Why do individuals with Asperger's Syndrome have difficulty recognising the emotions of others?

Alyssa Caroline Perkins Sawyer

BCA (creative writing), Grad. Dip. Psych., BA (Hons).

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Abstract

Humans have a well-developed ability to recognise the emotions of others on the basis of their facial expressions. However this skill does not appear to be intuitive for some populations, such as people with Asperger's Syndrome. The aim of this thesis was to understand why individuals with Asperger's Syndrome have difficulties recognising emotions on the basis of facial expressions and more broadly, how this may relate to their difficulties with social interaction.

Three factors that have the potential to explain impaired emotional recognition among individuals with Asperger's Syndrome were investigated: (i) avoidance of eye contact when scanning the facial expressions of others; (ii) problems using meta-cognitive skills (such as using confidence as a guide to the accuracy of decisions); and (iii) problems using cognitive processes when interpreting the facial expressions of unfamiliar people.

In Studies 1 and 2, the first two factors were investigated using an emotion recognition task developed and validated specifically for use in these studies. Both studies compared the emotion recognition performance of individuals with Asperger's Syndrome to individuals without Asperger's Syndrome. In Study 1, I found that there was no difference in the way individuals with Asperger's Syndrome scanned key regions of facial expressions. However, they were less able to accurately recognise both basic and complex emotions from facial expressions as compared to individuals without Asperger's Syndrome. As no difference was found in the way the two groups scanned facial expressions, the ability of the two groups to use meta-cognitive skills when making emotion recognition decisions was examined in Study 2. It was found that individuals with Asperger's Syndrome were able to use confidence as a guide to the accuracy of their

decisions similarly to individuals without Asperger's Syndrome. However, individuals with Asperger's Syndrome had more difficulty using this information to "filter" their responses (i.e., identifying which of their decisions were accurate versus which were inaccurate).

In Study 3, the extent to which individuals with Asperger's Syndrome have a specific problem with unfamiliar faces was investigated. Specifically, whether they had a problem generalising emotion recognition skills to recognise emotions from the facial expressions of unfamiliar people rather than a more general problem using emotion recognition skills (i.e., regardless of the familiarity of a face). Emotion recognition tasks were created for each participant, one displaying photographs of a familiar person's facial expressions, and one displaying photographs of an unfamiliar person's facial expressions. It was found that there was no difference in the accuracy with which individuals with Asperger's Syndrome where able to recognise emotions from familiar versus unfamiliar faces. Furthermore, there were no differences in the ability of individuals with Asperger's Syndrome to use meta-cognitive skills to make emotion recognition decisions in response to familiar versus unfamiliar faces.

Finally, in Study 4, I investigated the relationships between (a) emotion recognition skills and social skills, and (b) Theory of Mind (ToM), meta-cognitive skills and social skills. The key finding from this study was that ToM and meta-cognitive skills independently contributed to social skills, while emotion recognition skills did not. This finding is limited due to low power to detect significant relationships within each group, however the findings suggest that a focus on improving both meta-cognitive and ToM skills in order to improve the social skills of individuals with Asperger's Syndrome is a promising avenue for further research.

Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Alyssa Sawyer, BCA (creative writing), Grad. Dip. Psych., BA (Hons).

Declaration of Ethics Approval

All studies presented in this thesis received ethics approval for the Flinders University Social and Behavioural Research Ethics Committee. Approval numbers are as follows:

- Study 1: 4296; Study 2: 4719; Study 3 and 4: 4838

Peer-reviewed Publications Arising from this Thesis

Sawyer, A., Williamson, P., & Young, R. (2011). Can gaze avoidance explain why individuals with Asperger's Syndrome can't recognise emotions from facial expressions? *Journal of Autism and Developmental Disorders*. Advance online publication. doi: 10.1007/s10803-011-1283-0

Conference Presentations Arising from this Thesis

Sawyer, A., Young, R., & Williamson, P. (2009, August). *Understanding the eyes: Face processing and emotion recognition in Autism Spectrum Disorders.* Poster session presented at the meeting of the Asia Pacific Autism Conference, Sydney, Australia.

Sawyer, A., Williamson, P., Young, R., & Sawyer, M. (2010, October). *Can gaze avoidance explain why young people with Asperger's Syndrome have difficulty recognising emotions from faces?* Poster session presented at the meeting of the American Academy of Child and Adolescent Psychiatry, New York.

Sawyer, A., Young, R., & Williamson, P. (2011, September). *Meta-cognitive processes in emotion recognition: Are they different for adults with Asperger's Syndrome.* Paper presented at the meeting of the Asia Pacific Autism Conference, Perth, Australia.

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Chapter one -

Asperger's Syndrome and Emotion Recognition from facial expressions

Overview

Asperger's Syndrome and Autism, commonly referred to as Autism Spectrum Disorders (ASD), are both pervasive developmental disorders usually diagnosed in childhood (American Psychiatric Association, 2000). Individuals with Autism, as defined in the current Diagnostic and Statistical Manual of Mental Disorders, exhibit problems with language and cognitive development, marked difficulties with interpersonal relationships, and restricted and repetitive stereotyped behaviours or interests. Those with Asperger's Disorder experience similar difficulties, but typically have fewer problems with language and cognitive development. As first described by Kanner in 1943 a striking feature of these disorders is, 'an inability to form the usual, biologically provided affective contact with people" (Kanner, 1943, p. 250). This difficulty negotiating the social world remains a core diagnostic criterion for these disorders in the current Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2000).

A better understanding of these difficulties with social relationships has the potential to provide new insights into the aetiology of both these conditions (Schultz, 2005). Over the last several decades, recognition of this importance has encouraged wide-ranging research across many disciplines to identify factors which can facilitate or hinder interpersonal relationships. Within this context, there has been substantial interest in trying to understand why individuals with Asperger's Syndrome, who appear to have more typical cognitive and language development, experience significant difficulties with social relationships. This is an important issue because a better understanding of these difficulties has the potential to provide new insights into the aetiology of Asperger's Syndrome and Autism (Schultz, 2005). Previous work has shown that a capacity to accurately recognise the emotions being experienced by others is a key prerequisite for successful social relationships (Denham et al., 2003; Izard et al., 2001), and that individuals with Asperger’s Syndrome have difficulties recognising emotions from facial expressions compared to individuals without Asperger’s Syndrome (Baron-Cohen, Wheelwright, & Jolliffe, 1997; Corden, Chilvers, & Skuse, 2008; Golan, Baron-Cohen, & Golan, 2008; Hobson, 1986a; Sawyer, Williamson, & Young, in press; Wallace, Coleman, & Bailey, 2008). Several studies have also found a relationship between emotion recognition skills and social skills for individuals with Asperger's Syndrome and Autism (Boraston, Blakemore, Chilvers, & Skuse, 2007; Garcı´a-Villamisar, Rojahn, Zaja, & Jodra, 2010; Philip et al., 2010). This has been interpreted as suggesting that the difficulties individuals with Asperger’s Syndrome have interacting socially may result from the difficulties they have accurately recognising emotions from faces. It is likely that emotion recognition is important for social skills, since being able to accurately recognise emotions from facial expressions is likely to be necessary if we are to understand how someone feels and therefore give us information to guide us on how to behave and respond appropriately in a social interaction.

The emphasis of this thesis is to provide further understanding of the factors that affect the ability of individuals with Asperger’s Syndrome to recognise emotions from facial expressions within the broader context of social interaction deficits. This investigation focused on three factors that might underlie these deficits in facial emotion recognition:

1) Avoidance of eye contact when scanning the facial expressions of others;

2) Problems with meta-cognitive skill (more specifically, using one's level of confidence to guide decisions about the emotions of others); and
3) Problems using key cognitive emotion recognition processes when interpreting the facial expressions of unfamiliar people.

The goal is to understand how individuals with Asperger's Syndrome may differ from individuals without Asperger's Syndrome in relation to each of these factors. This may provide key information for understanding why individuals with Asperger's Syndrome have difficulties interacting in the social world. Finally, the present thesis also investigated these explanations for emotion recognition skills deficits in the broader context of social skills.

While studies of individuals with Asperger's Syndrome are the primary focus, studies of individuals with Autism are also included where their findings are deemed relevant. For the purpose of this thesis, relevant studies were identified from electronic searches of the PSYCINFO and PUBMED databases from 1991 to 2011 and from manual searches of scientific journals. The following keywords were used for electronic searches: *Autism, Asperger's Syndrome, emotion recognition, social skill, eye contact, eye movements, confidence, anxiety, meta-cognition,* and *familiarity*. Citations in publications identified by the electronic search were further searched to identify additional relevant studies. All relevant studies were initially stratified into categories which were representative of the different approaches used to investigate each factor. Subsequently, studies were selected for inclusion on the basis that they best illustrate the type of work being summarised in each area.

In order to understand the nature of social difficulties experienced by individuals with Asperger's Syndrome and their relationship to Autism, a review of the historical development of the concept of Asperger's Syndrome is initially provided. This is followed by a review of theories of emotion recognition which may help explain the difficulties individuals with Asperger's Syndrome have in recognising emotions from facial expressions.

Review of the Historical Development of the Concept of Asperger's Syndrome

The word 'autistic' was first used to describe the apparent lack of contact with the outside world and the disconnection from reality observed in individual's experiencing schizophrenia (Bleuler, 1913). The term was subsequently used by Kanner in 1943 to describe problems exhibited by eleven (eight male) children whose common symptom was an "innate inability to form the usual, biologically provided affective contact with people" (Kanner, 1943, p. 250).

A year after Kanner's description of Autism was published, Hans Asperger published a report describing four children whom he thought were suffering from "autistic psychopathy" (Asperger, 1944). However, as the latter paper was published in German, it was rarely cited in English-language research until it was discussed by Lorna Wing (Wing, 1981) and translated by Uta Frith in 1991 (Frith, 1991). Both Kanner (1943) and Asperger (1944) were describing children whose core difficulties were interacting socially and using social communication and language appropriately. However, the children described by Asperger had normal language development and were less likely to have experienced cognitive delay, although Asperger did not exclude children with cognitive impairments from his description of the disorder and described cognitive impairments in the disorder as falling on a spectrum from "genius to mentally retarded" (Asperger, 1944, p. 74) . Despite the similarities between the two descriptions of the disorders, they continue to be conceptualised as categorically separate conditions due to differences in language and cognitive development, and subtle differences observed in the social behaviour of these two groups of children (Wing, 1981). In her description of Hans Asperger's cases, Wing (1981) made a distinction between the social deficits experienced by children experiencing "Autism" and what she called "Asperger's Syndrome". She described children with Autism as aloof and indifferent to others, while the children with Asperger's Syndrome were described as trying to engage in social interaction but attempting to do so in inappropriate ways. Subsequently a large volume of research has focused on trying to establish the extent to which the symptomatology and aetiology of these two conditions differed or whether they were in fact variants of the same condition (Cederlund, Hagberg, Billstedt, Gillberg, & Gillberg, 2008; Frith, 2004; Macintosh & Dissanayake, 2004; Mazefsky & Oswald, 2007; Saulnier & Klin, 2007; Szatmari, Archer, Fisman, Streiner, & Wilson, 1995; Szatmari, Bryson, Boyle, Streiner, & Duku, 2003; Wing, 1991).

Before researchers could attempt to examine the extent to which the two conditions overlapped, clear diagnostic criteria for each condition needed to be established. Rutter (1974) suggested that three symptoms be used to define Autism: (1) failure to develop social relationships; (2) language retardation; and (3) ritualistic or compulsive behaviours. These symptoms formed the basis of diagnostic criteria utilised in the Diagnostic and Statistical Manual of Mental Disorders (DSM) III description of 'infantile Autism' (American Psychiatric Association, 1980) and were largely unchanged in the condition defined as 'Autism' in DSM-IV-R (American Psychiatric Association, 2000). There had been less agreement about the defining symptoms for Asperger's Syndrome (e.g., Gillberg & Gillberg, 1989; Szatmari, Bremner, & Nagy, 1989) until it was included for the first time in the International Classification of Disorders 10 (World

Health Organization, 1993) and the DSM-IV (American Psychiatric Association, 1994). In these classifications the main symptom that differentiated Autism from Asperger's Syndrome was the presence of language delay. The presence of language delay precluded a diagnosis of Asperger's Syndrome. In DSM-IV-TR, these two disorders continued to be viewed as categorically separate conditions. However, in the next revision of the DSM the diagnostic criteria used to describe the two conditions will be revised to reflect current understanding of these two disorders as falling along a spectrum of severity rather than as categorically different and aetiologically distinct conditions (Mattila et al., 2011).

This shift in perceptions of these disorders results from the fact that empirical research to date has failed to reveal categorical differences in the behavioural profile of individuals with Asperger's Syndrome and Autism (Sanders, 2009). However, as first described by Wing (1981), it has been suggested that those with Autism and those with Asperger's Syndrome may differ subtlety in their social deficits. Frith (2004) suggests that individuals with Asperger's Syndrome often stand out from those with Autism as they desire social interaction and friendship but are unable to negotiate this process. In contrast, individuals with Autism do not appear to desire this social contact. For example, individuals with Asperger's Syndrome often describe their interests to others in a pedantic manner, and ask intrusive questions of others in an attempt to socialise, without understanding the inappropriateness of their behaviour (Ghaziuddin, 2008; Klin, Pauls, Schultz, & Volkmar, 2005).

Ghaziuddin (2008) investigated this phenomenon by categorising individuals with high-functioning Autism and Asperger's Syndrome using Wing and Gould's social classification system (Wing & Gould, 1979). Ghaziuddin's study included 58 individuals with Asperger's Syndrome, aged 7-51, and 39 individuals with high-functioning Autism, aged 7-32. He reported that the majority of individuals with Autism fit the criteria for "aloof" ("indifferent in most situations and towards others") or "passive" ("did not initiate contact spontaneously but responded to questions appropriately"). In contrast, the majority of individuals with Asperger's Syndrome fit the criteria for "active but odd" ("initiated social interactions but were inappropriate in the manner they asked their questions"). This suggests that despite the large overlap between Autism and Asperger's Syndrome, those with Asperger's Syndrome differ in the nature of their social impairment. Individuals with Asperger's Syndrome appear to desire social contact but are unable to negotiate the subtle and often unspoken rules of social interaction. These results are also supported by longitudinal research by Szatmari et al. (2000) that found that at two year follow up children with Asperger's Syndrome differed in their social abilities from children with Autism.

In summary, both Autism and Asperger's Syndrome have as their key diagnostic feature an inability to effectively engage in the social world (Schultz, 2005). However, as defined most recently in DSM-IV-R, those with Autism also experience delayed language development whilst individuals with Asperger's Syndrome do not experience abnormal language delay. It is highly likely that a delay in language development will contribute to the social difficulties experienced by those with Autism and this may make it more difficult to untangle the factors that lead to these social difficulties. Therefore, in trying to understand the factors that may contribute to the social deficits experienced in these disorders the present thesis will focus on individuals with Asperger's Syndrome. It is important to understand why individuals with Asperger's Syndrome have difficulty interacting socially, despite attempting to interact and having generally typically developed structural language and cognitive skills, as this may well provide a clearer understanding of the mechanisms resulting in social deficits for those with Asperger's Syndrome and Autism.

Social Interaction: The Importance of Emotion Recognition Skills

In order to understand why individuals with Asperger's Syndrome have difficulties interacting socially, it is important to understand how individuals without Asperger's Syndrome successfully develop social interaction skills. This may provide insight into what goes wrong in this process for individuals with Asperger's Syndrome. One of the key cues we use when we interact socially is other peoples' emotions. Emotions can be displayed through vocal prosody, gestures, and facial expressions. However, it is the face in social interactions which provides the most potent information. Herba and Phillips (2004) suggest that the ability to correctly recognise emotions from facial expressions is necessary to develop functional social competence. Thus the ability to recognise emotion on the basis of facial expressions is likely to be a critical step for successful social interaction (Gepner, Deruelle, & Grynfeltt, 2001). It is likely that understanding another's emotions on the basis of their facial expressions is important for social skills as it allows us to quickly understand how someone is feeling, and therefore how we should behave and respond in order to interact successfully. Not being able to recognise emotions from facial expressions is likely to make social interaction difficult as we then have limited cues to use, including what the person says and the situation, in order to work out how to respond and behave appropriately.

Emotional competence (i.e., correctly recognising and identifying emotions) has been hypothesised as an important prerequisite for the development of social competence (Denham et al., 2003; Izard et al., 2001; Miller et al., 2005). In a prospective study, Denham et al. (2003) investigated the relationship between emotional and social competence in 143 children in the community aged 3-4 years and a year later at age 5-6 years. They found that emotional competence at age 3-4 predicted the development of social competence at age 5-6. Izard et al. (2001) also investigated this relationship in a longitudinal study of 72 economically disadvantaged children at age 5 and at age 9. They investigated whether the ability to recognise and label photographs of faces expressing emotions at age 5 predicted the children's level of social skills, behavioural problems and academic performance at age 9. They reported that level of emotion recognition ability at age 5 explained more of the variance in the level of social skills, behavioural problems and academic competence at age 9 than that explained by temperament, gender and verbal ability. Thus, it appears that emotion recognition abilities are an important skill that children use to develop an ability to interact with the social world. It is likely that these emotion recognition abilities are continually refined through experience and practise to develop a system of strategies and knowledge that allow individuals to fluently enact this skill and thus develop the ability to function successfully in the social world (Golan et al., 2008; Herba & Phillips, 2004; Sasson, 2006).

Emotion recognition skills are present and continue to develop from early infancy (Tronick, 1989). For example, new born infants show heightened attention to faces soon after birth and will look longer at facial configurations than non-facial configurations (Morton & Johnson, 1991). Children, adolescents and adults with ASD are commonly reported to have deficits in correctly recognising emotions from facial expressions compared to typically developing individuals (e.g., Adolphs, Sears, & Piven, 2001; Hobson, 1986a, 1986b). It may be that this difficulty accurately recognising emotions from facial expressions contributes to the difficulties individuals with Asperger's Syndrome have interacting socially. It is likely that if one is unable to interpret the meaning of facial expressions in a social interaction it makes it difficult to know how to respond to others and even makes it difficult to understand the behaviour and intentions of other people during social interactions.

Emotion recognition and Asperger's Syndrome

Emotion recognition is the ability to successfully identify and understand the social meaning of a particular emotion (Denham et al., 2003). Commonly, emotion recognition tasks involve the presentation of a photograph of a facial expression following which the participant must then select from a set of emotion words which word described the emotion displayed. There are two categories of emotion that have been investigated in research with individuals with Asperger's Syndrome: (1) basic emotional expressions such as happy and sad (Ekman & Friesen, 1975), and (2) complex emotional expressions such as scheming, admiring or interested (Baron-Cohen, Wheelwright, et al., 1997). These two categories of expressions are seen as differing in terms of their recognition difficulty, with basic emotional expressions involving more overt facial cues in both the mouth and eye region, while complex emotional expressions tend to involve more subtle facial cues predominately in the eye region.

Research with individuals with High Functioning Autism and Asperger's Syndrome examining emotion recognition accuracy has shown inconsistent results. Commonly individuals with Asperger's Syndrome are reported to not show deficits in the recognition of basic emotions (Baron-Cohen, Wheelwright, et al., 1997; Gepner et al., 2001). In contrast, some studies do report that individuals with Asperger's Syndrome have deficits in processing and identifying basic emotions (e.g., Fulvia Castelli, 2005; Celani, Battacchi, & Arcidiacono, 1999; Corden et al., 2008). Overall, however, the results of these studies show that individuals with Asperger's Syndrome have deficits accurately identifying specific emotions (i.e. fear) rather than all of the six basic emotions (Corden et al., 2008; Pelphrey et al., 2002). Results reporting the abilities of individuals with Asperger's Syndrome to recognise complex emotions have been more consistent with these individuals reported to have pervasive deficits in identifying complex emotions from faces (Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Baron-Cohen, Wheelwright, et al., 1997; Golan, Baron-Cohen, & Golan, in press; Heerey, Keltner, & Capps, 2003). Further research is required to identify whether individuals with Asperger's Syndrome have a general deficit identifying emotions from facial expressions or whether this difficulty only exists for more complex expressions.

How are the Emotions of Others Recognised?

Difficulties recognising the emotions of others and being able to engage with the affective lives of others has often been posited as a core deficit in Asperger's Syndrome. This began with Kanner's original description of Autism which stated that a core difficulty in the disorder was, "an inability to form the usual, biologically provided affective contact with people" (Kanner, 1943, p. 250). Hobson in later years also theorised that emotion recognition was a core deficit underlying the social problems seen in Autism (Hobson, 1993a). For example, in an experiment by Hobson (1986b) it was found that children with ASD were impaired in recognising emotions, compared to non-autistic intellectually impaired children matched on performance IQ, even when the task did not include faces (e.g. matching a vocalisation to a gesture). This lead Hobson to suggest that difficulty recognising emotion was a core deficit in Asperger's Syndrome and Autism. More recently Baron-Cohen (1997) has advanced this idea suggesting that the difficulties seen in these disorders are due to problems with 'theory of mind', the ability to understand not only emotions but also the intentions and behaviour of others.

In order to further understand why individuals with Asperger's Syndrome may experience difficulties recognising emotions it is important to understand what is known about how individuals without the disorder are able to seemingly effortlessly identify the inner emotional states of others, often just on the basis of facial cues. Two broad explanations have guided research seeking to explain how humans recognise the emotions of others on the basis of their facial expressions. The first explanation suggests that emotions are recognised via ‘bottom-up processing’. It is suggested that a core set of facial expressions are recognised instinctually and this ability is ‘hard-wired’ into the human central nervous system (Ekman & Friesen, 1975; Ekman & Friesen, 1969; Ekman et al., 1987; Ekman & Oster, 1979). The second explanation suggests that significant cognitive processing of information obtained from facial expressions is required to accurately recognise the emotions of others on the basis of their facial expressions (Barrett, Lindquist, & Gendron, 2007). That is, emotion recognition relies more on ‘top down processing.’

Studies testing the explanation that emotions are recognised via bottom up processing have identified six ‘basic emotions’: surprise, fear, anger, disgust, happiness and sadness (Ekman & Friesen, 1975; Ekman & Friesen, 1969; Ekman et al., 1987; Ekman & Oster, 1979). Evidence supporting this explanation is available from studies that have found that this set of basic emotions is accurately recognised cross-culturally (Ekman et al., 1987; Ekman & Oster, 1979; Izard, 2007). This suggests that regardless of different socialisation experiences, there are emotions that humans are biologically programmed to recognise perhaps due to their importance in evolutionary history (Ekman & Friesen, 1971; Ekman et al., 1987; Frank & Stennett, 2001). For example, Ekman et al. (1987) found that subjects from ten different cultures showed high agreement on what emotion was most strongly represented by different facial expressions. In this study participants were asked to indicate what emotion was most displayed in a set of expressions and also identify a second most likely emotion. Participants showed high agreement on both of these judgements, suggesting strong evidence that humans are biologically programmed to recognise these basic emotional expressions. Further evidence for the idea that we are born with the ability to recognise a discreet set of facial expressions comes from research that finds a neurological basis to emotion recognition in both humans and animals (Bowers, Bauer, & Heilman, 1993; Panksepp, 2007). Finally, research has also identified that these emotions are expressed cross-culturally using the same configuration of facial cues which can be identified using a measurement system (Ekman & Friesen, 1975; Ekman & Friesen, 1969). This is again interpreted as evidence that humans are innately programmed to recognise a key set of emotional expressions.

Recently, this theory of the ‘innate’ nature of emotion recognition has been challenged by research that has found that the emotion people recognise from an expression can be manipulated (Aviezer et al., 2008; Carroll & Russell, 1996; Righart & Gelder, 2008), even when these expressions are consistent with the measurements specified for each particular basic emotion by Ekman and Friesen (1975). For example, Carroll and Russell (1996) tested this by pairing basic facial expressions with incongruent contexts (i.e., a face expressing fear shown in a context suggesting anger etc.). They found that participants more often picked the emotion suggested by the situation rather than the facial expression. This finding provides evidence in contrast to the idea that certain basic facial expressions trigger a biologically programmed recognition. Aviezer et al. (2008) also found evidence to support this idea, they reported that not only did the context in which an expression was shown change the emotion identified as being expressed but also changed the way individuals looked at the faces. This suggested that factors other than just the configuration of facial cues can affect how individuals assess and interpret the emotional meaning of a facial expression.

Finally, research examining the effect of learning on emotion recognition has also found support for ‘top down’ processing being involved in emotion recognition (Pollak & Kistler, 2002; Pollak & Sinha, 2002). For example, Pollack and Sinha (2002) investigated whether children who had been abused, and thus exposed to facial expressions of anger more frequently, were able to recognise angry facial expressions more accurately and on the basis of less sensory information than children who had not been abused. They found that children who had been abused were able to more accurately identify facial expressions of anger on the basis of less sensory information than children who had not been abused. This suggests that experience and learning affect emotion recognition abilities and that these processes are not simply biologically programmed.

This has led to the development of the hypothesis that emotion recognition involves extensive ‘top down’ cognitive processing in order to accurately recognise emotions from the facial expressions of others. Proponents of this ‘top down’ explanation of emotion recognition suggest that acquired knowledge about emotions of others is used to categorise facial expressions and decide how best to respond when interacting with an individual who is expressing a particular emotion (Barrett et al., 2007). For example, acquired knowledge about expressions of anger may include an understanding of the facial expressions associated with anger, how people may react and think when they are angry, and how best to respond to an individual expressing this emotion. Barrett et al. (2007) proposed that evidence for this explanation comes from research that shows that language is crucial for the development and use of knowledge about emotions. Such evidence is found in studies which have shown that the emotions people recognise differ, depending on their culture and previous social experience. For example, Wierzbicka (2009) noted that people in cultures using different languages do not employ the same words for emotions and as a result individuals that speak different languages cannot recognise the same categories of emotions. Further evidence about the importance of language and cognitive processes for accurate recognition of emotions is available from a wide range of studies (Aviezer et al., 2008; Brosch, Pourtois, & Sander, 2010; Etcoff & Magee, 1992; Rump, Giovannelli, Minshew, & Strauss, 2009; Wierzbicka, 2009).

Perhaps the most convincing evidence for the role of language and top down processing in the recognition of facial expressions comes from research that uses the semantic satiation paradigm (Barrett et al., 2007). Semantic satiation refers to the idea that, ‘repeated pronunciation of a word affects the accessibility of semantic information related to that word’ (L. Smith, 1984, p. 486). This effect can be easily experienced by repeating aloud any word 30 or more times – what will be experienced is that the word loses its semantic meaning temporarily (Lewis & Ellis, 2000; L. Smith & Klein, 1990). Lindquist, Barrett, Bliss-Moreau, and Russell (2006) used this paradigm to assess whether semantic satiation of an emotion word would affect participant’s ability to recognise emotions in facial expressions. They found that participants were slower and less accurate at recognising emotions from facial expressions when the relevant emotion word had been semantically satiated in comparison to when the emotion word had been primed (repeated only 3 times). This suggests that emotion words and their associated emotion knowledge play an important role in the recognition of emotions from facial expressions.

Rump and collegues (2009) build on this idea by suggesting how it is that we may link emotion words and knowledge to the facial expressions that match them. They suggest that using emotion knowledge to interpret the meaning of facial expressions utilises comparisons of the facial expressions being assessed and stored mental representations of prototypical expressions (Valentine, 1991). When a match is achieved between a facial expression and a stored mental representation, the emotion displayed in the facial expression is categorised as belonging to a particular emotion. These investigators suggest that effective use of this process requires both the development of an appropriate store of mental representations and the ability to efficiently use this knowledge to process facial expressions during social interactions. They hypothesised that, as individuals develop into adulthood, their ability to recognise expressions improves because mental representations become more refined and the ability to compare expressions to these representations becomes faster and more efficient. This may occur as with age individuals become better at using confidence as a guide to the accuracy of potential matches between facial expressions and mental representations.

In summary, while there is evidence to suggest that some components of our ability to recognise emotions may be innate, there is also growing evidence that 'top down' cognitive processing highly influences the emotions we recognise from different facial expressions. It is likely that a common process important for emotion recognition, regardless of what theory one supports, is the act of looking at the face. It is likely that in order to trigger reflexive recognition, and in order to enable cognitive processing of expression information, people must look at the key regions of the face and encode the facial cues available. There is then good evidence to suggest that the next stage of this process involves cognitive processing of facial expression information in order to make a decision about the emotion that is being expressed. It is possible that individuals with Asperger's Syndrome may have difficulties with emotion recognition due to problems looking at the key regions of faces or due to difficulties cognitively processing facial cues in order to make emotion recognition decisions.

Why do Individuals with Asperger's Syndrome have Difficulties Recognising Emotions from Faces?

Asperger's Syndrome is a developmental disorder in which individuals experience a significant deficit in their ability to interact socially despite having mostly functional language and cognitive abilities. Emotion recognition is an important skill for successful social interaction and this ability is often tested in individuals with Asperger's Syndrome in order to explore possible causes for their social difficulties. Two major explanations for how humans recognise emotions exist: (1) that emotion recognition happens instinctively with little cognitive processing as humans are biologically programmed to recognise certain emotions, and; (2) that emotion recognition relies on cognitive processing of facial cues using 'emotion knowledge' and 'mental representations of expressions' to accurately interpret the emotional meaning of facial expressions (Barrett et al., 2007; Ekman & Friesen, 1975; Ekman & Friesen, 1969; Ekman & Oster, 1979; Rump et al., 2009). These explanations suggest three areas that will be investigated in the present thesis in order to try to understand why individuals with Asperger's Syndrome have difficulties recognising emotions from facial expressions.

1) Gaze avoidance: Do individuals with Asperger's Syndrome not make eye contact which then impairs their ability to scan key facial regions required to accurately recognise the emotions of others?
2) Cognitive processing of facial expressions: Do individuals with Asperger's Syndrome have difficulty using key cognitive processes, such as meta-cognitive skill, when making decisions about the emotional meaning of the facial expressions of others?

3) Familiarity: Do individuals with Asperger's Syndrome have a specific difficulty using emotion knowledge and mental representations when assessing the facial expressions of people unfamiliar to them?

These three broad areas are considered in the first three studies, respectively.

Finally, also in Study 4, the broader question about whether emotion recognition skills are important for social skills above and beyond other abilities that have been implicated as important for social skills was examined.

Chapter two - Study one: Can Gaze Avoidance Explain why Individuals with Asperger's Syndrome have Difficulty Recognising Emotions from Facial Expressions?

Overview

Autism Spectrum Disorders (ASD; including Autism and Asperger's Syndrome) are Pervasive Developmental Disorders characterised by problems with social interaction, communication and repetitive stereotyped behaviours (American Psychiatric Association, 2000). A qualitative impairment in social interaction is often considered to be one of the key diagnostic features in individuals with these disorders (Schultz, 2005). The ability to accurately recognise emotions from faces is important for successful social interaction. Individuals with Asperger's Syndrome are commonly reported to have difficulties recognising emotions from faces and to avoid eye contact, also referred to as "gaze avoidance" (Dalton et al., 2005; Davies, Bishop, Manstead, & Tantam, 1994; Hernandez et al., 2009; Klin, Jones, Schultz, Volkmar, & Cohen, 2002; Macdonald et al., 1989; Neumann, Spezio, Piven, & Adolphs, 2006; O'Connor, Hamm, & Kirk, 2005; Wallace et al., 2008). Since eye contact is important for accurate emotion recognition (Baron-Cohen, Jolliffe, et al., 1997; Bassili, 1979; J. D. Boucher & Ekman, 1975; De Bonis, 2003; Katsikitis, 1997; M. L. Smith, Cottrell, Gosselin, & Schyns, 2005) this has led to the hypothesis that gaze avoidance may be responsible for the difficulties individuals with Asperger's Syndrome have recognising emotions from facial expressions. This hypothesis was tested in the present study by investigating whether individuals with Asperger's Syndrome have difficulty recognising emotions from facial expressions, and whether this difficulty is due to gaze avoidance (i.e., decreased attention to the eye region and increased attention to the mouth region). Understanding why individuals with Asperger's Syndrome have difficulties recognising emotions from faces contributes to an understanding of why these individuals have difficulty interacting successfully in the social world despite not experiencing the cognitive impairments commonly associated with Autism.

Individuals with ASD are commonly reported to have problems recognising basic and complex emotional expressions. Basic emotions are commonly described as those which humans are biologically programmed to recognise, and include expressions (e.g., anger) where quick recognition may have been adaptive for human survival (Ekman & Oster, 1979). The identification of complex emotional expressions, such as confused and admiring, requires an understanding of the other person's thoughts or intentions. Therefore, these may require more cognitive processing in order to achieve accurate recognition (Baron-Cohen, Wheelwright, et al., 1997; Barrett et al., 2007). The evidence for emotion recognition deficits in the identification of basic emotions for adults with ASD is inconsistent. For basic emotions, commonly individuals with ASD have been found only to have difficulty recognising the basic emotion of fear (Corden et al., 2008; Pelphrey et al., 2002). In contrast, deficits in identifying complex emotions appear to be more pervasive among individuals with ASD (Baron-Cohen, Jolliffe, et al., 1997; Baron-

Cohen et al., 2001; Baron-Cohen, Wheelwright, et al., 1997; Golan et al., 2008; Heerey et al., 2003).

The emotions that individuals with ASD have difficulty recognising all require interpretation of information in the eye region in order to be accurately recognised (Baron-Cohen, Wheelwright, et al., 1997; Bassili, 1979; J. D. Boucher & Ekman, 1975; Katsikitis, 1997). For example, it is reported that for the basic emotion of fear, the eyes play a crucial role in correct identification (Katsikitis, 1997), while other basic emotions can be accurately recognised from information in the mouth region. Furthermore, Baron-Cohen, Wheelwright, et al. (1997) reported that viewing the eye region of a face expressing a complex mental state is crucial for accurate recognition. If it is assumed that individuals with ASD avoid eye contact then it would be expected that these individuals would have difficulty recognising complex emotional expressions as the eye region is crucial for the accurate recognition of these expressions. However, it would not be expected that individuals with ASD would have difficulty recognising basic emotions as not all of these expressions are reliant on information conveyed by the eye region.

Baron-Cohen, Wheelwright, et al. (1997) investigated whether the pattern of emotion recognition deficits experienced by individuals with ASD may be due to gaze avoidance. They compared the emotion recognition accuracy of individuals with high-functioning Autism (n = 4) and Asperger's Syndrome (n = 12) and age matched individuals (aged 18-48, n = 16) without ASD. Participants were given a photograph of the whole face or the eye region only, showing basic (e.g., happy, sad, etc.) and complex facial expressions (e.g., guilty, interested, etc). In the whole face condition, individuals with ASD were less accurate at recognising complex expressions in comparison to individuals without ASD but performed comparably when recognising basic emotions. In the eyes only condition, however, individuals with ASD showed deficits recognising both basic and complex expressions in comparison to individuals without ASD. Thus, individuals with ASD have problems identifying emotions from the eye region and this appears to interfere with the recognition of both basic and complex expressions. This finding suggests that individuals with ASD may be more reliant on other facial features (such as the mouth) to recognise emotions.

Support for this interpretation was found by Spezio, Adolphs, Hurley, and Piven (2007). They reported that individuals with high-functioning Autism looked more at the mouth than the eye region of photographs of basic emotional expressions. Nevertheless, they were no less accurate than individuals without high-functioning Autism at recognising basic emotions. This suggests that a preference for looking at the mouth region over the eye region of a face may only interfere with the recognition of emotions that require interpretation of information in the eye region (i.e., for complex emotional expressions).

To further test the proposition that emotion recognition deficits in individuals with ASD are due to gaze aversion, Rutherford and Towns (2008) employed the same emotion recognition task as Baron-Cohen, Wheelwright, et al. (1997) in combination with eye tracking technology. Rutherford and Towns, however, failed to find a relationship between gaze avoidance and emotion recognition deficits in individuals with ASD. They found no differences between the eye gaze behaviour or emotion recognition accuracy of adults with ASD in comparison to adults without ASD. They reported that there was a tendency for adults with ASD to fixate gaze less to the eyes in response to complex emotions but this trend was non-significant. However, given the Rutherford and Town’s sample of participants with ASD did not have any difficulties recognising complex or basic emotional expressions, in comparison to individuals without ASD, we would also not expect these individuals to show evidence of gaze avoidance. In this case it may be that the sample of participants with ASD in this study did not dramatically avoid looking at the eye region of the photographs of facial expressions and therefore did not show any evidence of emotion recognition difficulties. Although, Rutherford and Towns did not find a significant difference in emotion recognition performance, they did obtain a moderate effect size suggesting that the sample size may not have been large enough or that the measure of emotion recognition might not have been sensitive enough. Hence, in the present study, the study by Rutherford and Towns was replicated using a larger sample size and a more sensitive emotion recognition task. In the Rutherford and Towns task, participants were presented with two options and asked to choose which expression was shown in the photographs (e.g., happy or sad). In order to increase the difficulty of the task so as to increase the sensitivity to detect emotion recognition deficits, a four word response choice format that was tailored to the characteristics of each of the photographs (e.g., for an angry expression participants may be asked to choose from angry, disgust, scheming or arrogant) was used.

To summarise, the aims in the present study were to investigate whether differences in the way individuals with Asperger's Syndrome look at faces is an explanation for the problems these individuals have accurately recognising emotions from facial expressions. The three main questions addressed in the present study are: (a) do differences in emotion recognition accuracy exist between individuals with and without Asperger's Syndrome; (b) do individuals with Asperger's Syndrome look less at the eye region and more at the mouth region of photographs of facial expressions in comparison to individuals without Asperger's Syndrome, and; (c) for individuals with Asperger's Syndrome is there a relationship between gaze avoidance and emotion recognition accuracy?

Method

Participants. There were 75 participants in the present study: 48 in the Asperger's Syndrome group and 27 in the no-Asperger's Syndrome group. Participants with Asperger's Syndrome were recruited through Autism SA and had met the Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria for Asperger's Syndrome (American Psychiatric Association, 2000) through a formal diagnostic process. That is, diagnoses were supported by two independent psychologists/psychiatrists or two members of the Autism SA diagnostic team. Participants without Asperger's Syndrome were volunteer Flinders University first year psychology students. Participants with comorbid disorders were removed from the analysis (including: affective disorders, psychosis, acquired brain injury, attention-deficit/hyperactivity disorder, memory dysfunction and expressive language delay), leaving 30 participants in the Asperger's Syndrome group and 24 in the no-Asperger's Syndrome group. Furthermore, for one participant in the Asperger's Syndrome group eye tracking data was not recorded due to a computer malfunction therefore the eye tracking data are based on 29 individuals with Asperger's Syndrome and 24 individuals without Asperger's Syndrome. Four participants in the Asperger's Syndrome group were currently taking medications (1 participant taking Tegretol, 3 taking Risperidone). However, when analyses were run excluding these participants the results were found to be consistent with those found when these individuals were included, and thus these four participants were not excluded from any analyses.

There was no statistically significant difference in the age of participants (Asperger's Syndrome (AS) group: M = 21.6 years, SD = 9.8, group without Asperger's Syndrome (no-AS group): M = 24.0, SD = 9.2, t (52) = 0.92, p = .36). Both groups were of average intelligence as measured by the Wechsler Abbreviated Intelligence Scale. The groups did not differ on verbal intelligence scores (AS group: $M = 109.7$, $SD = 19.1$, no-AS group: $M = 113.4$, $SD = 12.8$, $t(52) = 0.82$, $p = .42$), performance intelligence scores (AS group: $M = 104.3$, $SD = 18.2$, no-AS group: $M = 111.4$, $SD = 12.8$, $t(52) = 1.62$, $p = .11$), or full scale intelligence scores (AS group: $M = 108.1$, $SD = 17.9$, no-AS group: $M = 114.1$, $SD = 13.0$, $t(52) = 1.36$, $p = .18$).

Both groups scored in the normal range for depression and anxiety, as measured by the Depression Anxiety and Stress Scale, and these scores did not significantly differ between the groups, $p > .05$. The AS group had significantly more males (69%) than the no-AS group (31%) $p = .03$, however, controlling for gender did not change the pattern of the results.

Design. A 2 (group: AS, no-AS) x 4 (condition: passive-viewing, full-face, eyes-only, mouth-only) mixed between-within subjects design, with condition as a within-subjects factor, was used. The dependent measures included: eye tracking measures (length of observation to the eye and mouth region of the photographs) and emotion recognition accuracy.

Apparatus. Eye gaze data were recorded using a Tobii T60 eye tracker, which monitors binocular eye movements using near infrared diodes which create reflection patterns on the participants' corneas which are monitored by image sensors. The eye-tracker is considered non-invasive, embedded in the computer monitor so as to be discrete and not restrict the head movements of participants.

Two eye gaze variables were examined: (a) observation length – the total length in seconds that an individual looked at a particular region; and (b) percentage observation length – the time in seconds that an individual looked at a particular region as a percentage of the total time the photograph was viewed. The eye and mouth regions were defined as the regions of interest. The eye region included a rectangle around the eye region (1 cm from the outer canthus of each eye and including the eyebrows). The mouth region included a rectangle around the mouth region (1 cm from the corners of the mouth and below the lower lip).

The Tobii software provides an indication of the quality and validity of each participants recording (e.g., a rating of 100% means that both eyes were found during the whole recording, 50% means that either one eye was found for the full recording or both eyes during half of the recording). Individuals were excluded if they had a validity rating less than 60%. Furthermore, individuals eye gaze data were only included if they had data available for at least 20 of the 32 images per condition. These criteria were used to ensure the validity of the eye tracking data that was assessed. There were no differences in the data quality of the groups as assessed by the Tobii software (passive viewing condition: AS group – 81.1%, no-AS group – 82.6%, full face condition: AS group – 76.6%, no-AS group – 78.0%, $p > .05$ for both comparisons). Furthermore, there were no differences in the percentage of missing data recorded for both groups (passive viewing condition: AS group – 5.5%, no-AS group – 2.1%, full face condition: AS group – 6.9%, no-AS group – 1.4%, $p > .05$ for both comparisons).

Materials.

Wechsler Abbreviated Scale of Intelligence. In order to ensure that participants had a sufficient level of verbal and performance competency to complete the emotion recognition task, participants were assessed on the Wechsler Abbreviated Scales of Intelligence (includes: Vocabulary, Similarities, Block Design, and Matrix Reasoning.) This measure also allowed for an examination of the effect of intelligence on emotion recognition and allowed this alternative explanation for the results to be investigated. A cut-off score of 80 for verbal and performance intelligence quotient (IQ) was used as an exclusion criterion in the present study. This is consistent with the strategy adopted by previous emotion recognition research with individuals with Autism or Asperger's Syndrome (Begeer, Rieffe, Terwogt, & Stockmann, 2006; Golan et al., 2008).

The Wechsler Abbreviated Scale of Intelligence (WASI) is a short form of the full Wechsler intelligence batteries. It is for use with individuals aged 6 to 89 years and can be completed in 15-30 minutes. It is made up of four of the subtests included in the full Wechsler intelligence batteries: vocabulary, similarities, block design and matrix reasoning. It provides an estimate of an individual's verbal, performance and full-scale IQ. This scale has been found to be a valid tool for screening levels of intelligence when it is not possible to use longer scales (Axelrod, 2002). Although the WASI does not show perfect correspondence to scores produced by longer scales such as the Wechsler Adult Intelligence Scale (Corden et al., 2008; Pelphrey et al., 2002), for the purposes of the current study it is capable of providing an acceptable estimate of an individual's level of intellectual functioning with a short administration time. The WASI has also been found to have good validity for children aged 6-16 and for adults aged 17-89. Reliability coefficients for the verbal, performance and full scale IQ scores range from .93 - .96 for children, and from .96 - .98 for adults (F. Castelli, Frith, Happé, & Frith, 2002). Furthermore, the Wechsler intelligence scales have been found to provide more accurate estimations of intelligence in individuals with Autism or Asperger's Syndrome than shorter measures such as the Ravens Progressive Matrices (Mottron, 2004). Finally, the WASI has demonstrated good discriminant and convergent validity when used with clinical populations (Hays, Reas, & Shaw, 2002)

Depression Anxiety and Stress Scale – Short form. The short form of the Depression Anxiety and Stress Scale (DASS) is a 21 item self-report scale assessing levels of depression, anxiety and stress (Crawford & Henry, 2003). The DASS short form will be used to measure participants' levels of depression, anxiety and stress to examine these alternative explanations for the results. The DASS short form is made up of 21 statements which individuals rate on a four point Likert scale (e.g. 0 = did not apply to me at all, to 3 = Applied to me very much, or most of the time) how much they experienced each item during the previous week. Although the DASS short form is commonly used for individuals aged 17 and above, it has been reported as reliable in persons as young as 15 (Tantam, Monaghan, Nicholson, & Stirling, 1989). In investigations of the scale's psychometric properties, the DASS short form has been found to be a reliable and valid measure (Antony, Bieling, Cox, Enns, & Swinson, 1998; Crawford & Henry, 2003; Keltner & Buswell, 1997; Tantam et al., 1989). Cronbach's α for each of the depression, anxiety and stress scales has been found to be .94, .87 and .91 respectively (Antony et al., 1998). Furthermore, the scores on the DASS-21 have found to be moderately positively correlated with other commonly used measures of depression and anxiety including the Beck Depression Inventory and the Beck Anxiety Inventory.

Emotion synonym task. An emotion word synonym task was developed in order to assess whether participants understood and were familiar with the emotion words to be used in the eye tracking task. Participants were presented with an emotion word and four response choices (one correct synonym for the emotion word presented and three incorrect synonyms) and asked to pick which response was most similar in meaning to the emotion word. All 16 of the emotion words used in the eye tracking task were examined. Participants received one point for each correct response. Both groups demonstrated similar understanding of the emotion words to be used: AS group showed 96 % (SD = 5.4) accuracy compared with 96.4% (SD = 9.0) for the no-AS group, $p > .05$.

Stimuli.

Emotion recognition task: Development. Seven actors (three male actors and four female; aged 18 – 38) were recruited from the Flinders University Drama Centre. The actors were asked to pose the facial expressions included in the current study, including six basic emotions (i.e. happy, sad, angry, afraid, surprised, disgusted; Ekman & Friesen, 1975) and the nine complex expressions, (i.e., scheming, guilty, thoughtful, admiring, quizzical, flirting, bored, interested, and arrogant) previously investigated by Baron-Cohen, Wheelwright, et al. (1997), and embarrassed (Heerey et al., 2003; Keltner & Buswell, 1997). Basic emotions were posed based on the descriptions of facial action for each expression described by Ekman and Friesen (1975). Complex emotions were posed using the photographs developed by Baron-Cohen, Wheelwright, et al. (1997) as a guide. Photographs were taken under standardized lighting levels with a standard white background. The emotion presented in each photograph was then validated by 20 individuals without Asperger's Syndrome or a family history of Asperger's Syndrome (male = 4, female = 16), recruited through email advertisements. These participants (aged 19 – 45 years) were presented with each photograph and asked to pick from the list of 16 emotions which they thought matched the expression shown in the photograph. Participants were asked to provide one main response, and were then allowed to provide any other 'guesses' that they thought may be correct if their first response was incorrect. As validation participants had 16 response choices for each photograph the level of accuracy for chance recognition (indicating participants were guessing) was 6.25%. In order to use a rigorous criterion for selecting photographs for our emotion recognition task only photographs that were accurately recognised at a level substantially greater than chance were included in the emotion recognition task (i.e., those recognised accurately at least 50% of the time by validation participants).

In order to control the difficulty of the emotion recognition task each photograph was presented with an individualised set of emotion response words (one target word and three “incorrect” words). The incorrect word options were selected from the 16 emotion words examined and were selected on the basis that they were not chosen by the validation participants as a secondary guess in more than 15% of cases.

From the remaining photographs that were not included in the full face, mouth or eye conditions, 32 were used in the passive viewing condition (two examples of each emotion; one female and one male). The passive viewing condition was included to allow an examination of whether the groups differ in how they look at a face when asked to judge the emotion expressed by a face versus how they normally look at a face.

Emotion recognition task: Format. Photographs were presented in four sections on a computer screen: (a) full face passive viewing; (b) full face emotion recognition; (c) mouth only emotion recognition and; (d) eyes only emotion recognition. For the emotion recognition sections there were six sets of 16 photographs (full face male actor & female actor, eyes only male & female actor, and mouth only male & female actor) shown to each participant (i.e., 32 photographs in each section). The order of presentation, gender of face and individual showing the face were all randomised in the presentation. Each individual actor’s photograph of an expression was only shown in one condition. Thus the same photograph was not shown in the full face condition and then repeated showing only the mouth or eye region in the face parts conditions. The sets were assessed to have equivalent cumulative accuracy ratings from the validation phase to ensure that the difficulty of the expressions presented did not differ across condition (i.e., set A = 68.6%, set B = 68%, set C = 68.3%). Each set was edited using Adobe Photoshop CS4 software to create the mouth and eye condition photographs. In these conditions the photographs were cropped to present just the region of interest (either eyes or mouth) which were then presented on a white background. The presentation of the photograph sets was in random order. Participants were randomly allocated to one condition from each set (e.g., full face for set C, eyes-only for set A and mouth-only for set B, etc.).

For each condition the task began with instructions presented verbally and on the screen. This was followed by two practice images to ensure participants understood the requirements of the task. For each trial, a fixation cross was presented on the left or right side of the screen for 1.5 seconds before each image to orient participants to the same visual starting point for each image. This location was chosen for the fixation cross in order to not artificially influence the first fixation point of the participants to either the eye, mouth or other region of the faces. Images in the passive viewing condition were presented for a total of 5 seconds before presenting the next fixation cross and the next image. In the three emotion recognition conditions, participants were asked to click the mouse once they had decided what emotion was shown in the photograph (they were asked to do this as quickly and accurately as possible). Following this, participants were presented with a response slide with four emotion response words. They were asked to choose the word which best fit with the emotion which they thought had been presented in the photograph (see Figure 1). The present study used a four-word response format in order to increase the sensitivity of the emotion recognition task to identify emotion recognition deficits (in contrast to the two-word response format used in the task by Baron-Cohen, Wheelwright, et al., 1997). Eye tracking data was recorded during the full face and passive viewing conditions in order to assess how individuals with Asperger's Syndrome looked at the faces when trying to recognise expressions, and the length of time they focused on either the eye region or the mouth region of the face. Eye tracking was not investigated for the eyes only and mouth only conditions as only one region of the face was presented.

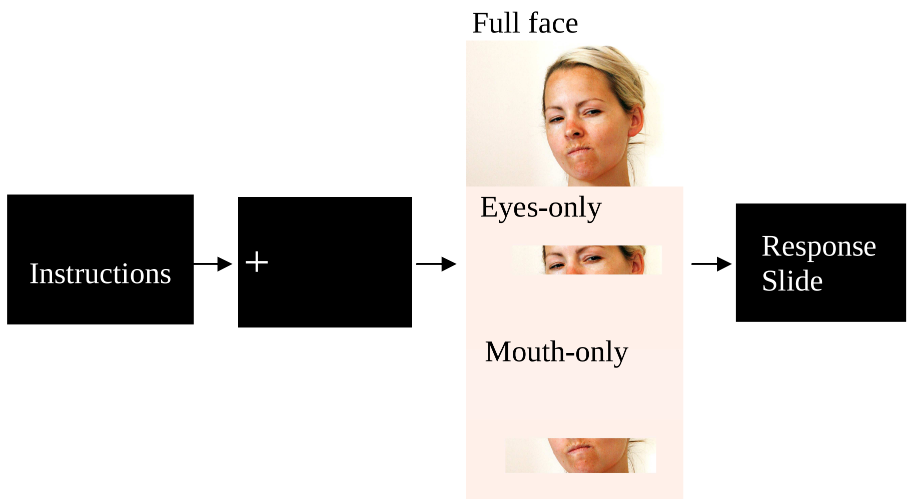

Figure 1. The presentation order of stimuli in the full face, eyes-only and mouth-only conditions.

Procedure. All participants attended an individual testing session at Flinders University. Participants initially completed the emotion synonym task. Participants then completed the emotion recognition tasks on the computer, during which eye tracking data was recorded. Next the participants completed the WASI. Finally, participants completed a demographics questionnaire and the DASS (short form) on the computer.

Results

Differences in emotion recognition accuracy due to diagnosis, face region condition and expression type. A 2 (diagnosis: AS, no-AS) x 3 (condition: full face, eyes only, mouth only) x 2 (expression type: basic, complex) mixed model analysis of variance (ANOVA) was undertaken to investigate whether those with Asperger's Syndrome displayed a deficit in emotion recognition accuracy. This revealed a large main effect of diagnosis, F (1, 52) = 27.5, p <.001, *partial* η^2= .35. Individuals with Asperger's Syndrome were less accurate at recognising emotions (M = 59.9, SD = 11.7) than individuals without Asperger's Syndrome (M = 72.8, SD = 6.2). There were no statistically significant interactions involving diagnosis (*p* > .05 for all), suggesting that the difference in emotion recognition accuracy between individuals with and without Asperger's Syndrome was consistent across all the conditions of the experiment (see Table 2.1).

Table 2.1

Emotion Recognition Accuracy (% correct) for AS and No-AS Groups from the Full Face, Eyes-Only and Mouth-Only Conditions

	AS group (n = 30)		No-AS group (n = 24)		
	M	*SD*	*M*	*SD*	*Cohen's d*
Full face	69.97	(11.09)	86.77	(11.04)	1.52
Eyes-only	58.03	(11.13)	69.65	(11.08)	1.05
Mouth-only	56.50	(11.02)	67.95	(10.98)	1.04

Irrespective of Asperger's Syndrome diagnosis, participants were much better at recognising basic emotions (M = 74.4, SD = 11.8) than complex emotions (M = 60.4, SD = 12.9), F (1, 52) = 114.8, $p < .001$, *partial* η^2= .69. However, the two-way interaction between emotion type and condition shows that this difference in recognition accuracy between the basic and complex expression types varied between the three experimental conditions, F (2, 104) = 22.19, $p < .001$, *partial* η^2 = .29. Means and standard deviations for each cell are shown in Table 2.2. Simple effects analyses comparing experimental conditions within each emotion type revealed that, for basic emotions, individuals performed best in the full-face condition, followed by the mouth-only, then the eyes-only condition. All differences between conditions were significant, $p < .01$ for all comparisons, and *d* ranged between 0.75 and 2.24. When recognising complex emotional expressions, participants also performed best in the full-face condition but, in contrast, performed better in the eyes-only condition relative to the mouth-only condition, $p < .001$ for all comparisons, and *d* ranged between 0.89 and 2.06.

Individuals with Asperger's Syndrome observed the photographs overall for longer ($M = 2.7$, $SD = 1.5$) than individuals without Asperger's Syndrome ($M = 1.9$, $SD = 0.7$), $t\ (44.9) = 2.5$, $p = .01$, *Cohen's d* = 0.65, and also took longer to select which emotion was shown in the photograph ($M = 3.1$, $SD = 0.8$) than individuals without Asperger's Syndrome ($M = 2.6$, $SD = 0.8$), $t\ (52) = 2.5$, $p = .01$, *Cohen's d* = 0.68. Therefore, there was no evidence of a speed-accuracy trade-off, as while participants with Asperger's Syndrome were less accurate they also looked at the photographs for longer. Although no IQ differences were found between the groups (see Method), it was still possible that emotion recognition accuracy and full scale IQ were related. However, there was no relationship between these two variables in either the AS group ($r = .15$, $p = .43$) or the no-AS group ($r = .23$, $p = .27$) was found.

Table 2.2

Emotion Recognition Accuracy Scores (%) for AS and no-AS Group for Basic and Complex Emotions

	Condition		
	Full-face	Eyes-only	Mouth-only
Basic emotions	86.70 (9.53)	66.08 (8.85)	72.85 (9.28)
Complex emotions	70.02 (8.59)	61.60 (10.22)	51.60 (9.28)

Differences in eye tracking due to diagnosis, face region condition and expression type. A 2 (diagnosis: AS, no-AS) x 2 (face region: eyes, mouth) x 2 (expression type: basic, complex) mixed model ANOVA was undertaken to investigate whether those with Asperger's Syndrome observed the eye and mouth regions of faces for a different length of time to individuals without Asperger's Syndrome. If the differences in emotion recognition accuracy between those with Asperger's Syndrome and those without were due to differences in the way each group examined faces, we would expect that the pattern of results for eye tracking would mirror the emotion recognition accuracy results. That is, those with Asperger's Syndrome would focus less on the relevant areas for recognising the different expression types. We would expect that those with Asperger's Syndrome, relative to individuals without Asperger's Syndrome, would focus less on the eye region of complex emotions and less on the mouth region of basic emotions, that is, an interaction between face region and diagnosis. However, the interaction between face region and diagnosis in the emotion recognition task was not significant, F (1, 50) = 0.02, p = .88, *partial* $\eta^2 < .001$. There was no difference between the observation length individuals in the AS group made to the eye region (M = 1.09, SD = 0.44) and the mouth region (M = 0.47, SD = 0.28), and the observation length individuals in the no-AS group made to the eye region (M = 1.01, SD = 0.49) and mouth region (M = 0.45, SD = 0.35). As individuals with Asperger's Syndrome observed the photographs overall for a longer period of time than individuals without Asperger's Syndrome it is possible that the results in regards to the observation length before participants decided they recognised the expression could be due to this difference in reaction time. Therefore, the results were re-analysed assessing the percentage observation length to the eye and mouth region (i.e., the percentage of time individuals viewed the eye and mouth regions out of the time they viewed the whole photograph) so that the groups could be directly compared despite the difference in reaction time. This analysis revealed the same pattern of results, F (1, 51) = 1.35, p = .25, *partial* η^2 = .02.

Potentially, individuals with Asperger's Syndrome may only examine complex emotional expressions differently to individuals without Asperger's Syndrome. However, the interaction between face region, emotion type, and diagnosis was not statistically significant, F (1, 51) = 0.39, p = .53, *partial* η^2 = .008. Means and standard deviations for each cell are shown in Table 2.3. For basic and complex expressions both groups observed the eye region for a longer period of time than the mouth region. The main effect of diagnosis was not statistically significant, F (1, 51) = 0.39, p = .53, *partial* η^2 = .008, and the interaction between diagnosis and expression type was also not statistically significant, F (1, 51) = 0.95, p = .33, *partial* η^2 = .01. The same pattern of results was found when the percentage length of observation was examined. Irrespective of expression type, both groups looked at the eye region longer than the mouth region of the photographs of facial expressions.

Table 2.3.

Observation Length (in Seconds) by AS and no-AS Group to the Eye and Mouth Region of Photographs of Basic and Complex Expressions.

	AS group (n = 29)		No-AS group (n = 24)	
	M	*SD*	*M*	*SD*
Basic				
Eye region	0.99	(0.44)	0.89	(0.45)
Mouth region	0.48	(0.28)	0.43	(0.34)
Complex				
Eye region	1.19	(0.46)	1.12	(0.55)
Mouth region	0.46	(0.31)	0.47	(0.40)

Finally, there was also no difference in the percentage of photographs where individuals with Asperger's Syndrome looked at the eye region first, 82% (*SD* = 15.37, *n* = 25), and the percentage of photographs where individuals without Asperger's Syndrome looked at the eye region first, 83% (*SD* = 21.29, *n* = 19), t (42) = 0.11, p = .92, *Cohen's d* = 0.03. Therefore in the present study, differences in the way individuals with and without Asperger's Syndrome examined facial expressions did not explain the lower level of emotion recognition accuracy achieved by individuals with Asperger's Syndrome.

Relationship between looking at the eye and mouth region and emotion recognition accuracy. While there was no difference between the AS and no-AS group in the length of time they observed the eye region of photographs, the correlations between observation length to the eye or mouth region and emotion recognition accuracy for basic and complex expressions were examined to assess whether these factors were related. For the AS and no-AS group there was no relationship between basic emotion recognition accuracy and observation length to the eye region or mouth region. Similarly, for both groups there was also no relationship between complex emotional expressions recognition accuracy and observation length to the eye or mouth region (see Table 2.4).

Table 2.4.

Correlations between Observation Length and Emotion Recognition Accuracy for Basic and Complex Expressions

			Expression Type	
			Basic	Complex
Face Region	Eyes	All	-.07	.01
		AS	.02	.13
		No-AS	-.29	-.16
	Mouth	All	.02	-.08
		AS	.09	-.16
		No-AS	.18	.23

* $p < .05$

Differences in eyetracking during the passive viewing task and the active emotion recognition task. The preceding results show that individuals with Asperger's Syndrome did not look at faces differently from those without Asperger's Syndrome when trying to recognise emotions. In particular, the results show no evidence that individuals with a diagnosis of Asperger's Syndrome avoided the eye region. However, it is possible that by cueing individuals to recognise emotions, participants were led towards gaze behaviour where the eye region becomes more salient. To test this proposition, eye tracking across two tasks was compared: the emotion recognition task and the passive viewing task.

A 2 (task type: emotion recognition, passive viewing) × 2 (face region: eyes, mouth) × 2 (expression type: basic, complex) × 2 (diagnosis: AS, no-AS) mixed model ANOVA was conducted to see if the preceding eye tracking results were moderated by task type. As participants viewed the photographs for 5 seconds in the passive viewing task, but were allowed to view the photographs as long as required in the emotion recognition task, observation length to the eye or mouth region was examined as a percentage of the total time the photographs were viewed in each task. The main effect of diagnosis was not significant, F (1, 49) = 0.76, p = .39, *partial* η^2 = 0.02, revealing no differences in eyetracking behaviour generally between those with a diagnosis of Asperger's Syndrome compared with those with no diagnosis. More crucially, there were no significant interactions involving diagnosis *and* task type, $F < 1.9$ and $p > .05$ for all interactions. Hence, there was no evidence that those with a diagnosis of Asperger's Syndrome changed their eye tracking behaviour when undertaking the emotion recognition task in comparison with their behaviour on the passive viewing task. Both groups of participants looked at the regions of the face in the same way irrespective of the task. Crucially, no evidence was found that those with a diagnosis of Asperger's Syndrome avoided looking at the eyes in the passive viewing task.

Discussion

Summary of findings. In the present study, individuals with Asperger's Syndrome were less accurate at recognising basic and complex emotions from photographs of facial expressions than individuals without Asperger's Syndrome. Consistent with previous research, individuals with Asperger's Syndrome had difficulties recognising basic and complex emotions from photographs of facial expressions even when forced to examine the eye region (Baron-Cohen, Jolliffe, et al., 1997; Baron-Cohen et al., 2001; Baron-Cohen, Wheelwright, et al., 1997; Corden et al., 2008; Golan et al., 2008; Heerey et al., 2003). Despite showing a deficit in emotion recognition accuracy, individuals with Asperger's Syndrome in the present study looked at the eye and mouth region of photographs of facial expressions in the same way as individuals without Asperger's Syndrome. Both groups examined the eye region for a longer amount of time than the mouth region, and tended to look at the eye region first for the majority of photographs. This pattern of results was the same for both basic and complex emotional expressions. The results will be discussed in three sections: the relationship between gaze avoidance and emotion recognition, the results for emotion recognition accuracy, and finally, eyetracking results.

Eye gaze relationship with emotion recognition accuracy. Baron-Cohen, Wheelwright, et al. (1997) suggested that gaze avoidance might explain the difficulty individuals with Asperger's Syndrome have recognising emotions from facial expressions. The present study tested this possibility and found that, despite finding a large difference in emotion recognition accuracy between individuals with and without Asperger's Syndrome, there was no difference in the way the groups looked at faces. Thus, gaze avoidance did not explain the difficulties that individuals with Asperger's Syndrome had in recognising basic and complex emotions from facial expressions.

This is consistent with the results of Rutherford and Towns (2008). They found that individuals with ASD did not look at facial expressions differently to individuals without ASD. However, as they also did not find a difference in emotion recognition accuracy between their groups, it was difficult to ascertain from that study whether or not this indicated that deficiencies in emotion recognition were due to differences in the way that those with ASD looked at faces as compared to those without ASD. However, while the difference in emotion recognition scores between individuals with ASD and without ASD did not reach statistical significance, Rutherford and Towns did report that the difference was in the expected direction and was a moderately sized effect. The present study had more statistical power and an emotion recognition task with greater sensitivity and is therefore able to provide more compelling evidence that the deficits in emotion recognition accuracy experienced by individuals with Asperger's Syndrome were not related to gaze avoidance. In combination with the findings of Rutherford and Towns, the results of the present study suggest that the difficulties individuals with Asperger's Syndrome experience trying to recognise emotions from facial expressions are not due to a difference in the way these individuals look at faces. That is, individuals with Asperger's Syndrome look at the same facial information as individuals without Asperger's Syndrome but are still not able to accurately recognise emotional expressions.

Emotion recognition accuracy from the eye only and mouth only conditions. When the face region to be viewed was manipulated (i.e., participants were forced to look at the eye-region-only or the mouth-region-only with the rest of the face not shown) individuals with Asperger's Syndrome were less accurate than individuals without Asperger's Syndrome when viewing the full face, the eye-region-only and the mouth-region-only. Individuals with Asperger's Syndrome in the present study did not demonstrate a larger deficit in emotion recognition accuracy when viewing just the eye region, in comparison to when viewing the full face or just the mouth region. This again suggests that the difficulty individuals with Asperger's Syndrome have recognising expressions is not due to a specific deficit recognising expressions from the eye region. This provides further evidence that avoidance of eye contact may not be a factor that interferes with the ability of individuals with Asperger's Syndrome to accurately recognise facial expressions.

This finding is in contrast to the study by Baron-Cohen, Wheelwright, et al. (1997) who found that the largest difference in emotion recognition accuracy between individuals with ASD and without ASD was in the eyes-only condition, for both basic and complex expression types. This difference in results may be due to ceiling effects in the full face condition but not the eyes-only condition of the task used by Baron-Cohen, Wheelwright, et al. That is, individuals without Asperger's Syndrome may have found the full face task with only two response choices (50% chance level) too easy. Therefore, the task may not have been sensitive enough to show the full size of the difference in emotion recognition accuracy between individuals with and without ASD. Therefore, the comparative disadvantage for individuals with ASD found in the eyes-only condition may just be an artefact of a ceiling effect. In the present study participants had four emotion words to choose from for each photograph (25% chance accuracy, see Method). This method was used in order to increase the sensitivity of the emotion recognition task to identify deficits in emotion recognition.

Emotion recognition accuracy overall: The effect of expression type. In the present study individuals with Asperger's Syndrome were less accurate at recognising emotional expressions than individuals without Asperger's Syndrome. This is consistent with previous research that has investigated the emotion recognition abilities of individuals with Autism and Asperger's Syndrome (Bal et al., 2010; Dalton et al., 2005;

Davies et al., 1994; Macdonald et al., 1989; Neumann et al., 2006; O'Connor et al., 2005; Wallace et al., 2008). In the present study two types of expression where investigated, basic emotional expressions and complex emotional expressions. These two emotion type categories were investigated as they are hypothesised to differ in how much they rely on cognitive processing and abilities such as Theory of Mind. That is, it is suggested that complex expressions are more difficult for individuals with Asperger's Syndrome to recognise as they require more attention to the eye region and greater Theory of Mind skill in order to be accurately recognised (Baron-Cohen, Wheelwright, et al., 1997). In the present study however, expression type was not one of the factors affecting the ability of individuals with Asperger's Syndrome to accurately recognise facial expressions. Instead, in the present study, individuals with Asperger's Syndrome were less accurate at recognising *both* basic emotional expressions and complex emotional expressions in the whole face, eyes-only and mouth-only conditions. There was no evidence for a relative emotion recognition advantage for individuals with Asperger's Syndrome viewing basic emotions. Again this is in contrast to the results of Baron-Cohen, Wheelwright, et al. (1997). Their results suggest that the deficit in emotion recognition accuracy for individuals with Asperger's Syndrome was greater when recognising complex emotional expressions than when recognising basic emotional expressions. This difference may also be due to the use of a more sensitive four-word response option style in the present study. It may be that when using a two-word response format it is easier to identify which emotion word does not match the photograph for basic emotions (e.g., it is not happy therefore the right response must be the other word provided) than for complex emotions (e.g., choosing between scheming and guilty). However, as most previous research (e.g., Davies et al., 1994; O'Connor et al., 2005) investigating emotion recognition abilities of individuals with Autism and Asperger's Syndrome has investigated basic emotional expressions, and found deficits, it may be that individuals with Asperger's Syndrome have difficulty recognising both categories of emotional expressions.

Eye gaze while recognising emotions from whole faces. The present study found that individuals with Asperger's Syndrome showed no evidence of gaze aversion. That is, individuals with Asperger's Syndrome examined the eye region of facial expressions for the same length of time as individuals without Asperger's Syndrome. These results are not consistent with previous research which has found that individuals with Autism and Asperger's Syndrome show evidence of gaze avoidance when asked to look at facial expressions (Bal et al., 2010; Corden et al., 2008; Dalton et al., 2005; Hernandez et al., 2009; Klin et al., 2002; Neumann et al., 2006; Spezio et al., 2007).

Three possible explanations are proposed for these differences in results. First, previous research has used either: (a) mixed samples of individuals with Autism, Asperger's Syndrome and Pervasive Developmental Disorder Not Otherwise Specified, (b) focused on individuals with Autism, or (c) used different criteria for diagnosing Asperger's Syndrome (e.g., DSM-III or previous criteria). Wing and Gould (1979) suggests that individuals with Asperger's Syndrome may differ from those with Autism in their social behaviour, with individuals with Autism being indifferent to social interaction while those with Asperger's Syndrome may be interested in attempting social interaction but do so in an "odd" way. This difference in social behaviour between Autism and Asperger's Syndrome suggests that these two groups may use different processes for recognising emotions. Secondly, studies such as Dalton et al. (2005) that have found evidence of gaze avoidance in individuals with Autism and Asperger's Syndrome have used a much younger sample of participants than the present study. It is possible that children with Autism and Asperger's Syndrome do not make eye contact as they are unable to make use of information from the eye region. With increasing age, however, it is likely that these children are taught to make eye contact during social interaction. While they may 'learn' to look at the eye region of the face as adults, they may not ever acquire the skills to make use of emotional information expressed in the eye region of faces. Finally, the present study may have found different results to previous research as static photographs of facial expressions were used, rather than more dynamic films of actors interacting and making facial expressions (e.g., Klin et al., 2002). It may be that participants with Asperger's Syndrome in the present study avoid eye contact in real life social situations or in response to films of interactions but do not avoid looking at the eye region of a photograph of a facial expression. However, research by Ponnet, Buysse, Roeyers, and De Corte (2005)found that during an in vivo social interaction individuals with Autism Spectrum Disorders did not show evidence of decreased gaze towards their interaction partners. Though this requires a more fine grained analysis to specifically assess whether individuals with Asperger's Syndrome did not show gaze avoidance, it does suggest that the results of the present study may be consistent with the behaviour of individuals with Asperger's Syndrome during real life social interactions.

The present study is not the only research to find evidence that individuals with Asperger's Syndrome do not avoid eye contact (Ostrovsky et al., 2010; Vivanti et al., 2011; Wallace et al., 2008). For example, Wallace's unpublished thesis (2002, as cited in Wallace et al., 2008) found that individuals with Autism and Asperger's Syndrome did not show evidence of gaze avoidance when looking at fearful expressions but did show decreased recognition accuracy and Ostrovsky et al.(2010) found no difference in the length of time children with Asperger's Syndrome looked at the eye region of photographs. Dalton et al. (2005, p. 552) also reported that "neither IQ nor performance" on an emotion recognition task was related to abnormal brain activation in individuals with Autism. However, gaze avoidance was related to this abnormal pattern of brain activation. Therefore, although not reported, it is unlikely that gaze avoidance was related to emotion recognition performance in that particular study as if this were the case it would be expected that both emotion recognition performance and gaze avoidance would be related to this pattern of brain activation.

Most importantly, the present study is consistent with previous research in the finding that individuals with Asperger's Syndrome do not successfully process emotional information from the eye region. The present study found that, despite looking at the eye region for the same length of time for photographs of whole face expressions, individuals with Asperger's Syndrome were still less accurate at recognising emotions than individuals without Asperger's Syndrome. Furthermore, the results suggest that individuals with Asperger's Syndrome do not have a specific deficit recognising emotions just from the eye region but rather a more general deficit recognising emotions. That is, results did not show a significant drop in accuracy for individuals with Asperger's Syndrome when recognising emotions only on the basis of information in the eye region in comparison to the whole face or mouth region. Also, our finding of no emotion recognition accuracy advantage for individuals with Asperger's Syndrome in response to photographs of the mouth region, as would be predicted by an increased focus on the mouth region instead of the eye region, is consistent with findings by O'Connor, Hamm and Kirk (2007) who found no processing advantage for the mouth region for individuals with Asperger's Syndrome. This is also consistent with Wallace et al. (2008) who found that individuals with ASD didn't show an accuracy advantage for either the mouth region or the eye region when recognising emotions. Intuitively this makes sense, as successful emotion recognition is likely to rely not only on looking at the most useful facial information, but also on being able to process and interpret this information successfully in order to select the correct response.

Eye gaze during passive viewing of faces in comparison to active emotion recognition. A secondary question examined in the present study was whether asking individuals to 'just look at' the photographs or to 'try and recognise the expressions' in the photographs affected the way individuals looked at the facial expressions. A difference in the eye tracking behaviour during these two tasks would suggest that people are conscious of changing the way they examine faces when they are trying to recognise the emotion being communicated. However, no differences were found in the way individuals looked at the photographs when viewing photographs passively versus when actively attempting to recognise the expressions shown in the photographs. People focused more on the eye region than the mouth region of photographs both when passively viewing facial expressions and when asked to consciously recognise the emotions in the facial expressions. This suggests that one of the key areas of a face that we focus on, regardless of our task or intention, is the eye region (Baron-Cohen, Wheelwright, et al., 1997; Bassili, 1979; J. D. Boucher & Ekman, 1975; Katsikitis, 1997). This was true for both individuals with Asperger's Syndrome and individuals without Asperger's Syndrome, who both looked at the eye region more than the mouth region when passively viewing faces and when actively trying to recognise facial expressions. Therefore, it is not likely that individuals with Asperger's Syndrome were cued to look at the eye region during the emotion recognition task more than they would normally when simply viewing faces.

Explanations for emotion recognition deficits in Asperger's Syndrome. The question remaining is why individuals with Asperger's Syndrome are often not able to accurately recognise emotions from faces despite looking at the eye region for the same length of time as individuals without Asperger's Syndrome. It is possible that individuals with Asperger's Syndrome use a different approach to face processing (i.e., configural versus holistic etc.). The present study was not set up to investigate this possibility and therefore it is difficult to make an informed comment on its likelihood. However, there are two pieces of evidence that provide a clue for future research: (a) Dalton et al.'s (2005) finding of abnormal brain activation in individuals with Autism and Asperger's Syndrome in response to emotional expressions, and (b) the finding that individuals with Asperger's Syndrome take longer to recognise emotional expressions. Dalton et al. (2005) report that eye gaze is associated with increased amygdala activity in individuals with Autism and Asperger's Syndrome. This suggests that individuals in the present study may have made normal eye contact but experienced abnormal arousal and anxiety in response to eye gaze leading to a decreased ability to accurately recognize emotions.

The reaction time results of the present study also suggest a difference in the way individuals with Asperger's Syndrome process emotional information. Individuals with Asperger's Syndrome looked at photographs of facial expressions for longer and also took longer to decide which emotion was shown in the photographs. This is consistent with previous research which also shows evidence of slower face processing in individuals with Autism and Asperger's Syndrome (Bal et al., 2010; McPartland, Dawson, Webb, Panagiotides, & Carver, 2004; O'Connor et al., 2007). In the present study there was no evidence of an accuracy-speed trade-off for the emotion recognition task: individuals without Asperger's Syndrome were both faster and more accurate at recognising both basic and complex emotions than individuals with Asperger's Syndrome. Reaction time is often measured as an indication of processing efficiency across a range of judgment types, including emotion recognition (Fazio, 1990; Fazio, Jackson, Dunton, & Williams, 1995). Commonly reaction time is found to involve an accuracy-speed trade off, that is, the quicker people are asked to respond, the less likely that they will be accurate. However this is not the case for emotion recognition judgments – accurate responses are performed faster than inaccurate ones in individuals without Asperger's Syndrome (Kirouac & Dore, 1983; Young et al., 1997). That is, reaction times are found to be shorter for social judgments that are well practised and more familiar (Fazio, 1990). This suggests that for individuals with Asperger's Syndrome processing information about expressions and deciding what expression is shown is more cognitively demanding.

Individuals with Asperger's Syndrome may find processing emotional information generally more difficult to process than individuals without the disorder. A number of studies have found that this difficulty recognising emotions is not just limited to facial expressions and that individuals with Asperger's also have trouble recognising emotions from gestures, scenes and bodies (Golan, Baron-Cohen, Hill, & Rutherford, 2007; Hadjikhani & De Gelder, 2003; Hobson, Ouston, & Lee, 1988; Hubert et al., 2007; Rutherford, Baron-Cohen, & Wheelwright, 2002). For example, Golan et al. (2007) found that individuals with Asperger's Syndrome and High Functioning Autism were less accurate than individuals without the disorder at recognising emotions from vocal cues. Furthermore Hubert et al. (2007) found that individuals with Asperger's Syndrome were able to recognise actions as accurately as individuals without the disorder, but they were not as able to accurately identify emotional gestures. This suggests that individuals with Asperger's Syndrome may find it more difficult to process emotional information generally. One way that processing information may be cognitively demanding is through meta-cognitive skill. Meta-cognitive skill is defined as the process of monitoring one's task comprehension and performance, and one's assessment of what one knows and the likely accuracy of this knowledge (Ames & Kammrath, 2004).This is particularly important given that emotion recognition tasks are often structured as multiple choice tasks in which the ability to use meta-cognitive skill is likely to assist participants in selecting the correct response (e.g., Dunlosky & Bjork, 2008; Dunning, Johnson, Ehrlinger, & Kruger, 2003; Koriat & Shitzer-Reichert, 2002). Commonly meta-cognitive skill is measured by assessing whether people are able to use their confidence as a guide to the accuracy of their decisions. Recent evidence suggests that individuals with Asperger's Syndrome may have greater difficulty using their confidence as a guide to the likely accuracy of their choices (Wilkinson, Best, Minshew, & Strauss, 2010). This is considered in Study 2.

Conclusion. In conclusion, individuals with Asperger's Syndrome showed large deficits in recognising basic and complex emotions from the full face, eye region and mouth region of facial expressions in comparison to individuals without Asperger's Syndrome. Despite showing a deficit in emotion recognition accuracy, individuals with Asperger's Syndrome did not show evidence of gaze avoidance in comparison to individuals without Asperger's Syndrome. The results showed that individuals with and without Asperger's Syndrome looked at the eye region longer than the mouth region and also tended to look at the eye region first for the majority of the photographs. This provides clear evidence that the way in which individuals with Asperger's Syndrome look at faces is not responsible for the difficulty they have recognising emotional expressions. Individuals with Asperger's Syndrome looked longer at the photographs of facial expressions and took longer to select the emotion they thought was being expressed. This suggests individuals with Asperger's Syndrome are less efficient at processing emotional information and that the process of recognising an emotion and deciding what emotion is expressed is more cognitively demanding than for individuals without Asperger's Syndrome. Recent research suggests that individuals with Asperger's Syndrome may have more difficulty using processes such as meta-cognitive skill (i.e., the ability to use confidence as a guide to the accuracy of decisions). It may be that individuals with Asperger's Syndrome are less able to accurately recognise emotions than individuals without Asperger's Syndrome due to difficulties cognitively processing emotional information and difficulties using processes important for making emotion recognition decisions such as meta-cognitive skill.

Chapter three –

Study two: Meta-cognitive Processes in Emotion Recognition. Are They Different in Adults with Asperger's Syndrome?

Overview

In Study 1, individuals with Asperger's Syndrome, despite not showing evidence of gaze avoidance, were still found to have difficulties accurately recognising basic and complex emotions from facial expressions in comparison to individuals without Asperger's Syndrome. Both groups looked at the same elements of faces and, therefore, presumably had access to the same expression information (including crucial information from the eye region). Thus the question remains: How do we explain the difficulties individuals with Asperger's Syndrome have in making accurate emotion recognition judgments?

One possible explanation for this difficulty is the higher levels of anxiety experienced by adults with Asperger's Syndrome during social situations (Kim, Szatmari, Bryson, Streiner, & Wilson, 2000; Simonoff et al., 2008), as it is likely that anxiety will affect emotion recognition performance. A promising avenue is the suggestion by Gudykunst and colleagues (Ge & Gudykunst, 1995; Gudykunst & Kim, 2003; Gudykunst, Ting-Toomey, Sudweeks, & Stewart, 1995) that anxiety affects how uncertain we feel when making emotion recognition decisions in social situations. If we feel uncertain during a decision making task, incorrect answers are likely to be perceived as just as plausible as the correct answer, which leads to more guesses being made. If we use confidence to aid our decision making, it works best when confidence in the chosen response is much greater than confidence in the alternatives. When we are uncertain, this is rarely the case and we may need to guess more frequently, which is likely to lead to poorer performance. This idea of uncertainty is closely related to meta-cognitive skill; processes which help us to discriminate accurate from inaccurate responses. It is likely that meta-cognitive skills are important both for making accurate emotion recognition decisions and interacting socially. For example, meta-cognitive skill is likely to add in making emotion recognition judgements as people high on this skill are able to use their confidence as a guide to which emotion, from a range of possible choices, is most likely to be accurate. Similarly, this confidence in the final choice can then be used to inform individuals about whether the final decision should be used as a basis for social behaviour. In the present study, the relationship between difficulties using meta-cognitive skills and the difficulties adults with Asperger's Syndrome have making accurate emotion recognition decisions was investigated.

The Relationship between Confidence, Anxiety and Accuracy

A factor that is likely to interfere with the ability of adults with Asperger's Syndrome to accurately recognise emotions from faces is anxiety and its potential effects on accuracy. Individuals with Asperger's Syndrome are likely to experience greater anxiety than individuals without Asperger's Syndrome when judging emotions from facial expressions. For example, individuals with Asperger's Syndrome experience a higher prevalence of social anxiety than individuals without Asperger's Syndrome (Kim et al., 2000; Simonoff et al., 2008). Furthermore, individuals with Asperger's Syndrome are also reported to have greater autonomic nervous system responses, reflecting increased arousal and anxiety, when viewing faces in comparison to individuals without Asperger's Syndrome (Joseph, Ehrman, McNally, & Keehn, 2008; Kylliainen & Hietanen, 2006).

Gudykunst and colleagues (Ge & Gudykunst, 1995; Gudykunst & Kim, 2003; Gudykunst et al., 1995) suggest that anxiety may have negative effects on accuracy as it leads to individuals feeling more uncertain about the accuracy of their judgments in social situations. Consistent with this suggestion, Duronto, Nishida, and Nakayama (2005) found that, during an interaction with a stranger, there was a positive relationship between the level of anxiety and the level of uncertainty individuals (*n* = 233 Japanese college students, *M age* = 20.8) felt about their ability to predict another person's behaviour and feelings. The more anxious they reported feeling, the more uncertain they were about their ability to make accurate judgments about the emotions of another person. Furthermore, Gudykunst and Nishida (2001) found that level of anxiety and level of confidence were negatively related for individuals without Asperger's Syndrome (*n* = 373 Japanese and American college students, *M age* = 20.03 and 22.95 respectively) during an interaction with a stranger, and also that anxiety was negatively related with how effective the individual thought they had been during the interaction. This suggests that when individuals experience anxiety during an interaction, this is interpreted as an indication that they are not likely to be successful during the interaction, and leads to decreased confidence in the accuracy of their decisions. These findings support the proposal that increased anxiety leads individuals to feel more uncertain during social situations making it more difficult to discriminate accurate from inaccurate emotion recognition judgments. A process that is important for discriminating accurate from inaccurate judgments that may be disrupted by uncertainty is meta-cognitive skill.

Meta-Cognitive Skill: Discriminating Accurate from Inaccurate Judgments on the Basis of Confidence

One of the key ways that we assess our knowledge when faced with a decision, such as an emotion recognition decision, is by using meta-cognitive skill. Meta-cognitive skill is an umbrella term that refers to the self-monitoring of task comprehension and performance, self-review of existing knowledge, and judgments about the quality of newly acquired knowledge (Ames & Kammrath, 2004). Specifically, in the context of recognition decisions, one of the ways this occurs is by introspecting about how confident one is in the accuracy of potential responses, and using this as a guide to aid in selecting the correct response. Using confidence to discriminate accurate from inaccurate choices is likely to be important for making accurate emotion recognition decisions. The ability to do this is referred to in the present study as “accuracy discrimination ability”.

Several studies have reported that there is a significant relationship between individuals’ level of confidence about the choices they make during emotional recognition tasks, and the true accuracy of these choices (Patterson, Foster, & Bellmer, 2001; H. J. Smith, Archer, & Costanzo, 1991). For example, H. J. Smith et al. (1991) investigated the relationship between confidence and accuracy when participants were asked to complete the Interpersonal Perception Task (IPT), in which participants view video clips of people interacting socially and have to infer information about their situation from the nonverbal and verbal cues in the scene. H. J. Smith et al. (1991) found that there was a positive relationship between confidence and the accuracy of judgments made by adults without Asperger’s Syndrome completing the IPT. This suggests that individuals use confidence to discriminate between accurate and inaccurate responses, and as a guide to aid in selecting an accurate response.

Individuals with Asperger's Syndrome and Autism have been found to have difficulties using meta-cognitive strategies in comparison to typically developing individuals when asked to complete memory based tasks (Bebko & Ricciuti, 2000; Farrant, Blades, & Boucher, 1999; Farrant, Boucher, & Blades, 1999). In these studies meta-cognitive strategies such as repeated rehearsal to improve memory were examined. Cognitive strategies such as repeated rehearsal are likely to be related to meta-cognitive skill as an individual must use their confidence to determine whether their memory is accurate or whether they need to continue to rehearse the information to be remembered. Bebko and Ricciuti (2000) found that children with high-functioning Autism spontaneously engaged in cognitive rehearsal when asked to remember the order of presentation of a series of pictures of objects. However, children with Autism were found to engage in less rehearsal than typically developing children. Furthermore, Farrant, Blades, et al. (1999) found that children with Autism were impaired in being able to judge when they had studied a series of pictures of objects long enough to remember them, a task that requires meta-cognitive skill (i.e., understanding when you are likely to remember information accurately), in comparison to typically developing children. These studies suggest that individuals with Asperger's Syndrome may not be able to use meta-cognitive skills as effectively as individuals without Asperger's Syndrome, and in particular may have less effective accuracy discrimination ability than individuals without Asperger's Syndrome.

A recent study by Wilkinson et al. (2010) investigated whether children and adults with high-functioning Autism were able to use confidence as a guide to the accuracy of their decisions during a face recognition task. This study is one of only a few studies to date to specifically look at accuracy discrimination ability in individuals with Autism. To do this, the investigators asked children (*n* =18, Age = 9-17 years) and adults (*n* = 16, age

=18-45 years) with high-functioning Autism to identify whether the face in a photograph had been previously shown to them. After they made their decision, they were asked whether they were ‘guessing’, ‘somewhat certain’, or ‘certain’ of their decision. The investigators compared the results obtained from these groups with two age- and IQ-matched groups of children (*n* = 13) and adults (*n* = 15) without Autism. They reported that children with high-functioning Autism were less able to match their level of certainty with their actual level of accuracy than typically developing children. While adults with high-functioning Autism were found to be able to meaningfully distinguish when they were ‘guessing’ from when they were ‘somewhat certain’ similarly to typically developing adults, they were less able to distinguish between when they were ‘certain’ and when they were ‘somewhat certain.’ This suggests that both children and adults with high-functioning Autism are not as good at using confidence as a guide to the accuracy of their decision making, and do not have as effective accuracy discrimination abilities as typically developing individuals. Therefore, it is likely that adults with Asperger’s Syndrome may have difficulty using accuracy discrimination abilities and this may explain some of their difficulties making accurate emotion recognition decisions.

Meta-cognitive Skill: Effective Filtering.

Besides establishing whether individuals can cognitively discriminate accurate from inaccurate decisions on the basis of their confidence, the extent to which individuals are likely to act on their meta-cognitive skill in a social situation is also an important consideration. While there is evidence to suggest that an ability to accurately recognise emotions from faces is an ability that is important for the development of social skills, this line of thinking suggests simply that the better our emotion recognition accuracy the better our social skills will be. In contrast, Beupre and Hess (2006) suggest a more complicated relationship between emotion recognition skill and social skills. They suggest that social skills are not just about recognising emotions accurately, but also knowing when one is likely to have made a correct emotion recognition judgment and therefore likely to be successful in acting on the basis of this judgment. For example, poor social skills can arise from either acting on an incorrect judgment or not acting on a correct judgment. That is, being able to identify when one has made a correct emotion recognition judgment, and then engaging in acting on the basis of this judgment, are important skills for effective social interaction. In the present study, this skill is referred to as “response filtering”. Response filtering involves two stages: (1) engaging in filtering responses, and; (2) doing so effectively, so that the majority of responses that are incorrect are *not* acted on, whilst the majority of correct responses *are* acted on.

In order to measure this in the present study, a paradigm suggested by Koriat and Goldsmith (1996) was utilised. In their paradigm, participants are given the option to ‘withhold’ responses for questions to which they believed they did not know the correct answer. Even for withheld responses, participants were asked to volunteer which response they would have picked if they had to select a “best guess”. In the present study a similar procedure was adopted by initially obtaining a response for each question, which forces a best guess if required, but then participants were permitted to submit or withhold that response. This allowed us to examine two processes: (1) whether participants engaged in any filtering at all by withholding at least one or more of their responses rather than submitting all judgments, and; (2) whether participants were effectively filtering their responses such that the majority of accurate responses were submitted (i.e., maximising the hit rate) and the majority of inaccurate responses were withheld (i.e., minimising the false-alarm rate). Employing this approach in the present study will allow not only an examination of the accuracy discrimination ability of adults with Asperger’s Syndrome, but also provide an indication as to whether or not adults with

Asperger’s Syndrome can effectively filter their responding.

Summary

In summary, the present study seeks to investigate whether adults with Asperger’s Syndrome have difficulties using meta-cognitive skill as effectively as adults without Asperger’s Syndrome, and whether this can explain the difficulties adults with Asperger’s Syndrome have accurately recognising emotions from faces. Meta-cognitive skill was envisaged as involving two key processes. First, the ability to use confidence during the decision making process to discriminate accurate from inaccurate responses to aid in selecting accurate responses. Second, after a decision has been made, the ability to effectively filter responding so that only accurate judgments are acted on in social situations. Thus meta-cognitive skill was assessed in two ways: (1) accuracy discrimination: the ability to use confidence to discriminate accurate from inaccurate responses, and; (2) response filtering: engaging in filtering responses, and doing so effectively. Furthermore, in the present study the extent to which adults with Asperger’s Syndrome may experience more anxiety when asked to recognise emotions from faces was investigated, along with a consideration of whether this may be related to their level of confidence in their task performance.

In the present study, three tasks were compared: an emotion recognition task, a general knowledge task, and a passive viewing task where participants were simply asked to view faces. The main aim was to see whether, as predicted, any deficits are specific to emotion recognition. Initially, the inclusion of a general knowledge task and a passive viewing task permits an investigation of whether adults with Asperger’s Syndrome feel more anxious during the emotion recognition task specifically due to the requirement to make a difficult emotion based decision, or whether any increase in anxiety is simply due to the requirement to look at faces or the requirement to make a difficult decisions. Secondly, the inclusion of a general knowledge task allows an investigation of whether any difficulties adults with Asperger's Syndrome have using meta-cognitive skills are specific to emotion recognition decisions, or are a reflection of a more general deficit using meta-cognitive skills to make multiple choice decisions. The present study has four specific hypotheses:

1) Adults with Asperger's Syndrome will experience more anxiety, in comparison to adults without Asperger's Syndrome, but only during the emotion recognition task.
2) Adults with Asperger's Syndrome will be less accurate at completing the emotion recognition task than adults without Asperger's Syndrome.
3) Adults with Asperger's Syndrome will have lower accuracy discrimination ability, and be less able to effectively filter their responding in the emotion recognition task than adults without Asperger's Syndrome.
4) Difficulties using accuracy discrimination will explain the difficulties adults with Asperger's Syndrome have accurately recognising emotions.

Method

Participants. There were 87 participants in the present study: 30 in the Asperger's Syndrome (AS) group and 57 in the no-AS group. Participants with AS were recruited through Autism SA and had met the Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria for Asperger's Syndrome (American Psychiatric Association, 2000) through a formal diagnostic process. That is, diagnoses were supported by two independent psychologists/psychiatrists or two members of the Autism SA diagnostic team. Note that the majority of these participants had previously participated in Study 1. Participants without Asperger's Syndrome were volunteer Flinders University first year psychology students. Participants with comorbid disorders or currently taking psychological medication were excluded from participation. Five participants in the no-AS group did not speak English as their first language and were therefore excluded from the analysis (leaving 52 participants in the no-AS group). Within the no-AS group a subsection of 30 participants also completed the Wechsler Abbreviated Scales of Intelligence (WASI) and the Depression Anxiety and Stress Scale to allow a comparison of the intelligence quotient (IQ) scores and depression, anxiety and stress levels of the no-AS and AS groups.

There were no statistically significant differences in the Full scale IQ of participants in the AS group and the subset of participants in the no-AS group who completed the WASI (AS: M = 105.6, SD = 15.1, n = 30, no-AS: M = 109.2, SD = 8.5, n =30, t (45.6) = 1.14, p = .26). Both groups were of average intelligence as measured by the WASI. The AS group was slightly older on average than the no-AS group (AS group: M = 29.9 years, SD = 11.5, no-AS group: M = 24.8, SD = 8.4, t (46.9) = 2.14, p = .04). Also the AS group scored higher on the DASS depression, anxiety and stress scores (in the moderate range on average, n = 30) than the no-AS group (in the normal range on average, n = 30), $p < .01$. However neither age nor scores on the DASS significantly correlated with emotion recognition accuracy scores on the emotion recognition task. There were no differences in the gender ratio of the AS group (30% females) and the no-AS group (32.7% females), p = 0.80.

Design. A 2 (group: AS, no-AS) x 3 (task: emotion recognition, general knowledge, passive viewing) mixed between-within subjects design, with task as a within-subjects factor, was used. The dependent measures included: task accuracy, self-reported confidence, anxiety, accuracy discrimination index (measured with the gamma correlation), whether participants engaged in filtering their responses by withholding responses, and filtering effectiveness (measured using d prime).

Materials.

Wechsler Abbreviated Scale of Intelligence. In order to assess the effect of intelligence on emotion recognition ability participants with AS and a subset of participants without AS completed the WASI. The WASI is a short form of the Wechsler Adult Intelligence Scale. It is for use with individuals aged 6 to 89 years and can be completed in 15-30 minutes. It is made up of four of the subtests including: vocabulary, similarities, block design and matrix reasoning. It provides an estimate of an individual's verbal, performance and full scale IQ. The psychometric properties of the WASI were previously described in Study 1 (pp. 24 - 25).

Depression Anxiety and Stress Scale – Short form. The short form of the DASS is a 21 item self-report scale assessing levels of depression, anxiety and stress (Lovibond & Lovibond, 1995). The DASS short form was used to measure participants' levels of depression, anxiety and stress to ensure the groups did not differ on their levels of depression and anxiety. Participants with Asperger's Syndrome and a subset of participants without Asperger's Syndrome completed the DASS. The psychometric properties of the DASS were previously described in Study 1 (p. 25).

Stimuli.

Emotion recognition task. The emotion recognition task consisted of validated photographs of full face expressions that had been used in Study 1 (see pp. 26-29; see also Sawyer et al., in press). Basic emotions included: angry, happy, sad, disgust, surprise, and fear. Complex emotions included: scheming, embarrassed, guilty, thoughtful, admiring, quizzical, flirting, bored, interested, and arrogant. The results of

Study 1 showed that accurate emotion recognition is likely to involve cognitive processing and that individuals with Asperger's Syndrome had difficulties recognising both basic and complex emotional expressions with accuracy. Furthermore, when expression type (i.e., basic versus complex) was considered as a factor in the analysis of the present study, the pattern of results was not found to differ. Therefore, no distinction between the two expression types was made and performance on the task will be referred to as "emotion recognition accuracy". As in Study 1, accuracy was scored as the percentage of responses correctly answered.

Throughout the task, two male and two female examples of each expression were displayed. The order of presentation, gender and individual showing the face were all randomised in the presentation. The task had three possible sets of 64 photographs that could be shown to participants. The set shown was selected on the basis that the participant had not been exposed to the set in a previous experiment.

The task began with instructions presented verbally and on the screen. This was followed by two practise images to ensure participants understood the requirements of the task. For each trial, a fixation cross was presented in the centre of the screen. Participants were asked to click the mouse once they had decided what emotion was shown in the photograph (they were asked to do this as quickly and accurately as possible). Following this, participants were presented with a response slide with four emotion response words. They were asked to choose the word which best fit with the emotion which they thought had been presented in the photograph. For each emotion recognition decision participants were asked to rate on a scale from 0% – 100% how confident they were that they had selected the correct response. Participants were then given the choice to submit the decision towards their total score or to withhold the decision if they thought they were likely to be wrong and they wanted to withhold that particular judgment from their total score. Participants were instructed that: "the aim of the task is to submit as many right answers as possible (you will receive points for submitting correct answers and lose points for submitting incorrect answers)." Finally, at eight times throughout the task (i.e., once every eight photographs) participants were also asked to rate how anxious they felt recognising emotions from photographs of facial expressions on a scale of 0% - 100%.

General knowledge task. Participants also completed a general knowledge task which was presented similarly to the emotion recognition task. This task was included to allow a comparison of participants' abilities to use their confidence as a guide to their accuracy during an emotion recognition task in comparison to during a task that does not involve faces or emotions (particularly as participants with Asperger's Syndrome may have difficulty doing this when asked to complete an emotion recognition task but may be able to use this ability during a task that does not involve emotions or faces). The task consisted of 32 general knowledge questions which were selected in an attempt to match the difficulty of the emotion recognition task (e.g., "What is the average depth of an ocean?", "How many sides does a RHOMBUS have?"). The order of presentation of the general knowledge questions was randomised. The task began with instructions presented verbally and on the screen. This was followed by two practise questions to ensure participants understood the requirements of the task. Similarly to the emotion recognition task, participants were shown a general knowledge task and given four choices from which to select the correct response. After each decision participants were asked to rate how confident they were that they had selected the correct response on a scale of 0%-100%, and then they were given the choice to submit the decision towards their total score or to withhold the decision so that it did not affect their total score. Finally, at four points throughout the task (i.e., once every eight photographs) participants were asked to rate how anxious they felt answering general knowledge questions on a scale of 0% – 100%.

Passive viewing task. Individuals with Asperger's Syndrome may feel increased anxiety when asked to complete an emotion recognition task. This may be due to the requirement to look at faces of strangers or due to having to make emotional recognition judgments. In order to examine these possibilities, participants were also asked to complete a passive viewing task. During this task participants were shown 32 photographs of facial expressions of emotion and instructed to simply look at the faces. At four points throughout the task participants were asked to rate how anxious they felt viewing facial expressions on a scale of 0% – 100%.

Procedure. All participants attended an individual testing session at Flinders University. Participants initially completed the DASS and a demographics questionnaire. Participants then completed the emotion recognition task on the computer, the general knowledge task and the passive viewing task. The order of presentation of the tasks was counter-balanced. After each judgment in the emotion recognition and general knowledge tasks, a rating of confidence was obtained. At differing intervals, during each task, self-rated anxiety was also assessed. For both the emotion recognition and general knowledge tasks, accuracy was scored as the percentage of questions correctly answered while confidence was scored as the mean rating across all trials. Anxiety was scored as the mean rating across all measurements within the same task.

Assessment of meta-cognitive measures.

Accuracy discrimination ability. Commonly, in research examining the relationship between confidence and accuracy during social decisions, meta-cognitive skill has been assessed by looking at the point-biserial correlation between confidence in decisions on a task and accuracy on the task (Patterson et al., 2001; H. J. Smith et al., 1991). Alternatively it has been measured by looking at the proportion of accurate responses in broad categories of confidence such as “uncertain”, “guessing” etc. (Wilkinson et al., 2010). Nelson, Narens, and Dunlosky (2004) suggest measuring this type of discrimination using the Goodman-Kruskal gamma correlation. This is advantageous because it does not assume a linear relationship between confidence and accuracy and thus is able to take into account more complex relationships (see Nelson et al., 2004, for a discussion of other advantages of using the Goodman-Kruskal gamma correlation to measure the relationship between confidence and accuracy). Goodman-Kruskal gamma correlations were calculated, individually for each participant, for both the emotion recognition and general knowledge tasks.

Engagement in filtering. Engaging in filtering was scored as either withholding no responses (i.e., submitting all responses) or withholding some responses (i.e., did not submit all responses).

Filtering effectiveness index (d prime). Filtering effectiveness can be examined by analysis of the difference between hit rates and false-alarm rates. The greater the difference in favour of hit rates, the more effective is the filtering of responses. This is best indexed using the Type-2 Signal Detection Theory d prime (d') statistic which considers the difference in proportions of hit rates and false-alarm rates (Higham, Perfect, & Bruno, 2009). To calculate d', the difference between the two proportions is calculated in standard deviation units. A score of zero indicates no difference between the hit rate and false-alarm rate and therefore that the person is not effective at filtering. In contrast, if someone has a much higher hit rate than their false-alarm rate, then their d' score would be significantly above zero indicating effective filtering.

Results

Overview of statistical analyses

In order to address the hypothesis of the present study, firstly, average accuracy, confidence and anxiety were compared for the AS and no-AS groups. Following these analyses the relationships between these scores were the assessed. The analyses then focused on examining the two stages of meta-cognitive monitoring in the present study, accuracy discrimination and filtering effectiveness, as well as the relationship between these meta-cognitive skills and accuracy, anxiety and confidence.

Emotion recognition and general knowledge accuracy. The first questions assessed were whether the AS and no-AS groups differed in the level of accuracy they achieved in the emotion recognition task, and whether this was specific to the emotion recognition task or whether the groups also differed in the accuracy they achieved in the general knowledge task. To investigate this, a 2 (diagnosis: AS, no-AS) x 2 (task: emotion recognition task, general knowledge task) mixed model analysis of variance (ANOVA) was carried out on accuracy scores. The interaction between task and diagnosis was statistically significant, F (1, 80) = 6.1, p = .01, *partial* η^2= .07. Simple effects analysis revealed that there was no difference in the general knowledge accuracy scores for the AS and no-AS groups, p = .30, however, the AS group had a significantly lower emotion recognition accuracy score than the no-AS group, p = .01 (see Table 3.1 for means and standard deviations). As in Study 1, the results demonstrated that those with Asperger’s Syndrome were less accurate at recognising emotions from faces than those without Asperger’s Syndrome. However, the results also showed that this deficit in accuracy was specific to emotion recognition as there were no differences between the groups for general knowledge accuracy. Finally, similarly to the results in Study 1, individuals with Asperger's Syndrome were worse at recognising both basic (No-AS group: *M* = 86.9, *SD* = 8.8, AS group: *M* = 82.2, *SD* = 12.8) and complex emotional expressions (No-AS group: *M* = 70.0, *SD* = 7.9, AS group: *M* = 65.8, *SD* = 9.9; main effect of diagnosis: F (1,80) = 6.37, p = .01, *partial* η^2= .07; interaction between diagnosis and expression type: F (1,80) = 0.03, p = *.87*, *partial* η^2<.001.)

Since the main aim of the following analyses was to attempt to explain differences in accuracy in the emotion recognition task, differences between the AS and no-AS groups in confidence, anxiety and meta-cognitive skill were examined using independent samples t-tests for scores from the emotion recognition task. These were contrasted with the same analyses undertaken for the general knowledge task. If these variables specifically explain emotion recognition deficits, then these variables will differ between the groups only on the emotion recognition task given that no differences were found in general knowledge performance between the two groups.

Average confidence and anxiety.

Are there differences between the AS and no-AS groups in self-reported confidence and anxiety? During the emotion recognition task there were no differences between the two groups' self-rated confidence in the accuracy of responses, t (80) = 0.42, p = .42 (see Table 3.1). In contrast, in the general knowledge task the AS group rated themselves as more confident in the accuracy of their responses than the no-AS group, t (80) = 2.37, p = .02. (Note: since the passive viewing task did not involve responding, no measures of confidence were elicited).

Table 3.1.

Means (Standard Deviations) for Percentage Accuracy, Confidence and Anxiety Reported by Adults with and without Asperger's Syndrome (AS) during the Emotion Recognition Task and the General Knowledge Task

	AS group (n = 30)	No-AS group (n = 52)	*Cohen's d* [a]
Accuracy			
Emotion recognition	71.9 (7.6)	76.4 (7.6)	0.59*
General knowledge	56.6 (11.4)	53.8 (11.5)	0.24
Confidence			
Emotion recognition	71.6 (13.8)	74.2 (13.9)	0.19
General knowledge	58.7 (15.1)	50.4 (15.2)	0.55*
Anxiety			
Emotion recognition	40.6 (22.8)	28.8 (23.0)	0.52*
General knowledge	39.4 (24.2)	36.5 (24.4)	0.12
Passive viewing	27.6 (21.7)	20.3 (21.8)	0.34

[a] Shows the effect size for individual comparisons across diagnosis for each task

* $p < .05$

The AS group reported experiencing greater anxiety during the emotion recognition task than the no-AS group, t (80) = 2.22, p = .03. However, there were no differences in the level of anxiety the two groups reported during the general knowledge task, t (80) = 0.53, p = .60. Finally, there were no differences in the level of anxiety reported by the two groups during the passive viewing task, *t* (80) = 1.46, *p* = .15. This is consistent with the interaction between task and diagnosis, *F* (1, 80) = 4.08, *p* =.04, *partial* η^2 = .05, which showed that the AS group were significantly more anxious in the emotion recognition task, *p* =.03, but not the general knowledge or passive viewing tasks (*p* =.60 and .15 respectively).

When one compares confidence and accuracy for each group, it is evident that ratings are similar during the emotion recognition and general knowledge tasks. This suggests that those in both groups have an idea about their abilities in each of the tasks, as they rate their confidence in their accuracy at a similar level to their actual accuracy in each task.

Furthermore, it appears that anxiety and confidence may explain the difficulties the AS group have accurately recognising emotions. This is counter-intuitive for confidence as there were no differences in the emotion recognition task but there were differences between the groups in the general knowledge task. However, if it is assumed that those with Asperger's Syndrome show a tendency for over-confidence (as seen on the general knowledge task), then the similar confidence seen on the emotion recognition task may reflect "relative under-confidence" which would fit the pattern of results seen for accuracy. If anxiety and/or confidence do explain the emotion recognition deficits then we should see significant correlations between anxiety and accuracy, *and,* confidence and accuracy.

The relationship between confidence, anxiety and accuracy for the AS and no-AS groups. For the whole sample there was a strong negative correlation between confidence and anxiety in the emotion recognition task, *r* = -.46, *p* < .001 (*95% CI* = -.61 – -.27), but no relationship in the general knowledge task, *r* = -.13, *p* = .24 (*95% CI* = -.34

– .09). The pattern and direction of effect did not differ when considering each group separately, the same significant relationship was observed in both groups on the emotion recognition task (AS: r = -.49, p = .006. *95% CI* = -.72 – -.16; no-AS: r = -.38, p = .005, *95% CI* = -.59 – -.11) whilst non-significant relationships were observed in both groups on the general knowledge task (AS: r = -.15, p = .42, *95% CI* = -.48 – .22; no-AS: r = -.15, p = .29, *95% CI* = -.41 – .13). Moreover, a test of differences in independent correlations (Cohen & Cohen, 1983) showed no significant difference between the correlations for the two groups: emotion recognition task, Z = 0.57, p = .57; general knowledge task, Z = 0.01, p = .99. Hence, greater anxiety was associated with lower confidence for both groups but only on the emotion recognition task.

In general, anxiety was not correlated with accuracy except among those without Asperger's Syndrome and only for the relationship between anxiety and emotion recognition accuracy (see Table 3.2) where greater anxiety was actually associated with better accuracy, r = .28, p = .04. In sum, anxiety appears to play some role in regard to confidence but not accuracy.

For the emotion recognition task, there was only a significant correlation for the no-AS group between confidence and accuracy (r = .30, p = .03) but not for the AS group (r = .19, p = .32) although a test comparing the two correlations showed no significant difference between the correlations for the two groups, Z = .49, p = .63. For the general knowledge task, confidence was only significantly related to accuracy for those with Asperger's Syndrome (r = .63, p < .001) but not for those without Asperger's Syndrome (r = .21, p = .14). In this case, the correlation was significantly stronger in the AS group, Z = 2.20, p = .03. For full details, see Table 3.2.

Table 3.2.

Correlations (with 95% Confidence Intervals in Brackets) between Confidence, Anxiety (Measured Separately in the two Tasks) and Accuracy During the Emotion Recognition and General Knowledge Tasks

	Accuracy			
	AS	No-AS	Z [a]	Whole sample
Confidence				
Emotion recognition	.19 (-.18 – .52)	.30* (.03 – .53)	0.49	.26* (.05 – .45)
General Knowledge	.63*** (.35 – .81)	.21 (-.07 – .46)	2.20*	.41*** (.21 – .58)
Anxiety				
Emotion recognition	-.14 (-.48 – .23)	.28* (.01 – .51)	1.79	.02 (-.20 – .24)
General Knowledge	-.23 (-.54 – .14)	-.05 (-.32 – .22)	0.77	-.12 (-.33 – .10)

[a] Comparisons are between the AS and no-AS groups using a test for comparing independent correlations (Cohen & Cohen, 1983).

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

As there was no clear difference in the pattern or direction of effect between the AS and no-AS groups for the relationship between confidence and accuracy these results were also examined for the whole sample. For the whole sample, confidence was significantly correlated with accuracy on both the emotion recognition task (r = .26, p =

.02) and the general knowledge task (r = .41, p < .001). Overall there is no evidence that anxiety affects emotion recognition accuracy, however it does appear that confidence may be important in emotion recognition.

Meta-cognitive skill: Accuracy discrimination.

Differences between the AS and no-AS groups for the emotion recognition and general knowledge tasks. The gamma correlation from the emotion recognition task for one participant in the AS group was an extreme outlier. Therefore, following the recommendation of Tabachnick and Fidell (1996) for dealing with outliers, this score was changed to one point below the lowest score so that all scores could be included in the analyses[1]. There was no difference in gamma correlation scores between the two groups during the emotion recognition task, t (80) = 1.26, p = .21, or during the general knowledge task, t (80) = 1.57, p = .12. Furthermore, the 95% confidence intervals did not cross zero for either group, for either task, suggesting that overall both groups were able to discriminate accurate from inaccurate responses on the basis of their subjective confidence in both tasks (see Table 3.3).

[1] Removal of this case did not change the pattern of results. In fact, it strengthened those where differences were found. However, it would have been an influential score and so a decision had to be made on whether to retain the participant or omit them from the analyses. Given that the other scores from this individual were not outliers, the strategy adopted was chosen so that all analyses involved the same participants.

Table 3.3.

Means (Standard Deviations) and 95% Confidence Intervals for Gamma Correlations for Adults with and without Asperger's Syndrome (AS) During the Emotion Recognition and the General Knowledge Tasks

	AS group (*n* = 30)	No-AS group (*n* = 52)
Emotion recognition task	0.53 (0.18)	0.57 (0.15)
95% confidence interval	0.46-0.59	0.53-0.62
General knowledge task	0.45 (0.20)	0.52 (0.19)
95% confidence interval	0.37-0.52	0.46-0.57

In summary, it was found that adults with Asperger's Syndrome are just as capable as adults without Asperger's Syndrome to use their confidence to discriminate accurate from inaccurate responses during both the emotion recognition and a general knowledge tasks. At this stage of processing, using confidence to identify accurate from inaccurate responses, adults with Asperger's Syndrome have a functioning ability and show the potential to be able to engage in subsequent stages of meta-cognitive skill.

Relationship between accuracy discrimination confidence, accuracy and anxiety in the AS and no-AS groups. Accuracy discrimination does not appear to explain the poorer emotion recognition in the AS group, given that there was no difference between the two groups' gamma correlation scores. Nevertheless, the relationship between accuracy discrimination ability and actual accuracy is still relevant. Furthermore, how confidence and anxiety relate to accuracy discrimination was also investigated. This was particularly pertinent for the AS group who experienced greater anxiety during the emotion recognition task.

The correlations and associated significance tests of differences in correlations across the two groups are shown in Table 3.4. In the emotion recognition task, accuracy was positively correlated with gamma correlation scores for the no-AS group, and while this relationship did not reach significance in the AS group, it was not significantly different from the relationship in the no-AS group (See Table 3.4). However, in the general knowledge task, there was a strong positive correlation between accuracy and gamma correlation scores for the AS group, but no relationship between these variables in the no-AS group. In regards to confidence, in the emotion recognition task confidence was positively correlated with gamma correlation scores for the no-AS group but not the AS group. While in the general knowledge task, confidence was positively correlated with gamma correlation scores for the AS group, but not for the no-AS group (though the size of the correlation did not significantly differ from that in the AS group.) Finally, for both the AS and no-AS groups anxiety was not related to gamma correlation scores for either task.

Table 3.4.

Correlations (with 95% Confidence Intervals in Brackets) between Gamma Correlation Scores, Anxiety and Confidence (both Measured Separately in the Two Tasks), and Accuracy During the Emotion Recognition and General Knowledge Tasks

Gamma Correlation (accuracy discrimination)				
	AS	No-AS	Z^a	Whole sample
Accuracy				
Emotion recognition	.26	.54***	-1.41	.43***
	(-.11 – .57)	(.31 – .71)		(.24 – .59)
General knowledge	.62***	-.22	3.96***	.13
	(.33 – .80)	(-.47 – .06)		(-.09 – .34)
Anxiety				
Emotion recognition	.15	-.02	0.71	.01
	(-.22 – .48)	(-.29 – .25)		(-.21 – .23)
General knowledge	-.03	.08	-0.46	.03
	(-.39 – .33)	(-.19 – .35)		(-.19 – .25)
Confidence				
Emotion recognition	-.12	.41**	-2.32*	.17
	(-.46 – .25)	(.15 – .61)		(-.05 – .34)
General knowledge	.42*	.22	0.94	.23*
	(.07 – .68)	(-.06 – .47)		(.01 – .43)

[a] Comparisons are between the AS and no-AS groups (Cohen & Cohen, 1983).

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

Meta-cognitive skill: Filtering effectiveness.

Filtering engagement for the AS and no-AS groups. To examine the first component of the next stage of meta-cognitive skill, engaging in filtering responses, an analysis was conducted to examine whether the groups differed in the number of participants who failed to attempt to filter their responses in the emotion recognition and general knowledge tasks. Participants were given the option throughout the tasks to 'withhold' answers that they believed were wrong in order to avoid losing points for submitting incorrect answers. The act of withholding responses was seen as participants attempting to engage in filtering their responses. A higher percentage of individuals in the AS group failed to withhold any responses (40%) in the emotion recognition task than individuals in the no-AS group (13.5%), χ^2 (1) = 6.1, *p* = .01, after continuity correction, φ = .30. Similarly, in the general knowledge task, a higher percentage of participants in the AS group failed to withhold responses (26.7%) than individuals in the no-AS group (5.8%), χ^2 (1) = 5.5, *p* = .01, after continuity correction, *φ* = .29, although the percentage of those entirely submitting all responses was noticeably lower on this task..

There are three possible reasons why an individual may rationally choose to *not* withhold any responses and to submit all answers for scoring: (1) if an individual's accuracy is near perfect (i.e., 99%); (2) if an individual's confidence in their accuracy during the task is very high (i.e., 99%), and; (3) if an individual's accuracy discrimination ability is very low (i.e., a score of 0) and they are aware of this deficit. In order to investigate this, scores for accuracy, confidence and gamma correlations were compared for those who withheld responses versus those who did not withhold responses. This analysis was only completed for the AS group on the emotion recognition task since the frequency of submitting *all* responses was low for the general knowledge task and the no-AS group. Results are presented in Table 3.5. For the emotion recognition task, those in the AS group who did not withhold responses were not less accurate, $p = .88$, did not have lower gamma correlation scores, $p = .12$, and furthermore did not experience higher anxiety, $p = .40$, than those who did withhold responses. While the difference between gamma correlation scores for those who did, and did not, withhold responses was a medium effect, the score achieved by those who did not withhold responses still indicates functional accuracy discrimination ability (i.e., scores were not nearing zero). Although those who did not withhold responses were more confident overall, $p = .03$, their confidence was far from 100%. In summary, in the AS group those who did not withhold responses were not more accurate or notably more confident than those who did withhold responses. Furthermore, there was evidence from the gamma correlation scores that these individuals had the potential to discriminate accurate from inaccurate responses on the basis of confidence, however when given the opportunity to use this ability to withhold low confidence responses, they chose not to do so.

Table 3.5.

Comparison of Accuracy, Confidence, Anxiety and Gamma Correlation Scores between those Participants with Asperger's Syndrome who did or did not Withhold Responses in the Emotion Recognition Task

	AS group (n = 30)		
	M (*SD*)	*n*	*Cohen's d*
Accuracy			
Did withhold	72.1 (10.6)	18	0.05
Did not withhold	71.6 (6.4)	12	
Average confidence			
Did withhold	66.4 (12.7)	18	0.84*
Did not withhold	79.4 (18.9)	12	
Gamma correlation			
Did withhold	.57 (.17)	18	0.58
Did not withhold	.47 (.17)	12	
Average anxiety			
Did withhold	43.7 (22.3)	18	0.32
Did not withhold	35.9 (27.4)	12	

*Note. C*omparisons are between those who "did not withhold" and those who "did withhold" within the AS group.

*p < .05

Overall, although adults with Asperger's Syndrome showed that they had the knowledge to discriminate accurate from inaccurate responses and were capable at the initial stage of meta-cognitive skill, for some reason a large and greater percentage of adults with Asperger's Syndrome did not use this knowledge to engage in filtering their responses in comparison to adults without Asperger's Syndrome. It appears that the ability to successfully use meta-cognitive skills breaks down for adults with Asperger's Syndrome at the point where they need to engage in filtering their responses.

Effectiveness in filtering responses AS versus no-AS group. To examine the second stage of filtering, effectively filtering responses, d prime (d') scores achieved by the groups during the emotion recognition task and general knowledge task were compared. The AS group had lower d' scores in the emotion recognition task than the no-AS group, t (80) = 1.81, p =.07 (see Table 3.6). This difference was a medium sized effect and while it only approached significance, this may be due to low statistical power. Thus it is cautiously interpreted as reflecting a difference between the groups. There were no differences in d' scores in the general knowledge task between the AS and no-AS group, t (80) = 0.93, p = .36. In summary, there is evidence to suggest that the AS group may be less effective at filtering their responses in the emotion recognition task, but there were no differences in the ability of the two groups to effectively filter their responses in the general knowledge task. However, it is worth noting that the 95% confidence intervals for d' scores did not cross zero, suggesting that both groups do have some ability to effectively filter their responses in both tasks.

Table 3.6.

Means (Standard Deviations) and 95% Confidence Intervals (CIs) for d' Scores for Adults with and without Asperger's Syndrome (AS) During the Emotion Recognition Task and the General Knowledge Task

	AS group	No-AS group	*Cohen's d*
Emotion recognition	0.56 (0.52)	0.78 (0.52)	0.42
95% CIs	0.37-0.76	0.63-0.93	-
General knowledge	0.66 (0.64)	0.78 (0.55)	0.21
95% CIs	0.42-0.89	0.63-0.94	-

Finally, the relationship between d' scores and, accuracy, anxiety, confidence and accuracy discrimination was assessed to examine whether the second stage of meta-cognitive skill was affected by anxiety and confidence, and whether it was able to explain the difference in accuracy in the emotion recognition task between the two groups. Neither accuracy nor confidence were related to d' scores on the emotion recognition task or the general knowledge task for the AS or no-AS groups (See Table 3.7).

For the whole sample, anxiety was negatively correlated with d' scores, showing that as anxiety increased the ability to effectively filter responses decreased. The pattern of this effect was in the same direction for the AS and no-AS groups, however the relationships between d' scores and anxiety did not reach statistical significance in either group when considered separately. For the general knowledge task there was no relationship between anxiety and d' scores for the no-AS group. While for the AS group there was a moderately sized negative correlation between anxiety and d' scores that approached statistical significance, *p* = .06, and was significantly stronger than the correlation for the no-AS group. Potentially, anxiety has an effect on filtering effectiveness in the AS group generally when making difficult multiple choice decisions, rather than specifically when making emotion recognition decisions. However, it is worth noting that the AS group only had difficulties filtering effectively in the emotion recognition task, and not the general knowledge task.

Finally, there was no relationship between gamma correlation scores and d' scores on the emotion recognition task for the AS group (*r* = .09, *p* =.62, *95%CI* = -.28 – .44) or the no-AS group (*r* = -.01, *p* =.93, *95%CI* = -.28 – .26), and there was no difference in the strength of these correlations, *Z* = .45, *p* = .65. Similarly, there was no relationship between gamma correlation scores and d' scores on the general knowledge task for the AS group (*r* = -.09, *p* =.62, *95%CI* = -.44 – .28) or the no-AS group (*r* = .03, *p* =.83, *95%CI* = -.24 – .30), and there was no difference in the strength of these correlations, *Z* = .45, *p* = .65. This suggests that accuracy discrimination ability and filtering effectiveness skill are not related abilities.

Table 3.7.

Correlations (with 95% Confidence Intervals in Brackets) between d' Scores, Confidence, Anxiety (Measured Separately in the two Tasks) and Accuracy During the Emotion Recognition and General Knowledge Tasks

	d' scores			
	AS	No-AS	Z [a]	Whole sample
Emotion recognition				
Accuracy	.20 (-.17 – .52)	-.11 (-.37 – .17)	1.31	.06 (-.16 – .27)
Confidence	.15 (-.22 – .48)	.22 (-.06 – .47)	0.30	.21 (-.01 – .41)
Anxiety	-.29 (-.59 – .08)	-.24 (-.48 – .04)	0.22	-.28* (-.47 – -.07)
General knowledge				
Accuracy	.21 (-.16 – .53)	-.01 (-.28 – .26)	0.93	.08 (-.14 – .29)
Confidence	.03 (-.33 – .39)	.09 (-.19 – .35)	0.25	.07 (-.15 – .28)
Anxiety	-.39 (-.66 – -.03)	.16 (-.12 – .42)	2.39*	-.03 (-.25 – .19)

[a] Comparisons are between the AS and no-AS groups (Cohen & Cohen, 1983).

*$p < .05$

Discussion

The findings in the present study showed that adults with Asperger's Syndrome were less accurate at recognising emotions from facial expressions than adults without Asperger's Syndrome. This is consistent with Study 1 and also a number of previous studies (e.g., Baron-Cohen, Wheelwright, et al., 1997; Corden et al., 2008; Heerey et al., 2003). This difference in accuracy was specific to the emotion recognition task as there were no differences in the accuracy of adults with Asperger's Syndrome versus adults without Asperger's Syndrome on the general knowledge task. There were also no differences overall in the average confidence between adults with and without Asperger's Syndrome for the emotion recognition task. In contrast, for the general knowledge task, adults with Asperger's Syndrome were more confident in the accuracy of their responses than adults without Asperger's Syndrome. This suggests that adults with Asperger's Syndrome were more at ease answering general knowledge questions than recognising emotions. This idea is also supported by the findings that adults with Asperger's Syndrome experienced more anxiety during the emotion recognition task than adults without Asperger's Syndrome, and had greater difficulty engaging in filtering their responses.

Meta-cognitive skill was investigated at two stages. First, the ability to use confidence as a guide to the accuracy of responses during the initial decision making stage (indexed by the gamma correlation). Secondly, the ability to effectively filter responses, which was captured two ways: (1) engaging in filtering responses, and; (2) doing so effectively so that the majority of responses that are incorrect are withheld (indexed by d' scores). Finally, anxiety was investigated as a factor that may interfere with the ability to use these meta-cognitive processes. These results will be discussed in three sections: (1) self-reported anxiety across the three tasks and its relationship with confidence and accuracy; (2) the relationship between confidence and accuracy (discrimination ability), and; (3) response filtering: engagement and effectiveness.

Self-reported anxiety: Comparison of emotion recognition, passive face viewing and general knowledge tasks, and the relationship between anxiety confidence and accuracy. The self-reported anxiety experienced by adults with and without Asperger's Syndrome was compared during three tasks: an emotion recognition task, a task where participants simply viewed faces, and a general knowledge task that did not involve faces or emotions. Adults with Asperger's Syndrome reported experiencing more anxiety than adults without Asperger's Syndrome only during the emotion recognition task. This was not due to the requirement to look at faces or having to complete a difficult multiple choice task, as adults with Asperger's Syndrome did not experience elevated anxiety in response to the passive face viewing task or the general knowledge task. Rather the results suggest that the requirement to specifically interpret emotional information from a face leads to increased anxiety among adults with Asperger's Syndrome.

In previous research children with Autism Spectrum Disorders have been found to have increased nervous system responses, reflecting increased arousal and anxiety, in response to viewing faces (Joseph et al., 2008; Kylliainen & Hietanen, 2006). The findings of the present study, although based on self-reported anxiety in adults, contradict these previous findings as adults with Asperger's Syndrome reported more anxiety when recognising emotions from faces but not when simply viewing faces. It appears that something specific about the act of interpreting an expression leads to an increased experience of anxiety in adults with Asperger's Syndrome. It is possible that this could be the result of previous negative experiences interacting socially or due to an increased prevalence of social anxiety amongst those with Asperger's Syndrome, which is associated with greater anxiety in response to making social judgments. This could be further investigated by assessing whether the anxiety reported by individuals with Asperger's Syndrome is associated with fear of performing poorly on emotion recognition tasks.

A potential limitation of the current findings is that adults with Asperger's Syndrome might be poor at introspecting about their own state of anxiety. However, adults with Asperger's Syndrome were able to differentiate between the levels of difficulty of the tasks with their confidence ratings, similarly to adults without Asperger's Syndrome, suggesting they were able to introspect accurately about their experience of the tasks. Whatever the case, the argument can be made that regardless of one's physiological anxiety, cognitive awareness of experiencing anxiety is likely to be important for effective decision making.

Consistent with Gudykunst and colleagues' hypothesis (Gudykunst & Kim, 2003; Gudykunst et al., 1995) for both adults with and without Asperger's Syndrome the present study found a negative relationship between confidence and anxiety; as anxiety increased, confidence decreased. In the present study, a relationship was not found between anxiety and accuracy discrimination ability, suggesting that while greater anxiety may lead to lower confidence in the task, it does not interfere with the ability of individuals to use the first stage of meta-cognitive skill. However, there was some evidence to suggest that anxiety may affect the ability to effectively filter responding. It may be that while anxiety does not interfere with the initial stage of meta-cognitive skill, it does lead people to feel more uncertain about which response to withhold, leading to difficulties effectively filtering their responding. It is worth noting however, that greater anxiety does not explain the behaviour of those in the AS group who did not engage in filtering as there was no difference in anxiety between those who engaged in filtering in the AS group and those who did not.

Most importantly, in contrast to the findings of Gudykunst and colleagues (Gudykunst & Kim, 2003; Gudykunst et al., 1995), it was found that there was no relationship between the anxiety adults with Asperger's Syndrome experienced in response to recognising emotions from faces and their actual accuracy. It appears that the increased anxiety experienced by adults with Asperger's Syndrome during emotion recognition judgments does not negatively affect the accuracy they achieve, however it may affect their ability to effectively filter their responses during social situations. The uncertainty that anxiety creates for individuals in social situations may lead to difficulties knowing how to behave leading to poor social interactions. It is possible that teaching adults with Asperger's Syndrome that feelings of anxiety experienced during an emotion recognition decision do not relate to whether they are likely to be accurate, may relieve these feelings of uncertainty and lead to better engagement in effective response filtering.

A limitation of the present study is the use of photographs of facial expressions rather than "live" social interactions. It is possible that adults with Asperger's Syndrome experience an even greater level of anxiety during live social interactions than when recognising emotions from photographs of facial expressions. Even if this was the case, it seems unlikely that this "greater anxiety" would then have an effect on the first stage of meta-cognitive skill and accuracy given the lack of relationships found between anxiety, accuracy and accuracy discrimination ability in the present study. However, such an investigation may provide more conclusive information about whether anxiety does interfere with the ability to effectively filter responding.

Relationship between confidence and accuracy: Accuracy discrimination index for adults with and without Asperger's Syndrome. Previous research has suggested that confidence is likely to be related to accuracy for social judgments (Patterson et al., 2001; H. J. Smith et al., 1991). The findings from the present study are consistent with these findings, suggesting that confidence judgments can be used to discriminate accurate from inaccurate emotion recognition judgments, referred to as accuracy discrimination ability.

In the present study a general knowledge task was included, which required participants to make non-emotion related judgments, as a comparison task to allow investigation of whether any difficulties adults with Asperger's Syndrome had with accuracy discrimination were specific to emotion recognition judgments. Comparing adults with and without Asperger's Syndrome, it was found that there were no differences in the abilities of these two groups to discriminate accurate from inaccurate responses on the basis of confidence during both tasks. That is, individuals' confidence ratings were able to discriminate accurate from inaccurate judgments for both social and non-social judgments. Thus, those with Asperger's Syndrome were equally capable of discriminating between correct and incorrect emotion recognition judgments. This suggests that adults with Asperger's Syndrome do not have difficulties using this first stage of meta-cognitive skill, and are able to usefully use confidence as a guide to the accuracy of their responses during emotion recognition decisions.

However this finding is not consistent with the findings of Wilkinson et al. (2010) who found that adults with Asperger's Syndrome were less able to reliably match their level of confidence with their actual level of accuracy for *face recognition* judgments. These contrasting results may be due to differences in how face recognition and emotion recognition judgments are made. Adults with Asperger's Syndrome may have difficulties using accuracy discrimination for face recognition decisions, but not emotion recognition decisions, due to different cognitive processing required for these different decision types. However Nagesh, Brewer, and Young (2009), who also investigated the ability of adults with Asperger's Syndrome to use accuracy discrimination skills during a face recognition task, found that adults with Asperger's Syndrome did not have specific difficulties discriminating accurate from inaccurate responses on the basis of their confidence for face recognition judgments. Therefore, it is not clear whether individuals with Asperger's Syndrome have completely intact accuracy discrimination abilities, or whether for some specific types of judgments, they do have difficulties using these skills.

A limitation of the use of a general knowledge task as a comparison task in the present study is that it doesn't allow investigation of whether any difficulties using meta-cognitive monitoring were due to difficulties making decisions about faces or due specifically to difficulties making decisions about emotions. However, in the current study as there were no differences in accuracy discrimination abilities for individuals with Asperger's Syndrome in either the emotion recognition or general knowledge tasks this was not problematic. In future research though it would be worthwhile comparing performance for individuals with Asperger's Syndrome on a perceptual based task (such as judging the gender of faces) to performance on an emotional based perceptual task (i.e., judging the emotion in facial expressions). Such a comparison would allow a definitive investigation of whether any difficulties individuals with Asperger's Syndrome have recognising emotions in facial expressions are due to difficulties processing emotional information or difficulties processing perceptual information from faces.

Response filtering: Engagement, and effectiveness. The second stage of meta-cognitive skill that was assessed was the participants' ability to use response filtering after they had made a decision. Two components of filtering were assessed: (1) whether or not participants engaged in filtering responses by withholding responses they believed were inaccurate, and; (2) whether filtering was used effectively so that a greater proportion of correct responses were submitted than incorrect responses (measured using d').

It was found that a greater proportion of adults with Asperger's Syndrome failed to act on their accuracy discrimination and filter their responses in comparison to adults without Asperger's Syndrome in both the emotion recognition and the general knowledge tasks. That is, a much larger percentage of adults with Asperger's Syndrome failed to engage in withholding responses that they believed were incorrect in comparison to adults without Asperger's Syndrome. Three possible explanations are proposed for this finding that might suggest that those with Asperger's Syndrome were merely making rational decisions. First, the participants who choose not to withhold responses may be those who have very poor accuracy discrimination ability and therefore made the wise decision to submit all responses as they were aware they had no reliable way of choosing which responses were more likely to be accurate. However, this was not the case as for those with Asperger's Syndrome there was no difference in the accuracy discrimination achieved by those who withheld responses and those who did not. Alternatively, it could be that the participants who submit all responses are very confident in the accuracy of their responses (i.e., 99% confident). However, this was also not the case as those who did not engage in filtering responses were not nearing 100% in their confidence in the accuracy of their answers in comparison to those who did engage in filtering. Finally, it could be that those who do not withhold choose not to do so as they are more often accurate in their responses (i.e., 99% accuracy) and withholding responses is more likely to decrease their overall accuracy. Again, this was not the case as it was found that there was no difference in the accuracy achieved by those who engaged in filtering responses and those who did not. Overall, this then suggests that these individuals had the potential to filter their responses on the basis of their subjective confidence but failed to do so.

In regards to filtering effectiveness, there was evidence to suggest that those with Asperger's Syndrome were less effective at filtering their responses than adults without Asperger's Syndrome in the emotion recognition task. It is likely that this difficulty effectively filtering responses was due to the large subgroup of adults with Asperger's Syndrome who failed to engage in filtering their responses and who were, by definition, not able to effectively filter their responding.

In summary, the findings thus far suggest that adults with Asperger's Syndrome are able to use confidence as a guide to accuracy during decision making, but that a large subgroup fail to use this information to filter their responding after they have made a decision. Caution is warranted in interpreting the use of the withhold/submit judgment as indicative of how participants would select judgments to act on in social situations or whether they would indeed act upon "submitted" responses. However, the results do suggest that adults with Asperger's Syndrome are likely to have deficits in discriminating which judgments to act on in social situations, and that this may be a major difficulty that some adults with Asperger's Syndrome experience in social situations.

It is unclear why adults with Asperger's Syndrome had greater difficulties engaging in filtering responses. While greater anxiety was associated with decreased filtering effectiveness, this was not specific to those who did not engage in filtering as they were not found to experience higher levels of anxiety than those who did engage in filtering. It is possible that this decision making difficulty is related to an overall deficit in executive function that is found in individuals with Asperger's Syndrome (e.g., Ozonoff, Pennington, & Rogers, 1991). Executive function is defined by Ozonoff, Pennington, et al. (1991) as "the ability to maintain an appropriate problem-solving set for attainment of a future goal; it includes behaviours such as planning, impulse control . . ." (p. 1083). While it is likely that executive function is important for a large number of abilities, it is possible that a deficit in executive functioning results in impairment in aspects of meta-cognitive skill. It is possible that a difficulty with executive functioning underlies the meta-cognitive difficulties observed in those with Asperger's Syndrome. Another possibility is that the difficulty effectively filtering responding observed in adults with Asperger's Syndrome may be related to a difficulty with Theory of Mind. It seems logical that the ability to understand one's own mental state is likely to be related to the ability to understand the mental states of others, known as Theory of Mind ability. Both these abilities have been found to be impaired in those with Asperger's Syndrome (Baron-Cohen, 1997; Hobson, 1993b). Furthermore, Lockl and Schneider (2007), in a longitudinal study, found evidence that early Theory of Mind ability predicts later meta-cognitive ability in children without Asperger's Syndrome. Further investigations on whether these two difficulties are related for adults with Asperger's Syndrome may help in understanding why a subgroup of adults with Asperger's Syndrome had a deficit in *acting on* their meta-cognitive skill, despite having an equivalent accuracy discrimination ability to adults without Asperger's Syndrome.

Conclusions. In summary, adults with Asperger's Syndrome were found to have a functioning ability during the first stage of meta-cognitive skill; that is, they were equally capable of using their confidence as a guide to accuracy during emotion recognition decisions. However, a large subgroup of adults with Asperger's Syndrome had difficulties acting on the basis of their meta-cognitive skill and filtering their responding. That is, while adults with Asperger's Syndrome showed an ability for accuracy discrimination, a large subgroup had difficulties then filtering their responding on the basis of this knowledge. Koriat and Goldsmith (1996) make the point that, when it comes to memory accuracy, people cannot improve the accuracy of what they retrieve from memory but can improve the quality of what they report by effectively filtering their responses. This statement also resonates with the findings of the present study for the emotion recognition judgments of adults with Asperger's Syndrome. Adults with Asperger's Syndrome have difficulties recognising emotions from facial expressions, and treatment studies that have attempted to improve these emotion recognition abilities have shown difficulties helping individuals to generalise any improvements to new situations (e.g., Golan & Baron-Cohen, 2006). The results of the present study suggest that another avenue to assist individuals with Asperger's Syndrome to improve their emotion recognition accuracy in social situations is to help them improve their engagement in response filtering, which is likely to lead to effective response filtering since they do show a capability for accuracy discrimination. That is, it may not be possible to improve emotion recognition accuracy for adults with Asperger's Syndrome, but it may be possible to improve the choice of judgments upon which they chose to act by improving response filtering. Furthermore, as individuals with Asperger's Syndrome are performing at a high level of accuracy, albeit lower than individuals without Asperger's Syndrome, it will likely be more profitable for intervention not to focus on improving accuracy but to take this focus on improving engagement in response filtering. This may also allow individuals to improve their social interaction skills by helping them to identify and act on judgments that are more likely to be accurate, as effective social skills may not be solely a function of emotion recognition accuracy but also about knowing when one's judgments are accurate and only acting on those decisions (rather than those that are likely to be inaccurate). For example, an individual who has only average emotion recognition ability may still demonstrate effective social skills due to appropriate use of response filtering.

Chapter 4 –

Study 3: Are Adults with Asperger's Syndrome Better at Recognising the Emotions of Familiar People than Unfamiliar People?

Overview

In Study 1 and 2, individuals with Asperger's Syndrome were found to be less able to recognise emotions from facial expressions in comparison to individuals without Asperger's Syndrome. Furthermore, in Study 2, a large sub-group of adults with Asperger's Syndrome were found to have difficulties using their meta-cognitive skills to filter their responding. In both Study 1 and 2, emotion recognition tasks with photographs of facial expressions performed by actors who were *unfamiliar* to the studies' participants were used. The main aim of Study 3 was to investigate whether familiarity affects the recognition of emotions from facial expressions for adults with Asperger's Syndrome.

It is suggested that individuals recognise emotions from facial expressions by having a store of emotion knowledge and prototypical mental representations of facial expressions (Barrett, 2006; Barrett et al., 2007). Expressions can be compared to this information in order to interpret the emotion being represented. To do this, individuals need to be able to generalise knowledge and mental representations in order to interpret the facial cues of unfamiliar people. Individuals with Asperger's Syndrome performed above chance level for emotion recognition accuracy in Study 1 and 2, suggesting that they do have emotion knowledge and mental representations available to interpret facial expressions. However, they do not seem to be able to use these as effectively as individuals without Asperger's Syndrome. One reason for this may be that adults with Asperger's Syndrome have difficulties generalising skills to new situations (Bolte et al., 2002; Golan & Baron-Cohen, 2006). Adults with Asperger's Syndrome may not have a general deficit recognising emotions from facial expressions, but instead have a specific deficit in using the generalisation process to enable them to recognise emotions from the facial expressions of unfamiliar people. In order to investigate this, the present study replicated the protocol used in Study 2 with photographs of facial expressions but included photographs of both familiar and unfamiliar faces. If generalisation is a problem, it is expected that adults with Asperger's Syndrome will be more accurate at recognising emotions expressed by familiar people as well as more consistently able to use their meta-cognitive skills to filter their responding for decisions about the emotions of familiar people.

The Effect of Familiarity and the Role of Generalisation

It is likely that familiarity is an important factor in understanding the difficulties individuals with Asperger's Syndrome have recognising emotions from faces, especially since individuals with Asperger's Syndrome and Autism are found to differ in how they interact with, and respond to, unfamiliar people. For example, children with Autism show empathy towards familiar people but not unfamiliar people (Hudry & Slaughter, 2009), experience less physiological arousal in response to interacting with a familiar peer than an unfamiliar peer (Lopata, Volker, Putnam, Thomeer, & Nida, 2008) and have fewer behaviour problems and better performance when tested by a familiar examiner (Szarko, 2000). Individuals with Asperger's Syndrome may process information from faces of those with whom they are familiar more successfully, experience less anxiety when confronted with familiar faces and therefore, may be able to more accurately recognise emotions from the facial expressions of familiar people.

Some evidence that familiarity plays a role in emotion recognition accuracy comes from studies that train individuals with Asperger's Syndrome or Autism to recognise emotions from facial expressions. Individuals with Asperger's Syndrome or Autism have been found to successfully increase their emotion recognition accuracy with training as they become more familiar with particular faces however, they have been found to have difficulties generalising this increase in skill to unfamiliar faces (Bolte et al., 2002; Golan & Baron-Cohen, 2006). For example, Golan and Baron-Cohen (2006) found that individuals with Asperger's Syndrome or Autism were able to become more accurate at recognising emotions from facial expressions after completing a training program that focused on providing feedback for a specific set of photographs of facial expressions. However, these individuals did not become more accurate at recognising the same facial expressions of emotion in a new set of photographs of different actors. This problem with generalisation has been found in a number of studies that attempt to train individuals with Asperger's Syndrome or Autism to improve skills important for emotion recognition and social interaction (Bolte et al., 2002; Golan & Baron-Cohen, 2006; Hadwin, Baron-Cohen, Howlin, & Hill, 1996; Swettenham, 1996).

Individuals with Asperger's Syndrome may tend to build up specific knowledge and mental representations for people with whom they become familiar, allowing better emotion recognition accuracy and more effective use of meta-cognitive skills. They may then be unable to generalise this information to unfamiliar faces meaning they are unable to use their emotion recognition skills until they have become familiar with a particular person. This difficulty with generalisation may also make it more difficult to use meta-cognitive skills to identify responses that are accurate from those that are inaccurate as individuals are not able to compare facial expressions to stored mental representations in order to work out what is the most likely accurate emotion expressed.

In summary, there are two reasons to suggest that familiarity is likely to be an important factor for the emotion recognition skills of individuals with Asperger's Syndrome. Firstly, with training and increasing familiarity, individuals with Asperger's Syndrome become better at recognising emotions from a particular set of facial expressions and secondly, when they are asked to recognise emotions from new photographs of unfamiliar people they decrease in their performance. It is likely that this occurs in social interactions, as when first interacting with an unfamiliar person, individuals may need to engage in more effortful cognitive processing in order to generalise emotion recognition skills to interpret unfamiliar people's facial expressions. As we become more familiar we may also become more efficient at this process and may build up specific knowledge about how to interpret the facial cues of this particular person. This may result in individuals being better able to recognise emotions from the facial expressions of familiar people. However, for individuals with Asperger's Syndrome who may have difficulties generalising emotion recognition skills to unfamiliar faces, they may retain an advantage for recognising emotions from familiar faces but not be able to use these skills to recognise emotions from the facial expressions of unfamiliar people.

It is argued that recognising emotions from unfamiliar faces requires more effortful cognitive processing. Reaction time will therefore also be assessed in order to test this possibility. Reaction time has been assumed to be an indicator of processing efficiency across a range of judgment types, including emotion recognition (Fazio, 1990;

Fazio et al., 1995). For emotion recognition and social judgments reaction times are shorter for well-practised and more familiar responses (Fazio, 1990). That is, reaction time gives an indication of the cognitive effort required to make particular judgments, and how efficient individuals are at processing particular judgments. Given the extra process of generalisation required that individuals with Asperger's Syndrome may have difficulty with, it would be expected that they would take longer to recognise emotions from unfamiliar faces.

Elfenbein and Ambady (2003) investigated whether people are faster, and therefore more 'cognitively efficient', at recognising emotions from familiar faces. They found that Chinese and American participants were faster and more accurate at recognising emotions expressed by members of their own respective cultures in comparison to members of the other culture. While caution is needed in extending the meaning of these results to personally familiar faces, this finding does suggest that people are able to more efficiently process emotional expressions performed by familiar individuals and that these decisions are less cognitively demanding.

In summary, it may be that in order to recognise emotions from the facial expressions of unfamiliar people, individuals must engage in more extensive cognitive processing to generalise their knowledge of emotions to interpret the likely meaning of an unfamiliar person's facial cues, and then engage in meta-cognitive skills to assess the likely veracity of their interpretation. It is expected that adults with Asperger's Syndrome will be slower to recognise emotions from unfamiliar faces as a result of difficulties generalising emotion recognition knowledge.

The Role of Confidence and Anxiety

While the ability to generalise emotion recognition skills and processes is likely to be important for accurately recognising emotions from the facial expressions of unfamiliar people, it is also likely that confidence and anxiety play a role in this ability. Gudykunst's theory suggests that as familiarity increases anxiety decreases, allowing individuals to more effectively use their confidence to guide the accuracy of their judgments (Gudykunst & Kim, 2003; Gudykunst et al., 1995).

Beaupre and Hess (2006) examined this possibility by asking adults to perform an emotion recognition task that used expressions performed by members of the same culture as the participant (familiar person), or members of a different culture to the participant (unfamiliar person). They found that the familiarity of the face expressing the emotion (same culture or other culture) had an effect on participants' confidence. Participants were found to be more confident when judging emotions from the facial expressions of people from their own culture as opposed to people from an unfamiliar culture. These findings suggest that with increasing familiarity confidence in the accuracy of responses also increases. This may also contribute to individuals being more accurate at recognising emotions from the facial expressions of familiar people as individuals may feel more certain about their abilities and therefore be better able to engage in meta-cognitive processes when interacting with familiar people.

Summary

In summary, the main aim of the present study was to investigate whether adults with Asperger's Syndrome have a specific deficit generalising their emotion recognition skills to unfamiliar faces. Individuals with Asperger's Syndrome have been found to have difficulties generalising skills to unfamiliar faces and this suggests that, despite being able to recognise emotions from the facial expressions of familiar people, they are unable to recognise emotions as accurately from unfamiliar faces. If this is so, individuals with Asperger's Syndrome would be less accurate and have longer reaction times when attempting to recognise emotions from the facial expressions of unfamiliar people. Furthermore, the question of whether confidence and anxiety play a role in this difficulty was also assessed. Specifically, this study examined whether familiarity affected the level of anxiety and confidence reported by participants during the emotion recognition tasks. Finally, it was also examined whether individuals were better able to act on their meta-cognitive skills and filter their responses for familiar faces.

Method

Participants. For this study, 20 participants with a diagnosis of Asperger's Syndrome (AS group) were recruited. They were recruited through Autism SA and had all met the Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria for Asperger's Syndrome (American Psychiatric Association, 2000) through a formal diagnostic process (i.e., diagnoses were supported by two independent psychologists/psychiatrists or two members of the Autism SA diagnostic team). Note that 17 of these participants had previously participated in Study 2. None of the participants had comorbid disorders or were currently taking psychological medication. All participants spoke English as their first language. Demographic details are presented in Table 4.1.

In addition, each participant nominated a familiar person for whom facial stimuli of emotional expressions were created. Demographic details are also shown in Table 4.1 for the "familiar other group". The familiar other group were generally older and a higher percentage were female than in the Asperger's Syndrome group.

Table 4.1.

Means (Standard Deviations) for Demographic Details of Adults in the Asperger's Syndrome (AS) Group and Familiar Other Group

	AS group (n = 20)	Familiar other group (n = 20)
Age	30.5 (10.7)	38.1 (14.1)
Gender (% female)	20%	75%
DASS - Depression	15.8 (11.1)	- -
DASS - Anxiety	13.3 (8.8)	- -
DASS - Stress	20.1 (8.9)	- -
FSIQ	106.8 (16.4)	- -

Note. DASS and WASI scores were only available for the 17 (of 20) participants who also had participated in Study 2.

Design. A 2 (task: familiar emotion recognition task, unfamiliar emotion recognition task) within subjects design was used. The dependent measures included: emotion recognition accuracy, self-reported confidence and anxiety, reaction time and measures of meta-cognitive skill (i.e., gamma correlation, d prime (d') scores and engagement in filtering).

Stimuli.

Familiar and unfamiliar emotion recognition task: Development. In order to develop an emotion recognition task for each participant with Asperger's Syndrome that included photographs of people who were familiar and unfamiliar to them, participants with Asperger's Syndrome were asked to identify someone they knew well who would consent to being photographed posing facial expressions (familiar other group). Of the types of relationships between members of the familiar other group and the Asperger's Syndrome group, nine (45%) were identified as spouses or defactos (all spouse pairs were that of a female without Asperger's Syndrome and a male with Asperger's Syndrome), six (30%) were identified as relatives (i.e., mothers or sisters; female/female and female/male pairings), four (20%) were close friends (female/male and male/female pairings) and one (5%) was identified as a friend (male/male pairing). In response to questions regarding how often the members of each pair interacted, 70% identified as interacting daily, and 10% (respectively) identified as interacting weekly, a couple of times a month, or a few times a year. Participants indicated that they had known each other on average for 13.9 years (*SD* = 11.6) with a range from 1 to 38 years. Overall, it is clear that the Asperger's Syndrome group were selecting 'familiar others' who they knew well and with whom they interacted with frequently. All familiar other participants spoke English as their first language except two participants who spoke Chinese as their first language (and were both born in China but had lived in Australia for at least 5 years). These participants were matched together in the emotion recognition task.

"Familiar other" participants were invited to attend a testing session where they were asked to pose sixteen facial expressions, including 6 basic emotions (i.e., happy, sad, angry, afraid, surprise, disgust) and 10 complex emotions, (i.e., scheming, guilty, thoughtful, admiring, quizzical, flirting, bored, interested, embarrassed, and arrogant). Basic emotions were posed based on the descriptions of facial action for each expression described by Ekman and Friesen (1975). Complex emotions were posed using the photographs developed by Baron-Cohen, Wheelwright, et al. (1997) as a guide. Photographs were taken under standardized lighting levels with a standard white background.

The photographs were presented in the emotion recognition task with response slides individualised to each type of expression. For each slide, the correct word was shown along with three incorrect choices randomly selected from the other expressions used in the task on the basis of whether the expression was positive or negative. For example, for a happy expression the word happy was shown along with three other choices randomly selected from the other positive expressions used in the task (i.e., surprised, admiring, flirting and interested).

Finally, participants with Asperger's Syndrome and the photographs of their familiar other were matched in pairs to another participant with Asperger's Syndrome (and the photographs of their familiar other). For example, Participant 1's familiar emotion recognition task had photographs of their familiar person in the familiar condition with Participant 2's familiar person's photographs used for their unfamiliar condition. Correspondingly, the familiar condition for Participant 2 involved photographs of their familiar person with their unfamiliar condition comprised of Participant 1's familiar person's photographs. This way, any differences in the ability of the familiar others to accurately pose expressions was controlled for.

Familiar and unfamiliar emotion recognition task: Format. Both the familiar and unfamiliar emotion recognition tasks were presented in the same way and each participant viewed a total of 32 photographs. The task began with instructions presented verbally and on the screen. This was followed by two practise images to ensure participants understood the requirements of the task. For each trial, a fixation cross was presented in the centre of the screen before the photograph was displayed. Participants were asked to click the mouse when they knew what expression was shown in the photograph. They were asked to do this as quickly and accurately as possible. Following this, participants were presented with a response slide with four emotion response words. They were asked to choose the word which best fit with the emotion they thought had been presented in the photograph. Reaction times were recorded in seconds for how long the participant looked at the photographs, and for how long it took the participant to select one of the four emotion words.

For each emotion recognition decision, participants were asked to rate how confident they were that they had selected the correct expression on a scale from 0% to 100%. Confidence was scored as the mean rating across all trials. Participants were then given the choice to submit the decision towards their total score (participants were told that they would receive points for correct answers but would lose points for incorrect answers), or to withhold the decision if they thought they were likely to be wrong and would like to withhold that particular judgment from their total score. The act of withholding one or more responses was defined as participants engaging in filtering their responding. Emotion recognition accuracy was calculated as the percentage of correct recognition judgments separately for both familiar and unfamiliar faces.

Two indices of meta-cognitive skill were assessed: (a) accuracy discrimination indexed using the Goodman-Kruskal gamma correlation, and; (b) whether participants engaged in filtering their responses (by withholding answers they thought were incorrect) and if so, whether they did this effectively (indexed using d'). For more information on the measures used to assess meta-cognitive skill refer to pages 61 - 62 of Chapter 3.

Finally, at four times throughout each task, participants were also asked to rate how anxious they felt on a scale of 0% - 100%. For each task, this was averaged across the four time points to provide a mean level of self-reported anxiety.

Procedure. All participants attended an individual testing session at Flinders University. Participants initially completed a demographics questionnaire. Participants then completed the familiar and unfamiliar emotion recognition tasks on the computer. Order of presentation of the emotion recognition tasks was counterbalanced across participants.

Results

The first question addressed was whether familiarity had an effect on accuracy, confidence, anxiety, reaction time, and meta-cognitive skill during the emotion recognition tasks. Paired samples t-tests were used to assess whether there were any differences in these factors for familiar faces versus unfamiliar faces. There were no differences in emotion recognition accuracy (t (19) = .41, p = .69), self-reported confidence (t (19) = .54, p = .59), and self-reported anxiety (t (19) = 1.0, p = .32; see Table 4.2 for means and standard deviations). Each measure was strongly positively correlated across familiarity conditions: emotion recognition accuracy, r = .61, p = .004, self-reported confidence, r = .80, p < .001, and self-reported anxiety, r = .88, p <.001.

Table 4.2.

Means (Standard Deviations) for Percentage Accuracy, Confidence, Anxiety and Reaction Time for Adults with Asperger's Syndrome in Response to Photographs of Familiar and Unfamiliar Faces During the Emotion Recognition Tasks

	Familiar	Unfamiliar	*Cohen's d*
Accuracy	79.5 (12.5)	78.6 (10.4)	0.08
Confidence	75.2 (18.7)	73.8 (17.3)	0.08
Anxiety	36.7 (25.3)	40.1 (30.6)	0.12
Reaction time			
Viewing image	3.1 (1.7)	3.0 (1.9)	0.06
Response selection	4.3 (1.3)	3.6 (2.0)	0.27*
Meta-cognitive skill			
Gamma correlation[a]	0.47 (0.37)	0.55 (0.22)	0.25
d'	0.57 (0.65)	0.56 (0.69)	0.01

[a] A gamma correlation was not able to be calculated for one participant due to insufficient variance in their confidence ratings therefore, this analysis is based on 19 participants.

* $p < .05$

The length of time participants took to: (a) recognise the expressions shown in the photographs, and; (b) decide which of four words best matched what expression they thought was shown, was compared across familiarity conditions. There was no difference in how long participants looked at the photographs of facial expressions before they decided which expression was shown, t (19) = .12, p = .90. However, participants did take longer to select which of four words best described the expression they identified for familiar faces, *t* (19) = 2.2, *p* = .04, although this corresponded to only a small effect size (see Table 4.2). For both reaction time measures, participants who were faster for familiar faces were also faster for unfamiliar faces (*r* = .82, *p* <.001, and *r* = .95, *p* <.001, respectively).

Finally, there was also no difference in the gamma correlation scores achieved in response to familiar faces versus unfamiliar faces, *t* (18) = 0.73, *p* = .48 (see Table 4.2). However, this was not consistent across participants, *r* = -.15, *p* = .54. Unlike accuracy, confidence, anxiety, and reaction time which were more stable across familiarity conditions, gamma correlation scores were not stable across tasks: accuracy discrimination ability for familiar faces was not related to accuracy discrimination ability for unfamiliar faces. Moreover, since the 95% confidence intervals for the gamma correlations do not include zero for either the familiar (0.29 – 0.65) or unfamiliar face conditions (0.44 – 0.65) the Asperger's Syndrome participants were able to use confidence as a guide to the accuracy of their emotion recognition responses for both familiar and unfamiliar faces.

Participants were given the option throughout the tasks to 'withhold' answers that they believed were wrong in order to avoid losing points for submitting incorrect answers. The act of withholding at any responses that may be wrong is seen as participants engaging in filtering their responding. A similar number of participants engaged in filtering responses in the familiar face condition (55%) compared with the unfamiliar face condition (60%), *McNemar change* χ^2 (1) = 0.00, *p* = 1.0. This suggests that engagement in filtering did not differ for familiar versus unfamiliar face emotion recognition. However, as shown in Study 2, it is also clear that many of those with Asperger's Syndrome chose to *not* withhold any answers despite indicating low confidence in many of their answers.

Furthermore, there was no difference in the d' scores for familiar faces versus unfamiliar faces, t (19) = 0.09, p = .93. This was strongly positively correlated across both familiarity conditions, r = .62, p = .003. Given that the 95% confidence intervals for d' do not include zero for either the familiar (0.27 – 0.87) or unfamiliar face conditions (0.23 – 0.87), it appears that the Asperger’s Syndrome group were able to effectively filter their responses in both conditions.

In summary, familiarity did not have an effect on how accurately adults with Asperger’s Syndrome recognised emotions from faces, how anxious or confident they felt while doing this, or how well they used their meta-cognitive skill. The final question considered was whether familiarity had an effect on the relationship between confidence and anxiety. Although the results of the present study did not find any differences in anxiety and confidence reported as a result of familiarity, Gudykunst and colleges (Gudykunst & Kim, 2003; Gudykunst et al., 1995) suggest that as familiarity increases confidence also increases while anxiety decreases. Therefore, it is possible that the strength of the relationship between confidence and anxiety may differ as a result of familiarity.

For familiar faces, there was a negative correlation between emotion recognition accuracy and self-reported anxiety which approached significance, r = -.43, p = .06. For unfamiliar faces the same negative relationship was found (r = -.49, p = .03) and the strength of the relationships for familiar versus unfamiliar faces was found to not significantly differ using a test for dependent correlations (Steiger, 1980), Z = 0.32, p = .75 (see Table 4.3). Overall, for individuals with Asperger’s Syndrome, greater anxiety was associated with lower emotion recognition accuracy. A similar pattern was observed for confidence ratings: greater anxiety, for both familiar (*r* = -.64, *p* = .003) and unfamiliar faces (*r* = -.55, *p* = .01), was associated with lower confidence ratings. For both familiar and unfamiliar faces the direction and strength of the relationship between confidence and anxiety was found not to differ, *Z* = 0.72, *p* = .47 (Steiger, 1980).

Table 4.3.

Correlations (with 95% Confidence Intervals in Brackets) between Confidence, Anxiety, and Accuracy in Response to Familiar Faces and Unfamiliar Faces

	Anxiety	
	Familiar face	Unfamiliar face
Accuracy	-.43[a]	-.49*
	(-.73 – .02)	(-.77 – -.06)
Confidence	-.64**	-.55*
	(-.84 – -.28)	(-.80 – -.14)

[a] *p* = .06

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

Discussion

The main aim of Study 3 was to assess whether individuals with Asperger's Syndrome were more accurate at recognising emotions from familiar faces than unfamiliar faces. In particular, the main question investigated was whether individuals with Asperger's Syndrome have a specific deficit recognising emotions from unfamiliar faces due to difficulties generalising emotion recognition skills, rather than a general deficit using emotion recognition skills. It was found that there were no differences in the emotion recognition accuracy that adults with Asperger's Syndrome achieved when recognising the facial expressions of familiar people well known to them in comparison to the facial expressions of unfamiliar people they had never met. Therefore, no evidence was found that adults with Asperger's Syndrome have a specific deficit recognising emotions from the facial expressions of unfamiliar people. Furthermore, adults with Asperger's Syndrome did not take longer to recognise emotions from unfamiliar facial expressions, suggesting that they were not engaging in greater cognitive processing in order to generalise emotion recognition skills to unfamiliar faces. In fact, individuals with Asperger's Syndrome were found to spend longer deciding what emotion word best fit the expression shown by familiar faces perhaps showing greater motivation to accurately recognise emotions from familiar faces and more cognitive effort used in these decisions. Despite this, there were no differences in the level of accuracy achieved for familiar versus unfamiliar faces. These findings, in combination with the findings in Study 1 and 2, suggest that adults with Asperger's Syndrome experience a general deficit using emotion recognition skills to accurately recognise emotions from facial expressions.

It would be possible to argue that the emotion recognition results of the present study were due to differences in the ability of the familiar and unfamiliar people to accurately express different emotions. This could mean that any differences on these two tasks could be masked by the level of expressivity of people in the two tasks. However, in the design of the present study each person posing the emotional expressions was used in both the familiar and unfamiliar emotion recognition task (see Method). This means that across the study's participants any effect of the expressivity of those posing the photographs is controlled. Therefore, the results were not unduly affected by this factor.

It was also found that there were no differences in the way anxiety and confidence functioned for adults with Asperger's Syndrome when recognising emotions from familiar faces. The relationship between anxiety and confidence was consistent with the results reported in Study 2: greater self-reported anxiety was associated with lower self-reported confidence. This confirms the relationship between confidence and anxiety as suggested by Gudykunst and colleagues (Gudykunst & Kim, 2003; Gudykunst et al., 1995). This is also consistent with the argument that as the anxiety levels of adults with Asperger's Syndrome increase, their levels of confidence decrease, although this is irrespective of familiarity. However, unlike Study 2 where anxiety was not related to emotion recognition accuracy, a strong negative correlation was found in this study. This is consistent with the findings of Gudykunst and colleagues that the more anxious a person is, the less accurate they are likely to be when recognising the emotions of others. Nevertheless, there was no support for the assertion that the more familiar individuals become with another person the more confident and less anxious they are when recognising their emotions. Familiarity had no effect on how confident or how anxious adults with Asperger's Syndrome reported feeling during the emotion recognition task. Finally, there were no differences in the ability of adults with Asperger's Syndrome to engage in and effectively filter their responses for emotion recognition decisions for familiar faces. In summary, familiarity had no effect on the relationships examined in the present study.

While results of the present study are inconsistent with the suggestion that individuals with Asperger's Syndrome are better at recognising emotions from familiar faces, they are consistent with research that suggests that individuals with Asperger's Syndrome and Autism have difficulties recognising the familiarity of a face (e.g., Klin et al., 1999). For example, it is commonly found that individuals with Asperger's Syndrome are not able to recognise familiar faces, that they have been trained to be familiar with, from unfamiliar faces that they have not seen before or seen only once (e.g., Klin et al., 1999). A few studies have also extended these findings to examine whether individuals with Asperger's Syndrome and Autism are able to recognise the "familiarity" of faces of people who are well known to them in comparison to faces of people they do not know (J. Boucher, Lewis, & Collis, 1998; Dawson et al., 2002). For example, Dawson et al. (2002) found that typically developing children showed a *different* brain activation to photographs of their mothers (familiar face) than photographs of a stranger (unfamiliar face). However, children *with* Autism or Pervasive Developmental Disorder showed *no difference* in their brain activation in response to photographs of their mothers (familiar face) and photographs of a stranger (unfamiliar face) suggesting that they did not show the normal recognition of the familiarity of the face of someone they know well. These findings help explain the findings of the present study. It may be that adults with Asperger's Syndrome do not show an advantage for recognising emotional expressions from photographs of familiar people as they do not experience the normal recognition of the level of familiarity of a face. This could be further tested by replicating the study by Dawson et al. using an emotion recognition task and assessing whether adults with Asperger's Syndrome fail to show a difference in their brain activation when recognising emotions from the facial expressions of familiar versus unfamiliar faces. Furthermore, this could also be examined by assessing whether typically developing adults, who do not have a deficit recognising the familiarity of faces, show an advantage for recognising emotions from familiar faces. A limitation of the present study was that this comparison was not included as it is possible that familiarity does not affect the emotion recognition accuracy of either individuals with or without Asperger's Syndrome. This should be investigated in future research. For now, the results of the present study suggest that individuals with Asperger's Syndrome do not have a specific deficit recognising emotions from the expressions of unfamiliar faces, as they perform this task similarly regardless of the familiarity of the face.

It is likely that the present study failed to find results consistent with the suggestion that familiarity should affect emotion recognition, due to the way familiarity was operationalised in previous emotion recognition research. The assertion that familiarity should affect emotion recognition comes from two different types of research: (1) research investigating emotion recognition skills cross-culturally and; (2) research that shows adults with Asperger's Syndrome increased their emotion recognition accuracy with training. It may be that when individuals are learning to recognise emotions in a new culture, it is not personal familiarity with people from the new culture that is the important factor. Rather, it may be that learning to interpret different culturally based cues for different emotions is the important factor which leads to an increase in accuracy with increasing familiarity with the new culture. Similarly, when individuals with Asperger's Syndrome and Autism increase their accuracy when recognising emotions from a set of photographs of faces, it may not be due to increasing personal familiarity with the people expressing the emotions. It is possible that individuals with Asperger's Syndrome are able to 'rote learn' that particular cues from particular photographs mean the photograph is showing a particular emotion. This compensatory strategy may allow individuals with Asperger's Syndrome to increase their accuracy for a set of photographs, however as they are not learning strategies to interpret emotions across faces their accuracy then decreases when they are shown photographs of new faces.

In conclusion, there were no differences in the way adults with Asperger's Syndrome cognitively processed or interpreted emotions from the facial expressions of familiar versus unfamiliar faces, and they were able to achieve the same level of emotion recognition accuracy regardless of the familiarity of the faces. This suggests that adults with Asperger's Syndrome do not have a specific deficit recognising emotions from the facial expressions of unfamiliar people, due to a difficulty generalising emotion recognition skills to unfamiliar faces. Rather, the results show that adults with Asperger's Syndrome have a general difficulty recognising emotions from facial expressions, and this ability is not affected by the familiarity of the face.

Chapter 5 –
Study 4: The Relationship between Social Skills, Emotion Recognition Accuracy, Meta-cognitive Skill and Theory of Mind Ability.

Overview

The main aim of the previous three studies has been to understand why individuals with Asperger's Syndrome have difficulties recognising emotions from facial expressions. One of the reasons for trying to understand this difficulty is that it may help in understanding why individuals with Asperger's Syndrome have difficulties interacting socially. It is often accepted that emotion recognition skills are likely to be important for social skills given research that finds these abilities are highly related in children (Denham et al., 2003; Izard et al., 2001). However, in Study 2 it was also found that a large sub-group of adults with Asperger's Syndrome had difficulties effectively filtering their responses. It is possible, as suggested by Beupre and Hess (2006), that this difficulty effectively filtering responses may contribute to the difficulties adults with Asperger's Syndrome have interacting socially. Beupre and Hess (2006) make the argument that social skill is not just about recognising emotions accurately, but also knowing when one is likely to have made a correct emotion recognition judgment and therefore likely to be successful when acting on this judgment. This was investigated in the present study by assessing whether there is a relationship between meta-cognitive skills and social skills. Meta-cognitive skill is likely to be important for social success as it is a process that helps us to identify when we have made an accurate emotion recognition judgment that is reliable enough to inform us about how to interact socially.

However, meta-cognitive skill also has striking similarities to Theory of Mind (ToM). ToM is another ability that has been implicated in the development of social skills for individuals with Asperger's Syndrome and Autism (e.g., Ashwin, Chapman, Colle, & Baron-Cohen, 2006; Baron-Cohen, 1997). ToM is defined as the ability to understand the thoughts, feelings and intentions of other people (Baron-Cohen, 1997). In contrast, meta-cognitive skill can be broadly defined as the ability to understand one's own thoughts, feelings and intentions. It is possible that these two abilities are components of the same general underlying ability to understand thoughts, feelings and intentions. There are two main aims in the present study. Firstly, to understand whether ToM and meta-cognitive skill are components of the same underlying ability that is necessary for individuals with Asperger's Syndrome to develop functional social skills, and secondly to understand whether emotion recognition skill is important for social skill for adults with Asperger's Syndrome over and above the effects of ToM and meta-cognitive skill. This investigation helps in identifying the key abilities to target in interventions aimed at improving the social skills of adults with Asperger's Syndrome.

The Relationship between ToM and Meta-cognitive Skill, and their Effect on Social Skills

Meta-cognition refers to the process of monitoring one's task comprehension and performance, and one's assessment of what one knows and the likely accuracy of this knowledge (Ames & Kammrath, 2004). When considering meta-cognitive skill during emotion recognition decisions we can think of this skill as involving two stages: (1) assessing one's confidence in potential responses to aid in selecting an accurate response (referred to as accuracy discrimination in Studies 2 and 3), and; (2) using confidence in the final response to guide behaviour and decisions about whether to act on the final judgment (referred to as effective response filtering in Studies 2 and 3; Koriat & Goldsmith, 1996). This second ability is likely to be particularly important for social skills. For example, even if an individual has low emotion recognition ability, a strong ability to identify accurate judgments to use as a basis for behaving is likely to benefit social skills.

Recently there has been interest in understanding how ToM and meta-cognitive skill are related (e.g., see Misailidi, 2010). ToM, similarly to meta-cognitive skill, involves understanding thoughts, feelings and intentions, but it involves being able to understand these in others rather than in oneself. Individuals with Asperger's Syndrome have difficulties understanding the minds of others (Baron-Cohen, Jolliffe, et al., 1997; Baron-Cohen et al., 2001; Golan, Baron-Cohen, Hill, & Golan, 2006), as well as difficulties being able to engage in understanding their own minds when asked to engage in meta-cognitive processes (Farrant, Blades, et al., 1999; Farrant, Boucher, et al., 1999; Wilkinson et al., 2010). For example, it is commonly reported that individuals with Asperger's Syndrome are not as able to successfully complete ToM tasks in comparison to individuals without Asperger's Syndrome (Baron-Cohen, Jolliffe, et al., 1997). Furthermore, the results of Study 2, as well as research by Wilkinson et al. (2010), suggest that individuals with Asperger's Syndrome have difficulties with meta-cognitive skills.

In theory, the ability to understand the minds of others and the ability to understand one's own mind are likely to be related (Wilkinson et al., 2010). However, this idea has only recently begun to be investigated (e.g., Lockl & Schneider, 2007). It is possible that these difficulties do not represent unrelated abilities. It may be that meta-cognitive skill and ToM ability are both simply components of the same underlying ability.

The relationship between meta-cognitive skill and social skills has not been as extensively researched as the relationship between ToM and social skill which has received considerable attention (e.g., Repachol & Slaughter, 2003). However, recent research has been conducted investigating the importance of meta-cognitive skill for social functioning in adults with schizophrenia (Lysaker et al., 2011). Lysaker et al. (2011) defined meta-cognitive skill as "the ability to use knowledge about one's own mental states and those of others to respond to psychological challenges" (p. 241). Meta-cognitive skill was measured by coding the responses of individuals with Schizophrenia during an interview about their experiences with mental illness. In order to receive a high score, showing strong meta-cognitive skill, participants had to spontaneously demonstrate an ability to critically and objectively assess their own thoughts and feelings, and how these may be causing particular problems socially with other people. Lysaker et al. (2011) found that there was a positive relationship between the level of meta-cognitive skill of adults with schizophrenia and the frequency of their social interaction with friends. However, it is important to note that Lysaker et al.'s definition and measurement of meta-cognitive skill also includes the ability to use knowledge and understanding of the mental states of others, an ability more closely aligned with ToM. Therefore, although their results suggest that both ToM and meta-cognitive skill may be important for social skills, it is not possible to assess whether these two abilities are inter-related or independently important for social skills.

While the relationship between ToM and social skill has received more research attention than the relationship between meta-cognitive skill and social skill (e.g., Astington, 2003; Bosacki & Astington, 1999; Dissanayake & Macintosh, 2003; Tager-Flusberg, 2003), a consistent relationship between ToM and social skill has not been discovered. For example, while Tager-Flusberg (2003) found a relationship between social skills and ToM ability for children with Autism, other research has not found such clear relationships. For example, Dissanayake and Macintosh (2003) found that for children with Asperger's Syndrome, ToM ability was only related to specific social abilities (such as social participation measured via observation) rather than more global measures of social skill. This difference in findings could be due to the use of a much broader test of ToM ability in Tager-Flusberg's (2003) study (i.e., they tested a number of ToM abilities appropriate from age 18 months to early adolescence), in comparison to Dissanayake and Macintosh's (2003) study which focused only on first-order ToM tasks that test the ability to infer the thoughts and intentions of others. However, this contrast in findings may also suggest that other abilities, such as meta-cognitive skill, are important for developing the full range of social skills. For example, both ToM and meta-cognitive skill may contribute to social skill in adults with Asperger's Syndrome. That is, strong ToM and meta-cognitive skill may add together to produce effective social skills in adults with Asperger's Syndrome. However, it is unclear whether ToM and meta-cognitive skills are components of a broad underlying ability that is important for social skill, or whether they are two separate abilities that are independently important for social skill. This was assessed in the present study by examining the relationship between ToM and meta-cognitive skill, and whether these abilities independently predict the level of social skills reported by adults with Asperger's Syndrome.

The Relationship between Emotion Recognition and Social Skill

Emotion recognition skills are often suggested as a core deficit in Autism and Asperger's Syndrome (e.g., Baron-Cohen, 1997; Hobson, 1989, 1993a). Furthermore, emotion recognition skills are often investigated in individuals with Asperger's Syndrome as a way to understand why individuals with Asperger's Syndrome have difficulties interacting socially. Previous work has shown that a capacity to accurately recognise emotions being experienced by others is an important prerequisite for successful social relationships in children (Denham et al., 2003; Izard et al., 2001). Several studies have also shown that individuals with Asperger's Syndrome have particular difficultly recognising emotions from facial expressions (Baron-Cohen, Wheelwright, et al., 1997; Corden et al., 2008; Golan et al., 2008; Hobson, 1986a; Sawyer et al., in press; Wallace et al., 2008). Thus, it seems plausible that this impairment plays an important role in the social difficulties experienced by individuals with Asperger's Syndrome and Autism.

Studies of typically developing children show that emotion recognition skills are important prerequisites for the development of social competence (Custrini & Feldman, 1989; Denham et al., 2003; Izard et al., 2001; Miller et al., 2005). For example, Izard et al. (2001) investigated this relationship in a longitudinal study of 72 economically disadvantaged children at age 5 and at age 9. They investigated whether the ability to recognise and label emotions from photographs of facial expressions at age 5 predicted the children's level of social skills at age 9. They reported that level of emotion recognition ability at age 5 explained more of the variance in the level of social skills at age 9 than that explained by temperament, gender or verbal ability. This suggests that emotion recognition abilities are an important pathway through which children develop an ability to interact socially.

However, only a few studies have specifically examined the relationship between emotion recognition and social skills in *adults* with Autism Spectrum Disorders (Boraston et al., 2007; Garcı´a-Villamisar et al., 2010; Philip et al., 2010). Although, close inspection of these studies reveals that they did not necessarily clearly measure the relationship solely between emotion recognition and social skills. For example, Boraston et al. (2007) argue that emotion recognition is important for social skill in adults with Asperger's Syndrome. They examined this by testing the ability of adults with Asperger's Syndrome and Autism to accurately recognise emotions from faces or from animations of a triangle and a circle interacting in comparison to typically developing adults. They found that adults with Asperger's Syndrome and Autism were less able to accurately recognise the emotion of sadness from faces and from the animated triangle and circle than typically developing adults. For individuals with Asperger's Syndrome or Autism, impaired recognition of sadness from the triangle and circle animations was associated with impaired social skills as assessed by the Autism Diagnostic Observation Schedule; however, there was no relationship between impairments recognising sadness from the facial expressions and social skill.

In interpreting the association reported by Boraston et al. (2007) between scores on the animation task and social skill, it is likely that the animations used to test "emotion recognition" are testing participants' ability to use ToM skills rather than emotion recognition per se. Previously, Castelli et al. (2000) used animations of triangles to test ToM ability. In their task, similarly to the task used by Boraston et al. (2007), the animations showed two triangles interacting in some way. In the task used by Castelli et al. (2000), the interactions were designed to show a complex mental state and participants received high scores for ToM if they were able to describe the interaction in terms of one triangle deliberately performing an action with the goal of affecting the other triangle's mental state. In contrast, in the task used by Boraston et al. (2007) the interactions were designed to evoke an emotion (i.e., an animation of the triangle and circle ‘hugging’ was used for happiness), and participants were asked to rate how accurately an emotion described the interaction in each animation. Given that both of these tasks involve assessing the interaction between two characters, rather than the emotion shown by a single character’s facial expressions, it is likely that the task used by Boraston et al. (2007) engages participants ToM ability. For example, one animation depicting ‘anger’ showed the triangle ‘jabbing repeatedly’ at the circle (Boraston et al., 2007). In order to understand the emotion this animation is supposed to invoke, one must first understand the thoughts and feelings of the triangle towards the circle, and the triangle’s intention in ‘hitting’ the circle. Regardless of a participant’s emotion recognition ability, participants with effective ToM skills are likely to score highly on this task. Therefore, the association reported by Boraston et al. (2007) between scores on the triangle animations task and social skills may arise from the effect of ToM ability on social skills rather than from emotion recognition per se. This possibility will be reassessed in the present study using separate measures of ToM and emotion recognition skill.

A further difficulty with teasing out whether it is emotion recognition and/or ToM ability that is important for adult social skills is that these abilities are often found to be highly related. A number of studies have reported a relationship between ToM and emotion recognition (Buitelaar & Van Der Wees, 1997; Mier et al., 2010; Ribeiro & Fearon, 2010; Saxe, Carey, & Kanwisher, 2004). For example, Mier et al. (2010) found that the brain activation associated with emotion recognition and ToM ability overlapped, while Ribeiro and Fearon (2010) found that ToM ability predicts how attention is allocated to different emotional expressions. Furthermore, Ozonoff, Pennington, et al. (1991) found a relationship between ToM and emotion recognition ability in children with or without Autism Spectrum Disorders. Potentially, in childhood, emotion recognition ability is related to social skill given the more simplistic nature of children's social interactions, while in adulthood it may be ToM which is important for social skills, given the more complex nature of adult interactions. To maximise the distinction between emotion recognition and ToM in the present study, the aim was to try to assess 'pure' measures of each ability; that is, by assessing emotion recognition specifically as the ability to recognise emotions from facial expressions and assessing ToM using tasks that did not include facial expressions and required participants to infer the thoughts, feelings and intentions of others on the basis of an interaction.

Summary

The main aim of the present study was to understand the abilities that are important for social skills in adults with Asperger's Syndrome. Specifically, the study was interested in whether both meta-cognitive skill and ToM are important for social skills. In addition, the question of whether ToM and meta-cognitive skill are highly related abilities was also of interest. These questions were investigated by examining the relationship between social skill, ToM ability, meta-cognitive skill, and emotion recognition skill for adults with and without Asperger's Syndrome.

Method

Participants. This study uses data previously collected as part of Study 2. Participants consisted of 82 participants (30 diagnosed with Asperger's Syndrome, AS group, and 52 without Asperger's Syndrome, no-AS group; see Chapter 3 for demographic details).

Materials.

Social Skills Inventory. To complete the Social Skills Inventory (SSI), adults rate their own level of social skills in a number of domains including emotional expressivity, emotional sensitivity, emotional control (i.e., the ability to control or hide one's emotions), social expressivity, social sensitivity and social control. The sum of the scores on the six domains provides a total index of one's social skills. The SSI have been shown to demonstrate acceptable psychometric properties (Riggio & Carney, 2003). They found that the overall social skills scores exhibited good test-retest reliability over a 2-week interval (r = .94), and good internal consistency (*Cronbach's* α = .88). The SSI was also found to be a valid measure correlating with a number of measures in the expected directions and showing the expected female advantage for social skills (Riggio & Carney, 2003). Two participants with Asperger's Syndrome failed to complete the self-rated SSI. In the present study the SSI was also found to have acceptable internal consistency for both adults with Asperger's Syndrome (*Cronbach's* α = .89) and adults without Asperger's Syndrome (*Cronbach's* α = .76).

Tests of Theory of Mind ability. Two tests of Theory of Mind (ToM) ability were used. The first task was the Strange Stories Task developed by Happe (1994). The task involves written descriptions of a situation or interaction (e.g., two people going for a picnic and it rains, one person says "what a lovely day for a picnic") and the participant must identify the intention behind the characters' behaviour. Two kinds of stories are included: ToM stories, where the aim is to identify the intention behind a character's action, and physical stories, where the aim is to answer a question that demonstrates correct comprehension of the story. Physical stories are included as a control measure to ensure that differences in scores on the ToM stories are not due to differences in the ability to read and comprehend a written story. All of the stories are scored out of two on the basis of the accuracy of the participant's written response and there are two scores assessed in the strange stories task: a ToM score and a physical stories score. Scores for the two sections range from 0 – 16 with higher scores indicating better ToM ability and better reading comprehension ability respectively. Scores are presented as percentages.

The second ToM task selected was the ToM Animations Task (F. Castelli et al., 2000). In this task participants are presented with four animations that show two triangles interacting in different ways. At the end of each animation, the participant is asked to describe what was happening and how the triangles were interacting. Participants are scored on four criteria: intentionality (whether the participant describes the action in terms of mental states and intentions), appropriateness (how well the underlying interaction is understood), certainty (whether they hesitate or provide a number of different possibilities), and length of response. Certainty and length were used as control measures to account for differences in comprehension, expressiveness and verbal ability.

Both tasks were rated by two raters who were blind to the diagnostic status of the participant (except for vocal certainty which was scored by the person running the testing session on the basis of vocal tone). The results for inter-rater reliability showed that ratings for the Strange Stories Task for both total scores, ToM scores and physical story scores, were acceptably reliable (ToM scores: r = .88, physical stories: r = .77). Similarly, results showed that the inter-rater scoring for the separate ToM animation scores were also acceptably reliable (intentionality: r = .83, appropriateness: r = .63, length: r = .84).

Table 5.1.

Percentage Scores for Adults with and without Asperger's Syndrome (AS) on the Strange Stories Task and the Theory of Mind (ToM) Animations Task

	AS group (n = 30)		No-AS group (n = 52)			
	M	*(SD)*	*M*	*(SD)*	*t* (df)	*Cohen's d*
Strange stories task [a]						
ToM stories	73.5	(17.3)	89.3	(12.5)	4.7(79)**	1.09
Physical stories	72.6	(16.7)	81.9	(14.3)	2.6(79)*	0.61
ToM animations						
Intentionality	57.3	(18.2)	82.2	(16.2)	6.4(80)**	1.47
Appropriateness	65.8	(20.3)	88.9	(12.2)	5.6(41.3)**	1.48
Vocal certainty	87.2	(15.7)	96.5	(6.9)	3.1(35.4)*	0.84
Length	48.7	(18.2)	62.9	(15.6)	3.7(80)**	0.86

[a] One participant in the AS group did not complete the Strange Stories task therefore the analysis was based on 29 participants.

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

Adults without AS were found to score significantly higher than adults with AS on the control measures for both ToM tasks (i.e., Strange Stories Task – physical stories; ToM Animations – vocal certainty and length; see Table 5.1). Therefore, each ToM score was regressed on its associated control scores. The final variable for each ToM score was the residual value obtained from each regression analysis. This produces pure measures of ToM since it removes the effects of the control measures. Using these ToM scores for the Strange Stories Task the no-AS group still scored higher on the ToM ability than the AS group, t (79) = 3.53, p = .001 (see Table 5.2). Similarly, for the ToM Animations Task, the no-AS group still scored higher intentionality scores, t (80) = 3.62, p = .001, and appropriateness scores than the AS group, t (36.8) = 3.12, p = .003, see Table 5.2. Finally, it was found that all three ToM scores were highly correlated. The ToM score from the Strange Stories Task was highly correlated with the two scores of ToM from the Animations Task (intentionality: r = .56, p < .001, appropriateness: r = .47, p <.001), and the two ToM scores from the Animations Task were both highly correlated (r = .82, p <.001). This shows that all three scores were measuring a similar construct (i.e., ToM).

Table 5.2.

Means (Standard Deviations) for Adults with and without Asperger's Syndrome on the Strange Stories Task and the Theory of Mind (ToM) Animations Task

	AS group (n = 30)	No-AS group (n = 52)	*Cohen's d*
Strange Stories Task			
ToM stories	-0.45 (1.03)	0.31 (0.87)	0.82
ToM Animations			
Intentionality	-0.49 (1.00)	0.28 (0.87)	0.83
Appropriateness	-0.49 (1.29)	0.29 (0.61)	0.85

Stimuli.

Emotion recognition task. Participants completed the emotion recognition task as described in Study 2. For full details of the task refer to pages 57 - 59 of Chapter 3. The same scoring for accuracy, confidence and meta-cognitive skill was used as in Study 2.

Results

Social skills: Relationship with ToM and meta-cognitive skill. Social skills were shown to differ between the two groups. The AS group reported lower social skills on the self-rated Social Skills Inventory (M = 239.9, SD = 35.2) than the no-AS group (M = 280.4, SD = 30.2), t (78) = 5.4, p < .001, *Cohen's d* = 1.27. Hence, deficits in social skills among those with Asperger's Syndrome mirror the findings obtained earlier for emotion recognition accuracy, meta-cognitive skill (Study 2 pp. 72 - 78) and ToM ability (Study 4, Method, pp. 119 - 120). Therefore, it is possible that each of these abilities may contribute to the social skills difficulties experienced by adults with Asperger's Syndrome. To investigate this, ToM, meta-cognitive skill, and emotion recognition accuracy were entered as predictors in a multiple regression analysis with social skills as the dependent variable. However, to put this in context, correlations between ToM, meta-cognitive skill, and emotion recognition accuracy were obtained to determine the extent to which these are independent abilities.

The relationship between ToM, meta-cognitive skill and emotion recognition accuracy. None of the meta-cognitive variables were significantly correlated with any of the ToM measures for either the Asperger's Syndrome (AS) group or the no-AS group (see Table 5.3). Thus, ToM and meta-cognitive skill appear to be independent abilities.

Table 5.3.

Correlations (with 95% Confidence Intervals in Brackets) between ToM and Meta-cognitive Skills for the AS and No-AS Groups

	Gamma correlation			d prime (d')		
	AS	No-AS	*Z*	AS	No-AS	*Z*
Strange stories task						
ToM score	.20 (-.18 – .53)	.20 (-.08 – .45)	0.01	.23 (-.15 – .55)	-.01 (-.28 – .26)	1.01
ToM Animations						
Intentionality	.06 (-.31 – .41)	.09 (-.19 – .35)	0.13	-.12 (-.46 – .25)	-.01 (-.28 – .26)	0.55
Appropriateness	.04 (-.31 – .40)	-.05 (-.32 – .23)	0.38	-.29 (-.60 – .08)	-.02 (-.29 – .25)	1.16

Note. Comparisons are between the AS and no-AS groups using a test for comparing independent correlations (Cohen & Cohen, 1983).

*p < .05

For both groups, the Strange Stories Task ToM score was strongly positively correlated with emotion recognition accuracy scores (see Table 5.4). For the ToM animations, neither ToM score was correlated with emotion recognition accuracy for either group. When considering both the no-AS and AS groups together, the intentionality score from the ToM animations was positively correlated with the emotion recognition accuracy score. While the correlations between the intentionality score and emotion recognition accuracy did not reach statistical significance within the separate groups, the direction of the effect is in the expected direction and, at least for the AS group, the relationship is moderate in effect size.

Table 5.4.

Correlations (with 95% Confidence Intervals in Brackets) between Scores From the ToM Tasks, Meta-cognitive Skill and Emotion Recognition Accuracy for the AS and No-AS Groups

	Emotion recognition accuracy			
	AS	No-AS	*Z* [b]	Whole sample
Meta-cognitive skill				
Gamma correlation[a]	.26 (-.11 – .57)	.54** (.31 – .71)	1.41	.43** (.24 – .59)
d'	.12 (-.25 – .46)	-.16 (-.42 – .12)	1.18	.01 (-.21 – .23)
ToM ability				
ToM score (Strange Stories)	.54* (.22 – .75)	.36* (.10 – .58)	0.95	.50** (.32 – .65)
Intentionality (Animations)	.31 (-.06 – .60)	.19 (-.09 – .44)	0.54	.32* (.11 – .50)
Appropriateness (Animations)	.10 (-.27 – .44)	.08 (-.20 – .35)	0.08	.18 (-.04 – .38)

[a] This result was previously reported in Study 2, in Table 3.4.

[b] Comparisons are between the AS and no-AS groups (Cohen & Cohen, 1983).

* $p < .01$, ** $p < .001$

Finally the relationship between emotion recognition accuracy and meta-cognitive skill was considered. As previously presented in Study 2, for adults in the AS group there was a small positive correlation between emotion recognition accuracy and gamma correlation scores (see Table 5.4). While this did not reach statistical significance the direction of the relationship was in the expected direction and the failure to reach statistical significance may be due to low statistical power in the AS group. Similarly, as previously presented in Study 2, for adults in the no-AS group there was a large positive correlation between emotion recognition accuracy and gamma correlation scores. There is some evidence that emotion recognition accuracy is related to both ToM and meta-cognitive skill (accuracy discrimination ability in particular).

Do ToM, meta-cognitive skill and/or emotion recognition accuracy predict social skills? It was found that filtering effectiveness (d') was strongly positively correlated with scores on the Self-rated Socials Skills Inventory (SSI) for adults with Asperger's Syndrome, but not for adults without Asperger's Syndrome (see Table 5.5). Furthermore, there was a strong positive correlation between ToM scores from the Social Stories task and self-rated social skills. Finally, there was no correlation between emotion recognition accuracy and social skills. In summary, there is evidence that ToM and meta-cognitive skill (specifically filtering effectiveness) are associated with social skills scores. However, there is no evidence to support the proposition that emotion recognition accuracy is associated with social skill for adults with Asperger's Syndrome (or even among adults without Asperger's Syndrome).

Table 5.5.

Correlations (with 95% Confidence Intervals in Brackets) between the Social Skills Inventory (SSI), Meta-cognitive Skill, ToM, and Emotion Recognition Accuracy Scores

	SSI			
	AS	No-AS		Whole Sample
	n = 28	*n* = 52	*Z* [a]	*n* = 80
Meta-cognitive skill				
Gamma correlation	-.29 (-.59 – .09)	.17 (-.11 – .42)	1.91	.05 (-.17 – .27)
d'	.40* (.03 – .67)	.09 (-.19 – .35)	1.36	.29* (.08 – .48)
ToM ability				
ToM score (Strange Stories)	.22 (-.17 – .55)	.09 (-.19 – .35)	0.54	.30** (.09 – .49)
Intentionality (Animations)	-.13 (-.48 – .26)	-.07 (-.34 – .21)	0.25	.13 (-.09 – .34)
Appropriateness (Animations)	-.10 (-.46 – .28)	-.25 (-.49 – .03)	0.63	.08 (-.14 – .30)
Emotion recognition				
Accuracy	-.15 (-.49 – .23)	.01 (-.26 – .28)	0.66	.12 (-.10 – .33)

[a] Comparisons are between the AS and no-AS groups (Cohen & Cohen, 1983).

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

A simultaneous multiple regression analysis was undertaken to assess whether ToM ability and meta-cognitive skill independently contribute to social skills. Emotion recognition skill was not included in this analysis as it had not been found to be correlated with social skills scores (despite being associated with ToM ability which was correlated with social skills scores). The predictor variables used for meta-cognitive skill and ToM ability were those significantly related to social skills; that is, ToM ability scores from the Strange Stories Task and filtering effectiveness indexed by d' scores.

From a theoretical perspective, it makes most sense to consider these analyses separately for each of the two diagnostic groups. However, a great deal of caution is required in interpreting the results due to the small sample sizes involved for each of these analyses. Neither variable significantly predicted variance in social skills in the no-AS group. For the AS group ToM did not significantly contribute uniquely to social skills, $\beta = .14$, $p = .46$. However, filtering effectiveness did contribute uniquely to social skills, $\beta = .37$, $p = .06$. While this relationship only approached significance, this may be a result of low statistical power due to the small number of participants in the AS group ($n = 30$). Filtering effectiveness was found to predict 12.9% of the variance in social skills for adults with Asperger's Syndrome.

Due to the small sample size in each diagnostic group and the lack of significant results in the preceding analyses, the same analysis was repeated for the sample as a whole – although some caution is again required since the earlier findings may have missed relationships due to low statistical power. For the sample as a whole, ToM and filtering effectiveness combined significantly predicted 14.7% of the variance in the social skills scores, F (2, 77) = 6.61, $p = .002$. ToM uniquely predicted 6.6% of the variance in social skills scores, $\beta = .26$, $p = .02$, while d' scores uniquely predicted 5.8% of the variance in social skills scores, β = .24, p =.03. This suggests that both ToM and meta-cognitive skill (in particular, filtering effectiveness) independently contribute to social skill for adults.

Discussion

The main aim of this study was to look at some of the key factors that may contribute to social skills in adulthood. This may aid in determining what could be targeted in interventions attempting to improve social skills in adults with Asperger's Syndrome. More specifically, the proposition that ToM and meta-cognitive skill are separate abilities that are independently important for social skills in adulthood was tested. It was found that ToM skill and meta-cognitive skill (in particular, filtering effectiveness) both independently contributed to social skill. Furthermore, it was investigated whether emotion recognition accuracy is related to social skills in adulthood, or whether it is simply an outcome of ToM ability. It was found that emotion recognition accuracy was highly associated with ToM ability but was not related to social skills. The findings from this study suggest that meta-cognitive skill and ToM are important abilities to focus on to gain an understanding of the social skills difficulties of adults with Asperger's Syndrome, and that emotion recognition accuracy does not appear to be important for social skills in adulthood.

Meta-cognitive skill, ToM and social skills. Consistent with previous research, adults with Asperger's Syndrome were found to have deficits in ToM ability (Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Golan, Baron-Cohen, Hill, & Golan, 2006). While it was thought that ToM and meta-cognitive skill may be components of the same underlying ability it was found that there was no relationship between ToM and meta-cognitive ability. This suggests that ToM and meta-cognitive ability are independent abilities. It is likely that the ability to understand the thoughts and feelings of others involves a different skill to being able to understand one's own thoughts and feelings. Potentially, being able to understand thoughts and feelings via perspective taking requires the prerequisite ability to understand that others have "minds" that are different to our own and as a result they are likely to interpret events and experiences differently. Then using this understanding, one must empathise with the perspective of the other person in order to understand their thoughts, feelings and beliefs. In contrast introspection may only require the ability to label and understand one's own internal experiences of events. Thus, having an ability to understand one's own thoughts and feelings via introspection does not necessarily translate to an ability to understand the thoughts and feelings of others via perspective taking.

Furthermore, the results of the present study provide some support that both ToM ability and meta-cognitive skill (in particular filtering effectiveness) were independently important for social skill in adulthood – although a slightly different interpretation arises when we consider each diagnostic group separately (see next paragraph). Due to the slightly differing pattern of findings, these results are interpreted with caution, particularly since statistical power issues underpin the findings. The findings are consistent with the suggestion by Beupre and Hess (2006) that the ability to identify accurate emotion recognition judgments to use as the basis for behaviour is a key skill for social interaction. This is also consistent with the study by Tager-Flusberg (2003) that reported that ToM and social skills were related. Furthermore, this helps us to understand the relationship between ToM and social skills. The results suggest that meta-cognitive skill contributes to social skills over and above that which is contributed by ToM ability. That is, both the ability to understand the thoughts, feelings and intentions of others, and the ability to effectively identify emotion recognition judgments to use as the basis for behaviour during a social interaction are important for effective social skills. In order to improve the social skills of adults with Asperger's Syndrome it is likely to be important to focus on improving both ToM ability and meta-cognitive skill.

When the relationship between ToM, meta-cognitive skill and social skills was considered separately for the two diagnostic groups it was found that filtering effectiveness contributed to social skills scores for adults with Asperger's Syndrome, though this effect only approached significance. This is almost certainly a function of low statistical power. In contrast, ToM and meta-cognitive skill did not predict social skills for adults without Asperger's Syndrome. Adults without Asperger's Syndrome all achieved relatively high ToM and meta-cognitive skill scores, perhaps because most of the individuals without Asperger's Syndrome had a functioning level of ability in these areas. It may be that better ToM and meta-cognitive skills do not continue to contribute to social skills beyond a certain level of competency. Adults with Asperger's Syndrome in comparison were found to have difficulties successfully completing ToM tasks and effectively filtering their responses. It may be that these individuals score below a level of competency that is necessary for successful social skills, meaning that for this group higher ToM and meta-cognitive scores do predict better social skills. This possibility could be examined by testing these skills in a larger group of adults without Asperger's Syndrome, including those who tend to score low on ToM and meta-cognitive skill. This would allow a comparison of low and high scorers to assess whether ToM and meta-cognitive skills do predict social skills in low scorers, who have not met the required level of competency, while these skills are not related to social skills for high scorers, who have met the necessary level of competency. This may provide information about the level of ToM and meta-cognitive skill that is necessary to achieve in order to have successful social skills, and after which no further improvements can be made to social skills by increasing ToM and meta-cognitive skills. However, this may not be a testable question as it is possible that typically developing individuals all develop a strong ability to successfully complete ToM tasks and to use meta-cognitive skills.

Emotion recognition skills and social skills. Previously research has shown that emotion recognition skills may be important for social skills in childhood (Denham et al., 2003; Izard et al., 2001). However, it was unclear whether emotion recognition continues to be the mechanism used in social interactions in adulthood. It was found that emotion recognition skill was not related to social skill in adults in the present study, but emotion recognition was highly related to ToM ability. One possible implication is that, in adulthood, emotion recognition ability is no longer crucial for social skills. Instead, it appears that ToM is more important for social skills in adulthood, and that adults use their ToM ability in order to complete emotion recognition tasks. This finding is consistent with Boraston et al. (2007) whose results suggested that the ability to recognise emotions *from faces* was not related to social skill in adults. It is possible that in adulthood the emotional meaning of facial cues is not always singular as it is in childhood, (e.g., crying in childhood almost always indicates sadness), but rather in order to understand what emotion another adult is feeling, adults need to also be able to take into account the other person's intentions and beliefs using ToM skills (e.g., understanding when crying is an expression of happiness, such as when an expected negative event does not occur).

Finally, while emotion recognition accuracy was not related to social skills, the ability to effectively filter emotion recognition decisions was related to social skills. It is likely that this skill is important for social skills specifically when used to assess the reliability of emotion recognition judgments. Alternatively, it may be that the ability to effectively filter responses is a general ability important for many kinds of judgments that we make about others in social situations and then use as a basis for behaviour. This could be tested by examining the relationship between social skills and filtering effectiveness on a more general social task such as the Interpersonal Perception Task, in which participants view video clips of people interacting socially and have to make judgments about their situation from the nonverbal and verbal cues in the scene.

A potential limitation of the present study is the use of a self-report scale to measure social skills. It is possible that adults with Asperger's Syndrome have difficulties accurately introspecting about their own level of social skills. However, the study did find the expected difference in social skills in comparison to adults without Asperger's Syndrome, suggesting that adults with Asperger's Syndrome were able to report on their own social skills. Furthermore, if adults with Asperger's Syndrome were unable to introspect about their social skills, then non-significant relationships for those predicted between social skills and the other factors tested would be expected. However, a relationship between ToM, meta-cognitive skills, and social skills for adults with Asperger's Syndrome was found in the expected direction. Again, this makes us more confident that adults with Asperger's Syndrome are able to introspect about their own social skills to some degree of accuracy. To confirm this, future research could involve replication of the present study using an observer-rated test of social skills, such as the Autism Diagnostic Observation Schedule.

A further limitation of the use of a self-report measure to assess social skills is that it is likely that this measure may also capture participant's ability to use meta-cognitive skill. It is possible that in order to introspect about one's own social abilities participants need to have good meta-cognitive skills. Therefore, the relationship between meta-cognitive skill and social skills could be due to the nature of the measurement of social skill in the present study. Again, it will be important for future research to investigate the relationship between meta-cognitive skill and social skill using objective, observer rated measures of social skill.

Summary. In summary, it appears that ToM and meta-cognitive skill (specifically, effective response filtering) are independent abilities that uniquely contribute to social skills in adulthood. In contrast, emotion recognition skill was found to be unrelated to social skills but was related to ToM ability and an aspect of meta-cognitive skill (accuracy discrimination ability). In sum, it does not seem to be the case that emotion recognition skill is a mechanism through which ToM affects social skill. This suggests that one potentially promising avenue for future interventions aimed at increasing social skills is to focus on improving ToM and meta-cognitive skill (particularly that related to effective filtering of emotion recognition judgments).

General Discussion

Overview

The main aim of this thesis was to understand why individuals with Asperger's Syndrome have difficulty recognising emotions from facial expressions and more broadly the implications of this difficulty for the social skills of people with this disorder. To investigate this the thesis aimed to answer four specific questions: (1) do individuals with Asperger's Syndrome scan faces differently than individuals without Asperger's Syndrome, resulting in their ability to recognise emotions being impaired; (2) are individuals with Asperger's Syndrome less able to effectively use meta-cognitive skills to make accurate decisions about emotional expressions resulting in more uncertainty in decision making; (3) do individuals with Asperger's Syndrome have a difficulty generalising emotion recognition abilities to unfamiliar faces, and; (4) what is the relationship between emotion recognition abilities and other abilities hypothesised as important for success interacting socially, including meta-cognitive skill and Theory of Mind (ToM) ability.

In the four studies, utilised to answer these questions, individuals with Asperger's Syndrome were consistently found to have difficulty recognising basic and complex emotions from facial expressions. This difficulty was not explained by gaze avoidance as individuals with Asperger's Syndrome did not show more gaze avoidance than individuals without Asperger's Syndrome (Chapter 2). Individuals with Asperger's Syndrome were found to have difficulty using meta-cognitive skills to make decisions about the emotions of others. That is, they were found to be less effective at filtering their responses in comparison to individuals without Asperger's Syndrome. Despite this, they were able to use accuracy discrimination abilities as well as individuals without Asperger's Syndrome when making emotion recognition decisions (Chapter 3). Moreover, individuals with Asperger's Syndrome were no better at recognising emotions from familiar faces than unfamiliar faces, suggesting that their difficulty recognising emotions from facial expressions was not due to a difficulty generalising skills to recognise the expressions of strangers (Chapter 4). Finally, as there was no relationship between emotion recognition accuracy and social skills, it is suggested that it is unlikely that the emotion recognition deficits of adults with Asperger's Syndrome have direct implications for their social skills; rather more complex abilities such as ToM and meta-cognitive skills appear to be more critical for effective social skills (Chapter 5).

Findings from the thesis are discussed in two sections. The first section describes what has been learnt about the emotion recognition skills of individuals with Asperger's

Syndrome from the results of the present thesis. The second section describes the findings that suggest that meta-cognitive skills and ToM abilities, rather than emotion recognition accuracy, are important for social skills.

What Have we Learnt about the Emotion Recognition Abilities of Individuals with Asperger's Syndrome?

Individuals with Asperger's Syndrome are commonly believed to have difficulty recognising emotions. This difficulty is thought to contribute to their difficulties with social interaction (e.g., Boraston et al., 2007; Garcı´a-Villamisar et al., 2010; Philip et al., 2010). In the present thesis, consistent evidence showed that individuals with Asperger's Syndrome do have difficulty accurately recognising emotions from facial expressions. This is consistent with results from previous research investigating the ability of individuals with Asperger's Syndrome to recognise emotions (Baron-Cohen, Wheelwright, et al., 1997; Corden et al., 2008; Golan et al., 2008; Hobson, 1986a; Wallace et al., 2008).

Findings from the thesis suggest that a greater focus on cognitive processing may provide a better understanding of the reasons why individuals with Asperger's Syndrome have difficulty recognising emotions and interacting socially. Firstly, at least in part, findings from Study 1 suggest that individuals with Asperger's Syndrome do not have problems looking at key regions of faces when asked to recognise emotions in facial expressions. For example, individuals with Asperger's Syndrome in the study looked at important regions of the face for the same length of time as individuals without the disorder. While they were still less accurate recognising emotions from facial expressions than individuals without Asperger's Syndrome, they did perform above chance level on the emotion recognition tasks. This suggests that they do have an ability to recognise emotions but this was less refined than the ability of individuals without Asperger's Syndrome. Secondly, there was evidence that making these decisions about the emotions of others was more cognitively effortful for individuals with Asperger's Syndrome. For example, they took longer to recognise and identify the emotions shown in facial expressions. Third, results showed that problems using ToM ability were related to the emotion recognition difficulties of individuals with Asperger's Syndrome. Specifically, it was found that greater ToM ability was associated with greater emotion recognition accuracy for individuals with Asperger's Syndrome.

Finally, while a difficulty using hard-wired biological recognition cannot be ruled out, there is evidence from other research to suggest that such a difficulty may not be responsible for the difficulty individuals with Asperger's Syndrome have accurately recognising emotions. For example, although previous research has reported that, in comparison to individuals without Asperger's Syndrome, individuals with the disorder have differences in their brain activity when assessing the facial expressions of others (Ashwin et al., 2006; Dalton, Nacewicz, Alexander, & Davidson, 2007; Dalton et al., 2005; Schultz, 2005), this abnormal activation has not been consistently associated with emotion recognition accuracy (e.g., Dalton et al., 2005). Even if a biological reflex process is responsible for identifying the emotions of others it is still likely that translating this into successful social behaviour requires engaging in cognitive processes, such as filtering effectiveness. A more thorough focus on the cognitive processes that are important for making accurate emotion recognition decisions has the potential to provide a better understanding of key components to target, leading to better psychological treatments to improve the social skills of individuals with Asperger's Syndrome.

Broadly speaking, the results from Studies 1, 2 and 3 suggest that the difficulty individuals with Asperger's Syndrome had accurately recognising emotions from facial expressions was due to a specific difficulty interpreting the emotional meaning of facial cues, rather than a more general information processing deficit. For example, it was found that this difficulty was not due to a more general deficit in scanning key regions of facial expressions (Chapter 2). Furthermore, it was found that this difficulty was not due to a more general deficit using accuracy discrimination ability to make accurate multiple choice decisions. Results showed that individuals with Asperger's Syndrome did not have a deficit using accuracy discrimination ability as compared to individuals without the disorder when making both general knowledge decisions (non-emotion based decisions) and emotion recognition decisions (pp. 67 - 69). Finally, the difficulty was also not due to a deficit in generalising emotion recognition abilities from familiar to unfamiliar faces, as individuals with Asperger's Syndrome showed no advantage for recognising emotions from familiar faces (pp. 99 - 100). Taken together these results suggest that the difficulty individuals with Asperger's Syndrome have recognising emotions arises specifically from problems in being able to accurately interpret the emotional meaning of facial cues. It was found that problems using ToM abilities contributed to this difficulty (pp. 121 - 123). It is possible that a difficulty accurately interpreting the emotional meaning of facial cues is part of a broader problem using ToM abilities to interpret and understand the thoughts, feelings and behaviour of others.

The specific difficulty accurately interpreting the emotional meaning of facial cues was not due to a lack of experience or practice using this ability. In Study 1 it was hypothesised that gaze avoidance may lead to individuals with Asperger's Syndrome being unable to interpret important facial cues from the eye region as this would result in limited experience examining and interpreting information from this region (pp. 16 – 21). However, individuals with Asperger's Syndrome did not show evidence of gaze avoidance, and they performed above chance levels even when the eye region was the only cue available to interpret the emotional meaning of a facial expression. While these results do not rule out the possibility that individuals with Asperger's Syndrome have difficulty encoding and interpreting the emotional meaning of facial cues, they do suggest that individuals with Asperger's Syndrome do not avoid looking at the eye region and do have some ability to interpret information from this region. A limitation of this investigation however, is that none of the studies in the present thesis addressed that possibility that individuals with Asperger's Syndrome may have difficulties encoding visual information during perceptual tasks. That is, it may be that individuals with Asperger's Syndrome have difficulties making both emotional and non-emotional judgements from faces, due to difficulties encoding perceptual information from faces. This would need to be investigated in future research, as discussed in Chapter 3, to confirm the results of the present study.

In Study 3 it was hypothesised that individuals with Asperger's Syndrome may be more accurate recognising emotions from familiar faces as they have more practice recognising emotions from the facial cues of those they know well (pp. 88 – 94). It was thought that even if individuals with Asperger's Syndrome do show some evidence of gaze avoidance in real life they will inevitably have more experience interpreting emotional cues from the eye region of those they know well, due to the greater amount of time spent interacting with familiar people. However, no effect of familiarity on emotion recognition accuracy was found. As previously discussed, a limitation of this study is that a comparison group of individuals without Asperger's Syndrome was not included. However, the results do show that individuals with Asperger's Syndrome do not differ in their emotion recognition accuracy for individuals they have more experience interacting with in comparison to those they have never met before. Thus, this study does provide some evidence that experience or amount of exposure to particular facial expressions does not change the emotion recognition abilities of individuals with Asperger's Syndrome.

In combination, these results suggest that increasing the amount of experience individuals with Asperger's Syndrome have making emotion recognition judgments is unlikely to lead to better emotion recognition accuracy. This is consistent with previous studies that have used practice-based interventions to train individuals with Asperger's Syndrome, and found no generalisation of any improvements to new faces or situations (Bolte et al., 2002; Golan & Baron-Cohen, 2006). Therefore, taken together, these results suggest that it is unlikely that interventions that focus on practising emotion recognition abilities will be of benefit for those with Asperger's Syndrome. Instead interventions should focus on targeting and improving the key cognitive processes that underlie emotion recognition abilities and social skills. This could be investigated in future research by comparing the efficacy of interventions that focus on improving emotion recognition accuracy through repeated practise versus interventions that focus on improving meta-cognitive skills to help translate emotion recognition accuracy into social skills. If this intervention were to lead to individuals with Asperger's Syndrome to being better able to identify when their emotion recognition judgements were accurate, in comparison to repeated practise style interventions, it would suggest that this may be a promising avenue for future treatments.

It is possible that repeated practice of emotion recognition abilities may not improve the underlying cognitive processes important for emotion recognition during social interactions, but instead lead individuals with Asperger's Syndrome to develop compensatory strategies to complete this task. These may enable individuals with

Asperger's Syndrome to more accurately complete tasks when they are performed in isolation from real social interaction such as during "laboratory-based" tasks but not lead to improvement in the key cognitive processes that are crucial for success in everyday social interactions (Repachol & Slaughter, 2003). It is important to acknowledge that the evidence of difficulties for those with Asperger's Syndrome in the present thesis is based solely on laboratory-based tests of emotion recognition and may not translate to emotion recognition in natural settings. There is evidence from previous research to suggest that individuals with Asperger's Syndrome may use compensatory strategies to complete these laboratory-based tasks. For example, Ponnet, Roeyers, Buysse, De Clercq, and Van Der Heyden (2004) found that individuals with Asperger's Syndrome were able to successfully complete laboratory-based tests of ToM, but were unable to utilise ToM ability to accurately interpret the thoughts and feelings of two people interacting. Furthermore, Koning and Magill-Evans (2001) found that adolescents with Asperger's Syndrome reported relying on facial cues in social situations, but failed to consider the range of other important social cues similarly to individuals without Asperger's Syndrome. It is possible that individuals with Asperger's Syndrome have difficulty in real life social interaction integrating all the necessary cues and simultaneously using all the necessary cognitive processes that are important for effective social interactions. Future research should investigate this by testing cognitive processes that are important for emotion recognition and social skills in live interactions that require the simultaneous and quick use of all these skills. This could be investigated using the paradigm employed by Ponnet et al. (2005) where individuals participated in a live social interaction and then rated their own and their partner's emotions and mental states using a video recording of the scene. This paradigm could be used to validate the importance of the cognitive factors identified in the present thesis as important for social interactions, particularly filtering effectiveness.

The two cognitive processes that were found to be important for accurate emotion recognition in the present study were ToM ability and accuracy discrimination ability. It is possible that these abilities help individuals to make more accurate emotion recognition decisions. For example, ToM ability is important as it enables individuals to take other people's perspectives and integrate information from a number of cues (beliefs, thoughts, intentions, facial cues, vocal cues) to reduce the number of possible emotional states other individuals may be expressing. Subsequently, accuracy discrimination is important as it can facilitate the use of confidence to guide choices about the emotional states of others.

While accuracy discrimination and ToM abilities may both be important to use in sequence to make accurate emotion recognition decisions, it is possible that these two abilities may not be linked (i.e., high abilities on one do not necessarily mean that an individual has high abilities on the other). In fact, the results from the present thesis suggest that these two abilities function independently of each other (p. 121 – 126). Furthermore, accuracy discrimination ability did not differ between those with Asperger's Syndrome and those without, but ToM ability did differ between these two groups. Thus, individuals with Asperger's Syndrome may have difficulty using ToM to initially assess the likely emotional state that another person is expressing. However their use of accuracy discrimination ability to make a final choice about the most likely emotion being expressed is still functioning normally (although likely reduced in effectiveness due to problems with ToM).

In the present study another characteristic that differed between those with

Asperger's Syndrome and those without Asperger's Syndrome was the ability to engage in effective filtering of emotion recognition decisions. It was found that a much larger proportion of those with Asperger's Syndrome failed to engage in filtering their responses (p. 72). Although, this difficulty was not related to emotion recognition accuracy, it was related to level of social skills (p. 124 – 126). Thus, those who were better at effectively filtering their responses were also better at interacting socially. This, in combination with the lack of correlation between accuracy discrimination and filtering effectiveness (p. 77), suggests that these two abilities are independent sub-components of meta-cognitive skill.

While in the present thesis accuracy discrimination ability was not related to social skills, similarly to filtering effectiveness, it is possible that this resulted from the way accuracy discrimination ability was tested. Study 2 tested participants' ability to use accuracy discrimination in order to increase the accuracy of emotion recognition decisions. However, Study 4 found that greater emotion recognition accuracy was not related to greater social skills. Thus, it makes sense that when tested in terms of emotion recognition decisions, accuracy discrimination ability was not related to social skills. Study 4 also found that better ToM accuracy was related to better social skills. Thus, if we tested participants' ability to use accuracy discrimination ability to increase the accuracy of their ToM decisions, then it is likely that we would have found a relationship between accuracy discrimination and social skills. It is worth noting though, that this argument assumes that accuracy discrimination is an ability that is used to make a range of social decisions. However, it is unknown whether participants use accuracy discrimination to make ToM decisions. This could be tested by including ratings of confidence throughout a multiple choice ToM task, and then assessing whether accuracy discrimination ability, when paired with ToM decisions, is in fact important for better social skill.

Alternatively, it is also possible that accuracy discrimination is not important for good social skills, given that social skills are measured in terms of the ability to translate judgments about the emotional state of others into successful behaviour rather than just the ability to make accurate judgments. Accuracy discrimination and filtering effectiveness may be components of a two stage process that is an important sequence for social skill, but that can occur independently. That is, accuracy discrimination may be a cognitive ability that we use to make a judgment about the emotional state of another. Once we have made this judgment we then use our filtering skills to assess the reliability of this judgment. If it is deemed likely to be accurate, we then make a decision to act on this judgment and translate it into behaviour. This is similar to the idea that intelligence gives a general indication of academic ability, but academic performance relies on a number of skills to translate this ability into academic skill.

This argument suggests that accuracy discrimination ability does not necessarily lead to skill with filtering. This is counter-intuitive as we tend to expect that if someone is able to use their confidence as a guide to the accuracy of their judgments about the emotions of others, they will also have a more global ability to assess the likely accuracy of their final decisions. However, this does not appear to be the case, particularly for those with Asperger’s Syndrome. It may be that in order to engage in effective filtering one also needs a global understanding of one’s emotion recognition abilities and self-awareness of the likely limits of one’s abilities to accurately predict the emotional state of others. For example, I may be capable of using confidence to discriminate which is most likely to be the correct emotion shown in a facial expression (e.g., I can tell that the expression is positive so I can rule out a number of options, I can see the mouth of the expression suggests that the emotion is surprised, so I select this option). However, if I do not have a self-awareness that I am not very capable at discriminating positive from negative emotional expressions, it is likely that I will not then engage in effective filtering and will fail to consider whether my judgment is sufficiently reliable to use as the basis for social behaviour. This could be tested by assessing whether the relationship between perceived accuracy and actual accuracy predicts whether or not individuals with Asperger's Syndrome are effective at filtering their responses. If a global awareness of one's emotion recognition accuracy abilities is important for engaging in effective filtering, we would expect that those who have a high correlation between their perceived accuracy and their actual accuracy would also be those who are more effective at filtering their responses.

It is possible that individuals with Asperger's Syndrome do not have an accurate self-awareness of their emotion recognition abilities, and this leads to a larger proportion of individuals with Asperger's Syndrome not engaging in effectively filtering their responses. This is consistent with the evidence from the present thesis that showed that individuals with Asperger's Syndrome may not have a good understanding of their own emotion recognition abilities. For example, it was found that there were no differences in how confident individuals with or without Asperger's Syndrome were in the accuracy of their responses in the emotion recognition task, despite individuals with Asperger's Syndrome being consistently less accurate (pp. 63 – 64). If self-awareness of one's abilities is important for engaging in effective filtering, this would suggest that to improve filtering in individuals with Asperger's Syndrome we would first need to improve their understanding of their own emotion recognition capabilities.

It is also possible that the difficulty individuals with Asperger's Syndrome have engaging in effective response filtering is a part of a larger deficit experienced by individuals with Asperger's Syndrome in executive functioning (Ozonoff, Rogers, &

Pennington, 1991; Ozonoff, South, & Provencal, 2007). Executive functioning is defined as "the cognitive construct used to describe goal-directed, future-oriented behaviours thought to be mediated by the frontal lobes including planning, inhibition of prepotent responses, flexibility, organised search, self-monitoring and use of working memory" (Ozonoff et al., 2007, p. 185). As such it is likely that problems with executive functioning may underlie the deficit engaging in effective response filtering. Furthermore, Ozonoff, Rogers, et al. (1991) found that individuals with Asperger's Syndrome had problems with executive functioning but not ToM. This suggests that these abilities may be independent which is consistent with findings in this thesis. This could be further tested by assessing whether the ability to successfully complete executive function tasks is associated with the ability to effectively engage in response filtering.

The Importance of Meta-cognitive Skills and ToM Ability for Social Skill

One of the broad aims of the present thesis was to understand the implications of difficulty accurately recognising emotions from facial expressions for the social skills of individuals with Asperger's Syndrome. While there is evidence that emotion recognition accuracy is important for social skills in children (Denham et al., 2003; Izard et al., 2001), it was found in the present thesis that emotion recognition accuracy was not related to the social skills of adults with Asperger's Syndrome. It is possible that the finding of a relationship between emotion recognition and social skills is a spurious finding arising from ToM ability being related to both emotion recognition and social skills. Alternatively, in childhood it is possible that emotion recognition skills are important to function effectively in the social world given the more simplistic nature of children's interactions (e.g., crying generally indicates sadness about something). In contrast, in adulthood the ability to recognise emotions from faces may be insufficient to function socially given the more complex nature of adult social interactions (e.g., the meaning of crying in adulthood may be sadness or happiness depending on the context, and the person's beliefs and expectations). In adulthood as well as being able to interpret the emotional meaning of facial cues, it may also be necessary to take into account preceding actions, the context, the person's beliefs and intentions, and how these factors may affect the emotions another person is expressing. ToM and meta-cognitive skills may allow us to weigh the importance of these different factors and integrate them in order to understand the emotions another person is expressing in a social situation, and to decide how to act socially appropriately in response.

It is important to note that in the present study while greater emotion recognition accuracy was not related to better social skills, the ability to more effectively filter emotion recognition judgments was related to better social skills. This suggests that there may be benefit if we change the way we conceptualise emotion recognition ability in order to understand its relationship to social skills. The results from this thesis suggest that social skills are better explained by considering how individuals interpret their emotion recognition ability rather than their emotion recognition ability itself. For example, the results from this thesis suggest that the ability to use cognitive skills, such as filtering effectiveness in relation to emotion recognition judgments, is important for effective social skills. It is recommended that future research that seeks to understand the social difficulties of individuals with Asperger's Syndrome should turn to trying to understand why individuals with Asperger's Syndrome have difficulties using these cognitive processes to translate emotion recognition judgments into successful social behaviour.

Consistent with the hypothesis of Study 4, that both ToM and meta-cognitive skill (specifically effective response filtering) are both important for social skills, it was found that these were independent skills that uniquely contributed to social skills for adults. Furthermore, it was also found that different aspects of ToM and meta-cognitive skill are likely to be important for emotion recognition versus social skills. For ToM, a relationship was found both with social skills and emotion recognition. However despite these two relationships, no relationship was found between emotion recognition and social skills. This suggests that different components of ToM ability may be important for emotion recognition in contrast to those that are important for social skills. For example, it may be that the ability to understand the mental states of others from their facial cues is important for emotion recognition, while the more general ability to integrate the psychological meaning of many sources of information, including the thoughts, intentions and behaviour of others, is an aspect of ToM that is important for social skills.

A similar pattern of results was also found for meta-cognitive skills. While accuracy discrimination ability was found to be associated with emotion recognition accuracy, effective response filtering was found to be associated with social skills. That is, the ability to use confidence to aid in selecting an accurate response was found to be important for emotion recognition accuracy. Once individuals have made a decision, the ability to then assess the reliability of the decision and select out only accurate decisions to act on was found to be important for better social skills. As previously discussed, accuracy discrimination ability may not be a precursor for filtering effectiveness, and in contrast different abilities such as self-awareness and executive functioning may lead to effective response filtering. An important limitation to note however is that in the present study, as social skills were self-rated, it is possible that this resulted in the relationship between meta-cognitive skill and social skills, as discussed in Chapter 3. Future research should attempt to replicate the relationship between meta-cognitive skill and social skills using objective observer rated social skills scales.

The question that remains is why both ToM and effective response filtering skills independently contribute to social skills. As previously mentioned, a potential explanation for this is that ToM is an ability that aids in making accurate judgments, while filtering effectiveness then works to translate these judgments into successful behaviour by identifying judgments to use as the basis for behaviour. It is possible that a global awareness of one's ability to interpret social cues leads to developing effective filtering skills, and that this occurs independently of developing skill in interpreting the thoughts, feelings and intentions of others. For example, I may be aware that I have difficulty accurately assessing when another's intention is to lie to me, therefore with this awareness I will monitor the context of social interaction to assess whether it may be a situation in which someone may lie and I should be more cautious about filtering my judgments. This ability may work in parallel to my ToM ability that enables me to accurately assess whether or not someone is lying. This argument is consistent with the suggestion that these two abilities have an additive effect on social skills. That is, if I have moderate ToM but poor filtering I will be accurate a certain amount of the time due to my moderate ToM abilities, leading to effective social skill. Similarly if I have moderate filtering skills but poor ToM abilities I may not make as many accurate judgments about the thoughts and feelings of others, but my moderate filtering skills will mean that I will only act on accurate judgments, again leading to effective social skills. To fully understand how these two abilities contribute to social skill it will be important for future research to examine the effects of these abilities during live social interactions, rather than assessing the relationship between these abilities when they are tested in discrete laboratory-based tasks. The dynamic nature of social interactions and the likelihood that these abilities need to be used in combination to integrate the large amounts of information processed in social situations, mean that these abilities may be used in a more inter-related way in live social situations. However, this is a question for future research and for now the results of the present study suggest that these abilities are independently important for social skills.

Finally, while it has been suggested that a deficit in executive functioning may contribute to the difficulty a large group of individuals with Asperger's Syndrome had engaging in effective response filtering, it is also possible that this ability contributes to the use of ToM ability during social interactions. For example, some previous studies have reported that there is a relationship between ToM and executive functioning abilities (Pellicano, 2007). However, since in the present study ToM and meta-cognitive skill functioned independently of each other, this suggests that different aspects of executive functioning may be important for these two different abilities. It is likely that abilities such as working memory and integrating a number of cues are likely to be important for using ToM ability during a social situation. For example, ToM may allow us to accurately assess the thoughts, feelings, intentions and behaviours of someone, but it is executive functioning that helps us to hold all of this information in working memory so that it can be integrated to come to a conclusion about the most likely emotion the person is experiencing. In contrast, abilities such as self-monitoring and response inhibition may be important for filtering effectiveness. For example, during a social interaction these abilities may allow us to continue to assess the likely accuracy of judgments and select out accurate judgments to use as the basis of behaviour, whilst inhibiting responding on the basis of judgments that are likely to be inaccurate. This could be tested in future research by assessing whether tests of these different aspects of executive functioning do show the expected relationships to ToM ability and filtering effectiveness skill. This would allow a more integrative understanding of how the different cognitive processing difficulties experienced by individuals with Asperger's Syndrome work together to affect social skills. It would also allow greater understanding of the different pathways to target in order to improve social skills for individuals with Asperger's Syndrome.

Summary

In conclusion, individuals with Asperger's Syndrome were found to have difficulty accurately recognising emotions from facial expressions. However, it was not accuracy alone that was found to be important for social skills, but engaging in the effective filtering of emotion recognition decisions. This suggests that we need to reconceptualise how it is we test emotion recognition ability if our goal is to understand how this affects the social skills of adults with Asperger's Syndrome. It was also found that ToM and effective response filtering were cognitive processes that are independently important for the social skills of individuals with Asperger's Syndrome. Interventions to improve social skills in adults with Asperger's Syndrome may benefit from focusing more on improving ToM and meta-cognitive skills. Trying to improve emotion recognition accuracy alone is unlikely to improve social skills. Furthermore, there is evidence to suggest that difficulties with executive functioning may also contribute to the use of ToM abilities and effective response filtering during social interactions, and this is an area for future research to investigate. Finally, it will be important for future research to begin to understand how these abilities work together in real life social situations to shape the social skills of individuals with Asperger's Syndrome. In real life social interactions it is likely that a combination of these skills needs to be used simultaneously to rapidly assess the emotions of others and formulate appropriate behavioural responses. Understanding how these different cognitive processes are involved in such real life social situations will be central to getting closer to understanding why individuals with Asperger's Syndrome experience difficulties interacting successfully in the social world.

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