Associations Among Perspective Taking, Facial Expression Recognition and Understanding Social Cues: Comparing Adults with Down Syndrome and Autism

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Abstract

Three groups of adults (with Down syndrome, age- and IQ-matched with ASD, and age-matched typically developing) were tested on perspective-taking ability and ability to recognize social cues. The ability to recognize static, dynamic, and socially-contextualized facial expressions of emotion was also tested. The ASD and DS groups demonstrated similar difficulties in recognizing negative facial expressions and understanding the perspective of others. However, the ASD group demonstrated lower overall accuracy in identifying facial expressions and in recognizing social cues. There was no evidence that facial expression recognition ability mediates the relationship between perspective-taking ability and the ability to recognize social cues. These results suggest that even though adults with Down syndrome generally demonstrate fewer socio-cognitive impairments than do adults with ASD, they still present with some limitations. Implications for comparing adults with DS and ASD on the study variables in the context of intervention and additional study are examined.

Keywords: Down Syndrome; Autism Spectrum Disorder; facial expression recognition; social cue recognition; socio-cognitive ability; perspective taking

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1. Introduction

Down syndrome (DS) is the single greatest cause of intellectual disability with an incidence of 1 out of every 650 live births (Guralnick, Neville, Hammond, & Connor, 2007). It is clinically characterized by congenital malformations, especially of the heart and gastrointestinal tract, that result in relatively high mortality rates within the first decade of life when compared to other developmental disabilities (e.g., Bittles & Glasson, 2004). For this reason, much of the published research about DS has focused on infancy and childhood. However, a combination of community living rather than institutional care, early and continuing access to clinical interventions, and positive developments in population health have improved and extended the lives of individuals with this disorder (e.g., Newton, 2004). As a result, the estimated life expectancy of those with DS has increased from just 9 years in 1929 (Penrose, 1949) to approximately 60 years in the present-day populations of developed, primarily Western countries (e.g., Bittles & Glasson, 2004; Guralnick et al., 2007). Such longevity requires a substantial shift by researchers towards considering the behaviors and abilities of individuals with DS as developing over the course of a lifespan as opposed to only being relevant during childhood.

One such topic that has recently received increased attention is social competence. Despite the centrality of socio-adaptive skills in defining DS as a developmental disorder, empirical investigations of social cognition in DS are surprisingly rare, even with children (e.g., Wishart, 2007). As well, it is unclear how socio-cognitive abilities such as empathy are expressed in adults with DS. Furthermore, although it is possible that adults with DS present syndrome-specific differences when responding to the emotions of others (e.g., Corona, Dissanayake, Arbelle, Wellington, & Sigman, 1998), the extent to which such responses are emulated by other atypical populations is unclear. For example, autism spectrum disorder (ASD) is a grouping of neurodevelopmental disorders that affects approximately 1% of the population with onset prior to age three (e.g., Baird et al., 2006). ASD is characterized by core deficits in communication, imagination, and social interaction (e.g., American Psychiatric

Association, 2000). Social symptomology in ASD generally includes unusual, avoidant eye contact and inadequate affect comprehension and emotional expression (e.g., Annaz, Karmiloff-Smith, Johnson, & Thomas, 2009; Hernandez et al., 2009). More specifically, a general inability for individuals with ASD to identify negative emotions and a preference for employing deductive "top-down" reasoning strategies that focus initially on imposing judgements on a situation based on attitudes and expectations and work towards processing the finer details of a "big picture" suggest similarities to the social cognitive deficits that are associated with individuals who have DS (e.g., Farran, Branson, & King, 2011; Hernandez et al., 2009); however, direct comparison of the facial expression recognition abilities of adults in these two groups has not been made.

In summary, adults with DS and ASD both appear to struggle with developing effective socio-cognitive skills, including the ability to recognize facial expressions of emotion. Previous research has not directly compared adults with DS and ASD in terms of their facial expression recognition abilities and it is unclear how these two groups match up in terms of this particular socio-adaptive area. The current study will address this gap in the literature by not only comparing the facial expression recognition abilities of adults with DS and ASD, but also examining facial expression recognition ability as mediator of perspective-taking ability and social cue recognition ability for these two groups in comparison to typically-developing peers. More specifically, this paper will begin by distinguishing empathy from emotional contagion and explain how perspective-taking ability can be viewed as a precursor to both affective and cognitive empathy in the perception of facial emotional expressions. This paper will then provide evidence that presents facial expression recognition ability and perspective-taking ability as precursors to social competence, and explain potentially common underlying mechanisms that might play a role in the similar socio-cognitive profiles that are associated with individuals who have DS and ASD. Next, the current study will be detailed in terms of its hypotheses, participants, procedures, measures, and results. Finally, the findings of the current study will be discussed with regard to their implications for adults with DS and ASD.

1.1. Defining Empathy and Empathic Accuracy

Although social cognitive deficits have been broadly associated with individuals who have DS and ASD, specific difficulties in the areas of empathy and empathic accuracy have been identified in both of these populations. Broadly construed, *empathy* has been defined as an emotional or affective response that is based on understanding another's emotional state in a similar fashion to what that other person is actually feeling in a given situation (e.g., Eisenberg & Fabes, 1990). Because the ability to perceive, share, and understand the affective states of others is crucial for successfully navigating the social world (e.g., Decety & Svetlova, 2012), empathy can be viewed as a phenomenon that facilitates our survival in social environments by allowing for socially appropriate responses (e.g., Fan, Duncan, de Greck, & Northoff, 2011).

In the context of its importance to human relationships, there has been increasing interest in identifying the neural mechanisms that underlie empathic processes (e.g., Decety & Jackson, 2006). Such empirical developments have allowed the neural mechanisms of empathy to be described in terms of neural "circuitry" of varied complexity, with "single-circuit" systems involving a group of neurons that are connected through anatomy and/or functionality to process specific types of information and "multi-circuit" systems involving more than one neural circuit. In the following section, the theoretical basis of these disparate processes will be explored with reference to specific meta-analytic findings and single-study claims as a means of providing background regarding empathic development.

1.1.1. "Single-Circuit" Empathy Systems: Distinguishing Empathy from Emotional Contagion in the Perception of Facial Emotional Expressions

In describing models that explain the development of empathy, some theories have focused exclusively on the direct perception aspect of empathic response, and as such, have examined the phenomenon of emotional contagion or emotional imitation also referred to as "mimicry" (e.g., Levenson, 1996). Mimicry occurs when one observes another person's expression and responds with a similar representation of that emotion (e.g., Doherty, 1997). Because unconscious, automatic imitation of another person's facial expressions (facial mimicry) and bodily gestures (motor mimicry) may generate an

automatic and synchronized response in the observer (e.g., Chartrand & Bargh, 1999; Zaki, Bolger, & Ochsner, 2008), such somatosensory outcomes may improve understanding of the target individual's experiences as well as satisfy basic evolutionary needs for connection and affiliation (e.g., Bavelas, Black, Lemery, & Mullett, 1987; Dimberg & Thunberg as cited in Preston & de Waal, 2002). As a result, individuals who show higher levels of spontaneous social imitation and affective resonance also tend to score higher on scales that assess empathic behavior (van Baaren, Holland, Kawakami, & van Knippenberg, 2004) and demonstrate a greater general understanding of emotion (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001).

The view that unconscious automatic mimicry generates the automatic response that is associated with the bodily state and facial expression displayed by the target has received empirical support from a variety of studies. For example, when individuals are exposed to pictures of emotional facial expressions, valence-appropriate muscles are spontaneously activated as measured by electromyography (EMG), even when the pictures are processed outside of conscious awareness (Dimberg & Thunberg as cited in Preston & de Waal, 2002). As well, it has been suggested that that a perceiver's accuracy in inferring a target's negative emotional states is related to the degree of physiological synchrony between the perceiver and the target. That is, when the physiological state such as heart rate or muscle activity of two individuals is more closely matched, they tend to more accurately perceive each other's feelings (e.g., Levenson & Reuf, 1992).

More specifically, the contagion of expressing and perceiving an emotion has been demonstrated for several particular emotional states. For example, fMRI experiments have shown that observing facial expressions of disgust and actual feelings of disgust activate very similar sites in both the anterior insula (AI) and anterior cingulate cortex (ACC) (see Decety & Jackson, 2006 for review). Associated neuroimaging studies have indicated that viewing masked fearful and angry expressions increase amygdala activity without regard for the intensity or valence of the emotional stimuli (e.g., Whalen et al., 1998). Positive blood flow in the amygdala has also been found with subsequent recall of pleasant pictures (Hamann, Ely, Grafton, & Kilts, 1999) and in response to nonaversive or neutral stimuli (Taylor, Liberzon, & Koeppe, 2000), implying that the amygdala may respond to meaningful stimuli in general as opposed to exclusively affectively-laden stimuli. Together, these results suggest that perceiving the actions and

emotional expressions of others may employ the same neural and cognitive resources that are also used when producing similar actions and emotional expressions in oneself. As such, these results lead to the possible notion of a "common neural code" that directly links action with perception in a "single circuit" that lacks the complexity and neural involvement that can be seen as distinguishing unconscious mimicry from a true empathic response (e.g., Levenson, 1996).

1.1.2. "Multi-Circuit" Empathy Systems: Perspective-Taking Ability as a Precursor to Affective and Cognitive Empathy in the Perception of Facial Emotional Expressions

Alternate models that describe the development of empathy have proposed that empathic response involves both cognitive and affective-emotional components (e.g., Decety, 2011; Decety & Meyer, 2008). For example, recent conceptual reviews have examined existing literature related to empathic interaction and recognized the distinction between cognitive and empathic empathy. Based on empirical findings from both cognitive neuroscience and developmental psychology, these reviews have proposed models that describe empathy as involving a deductive, "bottom-up" approach to information processing as well as the "top-down" perception of higher-level concepts such as motivation, intention, and self-regulation (e.g., Decety, 2011; Decety & Meyer, 2008). Self-referential cognition, however, allows for evaluation of the relationship between the emotional states of others and one's own emotions (e.g., Decety & Jackson, 2006). Such cognitive components are closely related to the concepts of theory of mind and mentalizing (e.g., Frith & Frith, 2003), and as such, the ability to adopt another's mental states and evaluate them from one's own perspective act as a precursor to inferring and predicting the intentions, beliefs, and feelings of other people. This, in turn, increases the likelihood of successful social interaction.

Viewed in this manner, the construct of empathy can be examined in the context of perspective-taking and considered within a conceptual framework that suggests a number of distinct neurocognitive components interactively combine to produce an empathic experience (e.g., Decety, 2010, 2011; Decety & Meyer, 2008). For example, the amygdala, hypothalamus and orbitofrontal cortex (OFC) can be seen as underlying rapid and prioritized processing of the emotion signal while the medial prefrontal cortex (mPFC), ventromedial prefrontal cortex (vmPFC), and frontoparietal circuits as well as

the temporoparietal junction (TPJ) provide for emotional understanding that depends on an awareness of self and others. The regulation of emotional expression, however, can be seen as dependent upon executive functions that are instantiated in the intrinsic cortical connections of the OFC, mPFC, and dorsolateral prefrontal cortex, as well as on connections with sub-cortical limbic structures that also help yield mental flexibility (e.g., Amodio & Frith, 2006).

Support for this model of emotion regulation comes from a quantitative meta-analysis employing whole-brain based multi-level kernel density analysis (MKDA) of 40 recent fMRI studies (Fan et al., 2011). In concert with the specified hypothesis, a collection of brain regions involving the ACC and medial cingulate cortex (MCC) were consistently activated during empathic experiences, independent of task and stimulus type. However, the affective-perceptual and cognitive-evaluative forms of empathy were found to activate different regions in addition to the set of regions conserved between them. More specifically, the right AI was more likely to be activated by affective-perceptual forms of empathy, the dorsal anterior midcingulate cortex was more likely to be activated by cognitive-evaluative forms of empathy, and the left AI was activated by both affective and cognitive forms of empathy (Fan et al., 2011). These findings confirm a model of emotion regulation that is composed of multiple brain-based components that necessarily interact to produce an empathic experience containing both affective and cognitive elements.

Recent cognitive neuroscience research with adult participants further suggests that the affective, cognitive, and regulatory aspects of empathy do indeed involve interacting yet partially non-overlapping neural circuits with different developmental trajectories (e.g., Decety & Jackson, 2006; Lamm, Meltzoff, & Decety, 2009). Multiple conceptual reviews (e.g., Decety, 2010) provide ample behavioral evidence demonstrating that the affective component of empathy develops earlier than the cognitive component. Affective responsiveness is known to be present from infancy, is involuntary, and relies on mimicry and somato-sensorimotor resonance between other and self. This primitive mimicry mechanism contributes to the development of empathy in the early preverbal period and continues to operate past childhood (e.g., Lamm, Decety, & Singer, 2011). In order to understand the emotions and feelings of others in relation to oneself, however, second-order representations of the other need to be

available to awareness without confusion between self and other for which the mPFC and vmPFC play a crucial role (e.g., Decety & Jackson, 2004).

In addition, emotion regulation taps into executive function resources that are implemented in the prefrontal cortex (e.g., Zelazo, Carlson, & Kesek, 2008). An early meta-analysis found that although the amygdala is associated with generating physiological components of emotional responses, more frontal regions, including the mPFC and ACC, are actually the most commonly recruited by emotional stimuli (Phan, Wager, Taylor, & Liberzon, 2002). More recent meta-analyses (e.g., Barrett, Mesquita, Ochsner, & Gross, 2007) suggest that frontal regions are associated with mental representations of emotion whereas the amygdala may indirectly influence perception and memory for emotional events because lesions in that area do not necessarily alter the experience of emotion (e.g., Anderson & Phelps, 2002). The prefrontal cortex (PFC), however, develops more slowly than other brain areas and reaches maturation only in late adolescence. Such frontal lobe maturation allows individuals to exercise inhibitory control over their thoughts, actions, and attention as well as use verbalizations to self-regulate their feelings (e.g., Diamond, 2002). This means that as a child matures into adolescence, responses to emotional events typically shift from using more limbic-related anatomic structures, such as the amygdala, to using more frontal lobe regions that control emotional response (e.g., Killgore, Oki, & Yurgelun-Todd, 2001).

1.2. Facial Expression Recognition Ability as a Precursor to Social Competence

With its influence extending across the lifespan, empathy can be viewed as underlying all aspects of social behavior (Batson, 1991; Eisenberg & Miller, 1987a; Hoffman, 1982, 1987) and considered so critical to the development of social relationships that its absence is commonly associated with conduct disorder, psychopathy, and sociopathological deviance (e.g., Blair, 2005; Eisenberg & Miller, 1987b). There are both theoretical and empirical reasons to believe that empathy is associated with healthy psychological development (e.g., Adler, 1998; Hoffman, 1990) as well as altruistic and prosocial behavior (Batson, 1998), emotional intelligence (Davies, Stankov, & Roberts, 1998), interpersonal forgiving (McCullough, Worthington, & Rachal, 1997), relationship satisfaction (Davis & Oathout, 1987), and low levels of

aggression towards others (Miller & Eisenberg, 1988). For these reasons, empathy can be considered an important task of human development as well as a crucial aspect of social competence (Kasari, Freeman, & Bass, 2003).

Processing facial information is quite possibly one of the earliest facilitators of social competence (Bushnell, Sai, & Mullin, 1989). Originally, Charles Darwin (1872) asserted that the recognition and understanding of basic emotional expressions is an innate ability, and more than a century of research has confirmed Darwin's claim. For example, studies have indicated that in typical development, even very young children spontaneously attend and discriminately react to emotional expressions in others with infants preferentially attending to faces within a few hours of birth (e.g., Johnson & Morton, 1991) and 10-week-old babies reacting appropriately to distinct expressions (Caron, Caron, & Myers, 1982; Izard, 1994; Klinnert, Campos, Sorce, Emde, & Svejda., 1983). Furthermore, typically developing infants are able to discriminate static displays of happy, sad, and surprised faces as early as 3 to 4 months of age (Young-Browne, Rosenfeld, & Horowitz, 1977) and dynamic displays of happy and angry faces by 7 months of age (Soken & Pick, 1992). By four years of age, typically developing children can freely label prototypical displays of happiness, sadness, and anger with almost perfect accuracy and are also becoming more adept at recognizing fear and surprise (e.g., Widen & Russell, 2003). Although some research suggests that the ability to recognize most emotional expressions reaches adult levels by 10 years of age (e.g., Durand, Gallay, Seigneuri, Robichon, & Baudouin, 2007), adolescents may still find it difficult to recognize less vividly displayed emotions (e.g., Thomas, De Bellis, Graham, & LaBar, 2007). This skill, along with the speed with which emotions are processed, continues to develop through adolescence before reaching its peak in adulthood (e.g., De Sonneville et al., 2002; Thomas et al., 2007). By adulthood, typical individuals are not only highly proficient and very fast at perceiving prototypical expressions of emotion in others (De Sonneville et al., 2002; Ekman, 1997), but they are also able to identify even very subtle expressions of emotion (e.g., Calder, Young, Perrett, Etcoff, & Rowland, 1996).

Children who are better able to accurately recognize the emotions of others are viewed as more socially proficient by both teachers and peers (Denham & Holt, 1993), and facial processing accuracy does appear to be positively correlated with social adaptation in adults with intellectual disabilities (Garcia-Villamisar, Rojahn, Zaja, &

Jodra, 2010); however, most studies of empathy have focused only on typically-developing children and adolescents. As a result, very little is known about empathy across the lifespan in individuals with developmental disabilities such as Down syndrome and autism.

1.2.1. Facial Expression Recognition Ability as a Precursor to Social Competence in DS

Although it is likely that developmentally delayed individuals present etiologic differences when responding to the affect of others, previous studies have generally neglected to separate developmentally atypical participants on the basis of diagnosis (e.g., Corona et al., 1998). That is, studies have typically included subjects delineated only as either typically or non-typically developing without sub-groups to separate the atypical individuals according to their diagnosis. For this reason, it is difficult to compare and contrast individuals with different developmental diagnoses with regard to their empathic abilities (Kasari et al., 2003). It is likely, however, that individuals with DS possess a particular set of characteristics that converge to provide a phenotypically-unique empathic response. For example, compared to those with other types of intellectual delay, children with DS appear to be more attentive to the faces of others, engage in more positive affect, and have more pleasant personalities (e.g., Hornby, 1995; Kasari, Freeman, Mundy, & Sigman, 1995). Because of their interest in and attention to the faces of others, as well as their typically pleasant interactional style, children with DS may learn about emotions and interpersonal interactions differently than their typical and atypical peers. As a result, these individuals may be more attentive to others in distress and also make greater attempts to comfort them (Kasari et al., 2003) without necessarily regarding the boundaries and actions that are typically associated with socially normative behaviors.

Although facial expressions are widely acknowledged as essential to communicating emotions and behavioral intentions (e.g., Ekman & Friesen, 1975), children with DS generally find it difficult to accurately recognize such expressions with improvement being unrelated to either developmental or chronological age (Williams, Wishart, Pitcairn, & Willis, 2005; Wishart & Pitcairn, 2000). This is important to consider because in order to respond appropriately to others, it is first necessary to identify the emotional states of others with some accuracy (e.g., Decety & Ickes, 2009). Specifically,

identifying both static and dynamic facial representations of surprise (e.g., Wishart & Pitcairn, 2000), anger, and fear (e.g., Kasari, Freeman, & Hughes, 2001) appear to be problematic for children with DS when compared to typical peers even though the addition of motion tends to improve recognition accuracy in all participants (Virji-Babul, Watt, Nathoo, & Johnson, 2012). Individuals with DS also tend to be less accurate in verbally labeling negative emotions, are less able to match expressions according to social context (e.g., Turk & Cornish, 1998), and tend to misidentify negative emotions as positive ones (Hippolyte, Barisnikov, & Van der Linden, 2008). The presence of these social cognitive deficits past adolescence and across the lifespan in individuals with DS, however, has just recently started gaining attention (e.g., Pinter et al., 2001).

In addition to etiologically-specific characteristics in emotion recognition, a second reason to focus on individuals with DS in the study of empathic response is that they tend to show progressively slower cognitive development over time (Hodapp, Evans, & Gray, 1999). The reasons for this slowing are unknown, but in some areas and at certain ages, intellectual development appears to plateau. For instance, Fowler (1992) noted limited improvement in syntactic comprehension in adolescents with DS in spite of rapid growth during the preschool years. Due to this decline in cognitive ability, individuals with DS might focus on salient aspects of their environment without necessarily consolidating their knowledge of those aspects into an understanding of the overall situation (Kasari et al., 2003). As an example, children with DS are typically more attentive to their mother's display of positive or negative emotion compared to typical peers but less able to connect their mother's emotion to a stimulus event from the external environment (Kasari et al., 1995).

The relevance of such cognitive slowing with respect to social cognitive development can be extracted from a study of facial expression recognition in which children with DS were able to label facial expressions of happiness, sadness, anger, and fear as well as mental age-matched typical peers when both groups were at a developmental age of three years. With the advancement of another year of chronological age, however, the children with DS performed more poorly than both mental age-matched typical peers and as well as mental age-matched peers with a developmental delay of unspecified etiology. When measured over a two year period, the children with DS did not lose their earlier abilities in emotion recognition but also did not show developmental increases (Kasari et al., 2001). This finding supports the

suggestion that general cognitive slowing may impact knowledge of emotion and resultant displays of empathic accuracy in children with DS, but the implications of this conclusion remain unknown for adults in the DS population.

Deficits in emotion recognition during childhood are especially troubling given that those with poorer empathic accuracy are more likely to become the target of relational victimization and are also more likely to suffer from internalizing problems such as unhappiness and depression (Gleason, Jensen-Campbell, & Ickes, 2007, as cited in Decety & Ickes, 2009). Children with DS report having friendships that are often less intimate (Stevens, Steele, Jutai, & Kalnins, 1996), less stable, more prone to conflict (Zetlin & Murtaugh, 1988) and of lower self-reported quality than those of typically developing peers (Bauminger & Kasari, 2000). Furthermore, children with DS struggle with extracting social cues from static images (Watt, Virji-Babul, & Johnson, 2010), show no preference for social over non-social play in group situations, and are less receptive towards social initiations when compared with typical peers (Sigman & Ruskin, 1999). Because most friendship-making skills hinge on the accurate assessment of others' feelings (Rosenthal, Hall, DiMatteo, Rogers, & Archer, 1979, as cited in Hall & Bernieri, 2001), achieving a more detailed knowledge of empathic engagement and the ability to interpret social cues across the lifespan of those with DS can be seen as critical to devising effective support strategies in the area of social development (Hartup & Stevens, 1997).

1.2.2. Facial Expression Recognition Ability as a Precursor to Social Competence in ASD

In comparison to individuals with DS, it is thought that impaired facial processing skills may also play a role in the characteristic social interaction deficits that are observed in individuals with ASD (e.g., Farran et al., 2011). For example, by 10 years of age, both low- and high-functioning children with autism are less able than typical peers to associate facial expressions of emotion with verbal and pictorial labels (e.g., Lindner & Rosen, 2006). As well, children with autism struggle with selecting the appropriate facial expression to match gestures, vocalizations, and emotional contexts (e.g., Hobson, 1986), tend to interpret emotions as negative rather than positive in nature (e.g., Kuusikko et al., 2009), and are better able to recognize simple emotions like happiness and sadness as opposed to more complex emotions such as jealousy (e.g., Bauminger,

2002, 2004), surprise, and embarrassment (e.g., Baron-Cohen, Spitz, & Cross, 1993). Moreover, both children and adults with ASD appear to be less sensitive to negative emotions, such as distress, fear, discomfort, and anger (e.g., Pelphrey et al., 2002), and generally have difficulty recognizing, identifying, and understanding the significance of emotions (e.g. Celani, Battacchi, & Arcidiacono, 1999) in a manner similar to that identified in individuals with DS (e.g, Farran et al., 2011; Hernandez et al., 2009).

Evidence for improvement in facial expression recognition throughout childhood and even adolescence for typical individuals (Thomas et al., 2007) suggests that social experience plays a significant role in this developmental process (e.g., Leppanen & Nelson, 2006). The importance of social experience also provides a possible explanation for facial expression recognition deficits in ASD: because infants with autism tend to demonstrate a lack of social orientation (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998), difficulty with establishing joint attention (Mundy, Sigman, & Kasari, 1994), and a lack of orientation to faces (e.g., Clifford, Young, & Williamson, 2007), they might have less social experience and consequently less exposure to various facial expressions, leading to difficulty with recognizing such expressions (e.g., Grelotti, Gauthier, & Schultz, 2002). Abnormalities and deficits in facial expression recognition that develop early in ASD could then further hinder social interaction, even if social orientation increases during later childhood and adolescence.

Additional explanation for the socio-cognitive profile associated with ASD may be found in a growing body of data that has demonstrated that individuals with ASD generally process faces differently than typically developing peers (Celani et al., 1999; Deruelle, Rondan, Gepner, & Tardif, 2004). For example, individuals with ASD tend to look less frequently at the eye region of emotionally expressive faces than do typical peers, rely more readily on information from the lower portions of the face when decoding emotion (e.g., Bal et al., 2010; Hernandez et al., 2009; Spezio, Adolphs, Hurley, & Piven, 2007), and do not use information from the upper regions of the face as effectively during emotion identification (e.g., Gross, 2008). Even though the eyes have been shown to be crucial to the successful identification of emotional expressions, it is possible that faces may hold less salience or reinforcing value for children with ASD compared to typical peers and thus relevant features such as the eyes draw minimal attention for these individuals (e.g., Pelphrey et al., 2002). Implementing such a limited processing strategy may result in an affect-related schema that is based upon select

facial features rather than whole face configurations (e.g., Gross, 2004), leading to a different understanding of facial features and emotional expressions than that which is acquired by individuals without ASD.

Such altered fixation patterns in ASD reflect the "top-down" modulation of eye gaze rather than the "bottom-up" effects of visual saliency in a manner that is similar to the visual processing patterns found in individuals with DS (e.g., Farran et al., 2011; Hernandez et al., 2009). This process, referred to as "weak central coherence," involves a tendency to process featural details of the face in a piecemeal, rule-based fashion instead of integrating information into a emotional gestalt of what's going on around the individual (e.g., Frith, 2003). Such a lack of holistic integration typically fails to capture the global meaning of the facial image and does not allow inferences to be made about the emotion being displayed (e.g., Ashwin, Baron-Cohen, Wheelwright, O'Riordan, & Bullmore, 2007; Baron-Cohen, 2003). Further, focusing on solitary details may be part of a more general perceptual bias in autism that favors processing local features over global elements in any visual display (e.g., Jolliffe & Baron-Cohen, 1997). This processing style appears to involve more effort than that which is followed by typically-developing individuals, and can be linked to recent evidence that children with ASD do not show deficits in identifying "basic" static and dynamic facial expressions such as anger, fear, and happiness when ample response time is provided (e.g., Piggot et al., 2004; Ponnet, Roeyers, Buysse, de Clercq, & van der Heyden, 2004; Rump, Giovannelli, Minshew, & Strauss, 2009; Tardif, Laine, & Rodriguez, 2007) although their responses may be more scripted in nature (Capps, Yirmiya, & Sigman, 1992).

Considering that individuals with ASD appear to apply a processing style that is more time-consuming and rule-based than that which is used by typical peers when perceiving facial expressions, a relatively slowed presentation speed may enhance the ability of these individuals to perceive and extract relevant details from dynamic presentations of facial gestures (Tardif et al., 2007). Although systematically applying a set of rules may allow individuals with ASD to accurately identify emotions in certain experimental contexts when ample time is provided, it may prevent recognition in more naturalistic contexts where expressions are shown only briefly and observers tend to be distracted (e.g., Rump et al., 2009). Participants in research studies are not dealing with real people, nor are there usually any references to future interactions. As such, a finding that children with autism tend to ignore emotional expressions under artificial

research-related circumstances might indicate that they failed to fully apply their ability to read emotional expressions in situations that they deemed to be irrelevant (e.g., Begeer, Rieffe, Terwogt, & Stockman, 2006). Because the task performance and motivation of children with autism can be enhanced when their task involvement is increased (e.g., Begeer, Rieffe, Terwogt, & Stockman, 2003; Koegel & Mentis, 1985; Rieffe, Meerum Terwogt, & Stockmann, 2000), the absence of social relevance in typical laboratory studies might be associated with a relative underestimation of the ability to process emotional cues by individuals with ASD.

1.2.3. Facial Expression Recognition Ability as a Precursor to Social Competence in Both DS and ASD: Common Underlying Mechanisms

There is much research support to indicate that individuals with DS or ASD struggle with accurately identifying facial emotional expressions (e.g., Farran et al., 2011; Wishart & Pitcairn, 2000). This overlapping phenotype and related social-emotional deficits (e.g., Farran et al., 2011; Hernandez et al., 2009), however, may be due to common underlying mechanisms. For example, the social and cognitive impairments of both DS and ASD may be associated with a malfunction of "central coherence", meaning that these individuals prefer to process and focus on particular details instead of developing a cohesive and holistic overview of social situations (e.g., Annaz et al., 2009; Frith & Happe, 1994). There is additional evidence that individuals who are unaware of the significance of looking at the eyes may be at a disadvantage when it comes to learning about mental states (e.g., Baron-Cohen, 1988; Baron-Cohen et al., 1993; Celani et al., 1999; Yirmiya, Pilowsky, Solomonica-Levi, & Shulman, 1999). As such, the lower performance of those with DS and ASD on tasks in which faces are used as stimuli might really be indicating similar information-gathering strategies as opposed to truly measuring difficulties in understanding the emotional meaning of facial expressions (e.g., Celani et al., 1999). In other words, individuals with DS and ASD may obtain and process information obtained from facial features in a similarly ineffective manner, and based on this faulty knowledge, these individuals build an understanding of facial emotional expressions that fits with their own developmental trajectory but is inaccurate compared to that experienced by typically developing peers.

In addition, postnatal developmental abnormalities in the hippocampal formation of the medial temporal lobe, with specific reference to the limbic system and amygdala, are thought to contribute to both ASD and DS as neurodevelopmental disorders. The resulting deficits have been related to social behavior in general and specifically to memory for faces and recognition and understanding of emotional expressions (e.g., Abraham et al., 2012; Groen, Teluij, Buitelaar, & Tendolkar, 2010; Jernigan, Bellugi, Sowell, Doherty, & Hesselink, 1993; Lavenex, Lavanex, & Amaral, 2007; Loveland, Bachevalier, Pearson, & Lane, 2008; Murphy et al., 2012; Pinter et al., 2001). The temporal limbic system has long been identified as important to social cognition and emotion recognition, and the amygdala has been associated with the recognition of negatively valenced emotions such as sadness and fear (e.g., Adolphs, 2001; Blair, Morris, Frith, Perrett, & Dolan, 1999). If such difficulties are present at younger ages, they may contribute to problematic aspects of early socio-cognitive development, such as establishing and maintaining joint attention (Cebula, Moore, & Wishart, 2010).

Findings that there is also a reduced volume of the frontal lobes associated with both ASD and DS (e.g., Sanchez et al., 2012; Wang, Doherty, Hesselink, & Bellugi, 1992) suggest that these individuals might well exhibit the classic effects of frontal lobe syndrome, including a lack of awareness of the relevance of the response of others (e.g., Eslinger & Damasio, 1985). This suggestion seems to fit well with the pattern of social response seen in many individuals with ASD and DS in which patterns of attention are not focused on interpersonal relations (e.g., McTurk, Vietze, McCarthy, McQuiston, & Yarrow, 1985) and the social behaviors produced may be repetitive and dysfunctional in problem-solving contexts (e.g., Pitcairn & Wishart, 1994). Additional difficulties with expressive language that emerge in the preschool years for children with ASD and DS (e.g., Chapman, 2003) may further affect the development of more complex socio-cognitive abilities as it is expected that socio-cognitive strengths and weaknesses will both shape an individual's social environment and change the landscape of their subsequent social interactions (Cebula et al., 2010).

1.3. Perspective Taking Ability as a Precursor to Social Competence

Many developmental researchers have acknowledged the importance of interpersonal interaction and social competence (e.g., Clarke-Stewart & Koch, 1983; Rehfeldt, Dillen, Ziomek, & Kowalchuk, 2007). Psychologists have long suspected, however, that an individual's social skills are associated with appreciation for the perspectives of others (e.g., Bartsch, Wade, & Estes, 2011; Chandler, 1988; Flavell, Miller, & Miller, 2002). Developmental psychologists have defined perspective-taking as an individual's awareness of informational states in oneself and others (Baron-Cohen, 1995; Premack & Woodruff, 1978). Research has shown, however, that children do not demonstrate perspective-taking abilities until they reach certain developmental milestones. For example, in one study, children aged 5, 7, and 10 years were read a series of short stories about a child emptying his toy box. The stories varied in terms of the boy's intentions for emptying the box and the information his mother had about his intentions. Only the oldest group of children in this study were able to correctly identify discrepancies in the boy's and the mother's perspectives on his informational states, thus demonstrating perspective-taking skills (Dixon & Moore, 1990).

A similar study required children to respond to a series of questions about the knowledge possessed by several characters in a story about the contents of a picture. Responding correctly to the questions required the children to change perspectives between characters in the story. Children who were four years old were unable to pass the test, and children who were six years old did pass the test but made more errors than did adult participants (Taylor, Cartwright, & Bowden, 1991). Other research found that children excel on perspective-taking tasks once they are approximately five years of age (Baron-Cohen, Tager-Flusberg, & Cohen, 2000). This body of findings suggests that perspective-taking skills emerge over the course of typical development. By the end of middle childhood, however, most typical individuals are able to simultaneously consider multiple social perspectives and realize that two people can have different interpretations of the same event (e.g., Davis-Unger & Carlson, 2008; Hughes & Ensor, 2005; Selman, 1980).

Although the mechanisms underlying the association between perspective-taking and social competence have not yet been clearly delineated (e.g., Bartsch, London, &

Campbell, 2007), viewing a situation from the perspective of another individual would seem to contribute greatly to an individual's success in social situations (e.g., Rehfeldt et al., 2007). For example, reciprocal conversation, cooperative play, and displays of sympathy and empathy are all social abilities that require an effective repertoire of perspective-taking skills. Because ASD is characterized by deficits in the ability to form reciprocal social relationships (e.g., Klin, Volkmar, & Sparrow, 1992), some researchers have suggested that deficits in perspective-taking may be closely tied to, if not the basis of, the social deficits commonly observed in autism. Indeed, several studies have found that individuals with ASD show marked deficiencies on perspective-taking tasks. For example, a task known as the "Sally Anne task" (Wimmer & Perner, 1983) was administered to typically developing children, children with ASD, and children with DS (Baron-Cohen, Leslie, & Frith, 1985). This task involves two dolls named Sally and Anne. The task begins with Sally placing a marble in a basket and then leaving the scene, at which time Anne enters the scene, removes the marble from the basket, and places it in a box. Sally returns to the scene, and participants are asked where Sally would look for the marble. It was found that children with ASD showed considerable difficulties with the task, whereas typically developing children and children with DS could correctly answer the experimenter's questions about the Sally doll's perspective (Baron-Cohen et al., 1985).

Other research has similarly found that children with ASD were strikingly deficient in terms of their performance on a version of the "Sally Anne task". In fact, the children with ASD were only able to pass the task after intensive behavioral intervention involving video modeling and positive reinforcement, and even then, the children's generalization of perspective-taking skills to new situations was limited. Finally, the performance of children with ASD on a perspective-taking task was found to be positively correlated with the children's social competence, as measured by two standardized scales. In other words, those children who performed worse on the perspective-taking task were clinically evaluated as being less socially competent (Dawson & Fernald, 1987). In a similar context, however, relatively little attention has been paid to the relationship between perspective-taking ability and social competence in those with DS, and is unknown how this population compares to those with ASD past childhood and into adulthood with a lifespan approach.

1.4. The Present Study

Empathy can be considered a particularly complex construct that incorporates a broad spectrum of phenomena, from feelings of concern for other people, to experiencing emotions that match another individual's experience, and to knowing what the other is thinking or feeling (e.g., Decety, 2011). More specifically, the ability to perceive another's verbal and non-verbal behaviors has been referred to as "empathic inference" (Stone, 2006), and the extent to which it is successful has been labeled "empathic accuracy". Empathically accurate perceivers are therefore "good" at inferring the specific content of another person's thoughts and feelings and consequently able to understand the internal states that a targeted individual is experiencing (Ickes, 1997, 2003). Within the current project, empathic accuracy will be approximated through the measurement of facial expression recognition ability in adults with DS and ASD compared to typical peers. Three different conditions of facial emotional expressions will be employed: static expressions, dynamic expressions, and expressions presented within a naturalistic social context.

With both the cognitive and affective aspects of empathic response being impacted by an individual's ability to understand the experience of others separately from one's own (e.g., Saarni & Harris, 1989), one pathway through which the viewpoints of self and other are incorporated involves the ability to understand the perspective of another individual. Such perspective taking could involve identifying with another's experiences through direct contact, conditioning, or retrieving relevant information from memory that fosters an understanding of the other individual's feelings or situation (e.g., Eisenberg, Shea, Carlo, & Knight, 1991; Ford, 1979; Mood, Johnson, & Shantz, 1978; Strayer, 1980, 1987; Strayer & Roberts, 1989). In this way, a highly empathic individual would be able to decode cues related to another's thoughts and feelings through "everyday mind reading" that is based on knowledge of the other's appearance, behavior, and character (Ickes, 1993; Ruby & Decety, 2004). In the current project, the perspective-taking ability of adults with DS and ASD will be measured in comparison to the performance of typical peers.

Further, there appears to be evidence from both behavioral and neurological investigations suggesting that the ability to identify another person's emotions through accurate interpretation of facial expressions is a fundamental link to many social

processes (Ekman, 1994). As such, within the current project, social competence will be approximated by measuring the ability of adults with DS and ASD to recognize social cues that are presented within stationary interpersonal scenarios in comparison to typical peers.

Finally, although it appears that the socio-cognitive phenotypes that are associated with ASD and DS may stem from common mechanisms, few researchers have compared adults from these groups with investigations focusing mainly on children and adolescents. The research that does exist has been overwhelmingly consistent in indicating that children with autism spectrum disorders tend to function more poorly than those with DS. Children with ASD have been found to have fewer adaptive skills (e.g., Rodrigue, Morgan, & Geffken, 1991), fewer social and communication skills (e.g., Bierberich & Morgan, 1998; O'Neill & Happe, 2000), more behavior problems (e.g., Eisenhower, Baker, & Blacher, 2005), more sleep problems (e.g., Cotton & Richdale, 2006), and less behavioral flexibility (e.g., Didden et al., 2008) compared to children who have DS. Children with ASD have also been found to exhibit more impaired interactions with their parents and siblings than have children with DS (e.g., Hoppes & Harris, 1990; Kasari & Sigman, 1997).

Because most comparative work in this area has been limited to children, however, it is not known whether a similar pattern of poorer outcomes persists into adulthood for individuals with autism spectrum disorders as compared to individuals with Down syndrome. As individuals with ASD and DS age beyond adolescence into adulthood, divergent life course trajectories for each group are suggested by within-group studies. Among adults with ASD, the severity of social deficits tends to abate with the progression of chronological age (e.g., Seltzer et al., 2003; Shattuck et al., 2007), whereas the acquisition of skills among adults with Down syndrome begins to level off and functional abilities decline in midlife (e.g., Esbensen, Bishop, Seltzer, Greenberg, & Taylor, 2010; Esbensen, Seltzer, & Krauss, 2008; Zigman, Schupf, Urv, Zigman, & Silverman, 2002). Thus, it is possible that the gap evidenced in studies of children with ASD versus DS may diminish and narrow in adulthood. Conversely, it is possible that adults with ASD continue to exhibit a profile of relatively poorer outcomes compared to adults with DS and that the difficulties they experience in adulthood are above and beyond what would generally be expected given their intellectual functioning and symptoms (e.g., Esbensen et al., 2010).

Assuming that adults with ASD continue to show greater social deficits compared to adults with DS, even though such deficits may stem from similar origins, direct comparisons between these two groups in terms of their facial expression processing abilities have yet to be investigated in the literature. In addition, it is unknown how perspective taking as a particular socio-cognitive skill may impact each group's capacities for empathic accuracy and resultant interpretation of social cues. The present exploratory study builds upon previous research by directly comparing the facial expression recognition abilities of adults with DS and ASD in three separate expression conditions (namely, static facial expressions, dynamic facial expressions, and facial expressions within a social scene). As well, facial expression recognition ability is investigated as a mediator of the relationship between perspective-taking ability and the ability to recognize social cues in adults with DS and ASD compared to typical peers (e.g., Eisenberg & Fabes, 1990; Preston & de Waal, 2002).

The specific hypotheses being evaluated in the current study are as follows:

1. Compared to the DS group, the ASD group will be less able to recognize static, dynamic, and contextualized emotional expressions; however, both of these groups will be less able to recognize static, dynamic, and contextualized emotional expressions compared to typical peers. This prediction is consistent with research findings suggesting that individuals with either DS or ASD tend to demonstrate socio-cognitive deficits that include difficulties recognizing facial expressions of emotion in comparison to typical peers; however, individuals with ASD tend to demonstrate more severe deficits with regards to interpersonal interaction than do individuals with DS.
2. Compared to the DS group, the ASD group will be less able to recognize angry, sad, and scared facial expressions; however, both of these groups will be less able to recognize angry, sad, and scared facial expressions compared to typical peers. No differences among the groups will be noted for happy facial expressions. Again, research findings suggest that individuals with either DS or ASD tend to struggle with recognizing negative facial expressions of emotion in comparison to typical peers; however, individuals with ASD generally tend to demonstrate more severe deficits with regards to interpersonal interaction than do individuals with DS, and as such, are expected to do more poorly in this regard in comparison to the other two groups.
3. Compared to the DS group, the ASD group will be less able to recognize social cues; however, both of these groups will be less able to recognize social cues compared to typical peers. This prediction is supported by research findings that suggest individuals with either DS or ASD tend to struggle with a variety of socio-cognitive activities including interpersonal interaction in comparison to typical peers.

From this, it can be hypothesized that recognizing social cues within interpersonal or social interactions would be difficult to master for individuals with DS or ASD. Individuals with ASD generally tend to demonstrate more severe deficits with regards to interpersonal interaction than do individuals with DS, however, and as such, are expected to do more poorly in this regard when compared to the other two groups.

4. Both the DS and ASD groups will be less able to recognize the perspective of others compared to typical peers. Previous research findings suggest that concepts such as theory of mind and perspective taking are difficult for individuals with DS or ASD to master; however, there is no indication that either group would be more severely disadvantaged in this regard when compared to typical peers.
5. The ability to recognize social cues will be predicted from the ability to recognize facial expressions for all three groups. That is, individuals who are more able to accurately identify facial expressions of emotion will apply that information to make better sense of the context in which the interpersonal interaction occurs, and as such, will more accurately identify social cues that are associated with that context.
6. The ability to recognize facial expressions of emotion will be predicted from perspective-taking ability for all three groups. For example, individuals who are better able to understand that the views of others may differ from their own perspectives will be better able to understand the thoughts and feelings experienced by others, including the feelings that are expressed through facial expressions.
7. The ability to recognize social cues will be predicted from perspective-taking ability for all three groups. That is, individuals who are better able to understand the views and experiences of others will be better able to accurately predict the experiences of others in social interactions, and as such, more accurately identify the subtle social cues that are present in such interactions.
8. The association between perspective-taking ability and the ability to recognize social cues will be mediated by facial expression recognition ability for all three groups. That is, individuals who are better at identifying the views of others and accurately recognizing facial expressions of emotion will also be better at accurately recognizing subtle social cues that are present within interpersonal interactions.

Figure 1 depicts the proposed mediation model whereby the ability to recognize facial expressions mediates the link between perspective-taking ability and the ability to recognize social cues that are associated with interpersonal interactions. Path “A” represents the association between perspective-taking ability and facial expression recognition ability (i.e., static expressions, dynamic expressions, and expressions placed

within a social context). Path “B” represents the association between facial expression recognition ability and the ability to recognize social cues that are associated with interpersonal relationships. Path “C” represents the direct association between perspective-taking ability and the ability to recognize social cues that are associated with interpersonal relationships. If one or more these three paths are not significant, researchers usually conclude that mediation isn’t possible. Assuming that significant relationships do exist in Paths “A”, “B”, and “C”, one would proceed to evaluate Path “C’ ”. Path “C’ ” represents the effect of perspective-taking ability on the ability to recognize social cues controlling for facial expression recognition ability. In this final equation testing mediation, if the predictor (perspective-taking ability) no longer independently predicts variability in the outcome (i.e., ability to recognize social cues), or if the association between the predictor and the outcome is weakened, then at least partial mediation is suggested (e.g., Baron & Kenny, 1986). The proposed mediation models will be tested with regression analyses and path models predicting each group’s ability to identify social cues.

2. Method

2.1. Participants

All study procedures were approved by the Simon Fraser University Department of Research Ethics and the Down Syndrome Research Foundation Ethics Review Board.

Fifteen adults with Down syndrome (DS) (females = 9) and 15 adults with autism spectrum disorder (ASD) (females = 6), aged 19 to 30 years, were recruited for this study from programming offered by the Down Syndrome Research Foundation (DSRF) and Glen Eden Multimodal Centre (GEMC). The DSRF is an independent non-profit organization based in Burnaby, BC that provides educational programming and services for individuals with DS and their families. The GEMC is an organization based in Vancouver, BC that provides a variety of programming and services to aid in the effective treatment of individuals who present with complex mental health and developmental conditions. A “snowball” recruiting technique was also employed in which individuals who contacted the research team were invited to recommend other individuals who might also meet study criteria and be interested in participating. Parents/caregivers/guardians of individuals who were within the specified age range were sent a recruitment poster and invited to contact the research team if they were interested in having their (adult) child/ward participate in this study.

Participants with DS averaged 23.3 years (*SD* = 2.2) with an average IQ of 67.4 (*SD* = 3.4), and participants with ASD averaged 21.08 years (*SD* = 4.5) with an average IQ of 69.0 (*SD* = 6.1); there were no significant differences between these groups in either age or IQ. Fifteen typical adults (average age 22.9 years, *SD* = 1.8, females = 11) with an average IQ of 105 (*SD* = 11.3), equivalent in chronological age (CA) to the other two groups, were recruited from postings on Internet and community bulletin boards. To be included, each participant needed to possess adequate visual abilities to view paper-

based and computer-based images and be willing to travel to the DSRF, the GEMC, or the SFU (Burnaby) campus to participate in the study.

2.2. Procedures

2.2.1. Informed Consent

The study consent form was given to interested parents/caregivers as well as adult participants, and the activities comprising the study as well as the risks/benefits of the study were outlined. Written consent from parents/adult participants was obtained before any participant was tested.

2.2.2. Testing

All participants were tested at the DSRF, SFU Burnaby campus, or GEMC. A PhD level researcher, a graduate student, and several trained assistants performed the testing in a quiet area away from distractions. The study measures were counterbalanced with participants randomly assigned to the counterbalanced order. Paper-based response forms were completed by the researchers as participants completed the study measures. All testing was ideally completed in one session, but additional sessions and/or short breaks were offered to accommodate participants who appeared fatigued or distracted. Participation in this project did not exceed one hour for any of the participants.

2.2.3. Anonymity

To ensure anonymity, neither the names of the participants or their parents/caregivers were associated with the data record and no identifying information was included as part of the data files.

2.2.4. Confidentiality and Security

Confidentiality of the participants was protected by storing consent forms, as well as any other study materials, in locked filing cabinets. The data will be used only for this research project and will not be disseminated publicly except in summary form through

professional journals, books, or scholarly meetings. Under no circumstances will individual subjects be identified. Electronic copies of the data will be retained for two years after publication of the results and they will then be destroyed by deleting them from the computer hard drive. Data stored in paper form will be retained for two years prior to destroying it through secured disposal.

2.3. Measures

Because individuals with DS generally struggle with both receptive and expressive language (e.g., Chapman, Hesketh, & Kistler, 2002), the measures selected for this study made minimal demands on the verbal memory and expressive language capacities of study participants (Hippolyte et al., 2008).

2.3.1. Static Facial Expressions Condition

Each participant sat opposite the experimenter and initially completed a training task that involved viewing a single page with four separate cartoon faces on it, each showing a different emotion. The participant was asked to identify which of the cartoon faces showed happiness, sadness, anger, and fear. Participants who incorrectly identified one or more of the faces on the first trial of the training task were asked to repeat the task. Any participant who incorrectly identified one or more of the faces on the second trial was excluded from all analyses; a total of two individuals with DS were excluded for this reason.

The ability to recognize static facial expressions was then assessed by presenting participants with 16 black and white photographs of human faces, taken from the Pictures of Facial Affect (POFA) stimulus battery (Ekman & Friesen, 1976). Each of these photographs expressed one of four basic emotions including happiness (4 pictures), anger (4 pictures), sadness (4 pictures), or fear (4 pictures). These images were presented one at a time on a laptop computer screen, and each image remained in view until the participant gave a response; there was no time limit for the stimulus exposure. Participants received one point for each correctly recognized emotion and zero points for errors. In addition to an overall sum, subscores for each type of emotion were calculated.

2.3.2. Dynamic Facial Expressions Condition

The ability to recognize dynamic facial expressions was assessed by presenting participants with 16 one-second videos of eight actors (4 males, mean age 24.4), taken from the Montréal Pain and Affective Face Clips (MPAFC) stimulus battery (Simon, Craig, Gosselin, Belin, & Rainville, 2008). Each video, presented on a laptop computer screen, showed a single human face demonstrating one of four emotions (happiness, sadness, anger, fear) against a dark background. Each video started with a neutral face and ended at the peak of the expression, and was set to "loop" repeatedly until it was stopped through user intervention. The validity of the prototypical facial expressions contained in these stimuli was established using the Facial Action Coding System (FACS) (Ekman & Friesen, 1978) and by subjective evaluations in an independent group of 15 normal volunteers (inter-rater reliability: Cronbach's $\alpha = 0.97$).

Participants were allowed to watch each video an unlimited number of times, and received one point for each correctly recognized emotion and zero points for errors. In addition to an overall sum, subscores for each type of emotion were also calculated.

2.3.3. Facial Expressions Placed within a Social Context Condition

The Awareness of Social Inference Test (TASIT) (McDonald, Flanagan, & Rollins, 2002) is an audiovisual tool designed for the clinical assessment of social perception. It is a three-part measure that is comprised of short videos lasting 15 to 60 seconds that display professional actors interacting dynamically in everyday situations. In some scenes, there is only one actor, either talking directly to the camera or to an unseen person on a telephone. Other scenes depict two actors, and instructions are provided by the assessor to focus on one actor in particular (e.g., "focus on the female"). The "target" actor in each scene is exhibiting one of six basic emotions: happiness, sadness, anger, surprise, revulsion (i.e., disgust), or fear (i.e., anxiety). As well, in some scenes, the actor is not exhibiting any particular or clear emotion at all (i.e., referred to as "neutral") (McDonald et al., 2002).

Only Part 1 of the TASIT was used for this project because it examines a person's ability to identify basic emotions. Sixteen scenes were used from Part 1, comprising four examples of each basic emotion (happiness, sadness, anger, and fear)

(McDonald et al., 2002). In each vignette, the actor was either engaged in an interaction without dialogue (e.g., listening on the phone) or with ambiguous dialogue that could be interpreted in multiple ways (McDonald et al., 2006). In an example of ambiguous dialogue, a man is shown speaking on the phone in a very angry tone but saying that everything is fine; this incongruence between message and intention could lead to differing assessments of the emotions involved depending on whether the content or tone of the man's voice was focused upon.

There was equal representation of scripted and improvised scenes as well as male and female actors in Part 1 of the TASIT. In addition, the videos were shown in the same order to all participants, and there was no limit on the number of times a participant was allowed to view each video before providing a response (McDonald et al., 2002). When analyzed in its entirety, Part 1 of the TASIT has demonstrated a high level of internal consistency according to published statistical guidelines (e.g., Arick et al., 2003; Hutchins, Prelock, & Chace, 2008) when it was tested with atypical individuals aged 19 to 32 years (α =.73).

During testing, each participant sat opposite the experimenter and watched each scene. The participant was then asked to choose the emotion she believed that the targeted actor was exhibiting from the four possible choices. The training card that was previously introduced with regard to the static facial expressions remained visible during testing, and participants were encouraged to point at it to indicate their response as an alternative to verbalization. Participants received one point for each correctly recognized emotion and zero points for errors. In addition to an overall sum, subscores for each type of emotion were also calculated.

2.3.4. Cues Related to Social Relationships

The *Characteristics of Friendship Scale* (COFS) (Watt et al., 2010) is a two-part measure that contains photographs of children and adults engaged in various social interactions (e.g., shopping, visiting a doctor, working in a classroom, etc.). Part 1, titled "Distinguishing Friendships from Non-Friendships", contains 18 slides and the participant is asked to select which of two displayed pictures best shows an image of "friends". Part 2, titled "Recognizing Friendship Activities", contains 16 slides and asks participants if it is "OK" for friends to do what is shown in the picture. Moderate test-retest reliability of

this measure has been demonstrated over a two week span with typical and atypical individuals aged 5 to 50 years (r = .67, p < .01). In addition, Cronbach's alpha on both Part 1 (α = .84, p < .10) and Part 2 (α = .70, p < .01) have demonstrated acceptable levels of internal consistency according to published statistical guidelines (e.g., Arick et al., 2003; Hutchins et al., 2008).

2.3.5. Perspective Taking

To measure the most basic cognitive mediator, distinguishing the self from another, each participant was asked to predict what another person could see. Six unique but familiar pictures (e.g., apple, car, seashell, cat) appeared on each side of a cube. Two of the pictures were in color, and the rest were the same color as the cube. Prior to starting the assessment, each participant was asked to examine the cube and label each picture either verbally or by pointing to a matching picture on a response card that was kept in view during the task. The cube was then placed between the participant and the tester. The participant, seated facing one picture on the cube, was asked to indicate what she saw and what the tester, seated opposite, saw, by either naming the picture or pointing to it on the response card. This sequence was repeated with one other cube, for a total of two cubes, three times each and a grand total of six trials. A score of 0 was given when the response naming what the other person saw was egocentric (i.e., what the participant saw); a score of 1 was given for an incorrect but non-egocentric response; and a score of 2 was given for a correct response (e.g., Masangkay et al., 1974; Strayer, 1980).

2.3.6. Intelligence

The TONI-3 (Brown, Sherbenou, & Johnsen, 1997) is a test of intelligence that does not involve language in its administration, item content, or response modality. According to the test authors, such characteristics make this test well suited for assessing individuals who have language or learning difficulties that are related to the presence of a developmental disorder (Brown et al., 1997), such as autism (Edelson, Schubert, & Edelson, 1998). The TONI-3 is composed of five training items and 45 test items of progressively increasing difficulty. Items resemble matrix analogy tests in that each page depicts a stimulus figure and a set of either four or six possible responses.

The examiner is able to pantomime instructions, and the participant may point, nod, or gesture non-verbally in response (Brown et al., 1997). Correlations between standard IQ tests and the TONI-3 have been shown to be high (r = .56 or greater) (Brown et al., 1997) and similar in strength to correlations between the TONI-3 and other nonverbal IQ tests (e.g., Bostantjopoulou, Kiosseoglou, Katsarou, & Alevriadou, 2001; Brown et al., 1997; Hammill, Pearson, & Wiederholt, 1996).

3. Results

The results obtained from this study will be reported in terms of the means and standard deviations of the study variables, followed by the relationships among the study variables. Then, facial recognition will be examined as a function of group, context, and expression type; the ability to recognize social cues will be examined as a function of group; and perspective taking performance will be examined as a function of group. Finally, perspective-taking ability will be examined as a mediator of the association between facial expression recognition and the ability to recognize social cues.

3.1. Descriptive Analyses: Means and Standard Deviations

Table 1A contains the means and standard deviations of the study variables for each group of subjects: DS, ASD, and Typical. All numbers are reported in percentages, unless otherwise specified.

3.2. Relationships Among the Study Variables

Table 2 contains the correlations between the study variables for the DS subjects. Table 3 contains the correlations between the study variables for the ASD subjects. Table 4 contains the correlations between the study variables for the Typical subjects.

3.3. Facial Recognition as a Function of Group, Context, and Expression Type

It was predicted that compared to the DS group, the ASD group would be less able to recognize static, dynamic, and contextualized emotional expressions. It was further predicted that both of these groups would be less able to recognize static,

dynamic, and contextualized emotional expressions compared to typical peers. Using ANOVA (3 groups X 3 contexts), a statistically significant difference was found among the three groups on recognition of static, $F(2,42) = 18.77$, $p < .0001$, dynamic, $F(2,42) = 26.78$, $p < .0001$, and socially contextualized facial expressions of emotion, $F(2,42) = 29.07$, $p < .0001$. Table 1A shows that the DS group correctly identified 83.7% of static facial expressions, 76.2% of dynamic facial expressions, and 71.2% of socially contextualized facial expressions. In comparison, the ASD group correctly identified 64.5% of static facial expressions, 57.0% of dynamic facial expressions, and 52.5% of socially contextualized facial expressions. The Typical group correctly identified 96.2% of static facial expressions, 94.1% of dynamic facial expressions, and 87.9% of socially contextualized facial expressions.

Post hoc Tukey tests indicate that the ASD group differed significantly from the DS ($p < .0001$) and Typical ($p < .0001$) groups in their ability to recognize static expressions of emotion while the performance of DS subjects was not significantly different from that of Typical subjects. There were also significant mean differences in the ability to recognize dynamic facial expressions between the ASD group and both the DS group ($p < .0001$) and Typical group ($p < .0001$), as well as between the DS group and the Typical group ($p < .0001$). Finally, significant differences were also indicated in the ability to recognize socially contextualized facial expressions between the ASD group and both the DS group ($p < .0001$) and Typical group ($p < .0001$), as well as between the DS group and the Typical group ($p < .0001$). These findings supported the stated hypothesis as the ASD group was less able to recognize static, dynamic, and contextualized emotional expressions compared to the DS group, but both the DS and ASD groups were less able to recognize static, dynamic, and contextualized emotional expressions compared to typical peers. No significant differences were observed between conditions (static, dynamic, or within a social context) for any of the groups.

It was further predicted that compared to the DS group, the ASD group would be less able to recognize angry, sad, and scared facial expressions. As well, it was predicted that both of these groups would be less able to recognize angry, sad, and scared facial expressions compared to typical peers but that there would be no differences among the groups for happy facial expressions. Using ANOVA (3 groups X 4 expressions), a statistically significant difference was found for the effect of group on recognition of sad, $F(2,42) = 20.85$, $p < .0001$, angry, $F(2,42) = 20.53$, $p < .0001$, and

scared facial expressions, $F(2,42) = 35.62$, $p < .0001$. No significant difference was found for happy facial expressions. Table 1B shows that the DS group correctly identified 98.3% of happy facial expressions, 74.4% of sad facial expressions, 67.2% of angry facial expressions, and 68.3% of scared facial expressions. The ASD group correctly identified 85.5% of happy facial expressions, 51.1% of sad facial expressions, 51.1% of angry facial expressions, and 44.4% of scared facial expressions. The Typical group correctly identified 93.8% of happy facial expressions, 93.8% of sad facial expressions, 92.2% of angry facial expressions, and 91.1% of scared facial expressions.

Post hoc Tukey tests indicate that the ASD group differed significantly from the DS ($p < .0001$) and the Typical group ($p < .0001$) in the ability to recognize sad facial expressions while the performance of DS subjects was also significantly different from that of Typical subjects ($p < .05$). There were also significant mean differences in the ability to recognize angry facial expressions between the ASD group and both the DS group ($p < .05$) and Typical group ($p < .0001$), as well as between the DS group and the Typical group ($p < .0001$). Finally, significant differences were also indicated in the ability to recognize scared facial expressions between the ASD group and both the DS group ($p < .0001$) and Typical group ($p < .0001$), as well as between the DS group and the Typical group ($p < .0001$). These findings supported the stated hypothesis as the ASD group was less able to recognize sad, angry, and scared emotional expressions compared to the DS group, but both the DS and ASD groups were also less able to recognize sad, angry, and scared emotional expressions compared to typical peers.

More specifically, ANOVA analysis (3 group X 4 expression X 3 context) indicated that the ASD and DS subjects were significantly less able to identify facial expressions of negative emotion (mad, sad, and scared) regardless of condition compared to the Typical subjects. For some test items (mad and scared in the dynamic condition; sad within a social context), DS and ASD subjects showed similar performance, both with significantly lower scores than Typical subjects (p's < .02). In other cases (sad and scared in the static condition; sad in the dynamic condition; mad within a social context), DS and Typical subjects showed similar performance, both with significantly higher scores than ASD subjects (p's < .05). In one particular instance (mad in the static condition), ASD subjects demonstrated a significantly lower performance compared to Typical subjects ($p < .0001$) but the DS group was not significantly different from either of the other two groups. In another instance (scared within a social context),

the performance of all three groups was significantly different from each other (p's < .0001). There were no test conditions in which the DS subjects showed lower accuracy than the ASD subjects, and no test conditions in which either the DS or ASD subjects showed lower accuracy than the Typical subjects. Again, these findings supported the stated hypothesis as the ASD group was less able to recognize sad, angry, and scared emotional expressions compared to the DS group, but both the DS and ASD groups were also less able to recognize sad, angry, and scared emotional expressions compared to typical peers.

3.4. Ability to Recognize Social Cues as a Function of Group

It was predicted that compared to the DS group, the ASD group would be less able to recognize social cues. It was further predicted that both of these groups would be less able to recognize social cues compared to typical peers. Using one-way ANOVA (3 groups), a statistically significant difference was found for the effect of group on recognition of social cues, $F(2,42) = 14.52$, $p < .0001$. Table 1A shows that overall, the DS group correctly identified an average of 93.5% of the social cues, the ASD group correctly identified 72.5% of the social cues, and the Typical group correctly identified an average of 93.3% of the social cues.

Post hoc Tukey tests indicate that the ASD group differed significantly from the DS ($p < .0001$) and the Typical group ($p < .0001$) in their ability to recognize social cues while the performance of DS subjects was similar to that of Typical subjects. Although the ASD group was less able to recognize social cues compared to both the DS and Typical groups, the stated hypothesis was not supported as the DS group was not significantly different from the Typical group.

3.5. Perspective Taking Performance as a Function of Group

It was predicted that both the DS and ASD groups would be less able to distinguish the perspective of self from others compared to typical peers. Using one-way

ANOVA (3 groups), a statistically significant difference was found for the effect of group on perspective taking ability, $F(2,42) = 3.26$, $p < .05$. Table 1A shows that the DS group scored an average of 89.4% on the perspective-taking task, the ASD group scored an average of 76.1%, and the Typical group scored 100%.

Post hoc Tukey tests indicate that the ASD group differed significantly from the Typical group ($p < .05$) in their perspective-taking ability but was similar to the DS group. As well, the DS group did not significantly differ from the typical group. Although the ASD group demonstrated less perspective-taking ability than the Typical group, the stated hypothesis was not supported as the DS group was not significantly different from the Typical group.

3.6. Perspective-Taking Ability as a Mediator of the Association Between Facial Expression Recognition and the Ability to Recognize Social Cues

A mediation model was proposed whereby the ability to recognize facial expressions would mediate the link between perspective-taking ability and the ability to recognize social cues that are associated with interpersonal interactions. It was predicted that individuals who had better perspective-taking skills would also demonstrate better ability to recognize facial expressions of emotion, and consequently would be better at recognizing social cues that are associated with interpersonal relationships. This model is depicted in Figure 1.

The mediation model was evaluated using a series of regression analyses following the logic of Baron and Kenny (1986). Conditions required to test mediation are that the predictor is related to the outcome and to the mediator variable, and the mediator variable is related to the outcome variable. If one or more these three paths are not significant, researchers usually conclude that mediation isn't possible. Assuming that significant relationships do exist in these three paths, one would proceed to evaluate the final equation testing mediation, that includes the effect of the predictor (i.e., perspective-taking ability) on the outcome (i.e., ability to recognize social cues) controlling for the mediator variable (i.e., facial expression recognition ability). In this final equation, *full mediation* is supported if the predictor is no longer significant when the mediator variable

is controlled; however, if the predictor is still significant when the mediator variable is controlled (i.e., both the predictor and the mediator variable significantly predict the outcome variable), the finding supports *partial mediation* (Baron & Kenny, 1986). The proposed mediation models will be tested with regression analyses and path models predicting each group's ability to identify social cues. Models will be evaluated separately for each group of subjects (i.e., DS, ASD, Typical).

In addition to examining the main effects that are indicated within the mediation model (i.e., static, dynamic, and socially contextualized emotion recognition abilities; and perspective-taking ability), the interaction of the three types of facial expression recognition abilities (i.e., static, dynamic, and socially contextualized emotion recognition abilities) was evaluated through implementation of a three-stage model: first, the main effects were entered at the first step of the regression equation; then the two-way interactions involving static, dynamic, and socially contextualized emotion recognition abilities were added at step two; and finally the three-way interaction of static, dynamic, and socially contextualized emotion recognition abilities was entered at step three. Examining these interactions was of interest in determining whether it is the combined effect of emotion-recognition abilities from multiple contexts that subsequently impacts one's ability to accurately interpret social cues as opposed to emotion-recognition abilities from a singular context. In all cases, each interaction term was created by centering the specified variables and then multiplying the centered terms together. By examining any resultant moderator effects, it was thought that a clearer understanding of facial expression recognition abilities in the context of social cue recognition and perspective-taking ability could be obtained on a group-specific basis.

3.6.1. Path A: Predicting the Ability to Recognize Facial Expressions from Perspective-Taking Ability

The hypothesis that perspective-taking ability would predict facial expression recognition abilities was tested with a set of regression analyses that examined each type of facial expression recognition (i.e., static, dynamic, socially contextualized) separately. As shown in Table 6, the results did not support the hypothesis for either the DS or ASD group. The regression analysis could not be computed with the results from

the Typical group because Perspective Taking was a constant (i.e., all participants scored 100% on this task).

3.6.2. Path B: Predicting the Ability to Recognize Social Cues from the Ability to Recognize Facial Expressions

The hypothesis that facial expression recognition abilities would predict the ability to recognize social cues was initially tested with a set of regression analyses that examined each type of facial expression recognition (i.e., static, dynamic, socially contextualized) separately. As per the logic of Baron and Kenny (1986), it was possible that the mediator and outcome variables could possibly be correlated if they were both caused by the initial variable. Due to this potential complication, the initial variable was controlled for when establishing the effect of the mediator on the outcome. As shown in Table 5, the results of this analysis partially supported the hypothesis. The ability to recognize dynamic facial expressions marginally predicted the ability to recognize social cues in participants with ASD, $t(14) = 1.95$, $p < .08$.

The ability to recognize dynamic facial expressions significantly predicted the ability to recognize social cues in Typical participants, $t(14) = 4.25$, $p < .0001$. The interaction of dynamic and TASIT facial expression recognition was also significant, $t(14) = -3.24$, $p < .05$, and predicted an additional 18% of the variance for the Typical group. The nature of the interaction was probed at a value of 1 for the moderator (see Figure 2), and at this value, the greater ability to recognize social cues was predicted from a combination of high (1 SD above the mean) ability to recognize dynamic facial expressions and low (1 SD below the mean) ability to recognize socially-contextualized (TASIT) facial expressions. By this calculation, the simple slope for TASIT facial expression recognition was significant, $t(14) = 2.33$, $p < .05$, and the simple slope for Dynamic facial expression recognition was marginally significant, $t(14) = 1.93$, $p < .10$. This means that for the Typical participants, those who were better at identifying dynamic facial expressions but poorer at identifying TASIT facial expressions were better at recognizing social cues. The ability to recognize facial expressions did not predict the ability to recognize social cues in individuals with DS.

3.6.3. Path C: Predicting the Ability to Recognize Social Cues from Perspective-Taking Ability

The hypothesis that perspective-taking ability would predict the ability to recognize social cues was tested with a set of regression analyses within which perspective-taking ability was entered as the independent variable and the ability to recognize social cues was entered as the dependent variable. As shown in Table 7, the results did not support the hypothesis for either the DS group or the ASD group. The regression analysis could not be completed for the Typical group because Perspective Taking was a constant (i.e., all participants scored 100% on this task).

3.6.4. Path C': The Ability to Recognize Facial Expressions as a Mediator of the Association Between Perspective-Taking Ability and the Ability to Recognize Social Cues

Within a mediation analysis, the purpose of examining paths a, b, and c is to establish that zero-order relationships exist among the specified variables. If one or more of these relationships are non-significant, researchers usually conclude that the conditions to test for mediation have not been met and mediation is therefore not possible (e.g., Baron & Kenny, 1986). Extending this logic to the current study, the conditions to test whether facial expression recognition ability mediated the association between perspective-taking ability and the ability to recognize social cues were not met as all of the necessary relationships between study variables (i.e., paths a, b, and c) were not established for any of the models. As such, the hypothesis of a mediated relationship could not be supported for any of the three participant groups.

4. Discussion

In this exploratory study, the ability of Typical adults and adults with DS or ASD to identify basic emotions (happy, sad, mad, and scared) was examined under three conditions: static (photographs), dynamic (one-second videos), and within a social context (15-60 second videos depicting social interaction). The present study is the first one seemingly that directly compares adults with ASD and DS using the same emotional expression measures in multiple conditions. In addition, the ability of these three samples to understand the perspective of another individual and to identify social cues related to social interaction was evaluated. The findings show that relative to adults with DS, adults with ASD continue to show the pattern of poorer socio-cognitive outcomes that past researchers have documented as evident during childhood.

To begin with, it was predicted that the ASD group would be less able to recognize static, dynamic, and contextualized emotional expressions compared to the DS group, and that both the DS and ASD groups would be less able to recognize static, dynamic, and contextualized emotional expressions compared to typical peers. This hypothesis was supported by the current findings. More specifically, the individuals who were diagnosed with DS or ASD demonstrated similar difficulties in interpreting facial emotional expressions, especially negative ones, relative to Typical individuals. For example, the DS and ASD groups were comparable in terms of their ability to recognize angry and scared facial expressions that were dynamic in nature and sad facial expressions that were set within a social context, even though their performance was lower than that demonstrated by Typical participants. This finding is consistent with known amygdala dysfunctions in both the ASD and DS populations (e.g., Murphy & Ellis, 1991). Amygdala damage has been shown to be specifically associated with impairment in the perception of negative emotions, such as fear (e.g., Adolphs, Tranel, Damasio, & Damasio, 1994). It is known that children with ASD and DS have a reduced volume in the temporal limbic cortex of the forebrain (e.g., Jernigan et al., 1993), an area that includes the amygdala. Such deficits are amplified by additional findings that suggest the

ability to recognize fear is more difficult and improves at a slower rate compared to other basic emotions, even in typically developing individuals (e.g., De Sonneville et al., 2002).

The ASD and DS groups in the current study also showed similar performance to one another with regard to their perspective taking abilities, relative to the Typical group. This finding may be linked to reduced frontal lobe volume in both of these populations (e.g., Sanchez et al., 2012; Wang et al., 1992). Symptoms of frontal lobe deficit include a lack of awareness regarding the relevance of socially interacting with others (e.g., Eslinger & Damasio, 1985; McTurk et al., 1985), that can be seen as a foundational condition for the establishment and maintenance of understanding another's intentions and behaviors. As a result, it would seem possible that the socio-cognitive difficulties demonstrated by individuals with ASD and DS with regard to processing the point of view and facial expressions of others might be due to underlying similarities in the neurological deficits that are common to these two populations.

Despite these similarities, however, the ASD group demonstrated lower overall accuracy in identifying facial expressions of emotion, regardless of the condition under which the facial expression stimuli were presented. The adults with ASD also scored lower in interpreting visual cues that are associated with interpersonal interactions than did adults with DS or typical adults. This data, consistent with predictions, may be due to differences in social experience that produce phenotypically-unique response sets. For example, infants with autism generally struggle with orienting to faces and establishing joint attention (e.g., Clifford et al., 2007). As a result, they might have less exposure to various facial expressions, leading to difficulty with recognizing such expressions in later life (e.g., Grelotti et al., 2002). These early deficits could then further hinder social interaction, even if social orientation increases during later childhood and adolescence. Children with DS, however, appear to be more attentive to the faces of others and generally possess more pleasant personalities (e.g., Hornby, 1995). As a result, children with DS may learn about emotions differently than do children with ASD and consequently become more able to distinguish facial expressions of emotion although still not achieving the level of ability demonstrated by typical peers. As such, the current data is consistent with past research that suggests individuals with ASD may continue to exhibit a profile of relatively poorer outcomes compared to individuals with DS across the lifespan, with the extent of such difficulties being unaffected by either chronological age

or intellectual functioning (e.g., Esbensen et al., 2010; Williams et al., 2005; Wishart & Pitcairn, 2000).

Although not formally hypothesized, the findings indicated that none of the groups did better in recognizing contextualized versus decontextualized facial expressions and no significant differences existed between conditions for any of the groups. Although this result is counter-intuitive, as it was assumed that social context would make it easier to identify facial expressions associated with emotion, it may be due to the fact that the contextualized stimuli were more complex than the static and dynamic stimuli; for example, in addition to sometimes having two actors on the screen, the verbal content was occasionally at odds with the emotion expressed (e.g., "That's just great" spoken in an angry tone, suggesting an incongruence between content and meaning and implying the presence of sarcasm). As well, the inclusion of an "other" category that was absent in the static and dynamic conditions may have complicated the identification of emotion for all three groups and counteracted any benefit obtained from the increased social context.

In addition, none of the groups did better in recognizing dynamic versus static facial expressions. This result was not only inconsistent with previous research findings (e.g., Watt et al., 2010) but also counter-intuitive, as it was assumed that the addition of motion would help lend context to emotional expressions and aid in their accurate identification. One possible explanation for this difference may be associated with the complexity of the chosen stimuli and the extent to which emotional expressions could be identified through an approach emphasizing face validity. Further investigation would be required to document such discrepancies and note their consequential impact on study results.

Further analysis indicated that there were no differences among the three groups with regard to identifying facial expressions of happiness in any of the three conditions. Although this finding is consistent with previous work showing that emotion recognition deficits in individuals with ASD and DS are more pronounced with negative as opposed to positive emotions (e.g., Kasari et al., 2001; Pelphrey et al., 2002), in the literature there is no known previous comparison showing similar accuracy in identifying facial expressions of happiness in these two clinical populations. Additional investigation may be warranted to explore such intricacies as the valence and context of facial emotional

expressions in explaining possible similarities between the two diagnosable populations under study.

Although the present findings show that adults with Down syndrome generally demonstrate fewer socio-cognitive impairments than do adults with autism spectrum disorders, it is noted that adults with DS still tend to present with some limitations. For example, examining the pattern of associations in this study revealed that the ability to identify pairs of friends and appropriate friendship behaviors were positively correlated with the overall ability to identify dynamic facial expressions in the ASD and Typical groups, but was in no way associated with the ability to recognize facial expressions in the DS group. This divergence suggests that perhaps adults with DS might not utilize facial cues to prompt their understanding of social scenes when other types of cues such as body language or environment are available; as such, this group might employ strategies that differ from those utilized by typical peers or peers with ASD. When viewed in this light, the current findings are consistent with recent research indicating that social skills are not a uniform strength among individuals with Down syndrome in that this group may experience difficulties with very specific aspects of socio-cognitive understanding such as theory of mind, empathizing, and social referencing (e.g., Binnie & Williams, 2002; Kasari et al., 2003; Walz & Benson, 2002). Additional research to further explore the specific patterns of socio-cognitive dysfunction that are demonstrated by adults with DS would therefore appear to be a useful pursuit in extending current knowledge of the interpersonal strategies employed by this population.

In this study, the final prediction was that the association between perspective-taking ability and the ability to recognize social cues would be mediated by facial expression recognition ability in adults with ASD and DS. This prediction was not supported, however, because the necessary relationships between study variables were not established for any of the three participant groups, and as such, the conditions to test for a mediated relationship were not met. However, the interaction of dynamic and socially-contextualized facial expression recognition abilities did predict social cue recognition, but only for the Typical group. The etiology of this interaction, with its suggestion that better accuracy in identifying dynamic facial expressions and less accuracy in identifying socially-contextualized facial expressions produced a greater ability to recognize social cues in the Typical group, is unclear. It was further notable that perspective taking ability was not associated with any other study variables for either the

ASD or DS groups. Although this result may reflect the insensitivity of study measures or other flaws in study design, it may also suggest that perhaps interpretation of others' facial emotional expressions by members of these two populations is largely based on one's own intentions and emotional state as opposed to an acknowledgement of another's point of view. Further investigation of this topic would appear to be both warranted and helpful.

In terms of strengths, a major strength of this study is that a group of adults with ASD were assessed in comparison to a group of adults with DS with the groups well matched for cognitive/intellectual functioning and chronological age. Other strengths of this study include the use of assessment tools that measure the abstract concepts of social cue recognition and perspective taking in a concrete manner that is well-matched to the limited language levels associated with both ASD and DS (e.g., Jobling & Moni, 2000). Furthermore, the sample size that was employed is consistent with meta-analyses that have reported the typical levels of power and effect size used in studying social competence (e.g., Alony & Kozulin, 2007; Newcomb & Bagwell, 1995). In addition, a sample size approaching 20 participants per group has been considered respectable in recent research investigating the socio-cognitive abilities of developmentally delayed individuals (e.g., Cebula & Wishart, 2008).

As previously mentioned, however, sample size could additionally be considered a limitation of this study because recruiting 15 participants for each group may not have been sufficient to meet the power-related requirements for detecting small between-group differences (Cohen, 1988, 1992). As a result, the present findings may under-represent the between-group differences that exist among participants with regard to the study variables. Although the social appropriateness of empathic accuracy may also vary by subgroup or culture, it's possible that understanding of visual stimuli associated with faces is more closely related to innate factors such as eye dominance rather than acquired cultural factors (e.g., Reiss, 1997); however, neither cultural nor innate factors were controlled for in the present study and as such may have unintentionally influenced the observed results.

Furthermore, the measure of social cue recognition that is being employed in this study may not be indicative of the participants' actual social skills, and more direct measurement of interpersonal interaction within naturalistic settings would be required

before definitive conclusions can be drawn on this topic. As well, only typical individuals are portrayed in the stimuli of the current project, and it is unclear how this influenced the responses of both typical and atypical participants. It is possible that participants in the ASD and DS groups found the task instructions to be beyond their linguistic capabilities, even though measures were chosen and instructions specified with the intent of minimizing demands on both receptive and expressive language. For example, with regards to the perspective-taking task that was utilized in this study, it is unclear whether the results that were obtained really demonstrate the subjects' ability to distinguish self from other as opposed to indicating subjects' understanding of the instructions posed to them or perhaps a lack of interest or motivation in complying with the instructions. This possibility seems unlikely, however. A final limitation involves the cross-sectional and correlational nature of this research that precludes any causal connections; a longitudinal research design would be needed to better understand the true causal trajectory of facial expression recognition and perspective-taking abilities within the larger context of socio-cognitive development through the life span from childhood through adolescence and into adulthood.

In conclusion, the ability to recognize facial emotional expressions is a foundational skill that is required in order to form meaningful connections with others. Poor attention to, and recognition of, emotional expressions has been reported in those with autism spectrum disorders as well as those with Down syndrome (e.g., Begeer et al., 2006); however, knowledge of how these two populations can be directly compared across their lifespan in terms of emotional expression recognition abilities is incomplete. The present study extends the existing research on emotion recognition in adults with ASD and DS by focusing on their capacity to process information from peoples' faces as well as situational cues. Although the ability to interpret others' emotional states is an imperative component of any social interaction, it was found that both the ASD and DS groups demonstrated difficulties in recognizing negative facial expressions relative to Typical peers with the deficits being more pronounced in the ASD population. The ASD population, but not the DS population, also showed difficulties in identifying cues associated with friendship. Whether these differences are due to disparities in facial attentiveness, visual processing, or social experience must be explored with further investigations. However, the current findings do tie in with previous evidence of

phenotypic socio-cognitive differences in adults with developmental disabilities and might contribute to the further development of theory in this area.

Although differences in etiology may lend importance to understanding the precise nature of demonstrated deficits, it is possible that the true extent of syndrome-specific difficulties may be detectable only within smaller-scale studies and in comparison to Typical profiles instead of in comparison to phenotypes that may differ only subtly from each other. If the inherent constraints in sample size for this type of research are to be overcome, however, multi-site studies with longitudinal designs will be needed to determine the precise extent of similarities and differences in social cognition as they apply to neurocognitively delayed individuals with varying diagnoses and etiologies (e.g., Wishart, Cebula, Willis, & Pitcairn, 2007). Pinpointing the specific neuropsychological origins of social-cognitive difficulties in adults with DS and ASD appears to be a work in progress; however, the current lack of neurological evidence does not invalidate the present study that indicates in comparison to typically developing peers, recognizing facial emotional expressions in general, and negative expressions in particular, are areas of difficulty for adults with DS and ASD.

Such areas of difficulty can be seen as having potentially dangerous consequences. For example, signs of threat that are ignored may lead an unsuspecting adult into unfavorable and perhaps unsafe situations. Adults with DS and ASD also may fail to recognize that individuals who appear to be scared may require assistance in avoiding or escaping a threat. As such, establishing and describing the empathic response potential of adults with DS and ASD can be considered instrumental in the practical context of intervention. Because impairment in emotion recognition appears to extend rather permanently across the lifespan in individuals with ASD and DS, intervention tools that improve the emotional recognition skills of these individuals would seem to be desirable.

A reasonable first step to developing such interventions involves recognizing the extent to which these individuals are able to view others as entities outside of themselves, with the possibility that similarities between the groups may become more evident and ultimately interventions may be designed that benefit both groups. Previous studies have found that social-emotional interventions can indeed produce positive results, emotion recognition can be taught, and greater social understanding can result

from such training (e.g., Golan & Baron-Cohen, 2006; LaCava, Golan, Baron-Cohen, & Myles, 2007). Facilitating friendships and social interaction is frequently specified as a goal with developmentally delayed individuals (e.g., Stainback & Stainback, 1987), but few lasting benefits have been reported from such programming for adults with either DS or ASD (e.g., Strain, Odom, & McConnell, 1984; Wishart, 2007). It is possible that such findings may be attributable to deficits in recognizing and decoding the emotional states of others in everyday situations and a consequential inability to accurately interpret social cues (e.g., Wishart, 2007).

Although there have been encouraging advances in specifying behavioral phenotypes that are associated with both DS and ASD, there still remains a wide gap between available research findings and the development of evidence-based interventions and effective educational approaches for adults from these populations. Truly translational research that leads to effective interventions is likely to require the co-ordination of many different levels of explanation for behavioral outcomes. For example, as with development in other cognitive domains, the development of interpersonal understanding is affected by both biological and environmental factors. The biological mechanisms underlying the difficulties associated with facial expression recognition seen in adults with DS and ASD appear unlikely to be open to intervention in the near future, however, leaving environmentally based intervention programs as the more realistic aim (e.g., Cebula et al., 2010). With this in mind, and considering the importance of expressive emotion for human communication throughout the life cycle, the relevance of encouraging effective and appropriate socio-affective behaviors from infancy onwards in individuals with DS and ASD is clear. For example, early interventions that focus on improving the relationship between children with neurodevelopmental delays and their parents and caregivers, who may consider them less capable of socio-emotional communication compared to typically-developing infants, may provide long-term benefits (e.g., Carvajal & Iglesias, 2002). This suggestion is consistent with recent generalized shifts in early intervention programming for children with developmental delays that focus more on supporting overall development and less on the acquisition of specific cognitive skills (e.g., Wishart et al., 2007). Educators and clinicians, however, need to be informed of research findings to guide their practice and remain alert that emotional nuances may not be picked up in a similar manner or through identical modalities by all individuals under their care (e.g., Wishart et al., 2007).

Finally, it is possible that foundational deficits in constructs such as perspective taking may need to be addressed before improvements in either facial expression recognition or social understanding can occur, making uninformed attempts at remediation ineffective. As a result, it is conceivable that more direct efforts to target the dynamics underlying empathic accuracy as a form of social competence and address deficits in an effective manner could lead to improved intervention strategies and provide a more positive long-term prognosis for adults who have been diagnosed with either Down syndrome or autism spectrum disorders (e.g., Jobling & Moni, 2000; Wishart, 2007).

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Appendix.

Tables and Figures

Figure 1. ***Perspective-taking ability as a mediator between facial expression recognition ability and the ability to recognize social cues***

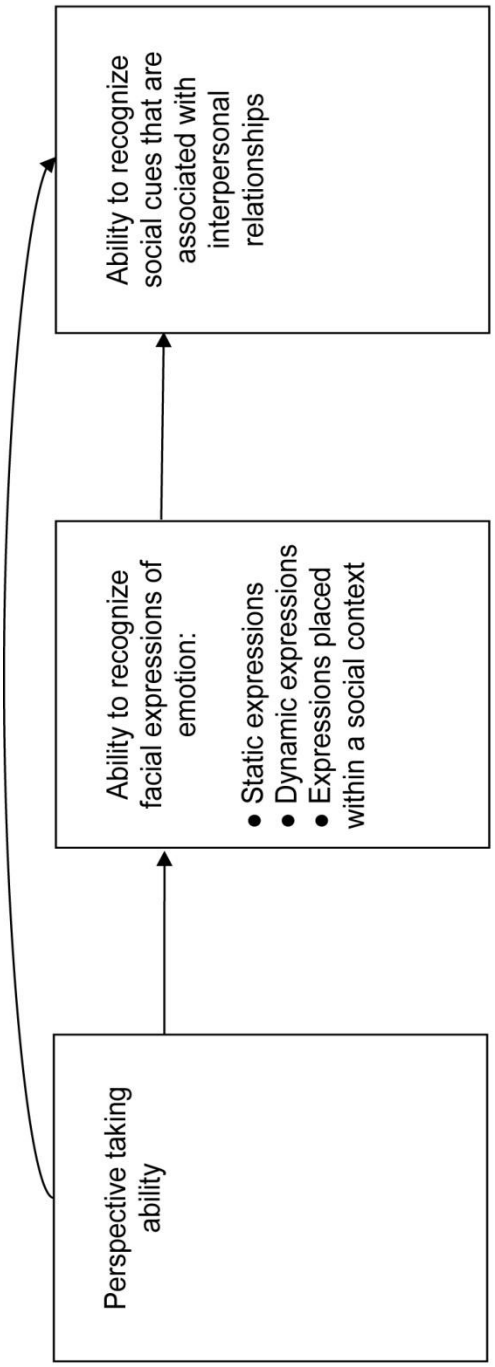

Figure 2. The ability to recognize social cues from the ability to recognize dynamic and TASIT facial expressions.

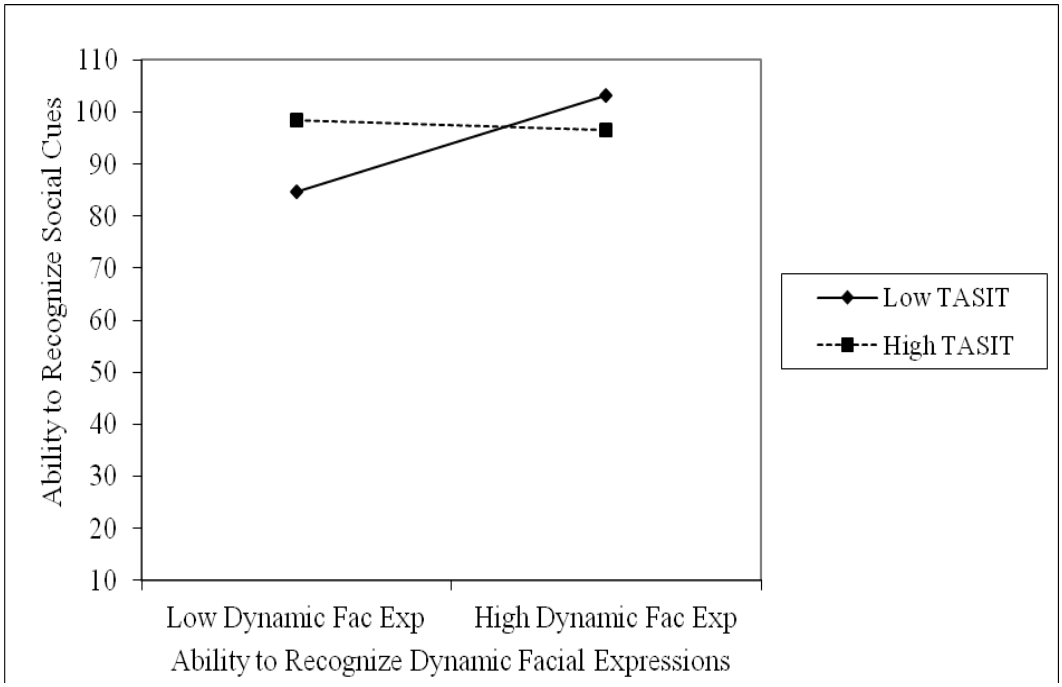

Table 1A. Means and Standard Deviations of the Study Variables

	DS		ASD		Typical	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Static Emotions:	83.7_{b}	11.2	64.5_{a}	21.7	96.2_{b}	3.1
Happy	100.0_{a}	0.0	90.0_{a}	26.3	100.0_{a}	0.0
Mad	66.6_{ab}	27.8	46.6_{a}	35.1	88.3_{b}	12.9
Sad	78.3_{b}	20.8	51.6_{a}	33.3	98.3_{b}	6.4
Scared	90.0_{b}	15.8	70.0_{a}	31.6	98.3_{b}	6.4
Dynamic Emotions:	76.2_{a}	11.3	57.0_{b}	19.7	94.1_{c}	7.6
Happy	100.0_{a}	0.0	86.6_{a}	26.5	93.3_{a}	14.8
Mad	53.3_{b}	35.1	46.6_{b}	31.1	95.0_{a}	10.3
Sad	86.6_{b}	20.8	50.0_{a}	36.5	96.6_{b}	8.7
Scared	65.0_{b}	20.7	45.0_{b}	31.6	91.6_{a}	15.4
TASIT:	71.2_{a}	12.4	52.5_{b}	17.0	87.9_{c}	6.4
Happy	95.0_{a}	14.0	80.0_{a}	27.0	88.3_{a}	15.9
Mad	81.6_{b}	24.0	60.0_{a}	31.0	93.3_{b}	14.8
Sad	58.3_{b}	27.8	51.6_{b}	31.9	86.6_{a}	15.9
Scared	50.0_{a}	31.3	18.3_{b}	17.5	83.3_{c}	18.0
Friendship Test:	93.5_{b}	5.5	72.5_{a}	18.8	93.3_{b}	7.8
Part 1	90.3_{b}	10.1	71.4_{a}	18.7	96.6_{b}	6.5
Part 2	97.0_{b}	3.9	73.7_{a}	20.6	89.5_{b}	10.4
Perspective Taking	89.4_{ab}	25.0	76.1_{a}	36.7	100.0_{b}	0.0

Note. SD = standard deviation; subscripts refer to homogenous subsets based on post-hoc Tukey tests, $p < .05$.

Table 1B. Means and Standard Deviations of the Four Facial Expressions, Collapsed Across the Three Contexts

	DS		ASD		Typical	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Happy Facial Expressions	98.3_{a}	4.6	85.5_{a}	19.7	93.8_{a}	9.6
Sad Facial Expressions	74.4_{a}	17.9	51.1_{b}	25.1	93.8_{c}	5.8
Angry Facial Expressions	67.2_{a}	18.4	51.1_{b}	23.7	92.2_{c}	5.8
Scared Facial Expressions	68.3_{a}	14.5	44.4_{b}	19.8	91.1_{c}	9.1

Note. SD = standard deviation; subscripts refer to homogenous subsets based on post-hoc Tukey tests, $p < .05$.

Table 2. Correlations Between the Study Variables for the DS Group

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. Age	-	-.15	a	-.32	-.13	.31	-.01	a	-.27	.16	.26	.22	-.12	.07	.08	.27	.08	.27	.02
2. Static Emotions:		-	a	.71**	.76**	.58*	.58*	a	.34	.43	.25	-.22	-.33	.30	.32	-.72**	.31	-.34	-.26
3. Happy			-	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
4. Mad				-	.20	.00	.31	a	-.30	.33	-.15	-.38	-.22	-.04	-.13	-.35	.20	-.19	-.21
5. Sad					-	.51*	.49	a	.28	.41	.18	-.16	-.24	.30	.48	-.82**	.33	-.26	-.09
6. Scared						-	.44	a	.06	.10	.76**	.24	-.24	.54*	.50	-.36	.10	-.28	-.23
7. Dynamic Emotions:							-	a	.85**	.45	.29	-.20	-.02	.17	.10	-.53*	.30	-.49	-.57*
8. Happy								-	a	a	a	a	a	a	a	a	a	a	a
9. Mad									-	.18	-.01	-.27	.21	-.02	-.07	-.44	.09	-.36	-.61*
10. Sad										-	-.33	-.03	-.24	.36	.28	-.47	.37	-.26	-.03
11. Scared											-	.06	-.18	.05	.07	.06	.12	-.21	-.17
12. TASIT:												-	.65**	.68**	.61*	.22	-.29	-.05	.23
13. Happy													-	.23	.22	.20	-.30	-.16	.05
14. Mad														-	.64**	-.35	-.16	-.34	.19
15. Sad															-	-.51	.13	.07	.03
16. Scared																-	-.33	.18	.16
17. Friendship Test																	-	.06	.26
18. Perspective Taking																		-	-.00
19. IQ																			-

Note. a = cannot be computed because at least one of the variables is constant; *$p < 0.05$; **$p < .01$.

Table 3. Correlations Between the Study Variables for the ASD Group

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. Age	-	-.06	-.20	-.00	-.10	.11	.00	.02	-.05	-.26	.34	-.20	-.24	-.07	-.35	.34	-.11	.22	-.14
2. Static Emotions:		-	.68**	.62*	.91**	.52*	.68**	.45	.34	.58*	.30	.54*	.51	.57*	.12	.06	.77	.01	.39
3. Happy			-	.25	.47	.25	.33	.56*	.11	.41	-.22	.28	.45	.29	-.13	.13	.61*	-.26	.26
4. Mad				-	.57*	-.21	.26	.28	.19	.17	.02	.33	.39	.40	.00	-.03	.36	.07	.14
5. Sad					-	.43	.60*	.27	.30	.43	.47	.56*	.48	.50	.24	.09	.56*	-.05	.45
6. Scared						-	.66**	.18	.29	.61*	.50	.29	.08	.37	.18	.01	.60*	.22	.21
7. Dynamic Emotions:							-	.64**	.74**	.78**	.31	.36	-.02	.45	.40	-.07	.75**	.35	.50
8. Happy								-	.53*	.55*	-.40	.12	-.02	.22	.13	-.10	.60*	.06	.41
9. Mad									-	.31	.07	.20	-.45	.31	.54*	-.04	.29	.45	.38
10. Sad										-	.03	.41	.31	.47	.26	-.20	.89**	.17	.33
11. Scared											-	.12	.03	.10	.05	.17	.05	.17	.15
12. TASIT:												-	.55*	.75**	.68**	.43	.54*	.25	-.04
13. Happy													-	.20	-.01	.26	.46	-.41	-.23
14. Mad														-	.43	.04	.61*	.48	.26
15. Sad															-	.10	.18	.46	.00
16. Scared																-	-.02	.10	-.26
17. Friendship Test																	-	.10	.26
18. Perspective Taking																		-	-.05
19. IQ																			-

Note. a = cannot be computed because at least one of the variables is constant; **p* < 0.05; ***p* < .01.

Table 4. Correlations Between the Study Variables for the Typical Group

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. Age	-	-.21	a	-.23	.18	-.14	-.18	-.08	-.00	-.23	-.15	.17	-.14	.29	.24	-.08	-.07	a	.37
2. Static Emotions:		-	a	.76**	.21	.21	.18	.14	-.27	.32	.22	-.19	-.04	-.56*	.04	.19	.13	a	.33
3. Happy			-	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
4. Mad				-	-.25	-.25	.05	.03	-.13	.02	.14	-.33	-.05	-.43	.05	-.12	.05	a	.30
5. Sad					-	-.07	.01	-.12	-.13	-.10	.29	.01	-.20	-.12	-.23	.51	.07	a	.29
6. Scared						-	.24	.34	-.13	.68**	-.14	.28	.23	-.12	.20	.12	.07	a	-.24
7. Dynamic Emotions:							-	.71**	.59*	.52*	.59*	.39	.49	-.26	.04	.29	.83**	a	.00
8. Happy								-	.05	.84**	-.06	.49	.77**	-.21	-.02	.22	.84**	a	-.22
9. Mad									-	-.19	.55*	.03	-.10	.05	.10	.00	.33	a	.32
10. Sad										-	-.21	.41	.65**	-.18	-.02	.18	.56*	a	-.35
11. Scared											-	.03	-.06	-.26	.06	.26	.28	a	.20
12. TASIT:												-	.59*	.38	.05	.54*	.39	a	-.36
13. Happy													-	.02	-.30	.20	.54*	a	-.51
14. Mad														-	-.21	-.11	-.22	a	-.26
15. Sad															-	-.36	-.00	a	.30
16. Scared																-	.27	a	-.12
17. Friendship Test																	-	a	.01
18. Perspective Taking																		-	a
19. IQ																			-

Note. a = cannot be computed because at least one of the variables is constant; *$p < 0.05$; **$p < .01$.

Table 5. Predicting the Ability to Recognize Social Cues from the Ability to Recognize Facial Expressions

	B	SE B	*β*	R^2
DS Group				
1. Static Facial Expressions	.02	.24	.05	.17
Dynamic Facial Expressions	.16	.22	.33	
TASIT Facial Expressions	.04	.35	.10	
2. Static X Dynamic Facial Expressions	.00	.02	.08	.21
Dynamic X TASIT Facial Expressions	.00	.03	.13	
Static X TASIT Facial Expressions	.00	.02	.15	
3. Static X Dynamic X TASIT Facial Expressions	-.00	.00	-.57	.28
ASD Group				
1. Static Facial Expressions	-.05	.32	-.06	.71
Dynamic Facial Expressions	.75	.36	.79^{+}	
TASIT Facial Expressions	.28	.25	.25	
2. Static X Dynamic Facial Expressions	-.01	.01	-.31	.81
Dynamic X TASIT Facial Expressions	.03	.02	.65	
Static X TASIT Facial Expressions	-.02	.01	-.46	
3. Static X Dynamic X TASIT Facial Expressions	.00	.00	.21	.82
Typical Group				
1. Static Facial Expressions	-.24	.42	-.09	.69
Dynamic Facial Expressions	.54	.22	.53*	
TASIT Facial Expressions	.28	.21	.23	
2. Static X Dynamic Facial Expressions	-.00	.07	-.01	.87
Dynamic X TASIT Facial Expressions	-.10	.03	-.55*	
Static X TASIT Facial Expressions	.03	.07	.08	
3. Static X Dynamic X TASIT Facial Expressions	.01	.01	.18	.88

Note. $^{+}p < .10$; * $p < .05$; ** $p < .01$.

Table 6. Predicting the Ability to Recognize Facial Expressions from Perspective-Taking Ability

	B	SE B	β
DS Group			
Static Facial Expressions	-.18	.11	-.41
Dynamic Facial Expressions	-.21	.11	-.47
TASIT Facial Expressions	-.06	.13	-.13
ASD Group			
Static Facial Expressions	-.01	.16	-.03
Dynamic Facial Expressions	.16	.14	.29
TASIT Facial Expressions	.10	.12	.21
Typical Group			
Static Facial Expressions	-	-	-
Dynamic Facial Expressions	-	-	-
TASIT Facial Expressions	-	-	-

Note. $^{+}p < .10$; * $p < .05$; ** $p < .01$.

Table 7. Predicting the Ability to Recognize Social Cues from Perspective-Taking Ability

	B	SE B	β	R^2
DS Group				
1. Perspective-Taking Ability	.01	.06	.06	.00
ASD Group				
1. Perspective-Taking Ability	.05	.14	.10	.01
Typical Group				
1. Perspective-Taking Ability	-	-	-	-

Note. $^{+}p < .10$; * $p < .05$; ** $p < .01$.