bars 95% CI.

Intensity

The model revealed a significant within-subjects main effect of duration; images seen for 2s were rated more accurately than those seen for 1s (see Tables 3 and 4). There were no significant interactions of age group or sex with duration. I did not find any significant between-subjects main effects of age group or sex, nor did I find an interaction effect between age group and sex (see Table 5).

Table 5

Between-Subjects Effects of Intensity Accuracy

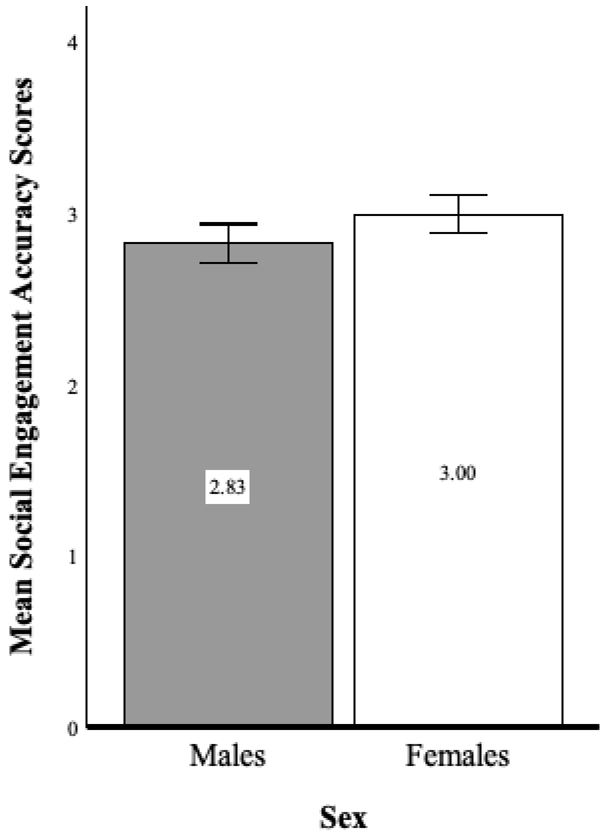
Variable	$F(1, 163)$	p	η_p^2
Age Group	1.10	.295	.007
Sex	0.29	.593	.002
Age Group × Sex	0.74	.391	.005

Social Engagement

The model did not reveal any significant within-subject effects for inferring social engagement (see Table 4). No significant within-subjects interactions were found. I did not find a between-subjects significant main effect of age, $F(1, 163) = 2.22$, $p = .138$, $\eta_p^2 = .013$. However, I did find a significant main effect of sex, $F(1, 163) = 4.40$, $p = .037$, $\eta_p^2 = .026$, such that females tended to be more accurate than males at inferring the level of social engagement depicted (see Figure 6). There was no significant interaction between age group and sex, $F(1, 163) = 0.20$, $p = .658$, $\eta_p^2 < .001$.

Figure 6

Mean Social Engagement Accuracy Scores by Sex



Note. Error bars 95% CI.

Post-Hoc Power Analysis

To assess the sensitivity of my study, I conducted a post-hoc power analysis and sensitivity test using G*Power. The analysis was based on the sample size (N = 167), alpha level (α = 0.05), and a three-way repeated measures ANOVA. The results indicated that the observed effect sizes had a power over .99, suggesting that the study had a very high probability of detecting effects of this size or larger. This high power makes it unlikely that any null findings were due to insufficient statistical power. The smallest detectable effect sizes at a power of .80 for the accuracy of valence, intensity, and social perception were η_p^2 = .005, .004, and .002, respectively. For a power of .99, the smallest detectable effect sizes were η_p^2 = .011, .008, and .006, respectively.

Discussion

Existing research on nonverbal sensitivity suggests two things: first, little time is required to make accurate inferences about various types of social information. Second, the ability to make quick, accurate inferences improves with age. However, little research has examined the development of this skill across adolescence. This is surprising as adolescence is a unique period of development in which the brain changes and shifts due to newly relevant social information (Burnett & Blakemore, 2009; Choudhury et al., 2006; Nelson et al., 2016). Due to these changes, we can expect changes or shifts in nonverbal sensitivity ability and the types of pertinent cues during this process. The current study sought to address this gap by examining differences in inference accuracy for line-drawn social scenes for adolescents and adults.

Duration of Exposure

My first hypothesis – which predicted that inferences made for images viewed at 1000 ms would be less accurate than those at 2000 ms – was only supported for the intensity dimension. However, the unique variance explained for this effect was low (2.6%); thus, this significant finding must be interpreted cautiously. There were no statistically significant differences in accuracy between duration exposures for valence and social engagement. This means that participants viewing the images for one second were as accurate as when viewed for two seconds. Further, these results agree with previous theory suggesting thin slices adequately represent behaviour (Ambady et al., 2000; Ambady & Rosenthal, 1992; Hall et al., 2008; Wang et al., 2021) as participants could make realistic judgments on behaviour even when exposed for short durations. This also concurs with findings suggesting that humans do not need to know the entire scenario with context to make better-than-chance accurate impressions (Archer et al., 2001; Archer & Akert, 1980). Participants in this study could make inferences without getting backstories on characters and information on context.

Initially, I hypothesized that there would be some decrease in accuracy as some research in thin-slice methodologies has supported that accuracy is lost with shortening exposures (for example, Murphy et al., 2019). It is important to note that my hypothesis was based on findings in the thin-slice literature; however, the methodology used in this study is fundamentally different. Thin slices consist of videotaped interactions, whereas I compare line-drawn still images. Consequently, my hypothesis was based on literature that compared minute-long segments (Murphy et al., 2019) instead of seconds of exposure of still images. Additionally, my study sought to examine nonverbal sensitivity in social scenes – particularly interactions – as opposed to simpler and isolated forms of social perception, such as emotion perception of a single target. Within the emotion perception literature, there has been evidence that as little as 10 ms is enough to identify emotions accurately at rates better than chance for still images and 250 ms for dynamic clips (Du & Martinez, 2013; Martinez et al., 2016). Therefore, it makes sense that 1 second versus 2 seconds would fail to yield losses in accuracy.

While my hypothesis was not fully supported, my findings hold important methodological implications. My findings suggest that researchers could expose their participants to as little as one second when using the PISCES database (2018) to assess nonverbal sensitivity to get relatively accurate inferences. Further, this opens up future research to examine even shorter durations. Although I do not believe that simple emotions and more complex social cues can be directly compared regarding accurate perception, perhaps future researchers can shorten exposure times to see if 250 ms may be enough time to make accurate inferences. This would also shorten study protocol and lessen participant fatigue as they would not need to be exposed to long protocols.

Age Effects

Theory of Mind and Social Reorientation theory suggests that adolescence is a crucial period for socio-emotional development. Certain abilities, such as meta-cognition, are better than in childhood, yet not near adult levels. These findings complement brain imaging studies that show shifts in several brain areas related to mentalizing (Burnett & Blakemore, 2009; Frith & Frith, 2003). Based on these developmental theories and previous research in related constructs, I predicted that adolescents would be less accurate at inferring various types of social information from social scenes than adults. My results were mixed. I only found statistically significant differences in accuracy between adolescents and adults in the valence condition – not for intensity nor social engagement. As predicted, adolescents were significantly less accurate than adults in perceiving the valence of social scenes. Theory of Mind would suggest that this finding means that inferring the valence of a situation – how positive or negative it is – consists of a higher-order task requiring more advanced thinking and perspective-taking. These findings suggest that inferring valence may be a developing component of mentalizing in adolescence. Thus, like other higher-order Theory of Mind tasks, adolescents can infer accurately valence, but they are not near adult levels yet. Further, perhaps this ability is refined through synaptic pruning as it involves brain areas such as the pre-frontal cortex and the limbic system, which peak in blood flow volume during adolescence (Burnett & Blakemore, 2009; Nelson et al., 2005, 2016). Upon further investigation, I found that adolescents rated images significantly more negatively and intensely than adults. This is in accordance with literature suggesting that adolescents tend to interpret social situations more negatively, especially in ambiguous situations (Bosacki, 2012;

Marusak et al., 2017). Overall, these findings support the theory that adolescents are still developing their social processing skills, and previous literature suggests negativity and intensity biases during this developmental period.

However, my results did not find significant differences in accuracy between adolescents and adults regarding intensity and social engagement. A potential explanation for these findings is the operationalization of accuracy. I used Teh et al.'s (2018) sample as my "norm" to compare to. The authors used 62 undergraduate students with mean ages of 20.3 for females and 23.9 for males. Undergraduate students' experiences and interpretations of social situations could be arguably closer to that of adolescents than to older adults, as their brains are still developing during this age (Burnett & Blakemore, 2009). Thus, it is possible that Teh et al.'s (2018) sample lies between my adolescent and adult sample, therefore not yielding significant differences.

Using Theory of Mind and Social Reorientation theory, my findings suggest that perhaps inferring intensity and social engagement may not be "in development" during adolescence. Possibly, accurately inferring these cues is mastered in childhood and may not have been challenging constructs to infer. Teh et al. (2018) proposed this "social engagement" as a novel construct in measuring social perception. The authors defined it as a "multidimensional construct representing various situational factors that may be relevant for regulating one's behavioral or emotional responses in real-life contexts" (p. 1796). This definition seems to represent a much broader construct than what participants were asked to rate (in their study and mine). Participants were asked to judge the degree of social engagement, with scores ranging from "completely no interaction or engagement with another person" to "extremely high degree of interaction or engagement with other people." Their form of measurement does not seem to be capturing their novel construct. Indeed, participants from Teh et al.'s (2018) study had the largest disagreement on judging the degree of social engagement, with a standard deviation of 1.86. This considerable disagreement, reflected by the high standard deviation, may contribute to my insignificant findings. The high SD suggests a wide variability in the data, which may weaken the correlation strength and result in the lack of statistically significant findings. Perhaps comparing my sample's scores to theirs to calculate accuracy may not work well with the social engagement construct. I tried to remedy this by selecting images from the PISCES database with the highest level of agreement per level (low, medium, high; see Methods and Appendix B). If social engagement had been operationalized differently – representing the broader construct originally intended – perhaps the results could have differed and been more challenging for adolescents.

Another potential explanation is the possibility that perceiving the degree of social engagement is not an ability that develops markedly with age – or at least is mostly developed by adolescence. Theory of Mind would suggest that this ability may not need a higher-order Theory of Mind. Thus, this may be developed fairly early (Rakoczy, 2022; Weil et al., 2013). Adolescent development theory posits that this developmental period is unique as there are a host of newly relevant and important social cues that adolescents must navigate in their daily lives, such as complex peer dynamics, romantic and sexual interests, social hierarchies and social approval (Brown & Larson, 2009). My results suggest that perceiving the degree of social engagement may not be one of the most relevant social cues adolescents develop or need – perhaps it may not be evolutionarily important to their social well-being.

Sex Effects

My third hypothesis sought to explore whether there were any differences in accuracy by sex. The literature suggests that females tend to have a slight advantage in inferring social cues accurately (Archer et al., 2001; Brey & Shutts, 2015; Hall, Gunnery, et al., 2016; Lawrence et al., 2015; Mobasseri et al., 2022). It may be more important for women to be accurate in their social interactions. Lancelot & Nowicki (1997) examined the relationship between nonverbal sensitivity and externalizing behaviours in 39 children from 9 to 14 years old (M = 12.04, SD = 1.89) and found that girls who were less skilled at nonverbal sensitivity tend to display more externalizing behaviours, such as anger, aggression, and social rule violations (Lancelot & Nowicki, 1997). They did not find this pattern amongst boys, though the mean number of externalizing behaviours was similar to that of the girls. This suggests that girls may be more socially disadvantaged if they are less skilled at reading their surroundings.

My findings suggest that females are significantly more accurate than males at inferring valence and degree of social engagement. No significant differences existed between males and females in ratings of intensity. Perceiving a situation's valence and degree of social engagement more accurately may be more important to females. A theory that could explain accurately perceiving valence particularly is stereotype threat. This social psychology theory explains that members of marginalized groups are aware of the stereotypes against them, which may affect their behaviours as a response (Hoyt & Murphy, 2016). There is a lot of research looking at the effects of stereotype threat across various identities, such as being female (Hoyt & Murphy, 2016). Perhaps it becomes essential to perceive a social situation's valence accurately to avoid fitting into stereotypes of “being negative” or “dramatic” as a woman. However, this theory applies less when considering being able to infer social engagement accurately. Perhaps it is more socially advantageous to infer these cues accurately.

In conclusion, my study sheds light on the differences in social cue accuracy between males and females, particularly emphasizing the significance of valence perception. The literature's indication of females having a slight advantage aligns with my findings, but only for valence and degree of social engagement. However, it is important to note that my study did not find significant differences in accuracy between males and females in inferring intensity. This suggests that while females may tend to excel in certain aspects of social cue perception, the broader context and intricacies of social interaction warrant further exploration beyond simple gender differences.

Limitations

Although this study adds to the literature on nonverbal sensitivity in adolescence, several limitations exist. First, line drawings may not be enough to capture the complexities of social situations. As nonverbal sensitivity covers a wide range of behaviours and cues – that often have different meanings depending on their interaction with other behaviours, cues or context, measuring it in a lab setting may need a more ecologically valid stimulus such as videotaped social scenes of humans having authentic interactions. The use of line drawings may also explain my results regarding duration exposure. We may not need much time to process still images of cartoon figures; as previously noted, some studies have suggested that 10ms is enough to identify emotion correctly from still images, while at least 250ms is needed for dynamic clips (Du & Martinez, 2013; Martinez et al., 2016).

Further, using Teh et al.'s (2018) study sample as a norm sample to compare to may not be ideal. The authors used a small sample size of 62 undergraduate students from Singapore, which may not be generalizable enough to serve as a norm. As I mentioned earlier in my discussion, a vital component of this study is measuring "accuracy." Operationalizing "accuracy" in the absence of ground truth is impossible in a line-drawn fictional social scene. In this case, I defined accuracy as data collected without any experimental components, such as time limits or manipulations. Thus, I used Teh et al.'s (2018) study sample as accurate values for the images and relevant constructs. However, if that original sample is not generalizable, it may not be the best placeholder for accuracy. Also, there was a high disagreement on the degree of social engagement displayed per image. This adds to the evidence that using that sample's data may not be ideal to represent accuracy.

Another possible limitation is my sample. I wanted to compare adolescents and adults to index the development of nonverbal sensitivity during adolescence. I grouped 14 to 17-year-olds as adolescents and 22 to 30-year-olds as adults. However, some participants in either group may have been too close in age, thus not portraying developmental patterns adequately. Also, I would have needed a more comprehensive range of ages to observe any developmental trends. It is possible that if I had included children or younger adolescents, I could have seen some significant differences.

Using data that was collected for different research questions has other potential limitations. This study was part of a larger study that focused on the effect of emotion regulation on a cognitively demanding task in adults and adolescents. Before completing the tasks mentioned in this thesis, participants were randomly assigned to emotional conditions and asked to perform a cognitively demanding task to measure emotion regulation. They were induced through an emotional interview to be angry, embarrassed, or neutral. This procedure could have left my participants still under the effects of their emotional condition or perhaps tired due to the prior task when completing the social perception task. Some research suggests that emotional states and judges' positions can affect social perception accuracy (Hall, Schmid Mast, et al., 2015). It may be useful to compare findings across emotional conditions to rule out possible effects, though participants were randomly assigned to the emotional conditions.

Future Directions

Regarding this study, future directions include addressing some of my limitations with Teh et al.'s (2018) study sample. First, I aim to extend their sample by collecting more diverse data. Hopefully, this can make their norm sample more generalizable for future comparisons. Also, I aim to try to norm new constructs such as the nature of relationships, hierarchy, and level of closeness. This is partially in response to what I believe Teh et al. (2018) attempted to measure with their "social engagement" construct but could not capture. Norming these new constructs might better represent relevant social cues needed in everyday life. Further, adolescent developmental theory would suggest that these cues may become essential to assess in preparation for adulthood, so there should be some developmental change in perceiving them accurately during this period.

For my broader line of research examining nonverbal sensitivity in adolescence, indexing nonverbal sensitivity development across age could greatly impact the assessment and identification of deficits (e.g., in populations with socio-developmental difficulties). For example, adolescence is marked by emerging romance and sexual desires that are relatively different from those in childhood. Research in adults has examined the ability to recognize romantic interest and the lack of it in others (e.g., Hall, Xing, et al., 2015; Place et al., 2012). As this is a new social desire experienced in adolescence, it would be interesting to study the development of socially perceiving romantic or sexual interests in others. I suspect this ability improves with age as being skilled at detecting romantic interest serves an important purpose in social success. Further, some research has found that adults are able to detect various social network characteristics from thin slices (Mobasseri et al., 2022). As peer dynamics become complex and various hierarchies develop, we can assume that the ability to process all this information is developed in adolescence. Theories such as social reorientation suggest that adolescence involves significant brain change to adjust to new social desires, expectations, and motivations, such as deep friendships, betrayals, hierarchies, intimacy, romance, and sexual discovery (Brown & Larson, 2009; Burnett & Blakemore, 2009). Examining when the ability to recognize various social cues accurately develops would be necessary.

Conclusion

In conclusion, this study attempted to contribute to the knowledge of development of nonverbal sensitivity – particularly across adolescence. The findings suggest that even brief exposures, such as one second, can yield relatively accurate inferences. This opens avenues for future research to explore even shorter durations. The study found that adolescents were less accurate at inferring valence than adults. Adolescents showed a negativity bias, perceiving social scenes more negatively, which aligns with developmental theories about social processing during adolescence. However, there is a need to explore further how accuracy is operationalized and the role of age-related interpretations of social scenes. The study also examined sex differences, finding that females were more accurate in valence and social engagement perception. This study lays the groundwork for understanding adolescent nonverbal sensitivity and its implications for social perception. It stresses the need for further research into measuring nonverbal sensitivity through adolescent-relevant constructs.

References

Ambady, N., Bernieri, F. J., & Richeson, J. A. (2000). Toward a histology of social behavior: Judgmental accuracy from thin slices of the behavioral stream. In *Advances in Experimental Social Psychology* (Vol. 32, pp. 201–271). Elsevier. https://doi.org/10.1016/S0065-2601(00)80006-4

Ambady, N., & Rosenthal, R. (1992). Thin slices of expressive behavior as predictors of interpersonal consequences: A meta-analysis. *Psychological Bulletin*, *111*(2), 256–274. https://doi.org/10.1037/0033-2909.111.2.256

Archer, D., & Akert, R. M. (1980). The encoding of meaning: A test of three theories of social interaction. *Sociological Inquiry*, *50*(3–4), 393–419. https://doi.org/10.1111/j.1475-682X.1980.tb00028.x

Archer, D., Costanzo, M., & Akert, R. (2001). The Interpersonal Perceptive Task (IPT): Alternative approaches to problems of theory and design. In J. A. Hall & F. J. Bernieri, *Interpersonal sensitivity: Theory and measurement*. Psychology Press.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind" ? *Cognition*, *21*(1), 37–46. https://doi.org/10.1016/0010-0277(85)90022-8

Bernieri, F. J., & Gillis, J. S. (2001). Judging rapport: Employing Brinswik's Lens Model to study interpersonal sensitivity. In J. A. Hall & F. J. Bernieri, *Interpersonal sensitivity: Theory and measurement*. Psychology Press.

Bosacki, S. L. (Ed.). (2012). *Culture of Ambiguity: Implications for Self and Social Understanding in Adolescence*. SensePublishers. https://doi.org/10.1007/978-94-6091-624-3

Breiner, K., Li, A., Cohen, A. O., Steinberg, L., Bonnie, R. J., Scott, E. S., Taylor-Thompson, K., Rudolph, M. D., Chein, J., Richeson, J. A., Dellarco, D. V., Fair, D. A., Casey, B. J., & Galván, A. (2018). Combined effects of peer presence, social cues, and rewards on cognitive control in adolescents. *Developmental Psychobiology*, *60*(3), 292–302. https://doi.org/10.1002/dev.21599

Brey, E., & Shutts, K. (2015). Children use nonverbal cues to make inferences about social power. *Child Development*, *86*(1), 276–286. https://doi.org/10.1111/CDEV.12334

Brown, B. B., & Larson, J. (2009). Peer Relationships in Adolescence. In R. M. Lerner & L. Steinberg (Eds.), *Handbook of Adolescent Psychology* (1st ed.). Wiley. https://doi.org/10.1002/9780470479193.adlpsy002004

Burnett, S., & Blakemore, S.-J. (2009). The development of adolescent social cognition. *Annals of the New York Academy of Sciences*, *1167*(1), 51–56. https://doi.org/10.1111/j.1749-6632.2009.04509.x

Carton, J. S., Kessler, E. A., & Pape, C. L. (1999). Nonverbal decoding skills and relationship well-being in adults. *Journal of Nonverbal Behavior*, *23*(1), 91–100. https://doi.org/10.1023/A:1021339410262

Choudhury, S., Blakemore, S.-J., & Charman, T. (2006). Social cognitive development during adolescence. *Social Cognitive and Affective Neuroscience*, *1*(3), 165.

Colvin, C. R., & Bundick, M. J. (2001). In search of the good judge of personality: Some methodological and theoretical concerns. In J. A. Hall & F. J. Bernieri, *Interpersonal sensitivity: Theory and measurement*. Psychology Press.

Cosme, D., Flournoy, J. C., Livingston, J. L., Lieberman, M. D., Dapretto, M., & Pfeifer, J. H. (2022). Testing the adolescent social reorientation model during self and other evaluation using hierarchical growth curve modeling with parcellated fMRI data. *Developmental Cognitive Neuroscience*, *54*, 101089. https://doi.org/10.1016/j.dcn.2022.101089

Dirks, M. A., Kirmayer, M. H., & Morningstar, M. (2018). Social competence. In R. J. R. Levesque (Ed.), *Encyclopedia of Adolescence* (pp. 3636–3647). Springer International Publishing. https://doi.org/10.1007/978-3-319-33228-4_27

Du, S., & Martinez, A. M. (2013). Wait, are you sad or angry? Large exposure time differences required for the categorization of facial expressions of emotion. *Journal of Vision*, *13*(4), 13–13. https://doi.org/10.1167/13.4.13

Eslinger, P. J., Anders, S., Ballarini, T., Boutros, S., Krach, S., Mayer, A. V., Moll, J., Newton, T. L., Schroeter, M. L., de Oliveira-Souza, R., Raber, J., Sullivan, G. B., Swain, J. E., Lowe, L., & Zahn, R. (2021). The neuroscience of social feelings: Mechanisms of adaptive social functioning. *Neuroscience and Biobehavioral Reviews*, *128,* 592–620. https://doi.org/10.1016/j.neubiorev.2021.05.028

Frith, U., & Frith, C. D. (2003). Development and neurophysiology of mentalizing. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *358*(1431), 459–473. https://doi.org/10.1098/rstb.2002.1218

Hall, J. A. (2001). The PONS test and the psychometric approach to measuring interpersonal sensitivity. In J. A. Hall & F. J. Bernieri, *Interpersonal sensitivity: Theory and measurement*. Psychology Press.

Hall, J. A., Andrzejewski, S. A., Murphy, N. A., Schmid Mast, M., & Feinstein, B. A. (2008). Accuracy of judging others' traits and states: Comparing mean levels across tests. *Journal of Research in Personality*, *42*(6), 1476–1489.

Hall, J. A., Andrzejewski, S. A., & Yopchick, J. E. (2009). Psychosocial correlates of interpersonal sensitivity: A meta-analysis. *Journal of Nonverbal Behavior*, *33*(3), 149–180. https://doi.org/10.1007/s10919-009-0070-5

Hall, J. A., Gunnery, S. D., & Horgan, T. G. (2016). Gender differences in interpersonal accuracy. In J. A. Hall, M. Schmid Mast, & T. V. West (Eds.), *The Social Psychology of Perceiving Others Accurately* (1st ed., pp. 309–327). Cambridge University Press. https://doi.org/10.1017/CBO9781316181959.015

Hall, J. A., Schmid Mast, M., & Latu, I.-M. (2015). The vertical dimension of social relations and accurate interpersonal perception: A meta-analysis. *Journal of Nonverbal Behavior*, *39*(2), 131–163.

Hall, J. A., Schmid Mast, M., & West, T. V. (2016). Accurate interpersonal perception: Many traditions, one topic. In J. A. Hall, M. Schmid Mast, & T. V. West (Eds.), *The Social Psychology of Perceiving Others Accurately* (1st ed., pp. 3–22). Cambridge University Press. https://doi.org/10.1017/CBO9781316181959.001

Hall, J. A., Xing, C., & Brooks, S. (2015). Accurately detecting flirting: Error management theory, the traditional sexual script, and flirting base rate. *Communication Research*, *42*(7), 939–958. https://doi.org/10.1177/0093650214534972

Hamlin, J. K., Hallinan, E. V., & Woodward, A. L. (2008). Do as I do: 7-month-old infants selectively reproduce others' goals. *Developmental Science, 11*(4), 487–494. https://doi.org/10.1111/j.1467-7687.2008.00694.x

Hoyt, C. L., & Murphy, S. E. (2016). Managing to clear the air: Stereotype threat, women, and leadership. *The Leadership Quarterly*, *27*(3), 387–399. https://doi.org/10.1016/j.leaqua.2015.11.002

Im-Bolter, N., Agostino, A., & Owens-Jaffray, K. (2016). Theory of mind in middle childhood and early adolescence: Different from before? *Journal of Experimental Child Psychology*, *149*, 98–115. https://doi.org/10.1016/j.jecp.2015.12.006

Kunzmann, U., Wieck, C., & Dietzel, C. (2018). Empathic accuracy: Age differences from adolescence into middle adulthood. *Cognition and Emotion*, *32*(8), 1611–1624. https://doi.org/10.1080/02699931.2018.1433128

Lancelot, C., & Nowicki, S. J. (1997). The association between receptive nonverbal processing abilities and internalizing/externalizing problems in girls and boys. *The Journal of Genetic Psychology*, *158*(3), 297–302.

Lansu, T. A., & van den Berg, Y. H. (2022). Thin-slice judgments of children's social status and behavior. *The Journal of Experimental Education*, *90*(4), 884–897.

Lawrence, K., Campbell, R., & Skuse, D. (2015). Age, gender, and puberty influence the development of facial emotion recognition. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.00761

Magill-Evans, J., Koning, C., Cameron-Sadava, A., & Manyk, K. (1995). The Child and Adolescent Social Perception measure. *Journal of Nonverbal Behavior*, *19*(3), 151–169. https://doi.org/10.1007/BF02175502

Malone, B. E., & DePaulo, B. M. (2001). Measuring sensitivity to deception. In J. A. Hall & F. J. Bernieri, *Interpersonal sensitivity: Theory and measurement*. Psychology Press.

Martinez, L., Falvello, V. B., Aviezer, H., & Todorov, A. (2016). Contributions of facial expressions and body language to the rapid perception of dynamic emotions. *Cognition and Emotion*, *30*(5), 939–952. https://doi.org/10.1080/02699931.2015.1035229

Marusak, H. A., Zundel, C. G., Brown, S., Rabinak, C. A., & Thomason, M. E. (2017). Convergent behavioral and corticolimbic connectivity evidence of a negativity bias in children and adolescents. *Social Cognitive and Affective Neuroscience*, *12*(4), 517–525. https://doi.org/10.1093/scan/nsw182

McCabe, R. E., Blankstein, K. R., & Mills, J. S. (1999). Interpersonal sensitivity and social problem-solving: Relations with academic and social self-esteem, depressive symptoms, and academic performance. *Cognitive Therapy and Research*, *23*(6), 587–604.

Millisecond. (n.d.). *Inquisit* [Computer software]. https://www.millisecond.com

Mobasseri, S., Stein, D. H., & Carney, D. R. (2022). The accurate judgment of social network characteristics in the lab and field using thin slices of the behavioral stream. *Organizational Behavior and Human Decision Processes*, *168*, 104103. https://doi.org/10.1016/j.obhdp.2021.09.002

Montirosso, R., Peverelli, M., Frigerio, E., Crespi, M., & Borgatti, R. (2010). The development of Dynamic Facial Expression Recognition at different Intensities in 4- to 18-year-olds. *Social Development*, *19*(1), 71–92. https://doi.org/10.1111/j.1467-9507.2008.00527.x

Murphy, N. A., & Hall, J. A. (2011). Intelligence and interpersonal sensitivity: A meta-analysis. *Intelligence*, *39*(1), 54–63.

Murphy, N. A., Hall, J. A., Ruben, M. A., Frauendorfer, D., Schmid Mast, M., Johnson, K. E., & Nguyen, L. (2019). Predictive validity of thin-slice nonverbal behavior from social interactions. *Personality and Social Psychology Bulletin*, *45*(7), 983–993. https://doi.org/10.1177/0146167218802834

Nelson, E. E., Jarcho, J. M., & Guyer, A. E. (2016). Social re-orientation and brain development: An expanded and updated view. *Developmental Cognitive Neuroscience*, *17*, 118–127. https://doi.org/10.1016/j.dcn.2015.12.008

Nelson, E. E., Leibenluft, E., McClure, E. B., & Pine, D. S. (2005). The social re-orientation of adolescence: A neuroscience perspective on the process and its relation to psychopathology. *Psychological Medicine*, *35*(2), 163–174. https://doi.org/10.1017/s0033291704003915

Nowicki, S., & Duke, M. P. (2001). Nonverbal receptivity: The Diagnostic Analysis of Nonverbal Accuracy (DANVA). In J. A. Hall & F. J. Bernieri, *Interpersonal sensitivity: Theory and measurement*. Psychology Press.

Pakkal, O., Fendler, V., & Shulman, E. P. (In Prep). Emotion regulation: Is it more taxing for adolescents than for adults? *Journal of Youth and Adolescence*.

Pfeifer, J. H., Kahn, L. E., Merchant, J. S., Peake, S. J., Veroude, K., Masten, C. L., Lieberman, M. D., Mazziotta, J. C., & Dapretto, M. (2013). Longitudinal change in the neural bases of adolescent social self-evaluations: Effects of age and pubertal development. *Journal of Neuroscience*, *33*(17), 7415–7419. https://doi.org/10.1523/JNEUROSCI.4074-12.2013

Place, S. S., Todd, P. M., Zhuang, J., Penke, L., & Asendorpf, J. B. (2012). Judging romantic interest of others from thin slices is a cross-cultural ability. *Evolution and Human Behavior*, *33*(5), 547–550. https://doi.org/10.1016/j.evolhumbehav.2012.02.001

Rakoczy, H. (2022). Foundations of theory of mind and its development in early childhood. *Nature Reviews Psychology*, *1*(4), 223–235. https://doi.org/10.1038/s44159-022-00037-z

Schmid Mast, M., & Hall, J. A. (2018). The impact of interpersonal accuracy on behavioral outcomes. *Current Directions in Psychological Science*, *27*(5), 309–314.

Somerville, L. H., Jones, R. M., Ruberry, E. J., Dyke, J. P., Glover, G., & Casey, B. J. (2013). The medial prefrontal cortex and the emergence of self-conscious emotion in adolescence. *Psychological Science*, *24*(8), 1554–1562. https://doi.org/10.1177/0956797613475633

Stella, F. N., Ramírez, V. A., & Ruetti, E. (2022). Individual differences in emotional appraisal during development: Analysis of the role of age, gender, and appraisal accuracy. *The Journal of Genetic Psychology*, *183*(1), 9–22. https://doi.org/10.1080/00221325.2021.1997896

Sternberg, R. J., & Li, A. S. (2020). Social intelligence: What it is and why we need it more than ever before. In R. J. Sternberg & A. Kostić (Eds.), *Social Intelligence and Nonverbal Communication* (pp. 1–20). Springer International Publishing. https://doi.org/10.1007/978-3-030-34964-6_1

Symeonidou, I., Dumontheil, I., Ferguson, H. J., & Breheny, R. (2020). Adolescents are delayed at inferring complex social intentions in others, but not basic (false) beliefs: An eye-movement investigation. *Quarterly Journal of Experimental Psychology*, *73*(10), 1640–1659. https://doi.org/10.1177/1747021820920213

Teh, E. J., Yap, M. J., & Liow, S. J. R. (2018). PiSCES: Pictures with social context and emotional scenes with norms for emotional valence, intensity, and social engagement. *Behavior Research Methods*, *50*(5), 1793–1805. https://doi.org/10.3758/s13428-017-0947-x

Wang, M. Z., Chen, K., & Hall, J. A. (2021). Predictive validity of thin slices of verbal and nonverbal behaviors: Comparison of slice lengths and rating methodologies. *Journal of Nonverbal Behavior*, *45*(1), 53–66.

Weil, L. G., Fleming, S. M., Dumontheil, I., Kilford, E. J., Weil, R. S., Rees, G., Dolan, R. J., & Blakemore, S.-J. (2013). The development of metacognitive ability in adolescence. *Consciousness and Cognition*, *22*(1), 264–271. https://doi.org/10.1016/j.concog.2013.01.004

Witkower, Z., Tracy, J. L., Pun, A., & Baron, A. S. (2021). Can children recognize bodily expressions of emotion? *Journal of Nonverbal Behavior*, *45*(4), 505–518. https://doi.org/10.1007/s10919-021-00368-0

Appendix A

Full Sample Participant Sociodemographic Characteristics by Age Group

	Adolescents		Adults		Full sample	
	n	%	*n*	%	*n*	%
Gender						
Female	41	46.1	52	56.5	94	48.4
Race						
White	62	69.7	61	65.6	123	67.2
Black	6	6.7	9	9.7	15	8.2
East Asian	9	10.1	3	3.2	12	6.6
South Asian	6	6.7	14	15.1	20	10.9
Other	6	6.7	6	6.5	13	7.1
Student						
Yes	89	98.9	26	28.0	116	63.0
Highest Level of Education						
High School or Less	90	100.0	3	3.2	94	51.1
Post-High School	-	-	90	96.8	90	48.9
Primary Parent’s Highest Level of Education						
High School or Less	5	5.6	5	5.4	10	5.4
Post-High School	85	94.4	88	94.6	174	94.6

Appendix B

PISCES Images Selected Mean Ratings by Construct and Sex

Construct	**Image Description**	**Males** *n*	*M*	*SD*	**Females** *n*	*M*	*SD*	**All** *n*	*M*	*SD*
Valence										
Low										
	10: Woman and sick child in a car	32	1.56	0.62	30	1.33	0.61	62	1.45	0.62
	18: Boy sees a spider	32	1.69	0.69	30	1.73	1.41	62	1.71	1.09
	20: Woman looking at dog and broken vase	32	1.81	1.15	30	1.70	1.18	62	1.76	1.15
	22: Boy drops icecream	32	1.91	0.69	30	1.63	0.72	62	1.77	0.71
	23: Girl sitting at table, looking at her homework	32	1.88	0.66	30	1.70	0.70	62	1.79	0.68
Medium										
	82: People in a queue at a ticket counter	31	4.03	0.66	30	3.73	0.58	61	3.89	0.64
	96: Woman buying items at a checkout counter	32	4.03	0.31	30	4.00	0.26	62	4.02	0.29
	100: Girl combing her hair	32	4.00	0.62	30	4.10	0.31	62	4.05	0.49
	101: Man reading a book	32	4.06	0.72	30	4.07	0.25	62	4.06	0.54
	110: Woman blow-drying a girl's hair	32	4.16	0.77	30	4.13	0.51	62	4.15	0.65
	119: Girl reading a book	32	4.31	0.74	30	4.13	0.35	62	4.23	0.58
High										
	180: Woman lifting up a baby	32	6.22	0.66	30	6.17	0.83	62	6.19	0.74
	199: Man kissing a woman on the cheek	32	6.59	0.67	30	6.50	0.68	62	6.55	0.67
	200: Two children hugging each other	32	6.56	0.56	30	6.53	0.51	62	6.55	0.53
	202: Two children playing in the pool	32	6.63	0.55	30	6.60	0.62	62	6.61	0.58
Intensity										
Low										
	82: People in a queue at a ticket counter	32	2.50	1.37	30	2.03	1.07	62	2.27	1.24

Construct	Image Description	Males *n*	Males *M*	Males *SD*	Females *n*	Females *M*	Females *SD*	All *n*	All *M*	All *SD*
	83: Boy washing his hands	32	2.06	1.08	30	1.90	1.09	62	1.98	1.08
	89: Boy drinking from a cup	32	1.81	1.03	30	2.13	1.53	62	1.97	1.29
	96: Woman buying items at a checkout counter	32	2.41	1.32	30	2.23	1.10	62	2.32	1.21
	119: Girl reading a book	32	2.19	1.28	30	1.80	1.10	62	2.00	1.20
Medium										
	37: Boy spilled water on his work	32	4.66	1.72	30	5.07	1.36	62	4.85	1.56
	39: Girl is wet and standing in the rain	32	3.28	1.69	30	2.47	1.22	62	2.89	1.53
	41: People sending off a girl at the airport	32	4.25	1.70	29	4.24	1.27	61	4.25	1.50
	107: Woman holding a torn bag; boy picking up some items on the floor	32	4.50	1.59	30	4.50	1.38	62	4.50	1.48
	158: Children doing clayart together	32	4.50	1.63	30	4.77	1.07	62	4.63	1.38
High										
	47: People on a roller-coaster ride	32	6.81	0.40	30	6.57	1.01	62	6.69	0.76
	165: Children in a soccer game	32	6.25	1.24	30	6.57	0.57	62	6.40	0.98
	173: Man carrying a child, looking at giraffes	32	5.94	1.11	30	6.10	0.80	62	6.02	0.97
	189: Boy playing the drums	32	6.06	1.05	30	6.47	0.63	62	6.26	0.89
	197: Two boys playing with waterguns	32	6.44	0.76	30	6.67	0.55	62	6.55	0.67
	203: Bride and groom posing for a photo	32	6.34	1.13	30	6.43	0.82	62	6.39	0.98
Social Engagement										
Low										
	187: Boy jumping on a trampoline	32	1.06	0.35	30	1.07	0.37	62	1.06	0.36
	196: Girl looking at a large pile of presents	32	1.09	0.30	30	1.60	1.43	62	1.34	1.04
	198: Girl sitting on a swing	32	1.13	0.55	30	1.33	1.30	62	1.23	0.98
	201: Boy playing frisbee with a dog	32	1.22	0.91	30	1.13	0.73	62	1.18	0.82
Medium										
	9: Boy looking at another boy with a bleeding knee	31	4.23	1.41	29	4.79	1.35	60	4.50	1.40

Construct	Image Description	Males			Females			All		
		n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
	45: Two girls working on a problem in class, and a boy and woman are behind them	31	4.58	1.48	30	4.60	1.48	61	4.59	1.46
	107: Woman holding a torn bag; boy picking up some items on the floor	32	5.00	1.67	30	4.83	1.39	62	4.92	1.53
	110: Woman blow-drying a girl's hair	32	4.56	1.48	30	4.17	1.64	62	4.37	1.56
	158: Children doing clayart together	32	4.09	1.77	30	4.47	1.46	62	4.27	1.62
High										
	177: Girl giving a boy a present	32	5.78	1.01	30	5.27	1.39	62	5.53	1.22
	188: People in a three-legged race	32	6.34	0.87	30	6.30	0.95	62	6.32	0.90
	190: Children on a bike and a skateboard	32	5.53	1.11	30	5.60	1.55	62	5.56	1.33
	191: Children playing with a skipping rope	32	6.22	1.13	30	5.80	1.16	62	6.02	1.15
	194: People at a birthday party	32	6.13	0.94	30	6.20	1.06	62	6.16	0.99

Note. Mean values are from Teh et al.'s (2018) supplementary materials.

Appendix C

Effects of Duration and Its Interactions with Age Group and Sex on Image Ratings for All Three Dimensions

Dimensions	$F(1, 163)$	p	η_p^2
Valence			
Duration	0.35	.555	.002
Duration × Age Group	0.06	.805	< .001
Duration × Sex	1.10	.295	.007
Duration × Age Group × Sex	0.09	.769	.001
Intensity			
Duration	1.64	.202	.010
Duration × Age Group	0.64	.425	.004
Duration × Sex	0.20	.657	.001
Duration × Age Group × Sex	2.14	.145	.013
Social Engagement			
Duration	0.75	.389	.005
Duration × Age Group	0.20	.654	.001
Duration × Sex	0.46	.498	.003
Duration × Age Group × Sex	0.18	.676	.001