Are children with Autism Spectrum Disorder sensitive to the different emotions underlying posed and genuine smiles?

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Abstract

Facial expressions are a useful source of information about the emotional state of others. However, facial expressions do not always correspond with an underlying emotional state. It is advantageous for perceivers to be able to differentiate between those expressions that are associated with a corresponding emotional state (genuine expressions) and those which are not associated with underlying emotions (posed expressions). The present study investigated the sensitivity of children with Autism Spectrum Disorder (ASD), and age and sex-matched control children to the different emotions underlying posed and genuine smiles. The first task required participants to listen to 12 emotion eliciting stories and select, from a grid of 4 facial expressions (a genuine smile, a posed smile, a neutral expression and a sad expression) that which matched how the target in the story would feel. Children with ASD correctly matched facial expressions and stories than did participants without ASD. The second task required children to look at a series of faces, each displaying either a posed smile, a genuine smile or a neutral expression and indicate whether each target was or was not happy. Participants with ASD were less sensitive both to the underlying emotional state of the targets and to the difference between posed and genuine smiles than were the control participants. Results are discussed in terms of the social deficits symptomatic of ASD.

The ability to recognise aspects of importance in the environment, including dangerous situations or opportunities of advantage is a fundamental aspect of human evolution. One of the most information-rich aspects of the environment is other people, and social interactions with them. In these social interactions, there is information that needs to be detected, such as the underlying emotion of an interaction partner. Underlying emotions affect the way individuals behave. Therefore, it is important to recognise different emotions in others. This skill allows predictions to be made about others' behaviour and gives perceivers the ability to change their behaviour to facilitate a more successful interaction.

Facial expressions are an effective method of recognising what other people are feeling. Without the ability to recognise the differences in facial expressions, gaining information about other people's underlying emotional state would be difficult. Without recognising their emotional state, one cannot predict their behaviour. Successful social interaction, where both parties interact without insult or injury to either person would be very difficult to achieve. However, underlying emotions do not always correlate with facial expressions. Display rules and the ability to deceive create situations where individuals may present facial expressions that are incongruent with underlying emotion. An individual experiencing anger but displaying a positive expression is likely to behave differently in an interaction than an individual who is genuinely happy. Smiles present one case whereby individuals can smile in congruence with the underlying emotion of happiness, creating a genuine smile. However, individuals can also smile when not experiencing genuine happiness, creating a posed smile. These smiles signal different interaction potential for others.

If the incongruence between underlying emotions and facial expressions is not recognised by others, such as the difference between posed and genuine smiles, successful interactions may not be possible. One population that experiences difficulties in social interactions is individuals with Autism Spectrum Disorder (ASD). It is possible that people with ASD do not recognise the differences between facial expressions and underlying emotions in interaction partners, and this lack of recognition is expressed in their difficulties with social interaction. Specifically, individuals with ASD may not be sensitive to the different emotions underlying posed and genuine smiles. This may impair their ability to successfully interact.

Emotions and the Emotion Response System

Emotions are a crucial aspect of human existence and evolution. At a basic level, emotions are "episodic, relatively short term, biologically based patters of perception, experience, physiology, action and communication that occur in response to specific physical and social challenges and opportunities" (Keltner and Gross 1999). Feedback is received from internal organs, muscles and the nervous system and causes individuals to experience difference sensations, often associated with pain (anger) or pleasure (joy) (Frijda 2005). These sensations are called emotions.

Over millennia of evolution, humans have developed methods of successfully navigating many challenges that both threaten and encourage survival. The emotion response system combines a basic, accurate structure that responds immediately to a threat with the behaviour package that has the highest probability of success. A more sophisticated filtering system evaluates the situation for the level of response that is needed. Situations that once caused one specific reaction, such as an escape reaction, may not always need the same specific reaction or the same intensity of reaction (Izzard, Schultz et al. 1999/2000).

Emotions can be inwardly focused, relating to an individual's state at a specific time, or can be outwardly focused, relating to the world and the individuals' place in the world. Emotions also help focus attention on situations that require action and allow individuals to respond with automatic behaviour sets that have the highest probability of successfully dealing with the situation or challenge (Frijda 1988; Keltner and Gross 1999; Levenson 1999). The design of the emotion system is such that it allows flexible behavioural responses to emotion provoking situations while still providing responses that have the highest chance of successfully negotiating the situation.

The more sophisticated emotion regulation system allows individuals to evaluate the situations before engaging in automatic reactions, alerting individuals for potentially important situations while allowing a measure of control needed for existing in a complex social group (Keltner and Gross 1999; Keltner and Haidt 1999; Levenson 1999).

Emotions not only cause individuals to behave in certain ways but also cause others to act reciprocally. Displays of infant distress routinely bring parents to administer care and to relieve the distress (Fernald 1992). The emotion of sadness often causes a lower tone of voice, weeping and low affect, all visible symptoms of sadness that may elicit sympathy and care from others (Levenson 1999). When one has committed a social transgression, forgiveness is more likely to be granted if embarrassment is displayed than when it is not (Keltner and Buswell 1997). Emotions affect the behaviour of individuals and also the behaviours of others during interactions with that individual.

The Universality of Emotions and Emotion Recognition

If emotions are of such importance to humans and society, it is plausible to expect that there would be a common recognition and understanding of emotions across different cultures. Much research has been conducted on the universal recognition of emotion and has emphasised the importance that emotion has in human development and interaction.

The evolutionary significance of emotions can be seen by the universality of their recognition and cross-cultural appearance. From preliterate tribes in New Guinea to individuals in Western cultures, it appears that some basic emotions are consistently and reliably identified (Ekman and Friesen 1971; Ekman 1992). When presented with pictures of other humans with specific facial expressions, people from these different cultures agreed on the labelling of at least five basic underlying emotions (happiness, surprise, fear, sadness, and anger) (Ekman 1992). Disgust and surprise are also highly recognisable, although debate remains as to the universality of their recognition (Ekman 1992). Clearly with emotions playing an important role on a biological and cultural level, there must be mechanisms through which to recognise different emotions in others.

If emotions have important social consequences, it is very beneficial to individuals if they are sensitive to others' emotions. Thus emotions must be able to be communicated and recognised between individuals. Although there are many ways of recognising emotion, such as, posture, the pitch and timbre of the voice, perspiration and facial muscle tone, facial expressions provide a rich source of emotion information (Buck, Savin et al. 1972; Frank 1988; Elfenbein and Ambady 2002).

Often arising from the internal emotional state within an individual, facial expressions can be visible gauges of how another person is feeling (Ekman 1993; Jakobs, Manstead et al. 1999). Facial expressions can appear when an emotional event is being experienced, remembered, imagined or anticipated (Ekman 1992). Although not every such event elicits a facial expression, associations have been made between facial expressions and corresponding specific emotional experiences. As emotions affect behaviour in others, the accurate recognition of facial expressions and their underlying emotion in others is used to inform behaviour in subsequent social interactions.

There are two dominant theoretical approaches to the functions of facial expressions and how they relate to behaviour. The behavioural ecological view of facial expressions posits that faces are primarily used as communication devices and are not usually associated with a congruent emotions (Fridlund 1991; Jakobs, Manstead et al. 1999). The emotion expression view of facial expression argues that facial expressions are directly related to the experience of an underlying congruent emotion (Buck, Savin et al. 1972; Ekman, Freisen et al. 1980). However, these theories need not be mutually exclusive. Research has shown that facial expressions are often related to an experience of an underlying congruent emotion (Ekman and Davidson 1993; Frank, Ekman et al. 1993; Izard, Schultz et al. 1999/2000). However individuals have developed methods by which to change or modify their facial expressions, independent of emotion felt (Hess, Banse et al. 1995; Jakobs, Manstead et al. 1999; Jakobs, Manstead et al. 2001), such that facial expressions are no longer congruent with one's emotional state. One way in which facial expressions of emotion are controlled is through display rules.

Display Rules and their relationship to Facial Expressions of emotion

Cultures and societies have developed different rules that indicate what overt emotional behaviour is appropriate and in what places. In Japan, expression of emotion, especially negative emotion is not socially acceptable. When participants were shown films of unpleasant scenes while alone, Japanese and American participants showed no differences in their displays of facial expression. However, in the presences of an authority figure, Japanese participants were more likely to mask their negative emotion with a small smile (Ekman and Friesen 1971).

More recently, a Canadian study investigated the displays of dominance and affiliation in men and women. It was hypothesised that men would make more dominance displays than women, with the reverse true for affiliation (Hess, Adams et al. 2005). It was found that in neutral situations, men of a high status showed anger significantly more than women. It was also found that women of high status showed happiness significantly more than men. Both these results indicate that there are rules proscribing who can display certain emotions and when or where it is appropriate to do so.

From a relatively early age, it appears humans regulate their non verbal behaviour in certain situations, even if they are unable to articulate their reasons for doing so (Saarni 1979; Harris, Donnelly et al. 1986; Boyatzis, Chazan et al. 1993). In an early study, children ranging from 6-10 years were interviewed regarding four situations containing interpersonal conflict. An age difference was found relating to the understanding of display rules. As age increased, so did the sophistication of the participants understanding of which emotions would be acceptable to show in certain situations (Saarni 1979). This age difference was also found in a later study by Josephs (1994), who used different scenarios to investigate the ability of 4-6 year old children to recognise and articulate different display rules. This research also found that young children often change and modify their emotion expression to obey display rules without explicit knowledge of the rules (Josephs 1994).

While facial expressions of emotion may often be the result of experiencing an underlying emotion, there are situations where we are able to deliberately change our facial expression depending on the situation. Display rules often govern the appropriate display of emotion, creating situations where facial expressions are not true representations of emotion felt. One instance where this occurs is in the case of smiling, which is the focus of the present research.

Facial expressions: The case of posed and genuine smiles

Individuals experiencing different emotions present different opportunities for interaction. Anger causes people to respond in different ways than sadness or joy (Frank 1988). Although there may be an adaptive advantage to the recognition of negative emotions, displays of positive emotions, specifically smiles, are among the facial expressions most quickly recognised (Ekman, Friesen et al. 1988; Fredrickson 1998). It is also advantageous to the perceiver to be able to distinguish between smiles associated with underlying positive affect and those not associated. People who are genuinely happy may offer different interaction affordances than those who are not genuinely happy, such as co-operation opportunities or the potential to provide assistance (Frank and Ekman 1993; Frank, Ekman et al. 1993; Owren and Bachorowski 2001). However, approaching an individual who is not genuinely happy and interacting with them based on the assumption that they are genuinely happy may lead to an unsuccessful interaction. Thus it is advantageous for perceivers to have sensitivity to the difference in underlying emotion between posed and genuine smiles.

In the late 1800s, a French scientist, Guillaume Duchenne, conducted a series of experiments, firstly on the heads remaining from guillotine executions and then on a man suffering facial paralysis. Duchenne was interested in the different muscles of the face and how they were activated. By attaching electrodes to different facial muscles, Duchenne was able to demonstrate, in particular, a marked difference between two types of smiles (Duchenne 1862/1990; Bruce, Cowey et al. 1992). He noted that one type of smile occurred when the zygomatic major facial muscle, the large muscle in the cheek that pulls the mouth outwards and upwards into the classic smile, was activated. However, when he told a joke to his in vivo participant, he noticed that the muscles around the eyes, the obicularis oculi, also activated, creating a different type of smile. Duchenne stated that the first smile was created by will but that the second was created only by experiencing underlying positive emotion (Bruce, Cowey et al. 1992)

This research was largely ignored till later in the 20th century, when researchers such as Ekman, Friesen and Frank began their work on cross-cultural recognition of facial expressions. In their research, they established that participants smiled when experiencing a positive emotion and also when they were not experiencing any such positive emotion (Fox and Davidson 1988; Ekman, Davidson et al. 1990; Bruce, Cowey et al. 1992).

Neurological research into facial expressions also identified differences in brain activation between voluntary and spontaneous facial expressions. When all spontaneous facial expressions occur, older neural pathways in the brain are activated (Gazzaniga and Smylie 1990; Brown and Moore 2002). These pathways differ from those activated when voluntary facial expressions are created. Voluntary facial expressions are created in the motor cortex area of the brain, a more recently developed area (Damasio 1994). Stroke patients who have had either of these areas affected can produce either voluntary or spontaneous expressions but cannot produce both, depending on whether the damage sustained occurred in the motor cortex region or the older neural pathways in the sub-cortical area of the brain (Damasio 1994; Kupferberg, Morris et al. 2001). This neurological difference between voluntary and spontaneous facial expressions supports evidence that posed and genuine smiles occur under different circumstances. While the zygomatic major muscle can be activated voluntarily (Ekman and Friesen 1982; Ekman, Davidson et al. 1990; Ekman and Davidson 1993; Damasio 1994), the obicularis oculi is under the control of the areas that are responsible for spontaneous facial movement. This is further supported by evidence that indicates only a small percentage of the human population can voluntarily contract the obicularis oculi muscles (Ekman, Roper et al. 1980).

The Facial Action Coding System (FACS) was one of several systems developed in order to identify and analyse the different aspects of facial expressions (Ekman and Friesen 1978; Ekaman, Friesen et al. 2002). FACS codes the different combination of muscles on the face that are used when specific facial expressions are created and measures their movement. The different combinations of movements are called Action Units (AUs), of which there are 46. FACS has been widely used in facial expression research to identify and describe facial movements (Jakobs, Manstead et al. 1999; De Sonneville, Vershoor et al. 2002; Gosselin, Perron et al. 2002; Gross 2004; Del Giudice and Colle 2007). In the case of posed and genuine smiles, FACS describes the activation of two specific muscles, the zygomatic major (AU12) and the obicularis oculi (AU6). Briefly, AU12 pulls the mouth into the classic smile formation, raising the cheek muscles and pulling the lip back towards the cheekbone. AU6 pulls the skin from the temples and cheeks towards the eyes, creating the “crows feet” wrinkles around the eyes and an narrowing of the eye aperture. During the display of a genuine smile, both AU12 and AU6 will be activated, however during a posed smile only AU12 will be activated (Ekman, Davidson et al. 1990; Ekman 1992). FACS criteria can be used to measure and code pre-existing facial expressions or can be used to instruct actors to create different facial expressions by controlling specific AUs. As these expressions are created by individually activating each AU, it is likely that they are different to spontaneous facial expressions created when experiencing underlying emotion.

Although the zygomatic major and obicularis oculi are important indicators of a posed and genuine smile, there are other features of these smiles that separate them, such as symmetry, smoothness, synchronisation of the zygomatic major and obicularis oculi action and the duration the expression is held for (Ekman, Davidson et al. 1990; Frank and Ekman 1993; Krumhuber and Kappas 2005). There is greater facial symmetry in genuine than posed smiles and the creation of a genuine smile is smoother than a posed smile. There is also greater synchronisation between the action of the zygomatic major and the obicularis oculi in genuine smiles than there is in the synchrony of movement between the zygomatic and other major facial movements in posed smiles. The duration times of posed and genuine smiles also differ, with the duration of the zygomatic contraction in genuine smiles more consistent than in posed smiles. However, the contraction of the zygomatic major, in concert with the activation of the obicularis oculi remains among the strongest indicators of a smile indicating genuine happiness. Only some of these features are available in static images, such as the contraction of the obicularis oculi and the symmetry of the expressions. Static images were used instead of dynamic displays in the current research, however research has indicated that individuals can recognise the difference between static displays of posed and genuine (FACS created) expressions at an above chance level (Ekman, Freisen et al. 1980; Izard 1994; Izard, Schultz et al. 1999/2000).

Having established that people smile in different situations and that there are different neurological pathways for spontaneous and voluntary facial expressions, further research investigated if smiles were created in different situations with different underlying emotions.

Firstly, research has discovered that individuals display genuine and posed smiles while experiencing different emotions, indicating that a genuine smile is associated with experiencing enjoyment. In an early study by Ekman and colleagues, participants watched either a negative film (about amputations) or an amusing film. Smiles that featured the contraction of the obicularis oculi were significantly more apparent in the positive film condition than in the negative film condition. Furthermore, researchers found that when participants in the negative film condition were trying to appear as if they were happy, their smiles did not feature the obicularis oculi contraction (Ekman, Friesen et al. 1988). This indicates that in the absence of an underlying positive emotion, smiles may not feature obicularis oculi contraction. This corroborates with earlier research which found that zygomatic major movement, responsible for creating the typical mouth smile, was present when participants were feeling negative affect but were attempting to appear happy (Ekman, Freisen et al. 1980).

Researchers have also identified that smiles with the Duchenne marker (obicularis oculi contraction) were more frequent among patients with depression at their discharge interview as opposed to their intake interview (Matsumoto 1986) and that smiles with the Duchenne marker increased over the course of psychotherapy programmes for patients who where reported to have improved. Participants also reported significantly higher levels of enjoyment when displaying genuine smiles than other types of smiles (Davidson, Ekman et al. 1990). This evidence indicates that genuine smiles, featuring the contraction of the obicularis oculi occur when happiness is experienced. Similar results were also found in a study investigating the effects of socialisation on posed and genuine smiles. As levels of socialisation increased, such as another person in the room, correlations between positive emotional feeling and zygomatic major activity decreased (Jakobs, Manstead et al. 1999). However, correlations between positive emotional feeling and obicularis oculi contractions remained high in all conditions. This indicates that it is possible to display a smile in some social situations when not feeling genuinely happy. Social situations appear to have fewer effects on the relationship between genuine happiness and a genuine smile as regardless of who was present in the room, participants feeling genuinely happy displayed genuine smiles (Jakobs, Manstead et al. 1999).

Smiling in different situations in response to different underlying emotions may be of less use if other people did not recognise the difference between these facial expressions. Evidence has been collected that indicates other people are sensitive to the difference between posed and genuine smiles.

Ekman and colleagues (1993) asked participants to make explicit distinctions between two facial expressions, specifically which smile was an enjoyment smile (genuine) and which was a social smile (posed). Smiles displaying the Duchenne marker were identified as being enjoyment smiles significantly more often than were smiles without the marker. Although this research does not indicate an explicit knowledge of the obicularis oculi demarcating a genuine smile, it does show that perceivers know what smile is associated with experiencing happiness (enjoyment) (Ekman and Davidson 1993).

In a more implicit setting, participants in a Finnish study reported higher levels of enjoyment and pleasure than when they viewed genuine smiles than when they were presented with posed smiles (Surakka and Hietanen 1998). Participants were sensitive to the difference between posed and genuine smiles, as indicated by the different levels of positive affect experienced by the participants when they viewed the different smiles. The tendency for people to mimic the facial expressions of others is a well documented phenomenon (Hatfield, Cacioppo et al. 1992; Lundqvist and Dimberg 1995). This research also found a significantly higher level of muscle activation in the obicularis oculi and zygomatic major when presented with a genuine smile as opposed to a posed smile. It would appear then, that genuine smile and posed smiles are responded to in different ways.

Taken together, this evidence indicates that at both a muscular and emotional level, perceivers are sensitive to the difference between posed and genuine smiles.

Research by Miles (Miles 2005; Miles and Johnston 2006; Miles and Johnston 2007) measured participant sensitivity to the underlying emotions of targets, as evidenced by the display of posed and genuine smiles. Participants viewed target faces displaying posed smiles, genuine smiles and neutral expressions. Results indicated that participants sensitive to the difference in underlying emotion between genuine smiles versus posed smiles and neutral faces, accurately identifying those targets displaying genuine smiles as experiencing happiness more often that those targets displaying either posed smiles or neutral expressions. Importantly, in contrast to previous research, Miles' research used ecologically valid posed and genuine facial expressions.

An additional study measured the implicit effects posed and genuine smiles had on product evaluation (Peace, Miles et al. 2006). Using the target faces mentioned in the previous research, participants were asked to evaluate t-shirts worn by a model displaying a posed smile, a genuine smile or a neutral expression. The T-shirts were evaluated more positively when the model was displaying a genuine smile than when she was displaying either a posed smile or a neutral expression. It appears that a genuine smile is associated with positive feelings which may be extended to items associated with the target (e.g., T-shirts), and this positive affect implicitly affects perceiver behaviour. Similar evidence has been collected by studies, showing that people displaying genuine smiles are perceived as more likable and more trustworthy than people displaying posed smiles (Frank and Ekman 1993).

This evidence indicates that individuals display posed and genuine smiles in different situations and are sensitive to the underlying emotions of posed and genuine smiles in others. Research has identified that people make these distinctions based on certain aspects of the face.

It also appears that people have learnt specifically to scan the face for relevant information about the genuine qualities of a smile. Eye tracking studies have found that the eyes are of particular importance when viewing facial expressions of emotion, as indicated by the length of time spent looking at the eye region of the face (Lansing and McConkie 1999; Klin, Jones et al. 2002). When making decisions about facial expressions, the eyes are of obvious importance to perceivers. If one of the crucial differences between posed and genuine smiles lies in the change in eye muscles, it is understandable that perceivers would focus on this area to identify whether or not a smile is posed or genuine. Such an effect was found when participants were presented with posed and genuine smiles and were asked to make decisions about the underlying emotional state of the target faces. Participants spent significantly more time examining the area around the corner of the eye where obicularis oculi contraction occurs when presented with genuine smiles (Williams, Senior et al. 2001; Boraston, Corden et al. 2007). This eye movement evidence indicates that perceivers are sensitive to the difference between posed and genuine smiles, knowing that the eye region of the face is where to look to distinguish one form of smile from the other.

Taken together, the research reviewed points to a body of evidence indicating two things; one, that people display a different smile when experiencing genuine happiness and two, that perceivers are aware of this genuine smile and its differences to other smiles. If there is a repertoire of smiles, including a genuine smile, then there also must be different situations in which it is appropriate to display different smiles, even when not genuinely happy. Thus, individuals need to be sensitive to the different emotions underlying posed and genuine smiles.

The current research investigates the sensitivity to such expressions in children with Autism Spectrum Disorder.

Methodology: Using elicited posed and genuine expressions of happiness

Although research has suggested an adaptive advantage to responding to negative facial expressions, in the current research smiles were used as the target facial expression stimuli. Smiles are among expressions most easily identified (Ekman and Friesen 1982; Ekman, Davidson et al. 1990; Frank and Ekman 1993; Beaupre and Hess 2003; Bornstein and Arterberry 2003). Much research has been conducted into the creation of different types of smiles, their facial physiognomy and their effect on behaviour (Bugental 1986; Ekman, Davidson et al. 1990; Hess and Kleck 1990; Fridlund 1991; Ekman 1992; Ekman and Davidson 1993; Frank and Ekman 1993; Sarra and Otta 2001; Scharlemann, Eckel et al. 2001; Williams, Senior et al. 2001; Gosselin, Perron et al. 2002; Guguen and De Gail 2003; Hall and Horgan

2003; Peace, Miles et al. 2006; Del Giudice and Colle 2007), giving a larger body of research with which to compare findings.

Most previous research into different facial expression recognition has been conducted using expressions created by actors trained to contract muscles based on the FACS criteria that correspond with different facial expressions, (Williams, Senior et al. 2001; Gosselin, Beaupre et al. 2002; Gosselin, Perron et al. 2002; Gosselin, Warren et al. 2002; Krumhuber and Kappas 2005; Del Giudice and Colle 2007). This has been done in many cases to control the physical parameters of smiles, such as individual difference in facial physiognomy (Gosselin, Beaupre et al. 2002; Gosselin, Perron et al. 2002; Del Giudice and Colle 2007). Others have used computer based face synthesisers that create expressions based on FACS criteria as it is “not possible, even for trained encoders, to produce voluntarily and precisely a well defined range of durations for specific components, such as the onset of a smile” (Krumhuber & Kappas, 2005, pg 6). These facial expressions of emotions are then used in research investigating sensitivity to the difference between posed and genuine smiles. The effect of using FACS criteria to create expressions leads to the use of expressions that may not naturally occur. It is likely that facial displays created through contraction of muscle groups may differ from those expressions produced in response to the experience of the target expression. Accordingly, in order to understand perceivers' sensitivity to emotional states in actual social interactions, it is important to employ ecologically valid facial expressions in research.

More recently, research has been conducted on facial expressions using expressions created while the participant is experiencing an underlying emotion (Miles 2005; Miles and Johnston 2006; Peace, Miles et al. 2006; Miles and Johnston 2007). Importantly, perceivers have been shown to be sensitive to the differences between these ecologically valid genuine and posed expressions of happiness The current research employed expressions from Miles and additional expressions created using similar techniques (McLellan 2006).

The Development of Sensitivity to Facial Expressions of Emotion

Much of the research on posed and genuine expressions of emotion has used an adult population. Although there is interest in the field of infant and child facial expression understanding, there is not yet a complete understanding of their ability to recognise posed and genuine expressions of emotion. The present research adds to this literature, by considering the sensitivity of children to posed and genuine expressions of happiness.

From an early age, humans are attracted to faces. Newborn infants prefer to fixate on faces, rather than inanimate objects (Easterbrook, Kisilevsky et al. 1999), will imitate different facial expressions soon after birth (Meltzoff and Moore 1977) prefer attractive faces to unattractive faces (Slater, Bremner et al. 2000) and have a rudimentary ability to discriminate between different facial expressions of emotion (Nelson, Morse et al. 1979; Slater and Quinn 2001; Rochat, Striano et al. 2002). However, the development of children's sensitivity to the different emotions underlying facial expressions is of the most importance in the current research.

Studies examining children's ability to understand facial expressions have discovered that they can accurately match facial expressions of emotion with the emotion eliciting situations (Camras and Allison 1985; Harris, Donnelly et al. 1986; Boyatzis, Chazan et al. 1993). One particular study investigated young children's ability to match an emotion eliciting story with different facial expressions (Boyatzis, Chazan et al. 1993). Thirty two preschool children aged between 3 and 5 years listened to a vignette about a boy called Tommy. Each vignette described a situation eliciting a specific emotion, including anger, disgust, fear, happiness, sadness and surprise. The children were then shown 3 photos of a 7 year old boy posing some of the emotions listed above (the correct choice and two other randomly selected photos from the remaining 6 photos). Children were asked to pick the photo that showed how Tommy felt in the story. Children were able to correctly match the facial expression to the congruent emotion eliciting situation. The study also found an improvement in accuracy between children aged 3 and children aged 5 (Boyatzis, Chazan et al. 1993).

While comparing several different facial expressions to one another may be a straightforward method of testing younger children's ability, it is not the strategy used most frequently in real-world interaction. More often humans are required to make a decision about one particular person's facial expression, based on a single expression of reference from that person. Furthermore, although accurate identification of emotions is important, the speed at which the identification is made is also a crucial factor. Social interaction is conducted very quickly, and rapid behaviour predictions are required. To do this, facial expressions of emotion must be accurately identified as quickly as possible.

More recent studies have combined these two factors to investigate the development of speed and of single-reference facial expression labelling.

In a recent comparative study into the face processing abilities of children and adults, participants were tested on their ability to identify facial expressions of emotion, as well as facial identity (De Sonneville, Vershoor et al. 2002). Children, in groups of 7, 8, 9 and 10 year olds were compared to a group of adults, with a mean age of 25. Participants were shown a target photo of a person displaying posed happiness, sadness, anger, fear, disgust, surprise, shame, and contempt. They were then presented with another photo (signal) of a face showing any one of the eight emotions previously mentioned. Participants were asked to identify whether the signal photo displayed the same expression as the target photo or different. Participants also completed a facial expression matching task, where they identified pairs of photos as having the same expression, or different expressions. Results indicated that positive emotion expressions were recognised faster than all negative emotions by both adult and child participants, with the happiness recognised most quickly. It is possible that although there may be an adaptive advantage to the recognition of negative affect (threat communication), there are fewer facial expressions of positive emotions (Ellsworth and Smith 1988; Fredrickson 1998). Thus facial expressions of positive affect, such as a smile, may be more easily recognised.

De Sonnerville et al (2002) also found that the speed at which facial emotions were processed improved with age, with adults performing at nearly twice the speed of their child counterparts (aged 7-10 years), with no speed-error trade off. Adults also had a much higher accuracy rate when presented with a single face with which to make their emotion judgements. However, the affect of age was much less substantial in the emotion matching task. Here, children and adults performed a similarly high accuracy rate. Other emotion tasks, such as identifying emotions at a high speed and using a single reference (such as one particular part of the face, or a static face rather than a dynamic display) to identify emotions, appear to require more familiarity with facial expressions (De Sonneville, Vershoor et al. 2002). Results from this and other studies indicate that although children lack the range of abilities possessed by adults, they can identify emotions at a high level of accuracy in when certain situations (De Sonneville, Vershoor et al. 2002; Herba, Landau et al. 2006).

Children appear to have different facial expression identification abilities than do adults. Nevertheless, the ability to recognise, differentiate and identify some facial expressions at an above chance level is apparent from the early stages of childhood.

Another crucial skill in the development of facial emotion recognition is the ability to learn which facial expressions are appropriate for certain situations. Children appear to learn at an early age that there are situations where displaying a certain emotion is not appropriate and possibly not advantageous. When interviewed about four interpersonal conflict situations, such as a child receiving a disappointing birthday gift, or a child being picked on by a bully in the presence of an onlooker, the complexity of display rule understanding increased with age (Saarni 1979). Of three groups of children (6 year olds, 8 year olds and 10 year olds) older children provided significantly more intricate reasoning about why a particular facial expression should or shouldn't be used in the different scenarios. However, when children were prompted by the adult interviewer, the effect of age disappeared. When asked if the main character could look another way (produce a different facial expression), younger children were more accurate at identifying the socially correct facial expression. By introducing prompts , the 6 year old children were able to explain their accurate understanding of display rules. This implies that children may not have explicit knowledge of display rules, rather an implicit knowledge. This may affect the ways in which sensitivity to the different emotions underlying facial expressions is measured.

Research suggests that, similar to the development of identification of facial expressions of emotion, display rule understanding increases with age (Saarni, 1979). However, if tasks demands are reduced, it becomes apparent that young children do have an understanding of when it is appropriate to display certain emotions, corroborating with other similar research (Harris, Donnelly et al. 1986; Josephs 1994).

Sensitivity to the different emotions underlying facial expressions may be one that requires a high level of explicit understanding of display rules and exposure and practice recognising these different facial expressions. Adults appear to be able to this spontaneously and explicitly while children appear to have more difficulty. It is clear that children can explicitly identify different facial expressions of emotions, such as happiness, sadness, fear and anger, and are able to recognise situations where one expression is more appropriate than another. However it is unclear whether children are sensitive to the different emotions underlying posed and genuine smiles.

Children's Sensitivity to Posed and Genuine Expressions of Emotion

The majority of the research into the ability of children to differentiate between posed and genuine expressions of emotion has indicated that children are less sensitive to the difference than adults (Gosselin, Beaupre et al. 2002; Gosselin, Perron et al. 2002; Gosselin, Warren et al. 2002; Del Giudice and Colle 2007).

Gosselin and Beaupre et al(2002) investigated the ability of children and adults to differentiate between genuine smiles and smiles that contained traces of anger. Two adult confederates were asked to display two stimuli smiles. The first contained the physical indicators of genuine happiness, with the simultaneous activation of the obicularis oculi and the zygomatic major. The second smile contained both of these features but also included the lip tightener, a facial movement not associated with genuine happiness (Frank, Ekman et al. 1993). This second smile contained some facial muscle activation usually associated with anger (the lip tightener) and thus served as a masking smile. Fifty two children and 26 adults participated in this research, distributed among 3 groups; 6 to 7 years old, 11-12 years old and 20 to 26 years old. All participants were told they would see two people smiling. Sometimes this person would be really happy when smiling and sometimes they would not be happy. The children were asked to provide a situational example of when it might be possible to smile but not feel happy, and were all able to do so. After each stimulus presentation, participants were asked to identify whether the stimulus person was really happy or just pretending to be happy. They were also asked if they person was pretending to be happy, if they were feeling another emotion and if so, was it fear, anger, surprise, sadness or disgust. Finally, the participants were asked to identify the particular regions of the face that different between each expression. The results demonstrated that 6-7 year old children had implicit knowledge of hidden emotions in masking smiles and were specifically sensitive to the presence of the lip tightener. Children in this age group were more likely to identify a smile as a genuine expression of happiness if this muscle was not activated, as were the older children and the adults. Explicit knowledge of the emotion masked by the smile was only found in adults. Younger children were less able than adults to identify what aspects of the face were different between posed and genuine smiles, indicating a lack of explicit knowledge of the difference between posed and genuine smiles (Gosselin, Beaupre et al. 2002).

Children also displayed a less in-depth understanding of the methods used to hide or change facial expressions of emotions. While the most effective method of hiding emotion felt may be to produce a different facial expression of emotion (masking) (Ekman and Davidson 1993), children choose neutralisation significantly more often than other display strategies (Josephs 1994; Gosselin, Warren et al. 2002). This lack of understanding of the most effective display strategies may also influence children's sensitivity to posed and genuine expressions of emotion.

Despite being less explicitly sensitive, children appear to be well versed in situations where there may be motivation to hide emotion. Similar to research on the development of display rule understanding, investigation has shown that children can identify situations where it would be appropriate to hide one emotion and show another different emotion (Saarni 1979; Harris, Donnelly et al. 1986; Josephs 1994). Children between the ages of 6 and 11 were presented with stories describing situations where the main character felt one emotion (happiness or sadness) but decided not to show it to the other characters (Gosselin, Warren et al. 2002). They were then presented with five photos of a similar-aged target displaying a sad face, a less, a neutral expression, a posed smile and a genuine smile. Children were asked what emotion the main character would have been feeling in the story and what their facial expression would look like. Children in this study demonstrated an understanding of the distinction between emotion felt and emotion shown (Gosselin, Warren et al. 2002). They were able to correctly identify the emotion felt by the main character in the story but were able to show that a facial expression different to the emotion felt would be more appropriate in the situation. This indicates that children are sensitive to situations where it would be appropriate to feel one emotion but to express a different emotion.

Previous research has established that adults respond differently to posed smiles and genuine smiles, identifying those individuals displaying genuine smiles as being happy more frequently than those displaying posed smiles (Ekman, Davidson et al. 1990; Frank and Ekman 1993; Frank, Ekman et al. 1993; Gosselin, Perron et al. 2002; Miles 2005; Miles and Johnston 2006; Peace, Miles et al. 2006; Del Giudice and Colle 2007; Miles and Johnston 2007). However, research has been divided in establishing if children can make this same distinction. Sensitivity to the differences in facial has been indicated to develop with age (Harris, Donnelly et al. 1986; Josephs

1994; De Sonneville, Vershoor et al. 2002; Mondloch, Geldart et al. 2003; Herba, Landau et al. 2006; Mondloch, Maurer et al. 2006) but other studies have shown that children can display sensitivity to posed and genuine smiles in certain situations (Gosselin, Beaupre et al. 2002). Thus it might be expected that children would be able to make the distinction between posed and genuine smiles.

Research on the distinction between adults and children's identification of the distinction between posed and genuine smiles found that the younger children, 6-7 year olds, were unable to make the distinction between these smiles (Gosselin, Perron et al. 2002). Participants included children aged between 6 and 7 and a group of adults with a mean age of 23. Participants were shown video excerpts containing a target person displaying different facial expressions of emotion. For some excerpts the target person was instructed to create a non enjoyment smile and for other excerpts a smile of enjoyment according to FACS criteria. Participants were asked if the person in the video was really happy or pretending to be happy. Children showed an explicit knowledge of the difference between pretending to be happy and feeling really happy prior to the administration of the videos by describing a situation where someone would feel happy and smile, and another situation where someone was not happy but smiled in order to look happy. Results indicated that adults identified the target person as being happy more often when their smile included the Duchenne marker (AU 6) than when it did not include the marker. There was no difference in the happy identification of smiles for the 6-7 year old children (Gosselin, Perron et al. 2002). These results differ from previous research by Gosselin, Beaupre and colleagues (2002) indicating children were implicitly sensitive to the masking of anger in smiles. However, other research by Gosselin, Perron et al (2002) indicates that children are not sensitive to the difference between posed and genuine smiles. Children in the two studies appear to be sensitive to different facial action units.

However, a group of 9 and 10 year olds were also included in the previous study, as well as the same age groups included previously (Gosselin, Beaupre et al. 2002). In this study, participants were shown different phases of each smile presented. The phases included a complete smile, from the onset to the end of the apex, and from the beginning to the end of the apex of the smile. Overall adults and children identified the smile containing the Duchenne marker as being happy more often then the smile that did not contain the marker in all conditions, except when the younger children were only shown the apex of the smile. Adults did have the largest difference in happy/pretending happy judgements, correctly identifying the Duchenne smile as being happy more often than both groups of children. Interestingly, substantial differences in happy/pretend happy judgement were found when the 9-10 year olds were shown the complete smile. During this presentation, the older children more often identified the smile with the Duchenne marker as being happy. No difference was found for the 6-7 year olds (Gosselin, Beaupre et al. 2002). It appears that in certain circumstances, such as a temporal complete smile, where there is more facial expression information available, some children are able to differentiate between posed and genuine smiles.

Recent research has found that 8 year old children can differentiate between different types of smiles, but are confused by the activation of other, unrelated facial muscles. Participants were presented with three different smiling faces, one displaying the activation of the obicularis oculi and zygomatic major, one displaying the activation of the zygomatic major alone and one displaying zygomatic major action with the activation of another eye muscle (lid tightener) not the obicularis oculi (Del Giudice and Colle 2007). Both the obicularis oculi and the lid tightener were significant predictors of smile authenticity for children, while the obicularis oculi was the only significant predictor of authenticity for adults. However, children were more likely to identify either of the smiles with any eye activation movement as feeling happy than the smile featuring only zygomatic major activation (Del Giudice & Colle, 2007). This indicates that children are sensitive to a difference between different smiles and that this difference is related to eye muscle movement. However, they are not yet sensitive to the difference between obicularis oculi activation and other types of eye movements.

Although children may not be able to differentiate between posed and genuine smiles as well as adults, they have the ability to do so under certain circumstances. Children appear to be sensitive to different facial expressions and their congruent emotions, such as happiness, sadness, fear, anger and shame (De Sonnerville, 2002; Boyatzis et al., 1991) and appear to be able to distinguish situations where it would be appropriate to display a different emotion than emotion felt (Gosselin et al, 2002a). Children also appear to be implicitly sensitivity to the different emotions underlying posed and genuine smiles (Gosselin, 2002b). Increasing the duration of the expression, presenting the display of the expression, for example displaying a the creation of a smile from conception, through to the apex of the smile and it's disappearance appear to improve the measurement of children's sensitivity to posed and genuine smiles (Del Giudice & Colle, 2007; Gosselin et al, 2002).

Research has yet to establish the ideal situations in which the sensitivity to posed and genuine smiles is best measured and at what stage of childhood development this ability emerges, however it is possible that children are sensitive to the different emotions underlying posed and genuine smiles. The present research aims to use the ecologically created facial expressions to test children's explicit knowledge of the difference between posed and genuine smiles.

Although children's sensitivity to posed and genuine smiles has not been established with certainty, typically developing children do not appear to have systemic social interaction difficulties. Children with Autism Spectrum Disorder do suffer from chronic difficulties with social interaction. It is possible that this difficulty is related to a lack of sensitivity to different emotions underlying different facial expressions, specifically posed and genuine smiles.

Autism: An example of impairment in facial emotional discrimination

Autism is a developmental disorder that is characterised by a severe impairment of social behaviour, language deficits, rigidity of thought and a preference for consistency, often expressed as stereotypies (Loveland, 1991). Autism is a spectrum disorder, with individuals having a number of symptoms at various levels of severity, leading the disorder to be labelled Autism Spectrum Disorder (ASD) (Diagnostic and Statistic Manual of Mental Disorders IV, American Psychiatric Association, 2000). While some of the symptoms of ASD are shared by other disorders such as Down Syndrome, and Pervasive Personality Disorder- Not Otherwise Specified (PPD-NOS), a defining symptom of autism is impairment in the skills that involve perceiving and interacting with others in social situations (Baron Cohen, 1991; Cohen & Volkmar, 1997; Happe, 1994; Hobson, Ouston & Lee, 1988; Loveland, 1991; Schultz, 2005). Individuals with ASD have difficulty engaging in a socially appropriate conversation, developing close relationships with friends, displaying socially appropriate emotions or perceiving and understanding sources of emotion in others (Loveland, 1997).

So marked is the deficit in social interaction and perception that it is often used as one of the earliest indicators of the disorder in young children. When analysing the home videos of one year old children who were later diagnosed with ASD, it was found that infants with ASD can be distinguished from infants with developmental delay and typically functioning infants (Osterling et al, 2002). Infants with ASD were less likely to look at people, orient to their name or look at objects held by people, all behaviours indicative of a lack in rudimentary social interaction usually displayed by infants without ASD. Although a retrospective study, these results are consistent with other studies focusing on early identification of individuals with ASD (Osterling & Dawson, Braneck, 1999, Adrien et al, 1993, Trillingsgaard et al 2005). Raters who coded the home movies were also blind to the child's diagnosis, providing further reliability for the results. The lack of these behaviours demonstrates a deficit in the development of social interaction skills.

Children with ASD also fail to display gaze monitoring (Baron-Cohen et al 1996) and aspects of joint attention, especially protodeclaritive pointing (Brunisma et al,2004). Both these behaviours are crucial in the development of social interaction and perception mastered by typically developing children.

One aspect of social interaction and perception where individuals with ASD appear to be especially deficient is perceiving emotion in others. Individuals with ASD appear to be unable identify emotions in other individuals and to recognise that specific situations would elicit specific emotions (Dennis et al 2000), or to react appropriately to the emotions of others (Loveland, 1997). Typically functioning individuals are usually able to identify and label emotions, such as sadness or anger, in their interaction partner, making this emotion identification rapidly and spontaneously (Del Giudice & Colle, 2007; De Sonnerville et al., 2002; Gosselin et al., 2002). Although there is evidence to suggest individuals with ASD are sometimes able to identify basic emotions such as happiness, sadness, or anger in specific circumstances, emotions with more complex associated social context such as surprise (Baron-Cohen et al. 1993) and jealousy (Bauminger, 2004) are not typically recognised by individuals with ASD (Begeer et al 2006, Loveland 1999).

In one of the first pieces of research dedicated to investigating individuals with ASD and their reaction to faces, Hobson, Ouston and Lee (1988) tested two groups of verbal mental age (VMA) matched adolescents with autism and developmentally delayed adolescents without autism for their ability to recognise emotion and personal identity in photographed faces. The participants were required to match expressions of emotion across different individuals, using the expressions of happy, sad, anger and fear. They were also asked to identify unfamiliar individuals despite changes in emotional expression. Results indicated that participants with autism identified emotion and recognised faces less well than the VMA matched developmentally delayed control group (Hobson et al, 1988). This indicates that impairments in face and emotion recognition in individuals with ASD is specific to ASD rather than any aspect of developmental delay.

More recently, research investigated understanding of deceptive emotion in children with ASD (Dennis, Lockyer & Lazenby, 2000). Children with ASD could match happy and sad facial expressions to situations where these emotions would be appropriate, however could do so less accurately than typically developing children. In addition, children with ASD were significantly less accurate than typically developing children in understanding when it would be appropriate to display a facial expression not felt and when this would be appropriate (Dennis et al, 2000).

In order to gain an understanding of facial emotion, one must first be aware of faces and include them in gaze patterns. Without looking at faces, forming an understanding of what facial expressions mean would be impossible. When measured using eye tracking equipment, it has been found that typically functioning individuals have a very specific gaze patterns when looking at facial expressions. Most individuals briefly look at the mouth of the person they are looking at and then sweep their gaze up to the eye region, especially when viewing smiles (Klin, Jones, Schultz, Volkmar and Cohen, 2002; Williams et al, 2001). As the both the mouth, and more importantly, the eyes play a very important part in emotion recognition, this visual gaze strategy is advantageous in emotion recognition. The gaze patterns of individuals with ASD differ from typically functioning individuals. A 2002 study used eye tracking equipment to measure eye gaze of individuals with ASD (Klin, Jones, Schultz, Volkmar and Cohen, 2002). Eye gaze was measured while participants watched digitised clips from the 1967 film version of Edward Albee's "Who's Afraid of Virginia Woolf?" The clip was chosen as it displays complex social interactions between four protagonists in social situations that demand high monitoring of facial expressions by the viewer (Klin et al 2002). After analysing visual fixation patterns, significant differences in percentages of time eye gaze was fixed on various parts of the face was found. The eye region emerged as the best predictor of group membership (control or clinical). The control group visually fixated on the eye region two times more than did the participants with ASD (Klin et al 2002). Lack of visual fixation on the eye region would debilitate emotion recognition as this region is very important in identifying many emotions in social interaction partners, such as the difference between posed and genuine smiles. One of the critical distinctions between these expressions is the activation of the obicularis oculi muscle, occurring when a smile is created in congruence with the underlying emotion of happiness. If this change is not attended to, the ability to be sensitive to the different emotions underlying posed and genuine smiles would be impaired.

It is worth noting here that some congenitally blind children share symptoms more commonly associated with ASD, such as echolalia, repeating meaningless words, abnormal patterns of mobility (toe walking, body rocking), and some social interaction deficits (Hobson, 1999, Hobson 2003). Children who are blind from birth have no visual experience at understanding and reacting to facial expressions of emotion. These children also suffer abnormalities in their social interactions with peers and others, although these social abnormalities are not as severe as those identified in children with ASD. However, it is possible to speculate that a lack of visual exposure to facial expressions in congenitally blind children plays an important part in the social impairments experienced in later life (Hobson, 1999 & 2003). For children with ASD, although fully sighted, it is likewise possible to theorise that lack of attention to facial expressions, whether due to different visual motivations or lack of intrinsic understanding of the importance of facial expression, helps to create the social impairment that is one of the distinctive symptoms of ASD.

Despite an apparent lack of eye gaze, when presented with facial expressions, it appears that individuals with ASD can correctly identify facial expressions of emotion when prompted to focus on the face or when motivation to recognise facial expressions is altered. However, if given a choice individuals with ASD will show a preference for non-emotion features (Berger et al 2006, Weeks & Hobson 1987, Grossman et al 2000). When presented with matching tasks, such as grouping faces either by facial expression or by items of clothing (Weeks & Hobson 1987) or presenting faces with matching or non matching words (Grossman et al 2000), children with ASD recognise different facial expressions of emotion but find applying this knowledge difficult in functional tasks such as verbally explaining why a person might look or feel a specific way. When given specific instructions to attend to facial expressions or when personal interest increased, children with ASD had improved performance on emotion recognition tasks (Beerger et al, 2003, Reiffe et al 2000). This evidence indicates that while typically functioning children will use the face spontaneously as a method for gaining information about emotions, children with ASD tend to not do this with the same spontaneity.

Motivation for using facial expressions of emotions in social interaction situations is a key factor in both typical human development and the development of individuals with ASD. A recent study investigated the how manipulation of motivation affected the recognition of facial expressions in children with ASD and typically developing control children (Beerger et al 2006). A 'neutral' setting was created, whereby the emotions of others had little consequence to the participants. Another setting was created where the emotions of others had direct implications for the participants' wellbeing (primed condition). If motivation is a factor in the use of facial expressions as a social interaction tool, a difference would be found in situations where the emotion expressed by an interaction partner had either no consequence on an individual or had implications for their immediate wellbeing. Three groups of all male participants were selected, one group with ASD, one with Pervasive Developmental Disorder- Not Otherwise Specified (PDD-NOS) and one group of typically developing control children. Both conditions used a face matching task whereby photos of faces could be sorted by either items of clothing (glasses- present or absent), facial features (moustaches- present or absent) or facial expressions of emotion (happy or angry). In the neutral condition, the participants were asked to simply match the photos according to similarity. In the motivation condition, the participants were instructed to match the photos according to who would be most likely to offer them a sweet, thus increasing the relevance to the participant of the situation. As predicted, the children with ASD in the neutral condition paid little attention to the facial expressions of emotion, giving facial expressions less priority as a matching criterion when compared to the control groups. The participants with ASD most often selected photos that matched on non-emotion features such as glasses. However, when the participants' motivation was manipulated, the group differences disappeared. When asked to focus on the future action of the people in the photos presented (whether or not a sweet would be given), participants from all groups equally often sorted the photos on emotion features

(Beerger et al 2006). While facial expressions appear to be extremely salient to typically developing children, regardless of extrinsic motivation levels, it appears that children with ASD only take faces into full account when the relevance of the emotional expressions was emphasised, either by explicit instructions to attend to the face or by changing the motivation to attend to the face. If children with ASD do not spontaneous attend to the face, they may not develop sensitivity to the different emotions underlying facial expressions, in particular posed and genuine smiles.

Although individuals with ASD can become aware of facial expressions of emotion and do appear to use them in social situations, individual motivation and the situations in which awareness may occur must be carefully manipulated. These individuals do not always attend to faces in the same way individuals without ASD attend to faces.

When task demands are reduced, personal motivation is altered and certain facial expressions are used, individuals with ASD appear to be able recognise facial expressions of emotion. However, these individuals have difficulty identifying emotions such as jealousy (Bauminger, 2004) and also have difficulty identifying situations where facial expressions and underlying emotions would not be congruent (Dennis et al., 2000). The current research aimed to identify whether individuals with ASD can differentiate between posed and genuine smiles. It was predicted that children with ASD would not be sensitive to the different emotions underlying posed and genuine smiles.

Summary of current research

Previous research investigating emotion identification and perceiver sensitivity to facial expressions, specifically the difference between posed and genuine smiles, has determined that typically functioning adults are sensitive to the different underlying emotional states of individuals displaying posed smiles and genuine smiles (Miles, 2005; Miles & Johnston, 2007, 2007; Ekman & Davidson, 1993; Frank & Ekman, 1993; Ekman et al., 1990)

Building on this previous research, the aim of the current research was to investigate whether children, with and without ASD are sensitive to the underlying emotional states of individuals displaying posed smiles and genuine smiles. Since individuals with ASD suffer from an impairment in social interaction, and sensitivity to the emotional states of interaction partners is vital for smooth social interaction, individuals with ASD were identified as a group that may also be impaired in emotion sensitivity (Baron-Cohen 1991; Loveland, Tunali-Kotoski et al. 1997; Loveland, Pearson et al. 2001; Williams, Wishart et al. 2005). Thus it may be expected that their sensitivity to the different emotions underling posed and genuine smiles may be different to that of typically developing individuals.

While other research has investigated emotion sensitivity in children with ASD, this research is unique in considering whether such children are sensitive to the differences between posed and genuine expressions of emotion, specifically posed and genuine expressions of happiness. An age range of 6-10 years was selected for participants in the present research. Participants had to be able to understand the experimental task instructions as given by the experimenter and so a verbal mental age (VMA) of 6 years was used as an cut-off for inclusion in the research. The Peabody Picture Vocabulary Test (PPVT) (Dunn & Dunn, 1997) was used to measure VMA since this test measures aural or hearing, rather than verbal, vocabulary and the present experimental tasks required aural vocabulary to follow the experimental instructions. The experimental materials were also presented aurally.

ASD is a spectrum disorder, with different individuals suffering different levels of ASD severity. Accordingly, it is likely that the individuals with ASD in the present sample will differ in severity of their ASD and also, therefore, in the degree of impairment in social functioning. Given the association between emotion sensitivity and social functioning, a measure of social functioning was included in the present research. A parent or guardian of each child who participated in the research completed the Social Communication Questionnaire (SCQ) (Rutter, Bailey & Lord, 2003) with reference to their child. This scale provides a measure of both lifetime and current level of social functioning of the child. Correlating scores on the SCQ with performance on the emotion sensitivity tasks will provide some insight into the extent to which emotion sensitivity is associated with social functioning.

To investigate emotion sensitivity, children completed two experimental tasks, modified from Miles (2005). The first task involved the participant listening to some stories. Each story described an event involving a central character. Each event was developed to elicit a specific emotional state in the central character (happy, sad, neutral). After hearing each story the child was shown a grid of photographs of the central character displaying different facial expressions (genuine smile; genuine expression of sadness; posed smile; neutral expression) and asked to select the photograph that matched how the character would look in the story they just heard. It is worth noting here that the posed smile used was created in the absence of any underlying emotion. This task provided the participants with a context (the event) and the opportunity to match the context to a facial expression. This required participants to identify the underlying emotional state of the character in the story and match it to the facial expressions they thought fit best. To do this, the participants needed to have an understanding of which underlying emotional states matched particular facial expressions. A correct response on this task was matching the most appropriate facial expression (genuine smile, posed smile, neutral expression, sad expression), to the context of the story. Sad expressions and congruent emotion eliciting scenarios were included to provide additional facial expression options.

The second task involved the participant looking at a series of photographs of target females one at a time. Each target was expressing a posed smile, a genuine smile or a neutral expression. In the first trial, the child was asked to indicate whether the target was looking happy or not looking happy. In the second trial, the child was asked to indicate whether the target was feeling happy on the inside or not feeling happy on the inside. Asking how the target person was looking and feeling was done to measure differences in sensitivity to the differences in posed and genuine smiles. Genuine smiles both look happy and the person displaying the genuine smile is also feeling happy on the inside. However posed smiles only look happy. The person displaying the posed smile should not be feeling any underlying emotion. Previous research has successfully used this task to identify whether adults are sensitive to underlying emotional states (Miles 2005). This task was designed to measure participants' sensitivity to the indicators of happiness present in facial expressions with no contextual clues.

It was predicted that children with ASD not be sensitive to the differences in emotion underlying facial expressions, specifically posed and genuine smiles. It is predicted that children without ASD will be sensitive to the different emotions underlying facial expressions, including posed and genuine smiles.

Method

Participants

Children with Autism Spectrum Disorder (ASD) were recruited from around Christchurch, through advertisements in the local newsletter of Autism New Zealand, through personal contacts of the experimenter and her supervisors, through holiday programmes run by Autism New Zealand and through several primary school newsletters in the Christchurch area. Each of these children had previously received a diagnosis of ASD from a General Practitioner (GP), a psychologist, a psychiatrist, a developmental paediatrician or a clinical practitioner specialising in Autism. Only children with a sole developmental diagnosis of ASD were recruited to avoid problems with co-morbidity. In total eight male children with a diagnosis of ASD were recruited for the current study.[1]

Eight male control children without a diagnosis of ASD were recruited from advertisements in the University of Canterbury online events diary, in the newsletters of local primary schools around Christchurch, in the *Christchurch Star* newspaper, and through personal contacts of the experimenter and her supervisors. None of these children had received any remedial education training, such as in reading or mathematics, and had not received therapy for any clinical psychological disorder. An age-match was recruited for each of the 8 children with ASD. This age match had to be within 3 months of the chronological age of the child with ASD. The mean age difference between the matched children was 1.63 months, with a range of 0-3 months. The actual age range for the control children was between from 7 years 0 months and 14 years 11 months, with a mean age of 10 years 7 months and for the children with ASD between 7 years 3 months and 14 years 11 months, with a mean of 10 years 6 months.

Each child had normal or corrected-to-normal vision and was familiar with using a computer. After completing the study, each child received a lucky dip toy and his parent/guardian received a $10 petrol voucher to compensate them for their time.

[1] In the process of participant recruitment, 2 children with Asperger's Syndrome were recruited. These children completed the experimental tasks but given the documented differences between children with ASD and with Asperger's Syndrome and the low number of the latter group recruited, it was decided to omit their data from the reported analyses.

Materials

Peabody Picture Vocabulary Test-III (PPVT)

The PPVT (Dunn & Dunn, 1997) was used to measure the children's' level of aural vocabulary. The PPVT consists of 204 testable words, separated into 17 sets of 12 words that range from basic words such as "cat" and "broom" to more difficult words such as "marsupial" and "edifice". Within each set, each word has an item number. The child listens to the experimenter say a word and is then required to point to the picture, from a group of 4, that best represents the word. The pictures are presented on an easel. The first step in testing involved the identification of the child's basal set of words. The basal set is defined as that in which the child makes no more than one error in the set. Each child started the PPVT at a set appropriate to his chronological age, measured in years and months (e.g., 12 years, 6 months). If the child made more than one error on his age-matched set then he was tested on the preceding set. Once the basal set had been established, testing moved forward one set at a time until the ceiling set had been reached. The ceiling set was reached when the child made eight or more errors in the set.

The time taken to complete the PPVT was dependant on the nature of the child's responses. If the child had a high level of aural vocabulary, more sets had to be administered to find the ceiling set. The average number of sets administered in this study was 6.5 sets. Children with ASD had an average number of 6.1 sets administered, while children without ASD had an average of 7.1 sets administered.

The PPVT was scored by subtracting the number of the ceiling item (the last item in the ceiling set) from the total number of errors in all sets completed. This gave a raw score which was then converted into a standard score using the norms booklet provided in the PPVT manual. Using the standard score, an age-equivalent score was calculated for each child using the PPVT norms booklet. The age-equivalent score indicates at what equivalent chronological age level the child is performing.

Social Communication Questionnaire (SCQ)

The Social Communication Questionnaire (Rutter et al, 2003) was completed by a parent/guardian of each child. The SCQ was developed to evaluate the level of communication skills found in children with ASD or Asperger's Syndrome, although it can also be completed for children without ASD or Asperger's Syndrome. There are two forms within the SCQ that can be administered, either as separate questionnaires or together. The SCQ Lifetime scale (SCQ-L) is used to identify behaviour over the lifetime of the individual. The SCQ Current scale (SCQ-C) is completed with reference to the individuals' behaviour over the previous three months. Both forms were administered in the current research, to provide a more extensive measure of each child's communication ability.

Each of the SCQ questionnaires (Lifetime; Current) consists of 40 items, each answered in a yes/no format (e.g. "Has her/his facial expression usually seemed appropriate to the particular situation, as far as you could tell?"; Question 9, Lifetime form) and took approximately 10 minutes to complete. Each item was given a score of either 0 or 1 depending on whether the answer to the item was yes or no. A total score for each questionnaire was computed by adding each item response score. Accordingly, for each scale, possible scores range from 0 to 40, with higher scores indicating a higher level of ASD communication behaviours displayed (i.e., poorer social communication skills). A score above 15 on either of the SCQ measures is usually considered to be indicative of an ASD diagnosis.

Faces

Facial displays were used in both the Story Task and the Categorization Task. The faces for the Story Task were taken from a single target. They were selected from a database of facial expressions compiled and rated for research on posed and genuine expressions of emotion (McLellan, 2006) and those for the Categorization Task taken from a database of multiple targets smiling (Miles, 2005). Further details can be obtained from Miles (2005), and Miles and Johnston (2006; 2007).

To create the expressions in both databases a similar procedure was used. The faces of female participants were recorded while they viewed a Powerpoint slideshow. The slideshow comprised of emotionally evocative pictures and sounds from the International Affective Picture System (IAPS; Lang, Bradley & Cuthbert, 2001) and the International Affective Digital Sounds (IADS; Bradley & Lang, 1999), which are normed for ratings of arousal and pleasure, instructions to reminisce about emotional events in the past and instructions designed to elicit posed expressions (e.g. smile as if you were having your passport photo taken). The participant was also asked to indicate how each target stimulus made them feel (happy, sad, fearful, anger, disgust, surprise and neutral) and the intensity of that feeling (low, medium, high)

A still display was captured at the apex of each expression recorded from the participant and coded for the appropriate Facial Action Units (AUs) using the Facial Action Coding System (FACS; Ekman, 2002). The FACS is a system used to analyse and label facial expressions based on different muscle movements in the face (Ekman, Friesen & Hager, 2002), having identified those muscles (or action units) that must be activated in order for an expression to be categorised as displaying a specific emotion, In addition, different patterns of muscle activation have been identified for genuine and posed expressions of emotions (Ekman et al., 2002).

For the Story Task four expressions were required from a single target – a neutral expression, a posed expression of happiness, a genuine expression of happiness and a genuine expression of sadness. In order to be identified as a neutral expression no action units were to be activated, to be identified as a genuine expression of sadness AU 1 and AU 4 were to be activated. To be identified as a genuine expression of happiness both AU 12 and AU 6 were to be activated and to be identified as a posed expression of happiness only action unit AU 12 was to be activated. Two additional criteria were also used. For an expression to be considered a genuine expression it had to be produced in response to an appropriate eliciting item in the Powerpoint slideshow and the individual had to report experiencing the relevant emotion at a moderate to high level on the intensity scale. For an expression to be considered a posed expression it had to be elicited in response to direct instructions to the individual to display that expression and was not accompanied by any self-reported experiencing of the relevant emotion.

For the categorization task a set of a neutral expression, a posed expression of happiness and a genuine expression of happiness was selected from each of 6 targets. The same criteria for the selection of genuine and posed expressions of happiness and neutral expressions as described above were employed.

Story Task

Twelve stories were developed by the researcher for use in this study, based on those used in previous research (Dennis et. al, 2000, Harris et. al, 1986). Each story was developed to describe an event in which one of three specific emotional states (i.e., happy, sad, or neutral) would be expected to be experienced by the central character, or in which the central character would be expected to look as if she were happy even though she would not be feeling happy. In each story the central character was a young adult female who was referred to as Julia (not her actual name). Three of the stories involved the description of an event in which Julia would be expected to feel and look happy. An example of one such story is: "Julia loves going to the zoo. On Saturday morning, her father takes her to the zoo". Three of the stories involved the description of an event in which Julia would be expected to feel and look sad. An example of such a story is: "Julia really wants to go swimming. This week, she can't go swimming because it is too cold". Three stories each described an event in response to which Julia would not be expected to feel happy but would be expected to look "as if" she was happy. An example of such a story is: "Julia is getting her photo taken for a family portrait. The photographer says 'Smile!'". The final three stories each described an event where Julia was not expected to experience a specific emotion or show a particular expression. An example of such a story was: "Julia goes to school. Her day was just ok".

Pilot testing with twenty girls without a diagnosis of ASD, aged between 6 and 8 years, was conducted to ensure both that the emotion eliciting stories (happy and sad) could be understood and that for each story, the expected facial expression of emotion was identified (e.g., for the sad stories, the children would select a picture of Julia displaying a sad expression as representing how she would feel). In the pilot test, the children were asked to listen to each of the stories and select, from the grid of four photographs of Julia, the expression which they thought the target would display during the event described. Overall results from the pilot study indicated that the children could indeed match the appropriate expression to each story (percentage correct for genuine smile stories= 51.67%, percentage correct for posed smile stories= 60%, percentage correct for sad expression stories=85%), although two of the stories aimed at describing situations associated with both genuine and posed needed minor modification to the wording.

Each stories read by an adult female in a neutral tone and recorded digitally.

Categorisation Task

Each child completed two blocks of 18 trials. In the first block of trials the child was asked whether the target person was *looking* happy and in the second block of trails whether the target person was *feeling happy on the inside.* The 18 target photographs were displayed one at a time on a computer screen using custom-written software (Walton, 2003), in a unique random order for each child within each block. Each photograph appeared in the middle of the screen, and was flanked on either side with the response boxes - YES and NO. Above each photograph, the target question appeared. In the first block of trials the question was, “Is this person looking happy?” and in the second block of trials, “Is this person feeling happy on the inside?”

Procedure

Children were tested individually. The child and his parent/guardian was met outside the Department of Psychology by the researcher and taken to the Social Perception Laboratory. The child was asked whether he wished to participate in the experiment using a standardised greeting protocol:

“I am doing a project. I need your help with my project. I’m going to ask you to come and look at some faces on a computer. It is ok if you get confused. I just want you to answer the questions as best you can. Your Mum/Dad/Guardian will be right outside this room and I will be in the room with you all the time. Do you want to help me with my project?”

All of the children answered “yes”. The researcher then administered the PPVT. Each child was given the following standardized instructions with regard to the PPVT:

“First we are going to look at some pictures on this table here. I want to know if you can answer my questions about these pictures. It is ok if you don’t know the answers. Then we are going to go and play on the computer”.

Following completion of the PPVT, the child was asked to sit in front of a computer with a touch screen monitor. The researcher sat behind the child, in front of a laptop computer that controlled the presentation of the stories. The researcher told each child that he would hear some stories and see some pictures of a girl called Julia. The following standardized instructions were provided:

“These stories are about a girl called Julia. The pictures of Julia were taken while she was doing different things. You are going to hear some stories about the different things that Julia does. At the end of each story, I want you to touch the face that you think is what Julia might look like in the story”.

Five practice trials were completed with the researcher providing prompts regarding the use of the touch screen, as required. The practice trials were designed to familiarise the child with the nature of the touch screen and the answering procedure, rather than the experimental content. Accordingly, these practice trials did not involve facial expressions but were of animals. For example, in one practice trial the grid consisted of a picture of a dog, a cat, a fish and a bird and the child was asked which of these can fly. At the end of the practice trials, the child was told that he was going to hear the stories.

The experimenter played the stories to the child one at a time, in a unique random order for each child. After hearing each story the child was asked to touch the picture of the target which best showed how she would feel in the story they had just heard. The response grid was the same for each trial and consisted of 4 pictures of the target – displaying genuine happiness, posed happiness, genuine sadness and a neutral expression – and a question mark. Children were told that they could touch the question mark if they were unsure of the correct answer. The pictures were always in the same position in the grid (see Appendix A). After the child had touched one of the pictures or the question mark the grid disappeared and then re-appeared and the experimenter played the recording of the next story to the child.

Immediately following completion of the Story task, the researcher asked the child whether he understood the difference between looking one way on the outside and feeling another way on the inside. He was asked if it were possible to experience one emotion but to display a different facial expression. The experimenter gave the example of when another person is mean to you but you do not want them to know they hurt your feelings so you smile instead. This was to clarify, for the child, the distinction between displaying a facial expression of emotion and experiencing an emotional state. The child was asked if he could provide another example of a time when he might feel one way on the inside and look another way on the outside. All of the children could provide such an example. The child was then given the following standardized instructions:

"Now we are going to do one more task on the computer. You are going to see one picture. You will be asked a question about this one picture. Let's practice."

Five practice trials were completed in order to familiarise the child with the response format. The practice trials involved pictures of familiar objects such as a pair of shoes, apples and a bird. A Yes/No question was asked each time an object was presented. For example, if the object was a hat, the question was "Can you wear this on your feet?" Children were required to touch either a NO on the left hand side of the screen or a YES on the right hand side of the screen. After the practice trials, the child was asked if he had any questions.

The researcher then told the child that they were going to see some more faces. This time they needed to answer a question. The researcher read the question above the photo out loud for the first five trials. If the child appeared to hesitate after the 5th trial, the researcher continued to read the question. The photograph and response boxes remained on the screen until the child touched one of the boxes to indicate his response. When the child touched the screen, the photograph and response option was replaced by the next photograph and response boxes. To avoid anticipatory responses the delay between one photograph disappearing from the screen and the next one appearing randomly varied between 1.5 and 3 seconds. The child's response was recorded by the computer software (Walton, 2003).

After all the trials were completed, the child rejoined his parent/guardian who had been completing the SCQ. The completed SCQ and the demographic information were collected from the child's parent/guardian (See Appendix B). The child and his parent/guardian were debriefed, thanked and given their toy/petrol voucher.

Results

Descriptive statistics

Comparisons between the children with ASD and the children without ASD were made on the Peabody Picture Vocabulary Test (PPVT) and the Social Communications Questionnaire (SCQ) measures. As a matched-pairs design was employed in this study, analyses for dependant groups were used. Table _ illustrates means and standard deviations for these measures.

PPVT: A dependent means t-test revealed a significant effect, $t(7) = -2.44$, $p < .05$, $\eta^2_p = .46$. Children without ASD scored significantly higher on the PPVT than did those with ASD (*Ms* = 12.23 vs. 7.46).

SCQ: Dependent means t-tests[2] were computed on both the lifetime scores (SCQ-L) and current (SCQ-C) scores and each revealed a significant effect, $t(6) = 8.70$, $p < 0.05$, $\eta^2_p = .93$ and $t(6) = 4.29$, $p < 0.05$, $\eta^2_p = .75$. The children without ASD scored lower than those with ASD on both the SCQ-L (*Ms* = 3.14 vs. 25.43) and SCQ-C (*Ms* = 2.43 vs. 13.86) measure. All children with ASD scored above 15 on the

[2] Note that for one child with ASD the SCQ was not completed, hence the reduced degrees of freedom in this analysis.

SCQ-L form, which is considered to be a cut-off score for an indication of ASD. None of the children without ASD scored above 5.

Table 1

Means and Standard Deviations for the Descriptive Measures

Measures	Participants (with or without ASD)	Mean	Standard deviation
Age			
	ASD	10.57	2.80
	Non ASD	10.50	2.83
PPVT			
	ASD	7.46	3.58
	Non ASD	12.23	4.63
SCQ-L			
	ASD	25.43	6.58
	Non ASD	2.75	1.58
SCQ-C			
	ASD	13.86	7.13
	Non ASD	2.25	1.49

Story task

The proportion of correct responses for each type of story (happy; sad; neutral; posed happy) was calculated for each child, and are shown in Figure 1, as a function of participant group.

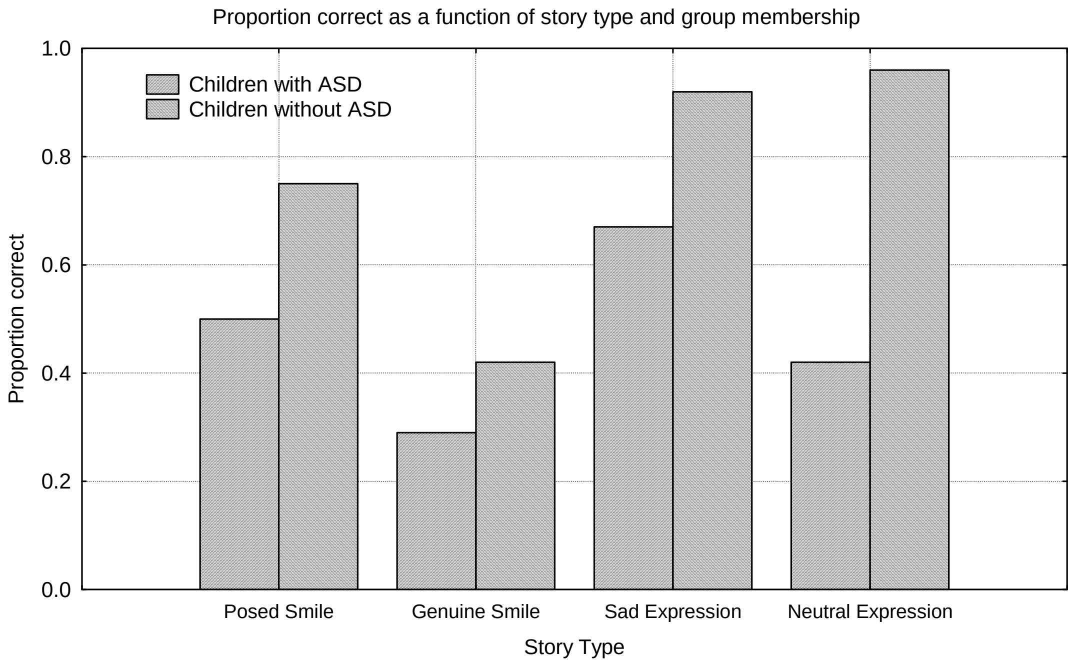

Figure 1: Proportion correct as a function of Story Type and Participant Group

A 2 (Group: children with ASD/children without ASD) x 4 (Story type: happy/sad/posed happy/neutral) repeated measures ANOVA on the proportion correct revealed main effects for Group, $F(1, 7) = 12.70$, $p < 0.05$; $\eta^2_p = .65$, and Story type, F $(3, 21)= 3.91$, $p < 0.05$; $\eta^2_p = .36$, but no interaction.

The children without ASD achieved a higher overall proportion correct than did the participants with ASD (*Ms* = .76 vs. .47). Post-hoc Tukey tests ($p < .05$) were computed on the Story main effect. This revealed only one significant effect, with a higher proportion of correct responses for the sad expression stories than the genuine smile stories (*Ms* = .79 vs. .36).

The responses to each story type were compared to 0.25 (representing chance level), separately for each participant group using single sample t-tests ($p < 0.5$). For the children with ASD, performance was only significantly greater than chance for the sad stories, $t(7)= 2.70$, $p <0.05$. For the children without ASD, responses were significantly greater than chance for the sad, $t(7)= 12.22$, $p <0.05$, posed happy, $t(7)= 6.00$, $p <0.05$, and neutral , $t(7)= 17.00$, $p <0.05$, stories but not for the happy stories.

To further investigate the nature of the errors made by the children, the nature of the responses made was considered. Tables 2 and 3 show the proportion each face was selected for each story type, as a function of participant group.

Table 2

Proportion of times each face was selected as a function of story type, by the children with ASD

	Responses				
Story Type	Posed smile	Genuine smile	Sad	Neutral	No response
Posed smile	0.50	0.42	0	0.08	0
Genuine smile	0.58	0.29	0.04	0.08	0
Sad Expression	0.04	0.12	0.67	0.12	0.04
Neutral Expression	0.17	0.29	0.08	0.42	0.04

As can be seen, when the story described a situation where a smile would be expected, the children with ASD were likely to select one of the smiling faces as their response, but they did not correctly identify the type of smile. For the sad and neutral stories the errors were distributed across each of the response options.

Table 3

Proportion of times each face was selected as a function of story type, by the children without ASD

Story Type	Responses: Posed smile	Genuine smile	Sad	Neutral	No response
Posed smile	0.75	0.25	0	0	0
Genuine smile	0.58	0.42	0	0	0
Sad Expression	0	0	0.92	0.08	0
Neutral Expression	0	0	0.04	0.96	0

As can be seen, when the story described a situation where a smile would be expected, the children without ASD exclusively selected one of the smiling faces as their response. For the posed happy stories the selection was usually correct but for the happy story the children did not differentiate between the smile types. For the sad and neutral stories very few errors were made and involved confusion between the neutral and sad expressions only.

Categorisation Task

The proportion of "happy" responses to each expression type (genuine smile, posed smile, neutral expression) was calculated for each child in each experimental condition (looking, feeling).

A 2 (Group: children with ASD/children without ASD) x 3 (Expression: genuine smile/posed smile/neutral expression) x 2 (Condition: looking/feeling) repeated measures ANOVA revealed main effects of Group, F (1, 7) = 9.03, $p < 0.05$; η^2_p = .56, and Expression, F (2, 14) = 63.89, $p < 0.05$; η^2_p = .90. These effects were qualified by a significant Expression by Group interaction, F (2, 14) = 4.41, $p < 0.05$; η^2_p = .39, which is shown in Figure 2.

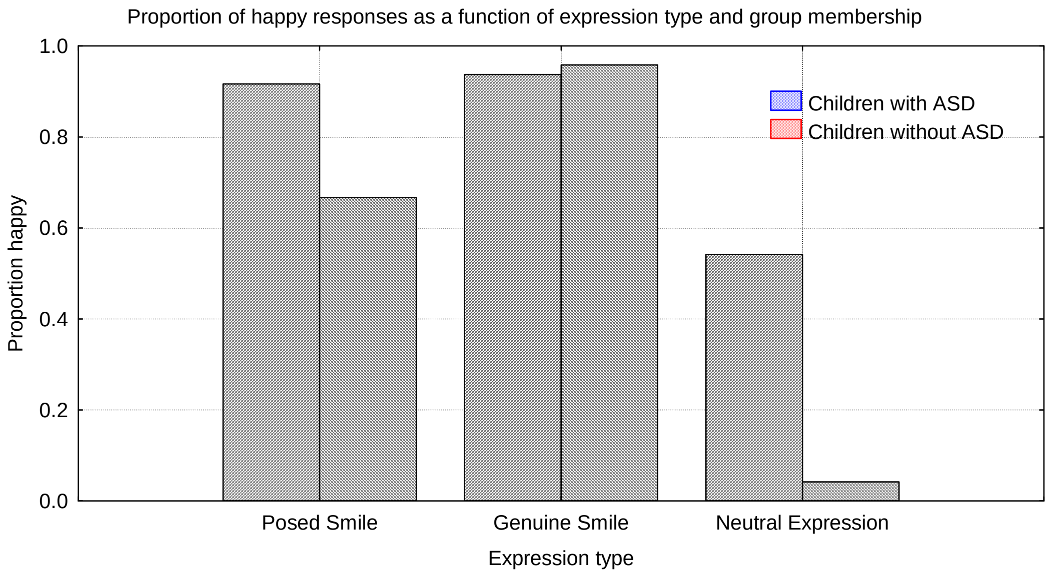

Figure 2: Proportion "happy" responses as a function of experimental group and expression.

Tukey post-hoc tests ($p < .05$) were computed to investigate the effect of expression type separately for each participant group and to investigate differences between experimental groups separately for each expression type. The children with ASD made a significantly lower proportion of "happy" responses for the neutral expression than for either the posed or genuine smile (Ms = .54 vs. .96 and .97). There was no significant difference in the proportion of happy responses to the posed and genuine smiles.

The children without ASD showed a similar pattern, with a significantly lower proportion of "happy" responses made in response to the neutral expression than to either the posed or the genuine smile (Ms = .05 vs. .78 and .98). There was no significant difference in the proportion of happy responses to the posed and genuine smiles.

There was a significant difference in proportion of "happy" responses made in response to the neutral expressions by the children with ASD and without ASD (Ms = .54 vs. .05). There were no significant differences between the experimental groups in the proportion of "happy" responses made to either the posed or genuine smiles.

Sensitivity and Bias

A non-parametric signal detection analysis (SDA; Green & Swets, 1966; Macmillan & Creelman, 1991; Snodgrass & Corwin, 1988) was performed to further investigate the pattern of responding to the different facial expressions in the categorization task. Hit and false alarm rates were calculated for each participant for each condition (looking/feeling) of the categorization task. A hit was defined as correctly identifying a genuine smile as happy, while a false alarm was defined as identifying either a posed smile or a neutral expression as happy.[3] The frequency of hit and false alarm rates was converted to associated rates of hits and false alarms using the correction formula recommended by Snodgrass and Corwin (see Appendix C).

Table 4

Hits and False alarms for all children in both conditions

Measure	Condition	Participants (with or without ASD)	Mean	***Standard deviation***
Hits	Looking			
		ASD	0.93	0.003
		Non ASD	0.93	0.003
	Feeling			
		ASD	0.87	0.12
		Non ASD	0.89	0.07
False Alarms	Looking			
		ASD	0.75	0.21
		Non ASD	0.48	0.09
	Feeling			
		ASD	0.71	0.30
		Non ASD	0.37	0.16

[3] Responding "happy" to a posed smile was considered to be a false alarm rather than a hit in this analysis as it is the sensitivity to the underlying emotion that is of interest. Responding "happy" to a posed smile indicates a lack of sensitivity to the underlying emotion (i.e., false alarm).

The hit rates and false alarm rates were then used to calculate sensitivity and response bias scores for each child and for each condition, using the formulae recommended by Snodgrass and Corwin (see Appendix B). Sensitivity and bias scores are shown in Table 5. High sensitivity scores indicate that a child is sensitive to the difference between expressions of felt happiness and expressions not related to an underlying experience of happiness. High bias scores indicate a tendency to respond "happy" more frequently than "not happy", regardless of expression type. As a result of the direction of coding used in this study, negative bias scores indicate a greater tendency to say "happy" than "not happy".

Table 5
Mean Sensitivity and Bias scores, as a function of Participant Group and Experimental Condition

Condition	Participants (with or without ASD)	Sensitivity Score	***Bias Score***
Looking			
	ASD	.620	-.415
	Non ASD	.834	-.570
Feeling			
	ASD	.581	-.283
	Non ASD	.851	-.336

Sensitivity: Each sensitivity score was compared to .5 (representing chance level responding and therefore no sensitivity), using single sample t-tests ($p < .05$). For the children with ASD sensitivity scores were not significantly different from 0.5 in either the looking condition, $t(7) = 1.59$, ns or the feeling condition, $t(7) = 1.04$, ns. For the children without ASD, sensitivity scores were significantly greater than 0.5 in both the looking, $t(7) = 30.66$, $p < 0.05$, and feeling conditions, $t(7) = 14.07$, $p < 0.05$.

A 2 (Group: children with ASD/children without ASD) x 2 (condition: looking/feeling) repeated measures ANOVA was conducted on the sensitivity score. There was only a significant main effect of group, $F\ (1, 7) = 9.73$, $p < 0.05$; $\eta^2_p = .58$. The children with ASD had a significant lower sensitivity score than the children without ASD (Ms = .60 vs. .84).

As there was a significant difference in the number of times neutral expressions were identified as “happy” by the children with and without ASD , a second sensitivity score was calculated to test the possibility that the difference in the percentage of neutral expressions categorized as happy by the two groups of children was driving the difference in sensitivity scores, rather than a difference in the perception of the genuine and posed smiles. Sensitivity scores were calculated using just the posed and genuine smiles. A hit was a correct identification of a genuine smile indicating that the target was “happy” and a false alarm was an incorrect identification of a posed smile as indication that the target was “happy”.
Sensitivity scores did not significantly differ from chance for the children with ASD, in either the looking or the feeling conditions (Ms= .504 and .553). Sensitivity scores did significantly differ from chance in both conditions for the children without ASD. A repeated measures ANOVA showed a significant effect of group, $F(1,7) = 8.11$, $p < 0.04$; $\eta^2_p = .54$. Children with ASD had significantly lower sensitivity scores than children without ASD (Ms= .53 vs. .65). Due to the similarity between the first sensitivity score, calculated using all three expressions, and the second sensitivity score, calculated only used posed and genuine smiles, all subsequent analyses were computed using the first sensitivity score.

Bias: Inspection of the bias scores in Table 5 shows that in all conditions children showed a bias toward categorizing any expression as “happy” rather than “not happy”.
Each bias score was compared to 0 (representing no bias), using single sample t-tests ($p < .05$). For the children with ASD bias scores were significantly different from 0 in both the looking condition, $t(7) = -7.27$, $p < 0.05$ and the feeling condition $t(7) = -3.38$, $p < 0.05$. Children with ASD displayed bias in both the looking and the feeling conditions. For the children without ASD, bias scores were significantly different from 0 in both the looking, $t(7) = -84.54$, $p < 0.05$, and feeling conditions, $t(7) = -$

5.99, $p < 0.05$. Children without ASD also displayed bias in both the looking and the feeling conditions.

A 2 (Group: children with ASD/children without ASD) x 2 (Condition: looking/feeling) repeated measures ANOVA revealed only a main effect of condition, $F(1, 7) = 6.10$, $p < 0.05$; $\eta^2_p = .47$. Bias was greater in the looking than the feeling condition (Ms = -.49 vs. -.34).

Relationships between performance on the emotion-related tasks, language and social communication skills

To investigate the relationship between performance on the two emotion-based tasks, correlations were conducted between the proportion of correct responses on the Story Task and sensitivity scores on the Categorization Task. Correlations were computed separately for the children with and without ASD and for the participant group as a whole. Correlations were computed separately for the looking and feeling conditions. Table 6 illustrates these correlations.

Table 6

Correlations between proportion correct on the Story Task and sensitivity scores

Condition	Participants (with or without ASD)	Correlation
Looking		
	ASD	.641 (n=8; p=0.09)
	Non ASD	-0.180 (n=8; p=0.67)
	All children	**0.693 (n=16; p=0.003)**
Feeling		
	ASD	**.795 (n=8; p=0.02)**
	Non ASD	0.475 (n=8; p=0.24)
	All children	**0.810 (n=16; p=0.0001)**

Note: scores in bold are statistically significant correlations ($p < .05$).

These correlations indicate that, for children with ASD, a higher proportion correct on the Story Task was related to a higher level of sensitivity in the Categorisation Task, although the correlation is only marginally significant in the looking condition. For the children without ASD, however, there was no relationship between performance on the 2 emotion-related tasks. For all children together, correlations show a positive relationship between proportion correct on the Story Task and Categorisation Task sensitivity in both the looking and feeling conditions. A higher proportion correct on the Story Task was associated with higher sensitivity on the Categorization Task, in each condition.

To further investigate the relationship between verbal mental ability and social communication skills and performance on the emotion tasks, correlations were computed between scores on the PPVT, SCQ-L and SCQ-C and the overall proportion correct on the Story Task and between scores on the PPVT, SCQ-L and SCQ-C and sensitivity scores.[4] These correlations were computed separately for the children with ASD, the children without ASD and for the all children. The correlations for the Story Task are shown in Table 7 and for the Categorization Task in Table 8.

Table 7

Correlations between the proportion of correct answers on the Story Task and PPVT, SCQ-L and SCQ-C scores as a function of participant group

	PPVT	SCQ-L	***SCQ-C***
Children with ASD only	.406 (n=8; p =.318)	-.636 (n=7; p=.12)	-.691 (n=7; .p=.09)
Children without ASD only	.023 (n=8; p=.96)	-.625 (n=8; p=.10)	.257 (n=8; p=.96)
All children	**.469 (n=16; p=.06)**	**-.776 (n=15; p<.01)**	**-.771 (n=15; p<.001)**

Note: scores in bold are statistically significant correlations (p < .05).

No correlations were significant when considering either group in isolation. When all the children were considered, however, significant correlations were observed between both the SCQ-C and SCQ-L scores and the overall proportion correct in the Story Task, and the correlation with PPVT scores approached significance. The negative correlations between SCQ scores and proportion correct indicate that the greater the children's social communication skills, the better they performed on the Story Task. The positive correlation with PPVT scores indicates that higher PPVT scores are related to higher proportion correct on the Story Task.

A multiple regression was conducted on the overall proportion correct in the Story task to identify the relationship between overall PPVT, SCQ-C, SCQ-L and

[4] As no group differences were found on bias scores, correlations for this variable were not computed.

performance on the task.[5] The regression was not significant, $F(3,11)= 5.94$, ns; $R^2_{adj} = .51$, and there were no significant predictors of proportion correct.

Table 8

Correlations between the proportion of correct answers on the Categorisation Task and PPVT, SCQ-L and SCQ-C scores as a function of participant group

Condition	Participants (with or without ASD)	PPVT	SCQ-L	SCQ-C
Looking				
	ASD	.588 (n=8; p =.13)	**-.771 (n=7; p=.04)**	-.624 (n=7; p=.13)
	Non ASD	.170 (n=8; p=.69)	-.534 (n=8; p=.17)	-.589 (n=8; p=.12)
	All children	**.566 (n=16; p=.02)**	**-.824 (n=15; p=.0002)**	**-.810 (n=15; p=.0002)**
Feeling				
	ASD	.605 (n=8; p=.12)	**-.876 (n=7; p=0.01)**	**-.824 (n=7; p=0.01)**
	Non ASD	.032 (n=8; p=.94)	-.408 (n=8; p=.31)	**-.713 (n=8; p=.05)**
	All children	**.576 (n=16; p=.37)**	**-.879 (n=15; p=.0003)**	**-.913 (n=15; p=.0003)**

Note: scores in bold are statistically significant correlations ($p < .05$).

[5] As there were no significant correlations between chronological age and sensitivity scores, age was not entered as a predictor variable in the multiple regression.

For the children with ASD there were no significant correlations with PPVT scores, but significant negative correlations between sensitivity scores and SCQ-L and SCQ-C scores in the feeling condition and a significant correlation between SCQ-L and a marginally significant correlation between SCQ-C scores and sensitivity scores in the looking condition. For the children without ASD there were no significant correlations in the looking condition and in the feeling condition there was only a significant negative correlation between SCQ-C scores and sensitivity. When considering all the children there were significant correlations between the SCQ-L, SCQ-C scores, PPVT score and sensitivity in both the looking and feeling conditions. Greater social communication skills and higher verbal mental ability were associated with higher sensitivity scores.

To further examine the relationship between the descriptive factors and sensitivity scores on the categorization task, a multiple regression analysis was performed with sensitivity scores as the dependent variable and PPVT, SCQ-C, and SCQ-L scores and group (dummy coded) as predictor variables.[6] In the looking condition, the regression was significant and explained a high level of the variance in sensitivity scores, $F\ (4,10)=9.49$, $p < 0.05$; $R^2_{adj} = .71$. Only SCQ-L was a significant predictor of sensitivity, B=-2.56; $t\ (10)=-2.42$, $p < 0.05$), although group was also marginally significant, B=-1.29; $t10=-2.16$, $p< 0.06$. Lower scores on the SCQ-L predicted higher sensitivity in the looking condition. Group membership also predicted sensitivity score, with higher sensitivity for those in the non-AS group.
In the feeling condition, the regression was significant and explained a high level of the variance in sensitivity scores, $F\ (4, 10)= 15.27$, $p <0.05$; $R^2_{adj} = .80$. However none of the predictor variables was independently a significant predictor of sensitivity.

[6] As there were no significant correlations between chronological age and sensitivity scores, age was not entered as a predictor variable in the multiple regression.

Discussion

The main focus of the present research was to investigate the sensitivity of children, with and without ASD, to the different emotional states underlying posed and genuine smiles. As hypothesised, the children with ASD were not sensitive to these differences in either the Story task or the Categorisation task.

It was predicted that children without ASD would be sensitive to the differences in emotional states underlying posed and genuine smiles. Results from the Categorization Task supported this hypothesis. The results for each group will be discussed in turn and between group differences will also be considered. The implications of the research will be considered as will limitations and directions for future research.

Children with ASD

Children with ASD were not sensitive to the different emotions underlying posed and genuine smiles, in either of the experimental tasks. In the Story Task these children performed at chance level when selecting the expression matching a story designed to elicit happiness and one designed to elicit a situation where a smile would be expected despite the target not actually feeling happy. It is noteworthy, however, that the children did tend to select one of the smiles in response to these stories but did not differentiate between the posed and genuine smiles in doing so. In the Categorization Task the sensitivity scores for the children with ASD similarly did not differ from chance. This was the case for both the calculations of sensitivity – when considering sensitivity to the emotional state of the targets and when considering the differences between genuine and posed smiles only. As expected, the children with ASD were not sensitive to the different emotional states underlying genuine and posed smiles.

These findings extend the understanding of the sensitivity of children with ASD to emotional expression. Previous research has suggested that children with ASD are able to recognize basic expressions of emotion (e.g., Baron-Cohen et al., 1993). The results from the Story Task offer support for this finding. The children with ASD were able to match the sad expression with the story eliciting sadness at a level above chance and selected a smile for the story eliciting happiness. The current research demonstrates the limitations of that ability. When given more than one smile in the response grid, the performance of the children with ASD dropped to chance level. It is likely that had there been more than one sad expression (e.g., a genuine and a posed sad expression) that the performance of the children in selecting the relevant expression for the sad eliciting story would also have dropped to chance level.

The lack of sensitivity to the emotional states of others is consistent with the social deficits documented in children with ASD (Macintosh & Dissanayake, 2006; Grelotti, Gauthier & Schultz, 2002). Further, the negative correlations between scores on the SCQ scales, measuring social communication skills, and sensitivity scores among children with ASD seen in the present research clearly suggest that poorer social skills are associated with poorer sensitivity to the emotional states of others. Previous research has identified several difficulties that children with ASD experience in social interaction which may contribute to this poor sensitivity, and support the link with social communication skills.

Firstly, children with ASD may not have had the same exposure to the relationship between posed and genuine smiles due to their lack of social interaction. During social interactions with other individuals, the link between underlying emotion, facial expressions and behaviour becomes apparent. For the same reasons, children with ASD may not have had the practice at recognising underlying emotions from facial expressions as typically developing individuals.

A lack of sensitivity to the emotions underlying facial expressions may also be related to the absence of exposure to facial expressions. The current research investigated sensitivity to posed and genuine smiles. One of the most salient cues that distinguishes a posed smile from a genuine smile is the activation of the obicularis oculi. If there has not been enough exposure to genuine smiles in early development, it would be difficult for any relationship between this facial expression and genuine happiness to be observed and learned, difficulty identified by the results obtained in the current research.

When analysing videos of children diagnosed with ASD and retrospective parent reports, a lack of social interaction behaviour by these children has been identified. Infants who were later diagnosed with ASD displayed a lack of attention to their name, a lack of joint attention and an avoidance of eye contact with other individuals (Trillingsgaard et al., 2005; Brunisma et al., 2004; Osterling et al., 2002, Charman & Baird, 2002; Wimpory et al, 2000; Baron-Cohen et al, 1996; Osterling & Dawson, 1994). It may be possible that parents of children with ASD behave differently towards their children in response to the lack of social interaction displayed by their children. Parents of children with ASD may smile fewer genuine smiles when interacting with their children and this may impede the development of sensitivity to the underlying emotional state of a genuine smile.

Research has indicated that there is a difference in the types of facial expressions displayed by parents in response to their children and that infants react differently to different adult facial expressions, including posed and genuine smiles (Rochat, Striano & Blatt, 2002; D'entremont & Muir, 1997; Bigelow, 1998; Symons, Hains, & Muir, 1998; Fox & Davidson, 1988, Fogel, Hsu, Shapiro & Nelson-Goens, 2006). Primary caregivers (usually the mother) with a mental illness such as depression often show less positive affect towards their children (Hart, Field & de Valle, 1998) and infants of depressed primary caregivers habituate to smiling faces more slowly than infants of non-depressed parents, indicating that the infants of depressed caregivers may have become accustomed to viewing sad expressions. Thus when presented with a picture of a smiling face, they take longer to habituate as it is a novel expression for them (Hernandez-Reif, Field, Diego, Vera & Pickens, 2006). Mothers suffering from psychiatric illnesses show significantly lower levels of positive affect when engaging with their infants than mothers not suffering psychiatric illnesses (Albertsson-Karlgren, Graff & Nettelbladt, 2001). Conversely, infants of mothers who scored highly on tests of responsiveness towards their child also scored highly on responsiveness tests (Symons & Moran, 1987). This indicates that changes or absences of certain expressions in primary caregivers affect the recognition of these expressions in infants. In addition, primary caregivers of infants who irritable, displaying behaviour such as prolonged or un-sootheable crying, display fewer instances of close interaction between themselves and their infant (van den Boom, 1994).

This evidence demonstrates that the behaviour of infants is related to the behaviour of their primary caregiver. If irritable behaviour is displayed, caregivers display less positive interaction with the infant. Lack of exposure to genuine smiles may inhibit the development of sensitivity to the different emotions underlying posed and genuine smiles. It is possible that parents of children with ASD respond to their behaviour, displaying less positive affect, specifically genuine smiles. As a consequence, children with ASD lack formative exposure to genuine smiles. This may inhibit the development of sensitivity to the different emotions underlying posed and genuine smiles.

Individuals with ASD may also experience a lack of practice interpreting posed and genuine smiles as these individuals tend to avoid social interaction (Loveland, 1991). Research has indicated that children with ASD are more likely to avoid interaction with others (Szatmari, Archer, Fisman, Streiner & Wilson, 1995) and engage in fewer spontaneous social interactions than children without ASD (MacIntosh et al., 2006). Additionally, children with ASD are also more likely to engage in inappropriate forms of social interaction (Scattone, Tingstrom & Wilczynski, 2006; Volkmar et al, 2004; Szatmari et al, 1995). Without consistent social interaction, the relationship between facial expressions, underlying emotions and behaviour would be difficult to acquire.

It is also possible that individuals with ASD are not sensitive to underlying emotions of posed and genuine smiles due to a lack of spontaneous attention to the face and its uses as an information source in social interaction. Many studies have investigated the attention paid to the face by individuals with ASD. These studies have found that individuals with ASD do not attend to the face with the same frequency as do individuals without ASD (Begeer et al, 2006; Grelotti, Gauthier & Schultz, 2002; Baron-Cohen, Cox, Baird, Swettenham, Nightingale, Morgan, Drew & Charman, 1996; Trillingsgaard, Sorensen, Nemec & Jorgensen, 2005; Osterling, Dawson & Munson, 2002; Brunisma, Koegel & Koegel, 2004). Although individuals with ASD appear to attend to the face in certain situations, such as explicit instructions to attend to the face or by making identification of the face personally motivation (Beeger et al., 2006), they do not attend to the face with the same frequency and spontaneity as typically developing individuals. This lack of spontaneous facial attention is particularly important in terms of posed and genuine smiles.

One of the crucial differences between posed and genuine smiles is the activation of the obicularis oculi that occurs when a smile is related to underlying emotions of happiness. Accordingly, the contraction of the obicularis oculi is one of the most reliable markers of a smile of enjoyment. Typically developing individuals use this maker, among others, to differentiate between posed and genuine expressions of happiness. To identify this marker of a genuine smile however, attention must not only be paid to the face but to the eye region specifically. If the face is not attended to, the contraction of this critical muscle will be missed and the ability to identify the difference between posed and genuine smiles impaired.

Eye tracking studies have indicated that typically functioning individuals focus on the eyes in social interactions (Haith, Bergman & Moore, 1979; Baron-Cohen, Wheelwright & Joliffe, 1997; Williams, Senior, David, Loughland & Gordon, 2001). This may facilitate the recognition of many emotions, especially the differences between posed and genuine smiles (Williams et al, 2001). Thus it would be reasonable to hypothesis that individuals with ASD would pay less attention to the eye region of the face than would typically functioning individuals. Indeed, this is the evidence that several eye tracking studies have found. Klin and colleagues (2002) found that when viewing video clips of social interactions in movies, individuals with ASD spent less time looking at the face and eyes of the actors than did their typically functioning counterparts. Another study by Klin et al (2002b) found that reduced eye fixation time was the best predictor of ASD.

A recent study specifically investigated the eye tracking of individuals with ASD when viewing posed and genuine smiles (Boraston, Corden, Miles, Skuse & Blakemore, 2007). Participants with and without ASD viewed target faces displaying posed smiles, genuine smiles and neutral expressions. These faces were the same faces that were used in the current research. In the first condition, participants viewed smiling faces and were asked to decide whether each smile was posed or real. In the second condition, participants saw faces displaying posed smiles, genuine smiles and neutral faces. They were asked to decide whether each expression was smiling or neutral. During each condition, participants eye movements were monitored and gaze time and fixation were measured.

Results indicated that the individuals with ASD spent significantly less time looking at the eye region. Although it did not reach significance, there was a trend for the individuals with ASD to look at the mouth region more than the control individuals. Again, a similar interaction was observed when analysing fixation data. Individuals with ASD had significantly fewer fixations on the eye region of the face than did typically functioning individuals when viewing facial expressions (Boraston et al, 2007). This data indicates that individuals with ASD focus on different aspects of the face when making distinctions between posed and genuine smiles than do individuals without ASD.

Without the fixation on the eye region, identification of the obicularis oculi contraction is impossible and distinctions between posed and genuine smiles difficult, possibly explaining the between group differences found in the current research in sensitivity to the differences in underlying emotions of posed and genuine smiles.

Often, the display of posed smiles is related to obeying social rules, such as smiling at an acquaintance to appear friendly, even when not truly happy. Although research indicates that children with ASD can identify appropriate facial expressions in certain situations (Bauminger, 2004; Boraston et al, 2007), other research indicates that individuals with ASD find social rules where facial expressions are not congruent with emotion felt difficult to understand (Dennis et al., 2000), possibly explaining why they have difficulty differentiating between posed and genuine smiles.

Research by Dennis and colleagues (2000) identified that while children with ASD had limited understanding of emotions that related to a social context, such as an emotion designed to deceive, they were not as able as typically developing children when explaining the social reasons someone might display a deceptive emotion. Children with ASD could not articulate the display rules as easily as children without ASD could. Similar findings have been identified in other research investigating emotion understanding in children with ASD (Laurent et al, 2004; Macintosh & Dissanayake, 2006). Recent research investigated the use and understanding of display rules by video taping children with ASD and typically developing children interacting with a researcher (Babaro & Dissanayake, 2007). To assess usage of display rules, the researcher initiated a scenario where the children were required to use a display rule, the hiding of inappropriate happiness. Children's facial expressions were coded for signs of neutralising the smile, suppressing the smile or covering their mouth with their hands to hide their smile. Hands over mouth was considered to be the least effective method of actualising a display rule, as this indicated an external modification of emotions rather than an internal modification. Neutralisation was considered to be the most effective, followed by suppressing. To assess understanding of display rules, the children then performed a matching task, matching appropriate facial expressions to emotion eliciting situations. The emotion eliciting situations in the matching task required the application of display rules and also required the child to asses the situation from the perspective of three different characters.

Results indicated that children with ASD did not use as effective display rules as typically developing children. Children with ASD used the hands over mouth technique rather than the more successful neutralisation or suppression. However, results from the task designed to asses display rule understanding showed no significant differences between children with ASD and typically developing children if verbal mental age was controlled for. If verbal mental age was not taken into account, there were significant differences in the understanding of display rules between the two groups (Babaro & Dissanayake, 2007). This research indicates that children with ASD may not utilise display rules as effectively as typically developing children. Although there are fewer differences between the groups in understanding different display rules, children with ASD appear to have greater difficulty with display rules than do children without ASD.

Taking into account previous research indicating that children with ASD have difficulty understanding display rules, it appears that results from the current research, in particular the Story task, may relate to this understanding of display rules and utilisation of such display rules. Children with ASD may understand situations where it is appropriate to display a smile, but may not understand the situations where a posed or genuine smile is appropriate.

It is possible that sensitivity to the underlying emotions of posed and genuine smiles is based on the understanding different social. It may be that for this reason, children with ASD find it difficult to differentiate between posed and genuine smiles, such is their difficulty in understanding and utilising display rules. The evidence found by the current research indicates that children with ASD were not sensitive to the different emotions underlying posed and genuine smiles. This does appear to concur with other research, indicating that individuals with ASD have difficulty explaining and understanding display rules. This may in turn affect their development of sensitivity to posed and genuine smiles.

The combination of lack of exposure to different facial expressions, lack of practice interpreting facial expressions and underlying emotions, differences in eye gaze and difficulty using and understanding display rules may explain why children with ASD in the current research were not sensitive to the different emotions underlying some facial expressions, specifically posed and genuine smiles.

Children without ASD

Support for the hypothesis that children without ASD would be sensitive to the different emotions underlying genuine and posed smiles was mixed. On the categorization task the children without ASD did show sensitivity scores above chance, both when considering sensitivity to underlying emotion and sensitivity to the differences between posed and genuine expressions, performing at a level comparable to that of healthy young adults (Miles, 2005; Miles & Johnston, 2007). However on the Story task, the children without ASD did not display sensitivity to the different emotions underlying posed and genuine smiles. For the posed happy story the children did perform at a level above chance but for the story designed to elicit happiness the children performed at chance level. It is again notable, however, that the children always selected a smile for this story but did not differentiate between the genuine and posed smiles.

The results of the Story Task are consistent with past research that has demonstrated that children are able to recognize basic emotions (Carey et al, 1980; Camras & Allison, 1985; Harris et al, 1986; Boyatzis et al, 1991; De Sonnerville et al, 2002; Mondloch et al, 2003; Mondloch et al, 2006; Herba et al, 2006). The children without ASD were able to select the appropriate expression for the sadness eliciting and the neutral stories and for the story eliciting happiness and the posed happy story the children always selected a smiling expression. This inconsistency in the sensitivity shown to the emotions underlying the genuine and posed smiles on the two tasks was unexpected. In the Story task, the children were required to listen to a story, and then select from one of four faces the one that matched how the target in the particular story would look. In the Categorisation task, however, the children viewed the target faces one at a time and simply had to judge whether the target was or was not happy. This difference between tasks may have affected the judgements the children without ASD made in each task, thus affecting their apparent sensitivity to posed and genuine smiles. Further research is needed to consider the conditions under which children do display sensitivity to the emotions underlying different facial expressions.

Findings from the current research add to the limited past research looking at the sensitivity of typically developing children to the differences underlying posed and genuine smiles. The past research has revealed mixed results. Some studies have revealed that children aged 6-7 years show implicit sensitivity to different smile types, recognizing that genuine smiles identify a target as feeling happy (Gosselin et al, 2002a), and similarly that 9-10 year olds show implicit sensitivity to the difference between posed and genuine smiles (Gosselin et al, 2002b) . Other studies have, however, shown children to lack sensitivity to the different types of smile (Del

Guidice & Colle, 2007; Gosselin et al., 2002c). Gosselin and colleagues found that 9 and 10 year old children were implicitly sensitive to the changes in the obicularis oculi but only if they viewed the complete temporal smile display. The same study found that 6 and 7 year old children were not sensitive. The results of the current research indicate that children without ASD are as sensitive to the different emotions underlying posed and genuine smiles as adults tested using the same task, indicating a robust effect.

One important difference between the current study and past research is in the nature of the facial displays employed. Target expressions in the current research were created using ecologically valid methodology. The genuine smiles were spontaneously displayed by the targets in response to an appropriate eliciting situation and the target was actually feeling happy. This is in contrast to past research where actors have been used to "pose" genuine expressions based on the contraction of the appropriate FACS action units. It is possible that the "genuine" expression created through these two methods may differ and children are more sensitive to differences between the former and posed smiles than between the latter and posed smiles. Krumhuber and Kappas discuss this possibility, explicitly stating that it is impossible for encoders trained using FACS to produce spontaneously and exactly, the many components that make up a genuine smile, such as duration, synchronisation and smoothness (Krumhuber & Kappas, 2005). The use of ecologically valid facial expressions may have made children sensitivity to the different emotions underlying posed and genuine smiles easier to measure.

The current research identified the sensitivity of children to static displays of posed and genuine smiles. Static displays do not contain all the information differentiating between posed and genuine smiles. However, significant results were still achieved, indicating the robustness of the results.

Between group differences

In order to measure between group differences, children with ASD were aged matched with the children without ASD. This was done to rule out the developmental aspects of facial expression understanding observed in typically developing children (Langlois, Ritter, Roggman & Vaughn, 1991; Harris et al., 1986; Slater & Quinn, 2001).

Children without ASD were significantly more accurate at matching the appropriate facial expression to a corresponding emotion eliciting situation. Although children without ASD did not differentiate between posed and genuine smiles, they made significantly fewer errors than children with ASD in choosing the correct face.

However, another important between group difference was identified in the current research. Children without ASD showed sensitivity to the different emotions underlying posed and genuine smiles while children with ASD did not. In addition, social communication skills were positively associated with sensitivity to posed and genuine smiles on the two experimental tasks. Children who scored lower on the SCQ (indicating higher social communication skills) were more sensitive to the difference in emotion underlying posed and genuine smiles. This relates to the finding that increased social communication skills predicted increased sensitivity in both the experimental tasks. There is a difference in the amount and type of social interaction experienced by children with ASD and typically functioning children. Children with ASD are less likely to engage in ongoing interactions with peers and are less likely to engage with larger groups of peers. Children with ASD are also less likely to engage in spontaneous interaction with peers (Macintosh & Dissanayake, 2006). In addition, children with ASD can also be unaware of social norms, leading to unsuccessful social interactions (Volkmar and colleagues, 1994). Typically developing individuals experience more practice and exposure to facial expressions and their relationship to emotion and behaviour and thus develop sensitivity to the different emotions underlying different facial expressions, specifically posed and genuine smiles while children with ASD do not.

Implications

The findings of the present research may have implications for possible therapy options for individuals with ASD. Some popular therapies for individuals with ASD focus on using stories similar to those in the Story task in the current research to teach appropriate behaviour and to help children with ASD learn appropriate social interaction skills (Crozier & Tincani, 2007; Reynhout & Carter, 2007). However, therapy may need to focus on how behaviour, either antecedent or consequential, relates to facial expressions. If individuals with ASD can be taught to associate behaviour patterns with specific facial expressions of emotion, as well as understanding the underlying emotion of the facial expression, they may learn the skills necessary for successful social interaction (Bauminger, 2007). In addition, by making the subsequent behaviour patterns personally relevant for the person with ASD involved in the interaction, social interaction skills maybe easier to learn (Begeer, 2007).

Additionally, learning about the different behavioural antecedents and consequences of posed and genuine smiles may facilitate social interaction. Research by McIntosh and colleagues (2006) indicates that individuals with ASD can voluntarily mimic facial expressions of emotions but do not do so automatically as do typically functioning individuals. However, if individuals with ASD can learn to mimic posed and genuine smiles in the correct situations, social interactions may be made much easier and more successful for them. Increased social interaction may facilitate increased learning of display rules, facial expressions and related underlying emotions. Research has indicated that intervention for socio-emotional understanding in individuals with ASD can be successful in teaching social interaction skills (Bauminger, 2002).

The sensitivity to underlying emotions for individuals with ASD could also be improved if individuals with ASD were given specific instructions about the different facial movements that accompany posed and genuine smiles. Individuals with ASD do not automatically attend to the face nor do they display the same face scanning patterns that typically functioning individuals use (Boraston, Corden, Miles, Skuse & Blakemore, 2007; Wang et al., 2007; Begeer et al., 2006; Grossman et al., 2000). Although specific instructions were given to attend to the facial expressions in the Story task of the current research, future research could manipulate different instructions to attend to facial expressions to investigate the effect of them on children with ASD's sensitivity to underlying emotion.

Limitations of the Current Research and Directions for Future Research

Despite a small sample size, the present findings demonstrated significant differences in the sensitivity to the emotions underlying posed and genuine smiles between children with ASD and children without ASD. Effect sizes for these differences were medium in size. In addition, control participants clearly performed well above chance on both the research tasks, and their sensitivity scores on the Categorization Task were comparable to those shown by healthy young adults (Miles, 2005; Miles & Johnston, 2007). Nevertheless, caution should be exercised in generalising the reported findings because of the small sample size. Future research should aim to increase sample size in order to increase the robustness and validity of findings.

Almost all studies involving individuals with ASD perform diagnoses of ASD prior to the experiment. Such a diagnosis process was outside of the scope of the present research, and instead the current research relied on diagnoses made previously by relevant health professionals. However, future research should aim to obtain professional diagnoses of ASD prior to participation in the experiment. This is particularly pertinent as autism as it is a spectrum disorder, and as suggested by the SCQ results in the present research, degree of severity of ASD may be related to performance on emotion recognition tasks.

One limitation that is of issue when discussing the results of the children without ASD is that all of these children were male. However, ASD is more prevalent among males and thus it was appropriate to use a sex-match for the control participants. However, caution must be exercised in generalizing the findings to females and subsequent research in this domain should endeavour to include female participants.

In addition, all of the target faces in the present research were of females. Females are generally considered to be more expressive than males (Wallbott, 1988; Brody, 1996) and so it should be easier to recognize emotions expressed by female than male targets. Furthermore, female faces have also shown to be stereotypically associated with displaying smiles (Becker, Kendrick, Neuberg, Blackwell & Smith, 2007), increasing the ease with which positive emotion expressed by female targets is recognised. However, as with the consideration of the sex of participants above, caution must be taken in generalizing the present findings to male targets.

Results indicated that level of social functioning, as measured by the SCQ, was related to degree of sensitivity to the different emotions underlying posed and genuine smiles. However, the SCQ was specifically designed for use in populations of children with ASD and Asperger's syndrome (Rutter et al., 2003) and thus may not be an appropriate tool to measure social functioning of typically developing children. Indication of this lack of fit can be seen in the difference in SCQ score ranges between the two groups. Children with ASD had a larger range of scores on the SCQ scales, while no child without ASD scored over five. This limits the extent to which the link between social functioning and emotion sensitivity identified in the current research can be generalised to other populations. Future research should aim to measure the social communication skills of children without ASD or social impairment with a measure designed for such a population.

One of the important features of the current research was the use of ecologically valid target faces. There should be more widespread use of such target faces. Research often endeavours to identify sensitivity to underlying emotion using faces built with the FACS criteria. These FACS faces have been created in the absence of underlying emotion. Hence, in order to measure sensitivity to underlying emotions, future research should use expressions created in congruence with underlying emotion.

Conclusion

The recognition of different facial expressions and their subsequent behaviour patterns is an important facet of human social interaction. Those who miss out on successful social interactions may suffer negative outcomes such as social isolation. Posed and genuine smiles represent a small, yet crucial part of social interactions that can have a large effect on successful interactions. It appears that children with ASD do not differentiate between posed and genuine smiles. However, this research also indicates that children without ASD can differentiate between these facial expressions. If it is possible to investigate this ability further and perhaps discover methods of teaching children with ASD to understand the difference between these facial expressions, then a group of socially disadvantaged people may be provided with the tools to engage successfully in society. The positive and enjoyable consequences of successful social interactions should be available to all, despite impairment or disadvantage. Perhaps more effort should be taken to investigate abilities in children, using ecologically valid methods of testing. For if any improvements are to be made in possible interventions for those who lack social interaction skills then it is important to understand how these skills develop and change throughout the lifespan.

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Appendix A: Response Grid for children in the Story task.

Appendix B: Information sheet, Consent form and Demographic Information completed on behalf of the children by their parent or guardian.

Facial Emotional Discrimination

Your child has been invited to participate in a study investigating the responsiveness of children to different facial expressions of emotion. Children with and without a diagnosis of autistic spectrum disorder (ASD) have been recruited to participate in this project. Further details regarding the research hypotheses will be provided at the end of the study and you will have the opportunity to ask the researcher any questions.

Your child will be asked to complete two emotional discrimination tasks on a computer. The first task involves the child listening to a number of very short stories and then selecting which photograph shows how the target of the story (Julia) would look during that story. The stories will describe situations of mild sadness, mild happiness and neutral (or no) feelings. For the happiness expressions there will be two photographs – one a genuine smile (when the target was actually feeling happy) and one a posed smile (when the target was trying to look happy but was not actually feeling happy). The second task involves the presentation of a number of photographs on the computer screen. For each photograph the child will be asked whether the person is happy or not.

During this experiment, your child will be asked to complete an additional test that will help researcher further understand the results gathered from the two emotional discrimination tasks. This test will be a vocabulary test commonly used with children (Peabody Picture Vocabulary Test). Parents/guardians will also be asked to fill out a questionnaire pertaining to your child's typical levels of communication (Social Communication Questionnaire).

If at any time your child becomes distressed or uncomfortable, the experiment will stop immediately and your child will be allowed to return to you. There will be a researcher present in the room with your child at all times.

Responses to all of the experimental tasks, both completed by you and your child, will be completely confidential. No names will be stored alongside the data collected. In addition to consent provided by parents/guardians, your child will also be asked for consent before participating in the study (see below). You may withdraw the participation of your child, along with any information provided by you or your child, at any time during the experiment.

At this point in time, we would ask you to answer some questions about your child (see below). This information is strictly confidential.

This research will be conducted at the Social Perception Laboratory at the University of Canterbury Psychology Department. It is estimated that your chid will spend approximately forty-five minutes completing the experiment.

At the completion of this research, you and your child will be provided with a summary of the results.

This research is being conducted under the supervision of Dr. Lucy Johnston, Dr. Kathleen Liberty and Dr. Lynden Miles at the University of Canterbury. Meredith can be contacted via email at mbl30@student.canterbury.ac.nz or by phone 03 337 0312 and will be pleased to discuss any concerns you may have about your child's participation. Alternately, Dr. Johnston can be contacted via email on lucy.johnston@canterbury.ac.nz or by phone 03 364 2967.

Information given to your Child

Appendix B: Information sheet, Consent form and Demographic Information completed on behalf of the children by their parent or guardian.

Prior to participating in this study, your child will be given the following information. “I am doing a project. I need your help with my project. I’m going to ask you to come and look at some faces on a computer. It is ok if you get confused. I just want you to answer the questions as best you can. Your Mum/Dad/Guardian will be right outside this room (or behind the curtain depending on if the child or parent/guardian decided to be in the room) and I will be in the room with you all the time”.

Consent Form

Facial Emotional Discrimination

Parent/Guardian Consent

I have read and understood the description of the above named project in the information sheet provided. On this basis, I agree to allow my child (named below) to participate as a subject in the project.

I am aware that all information provided by myself and my child is confidential.

Name (please print):…………………………………………………………………..

Relationship to child:..

Signature:

Date:

Demographic Information

Child’s Name:

Years *Months*

Age of Child:

Sex of Child: M F

Has your child received any diagnosis of clinical conditions? If so please list these below, indicating the nature and date of the diagnosis and who made that diagnosis (e.g., a GP, a psychologist).

Diagnosis	Date of Diagnosis	Diagnosis administered by (e.g. GP)?
1.		
2.		
3.		

Does your child use a computer (at school or at home)? YES NO

If YES, approximately how many hours per week does your child use a computer?

Appendix B: Information sheet, Consent form and Demographic Information completed on behalf of the children by their parent or guardian.

Does your child wear eye-glasses or contact lenses?   YES   NO
Does your child take any prescription medication?   YES   NO
If YES, please describe below what medication they are prescribed.

Has your child received reading recovery or worked with an RTLB teacher at school?
YES   NO

Appendix C: Formulae for calculation of non-parametric indices of sensitivity (A') and response bias (B").

Sensitivity (*A'*):

- For $H \geq FA$: $A' = 0.5 + [(H - FA)(1 + H - FA)] / [4H(1\text{-}FA)]$
- For $FA > H$: $A' = 0.5 - [(FA - H)(1 + FA - H)] / [4FA(1\text{-}H)]$

Response bias (*B"*):

- For $H \geq FA$: $B'' = [H\,(1 - H) - FA(1 - FA)] / [(H\,(1 - H) + FA(1 - FA)]$
- For $FA > H$: $B'' = [FA(1 - FA) - H(1 - H)] / [(FA\,(1 - FA) + H(1 - H)]$

Where H = hit rate, and FA = false alarm rate.