Can systemising facilitate empathising? Enhancing emotion recognition in children with autism: an evaluation of the 'Transporters' intervention, implemented in an educational establishment

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ABSTRACT

AIMS: The current research aims to establish whether a purpose made, animated TV series with dynamic human faces (The 'Transporters', Golan *et al.,* 2010) can enhance emotion recognition in children with autism. METHOD: Three groups of participants aged 7-11 years (autistic experimental n=9, autistic control n=8 and a typically developing (TD) control n=8) were given indirect assessments to establish their ability to define and recognise 16 emotions. The assessment used novel dynamic video clips. The autistic experimental group watched the 'Transporters' (Golan *et al.,* 2010) at an educational establishment, 5 days a week for 4 weeks whilst both control groups received no intervention. The vocabulary definition and emotion recognition assessments were repeated using novel dynamic stimuli. Scores from time1 and time2 were analysed using a 3x2 mixed ANOVA. RESULTS: The interaction effect revealed significant improvement in vocabulary understanding for the autistic experimental group and the TD control group ($F[2,22]=5.27$ $p<.05$). The results also revealed a selective significant improvement in emotion recognition for the experimental group ($F[2,22]=28.40$ $p<.001$), which suggests that autistic children can be taught emotion recognition which reflects cognitive empathy and effectively generalise to novel human faces. Implications for future research are discussed.

KEY WORDS:	AUTISM	TRANSPORTERS	EMOTION RECOGNITION	FACE PROCESSING	INTERVENTION

INTRODUCTION:

One of the many debilitating difficulties encountered by individuals with autism is the apparent lack of emotional connectedness, internal emotion identification and emotion recognition. Ekman & Friesen (1971) defined six basic emotions which are thought to be innate and universal: happy, sad, angry, afraid, disgusted and surprised. More complex emotions are thought to reflect a cognitive state and may be contextual and influenced by culture (Baron-Cohen, Golan & Ashwin, 2009). The 'Transporters' is an intervention designed to enhance emotion recognition in children with autism (Golan, Humphrey, Chapman, Gómez de la Cuesta, Peabody *et al.,* 2009). During the compilation of the current report, an article was published on an evaluation of the effectiveness of the 'Transporters' on emotion recognition in autistic children aged 4-7 years old. The intervention was conducted in a home environment with no real measurement of exposure (Golan, Ashwin, Granader, McClintock, Day *et al.*, 2010). The current study looked at the impact of the intervention on autistic children aged 7-11 years old. In contrast to the previous study, the intervention exposure was measured in an educational establishment.

What is Autism?:

Autism is a developmental condition that has many manifestations. The National Autistic Society estimates that 1 in 100 children in the United Kingdom have an autistic condition. Kanner (1943) was the first to conceptualise autism when he suggested that the autistic child was born with "an innate inability to form the usual biologically provided affective contact with people" (Kanner, 1943, p.250). These autistic children seemed oblivious to the world around them, language impaired and resistant to change. Simultaneously, Hans Asperger (1944) noted some higher functioning children who had little or no communication difficulties, but significant deficits in social skills. He introduced the term 'Asperger's Syndrome' to incorporate the less severe individuals who demonstrated rigid ritualistic behaviours (cited in Frith, 1991). However more recent research by Frith (2004) suggests there is some controversy over the existence of this distinction and suggests that Asperger's syndrome is merely one of many variations of autism.

Since Kanner's original diagnosis of early infantile autism, there have been many adaptations and enhancements regarding the diagnosis, aetiology and treatment of autism. Wing and Gould (1979) introduced the term 'autistic spectrum disorder' as they suggested that autism exists on a continuum, this term has now been superseded by 'autistic spectrum *condition*' (ASC) (Baron-Cohen, 1995). The condition covers a complex combination of difficulties displayed in varying degrees within each individual. The spectrum spans from low to high functioning with various subgroups including Asperger's Syndrome.

Wing and Gould's (1979) research highlighted three core characteristics of autism which they referred to as 'the triad of impairments'. They suggested that all individuals situated throughout the spectrum will have impairments in social interaction, social imagination and communication. The manifestations of these impairments vary with the severity of the disability. The extent of social interaction

difficulties may vary between individuals; some are quite profound, whilst others are less severe. Some children fail to show any form of emotional attachment and often fail to acknowledge the presence of others; others will interact with peers but in an awkward and stilted way (Frith, 1991). Communication difficulties are manifested in a variety of ways, some children are extremely articulate but tend to monopolise conversations, whilst others have no form of communicative speech (Dodd, 2005). Unusually strong narrow interests, known as fascinations or repetitive behaviours are common aspects of social imagination difficulties (Frith, 1991) and observations reveal that children with autism spend much less time in 'symbolic play' than their typically developing (TD) peers (Libby, Powell, Messer & Jordan, 1998).

The most common denominator of Autism is the social interaction deficit, which may be confounded by the inability to empathise with others as a result of diminished attention to faces (Baron-Cohen, 2009). Many studies have highlighted that numerous children with autism struggle with the concept of empathy and have a deficit in emotion recognition abilities. (Baron-Cohen, Wheelwright, Hill, Scahill, Lawson & Spong, 2001; Dawson, Webb & McPartland, 2005; Baron-Cohen, Golan, Wheelwright, & Hill, 2004).

Visual attention and perception:

The ability to recognise emotions through facial expressions is an ability demonstrated at a very young age. Newborn infants were found capable of distinguishing the faces of their mothers from matched females, based on visual cues alone (Bushnell, Sai & Mullin, 1989). According to Haviland and Lelwica (1987) 10 week old infants are capable of discriminating between happy, sad and angry facial expressions displayed by their mother. Their research also revealed that some of the infants attempted to match their mother's facial expressions. Contemporary research using Event Related Potential (ERP) studies on 7 month old infants support the claim that infants are capable of emotion recognition; researchers found a distinction between fear and anger recognition at an electrophysiological level (Kobiella, Grossmann, Reid & Striano, 2008). 14 month old, TD toddlers are able to determine which object is the focus of another's visual attention, yet Swettenham and colleagues (Swettenham, Baron-Cohen, Charman, Cox, Baird & Drew, 1998) found reduced joint attention in children on the autistic spectrum. Unfortunately, as a result, people with autism tend to struggle throughout life with understanding that facial expressions reflect thoughts, feelings and emotions (Baron-Cohen *et al.,* 2001).

One area of autism research focuses on altered neurological processes that may be responsible for the lack of attention to faces by individuals on the spectrum. The Fusiform gyrus and N170 waveforms have been implicated in processing upright faces by many event-related potential (ERP) and functional magnetic resonance imaging (fMRI) studies (Bentin, DeGutis & D'Esposito, 2007; Vuilleumier, Mohr, Valenza, Wetzel, Landis & Robertson, 2003). Grice *et al.* (2005) found reduced N170 activity in ASC children as opposed to TD and matched developmentally delayed (DD) children (Grice, Halit, Farroni, Baron-Cohen, Bolton & Johnson, (2005). This was supported by Webb and colleagues (2006) who conducted studies on 3-4 year olds and found that children in the autistic group demonstrated atypical brain responses to faces and objects, which reflected their behavioural preferences. The N170 waveform was found to be significantly more responsive to object recognition than face recognition in the ASC group (Webb, Dawson, Bernier & Panagiotides,

2006). The amygdala has been associated with difficulties in recognising fear from facial affect (Richardson, Strange & Dolan, 2004) and the insula and basal ganglia have been implicated in recognising disgust (Sprengelmeyer, Young, Calder, Karnat, Lange & Homberg, 1996). However, research has found a specific area containing 'mirror neurons' which appear to be activated when interpreting a variety of facial expressions; autistic children show reduced activity in this area (Dapretto, 2001). It is unclear as to whether inadequate facial processing may be the result of congenital faulty neuronal circuitry or developmental issues. The 'social motivation hypothesis' suggests that autists have a reduced desire to attend to faces which results in restricted stimulation and the typical development of specialised cortical areas (Dawson, Webb & McPartland, 2005). According to the 'social motivation hypothesis', early socio-emotional intervention is crucial to achieve normalised brain function in children with autism. As maturation occurs, the brain loses its malleability and autists can only adopt alternative strategies to recognise emotion as they grow older (Dawson, Webb & McPartland, 2005).

Baron-Cohen and colleagues (1993) suggest that altered face processing in autists could lead to a lack of ability to infer mental states from information conveyed by the eyes (Baron-Cohen, Spitz and Cross, 1993). Children with Asperger's were found to focus on the mouth area, perhaps to extract verbal information to compensate for their lack of ability to interpret facial expression (Grossman, Klin, Carter & Volkmar, 2000).The unpredictability of the human face may lead to many autists to avoid eye contact, which results in the inability to evaluate facial expressions which serve to reflect one's emotional state (Baron-Cohen, 1995; Dawson, Webb & McPartland, 2005). As a result they may fail to attend to invaluable clues as to how their behaviour is impacting upon their peers or carers.

The revised version of the 'Reading the Mind in the Eyes' test was constructed and administered to 15 high functioning autistic adults and over 200 controls. Participants were required to select one of four words that best described the emotion depicted by a photo of the eye region. Results showed that mean scores for emotion recognition were negatively correlated with scores generated by the Autistic Quotient (AQ), which is an instrument designed to measure autistic traits in adults. In addition no relationship between emotion recognition and Intelligence Quotient (IQ) was detected (Baron-Cohen, Wheelwright, Hill, Raste & Plumb, 2001). The results suggest that the eyes convey essential information needed for successful emotion recognition, particularly complex emotions. However this supposition has been challenged by contemporary research which used computerised facial manipulation techniques to freeze or animate certain areas of the face. The results demonstrated that although ASC children performed worse overall than TD peers, their correct responses were decreased when the eyes remained neutral, suggesting that autists do utilise the eyes in emotion recognition (Back, Roper and Mitchell, 2007). There is evidence to suggest however, that using dynamic facial expressions facilitates emotion recognition in comparison to static representations (Bould and Morris, 2008). Bal and colleagues (2009) used dynamic expressive faces to measure response rates to recognition and found that even when ASC children recognised the emotion, they were much slower than their TD peers (Bal, Harden, Lamb, Hecke, Denver and Porges, 2009).

Research by Hefter and colleagues (2006) questions the premise that compromised facial processing is responsible for emotion recognition difficulties

(Hefter, Manoach & Barton, 2005). Their research on adults with autism found that discrimination between familiar and unfamiliar faces did not correlate with correct interpretation of emotional expressions. In fact, a double dissociation was found. This research supports the suggestion that diverse neurological pathways are used for face recognition and other processes such as facial expression, lip-reading and visual appearances such as race or gender (Valentine, Powell, Davidoff, Letson and Greenwood, 2006).

Although people on the autistic spectrum tend to demonstrate reduced visual attention to faces, they have heightened general visual attention. Many autists have difficulty in understanding abstract concepts and require visual representations to make sense of the world. The TEACCH (Treatment and Education of Autistic and related Communication handicapped Children) approach (Mesibov, Shea, & Schopler, 2004) is an established framework implemented in the education system which emphasises the need to utilise visual aids and visual learning techniques to assist communication development. This paradigm is supported by Rao and Gagie (2005) who state that:

> *Although there is no one best program or one best way of helping children with autism, the importance of using supports based on concrete and visual teaching aids is largely upheld* (Rao and Gagie, 2005, p.26).

This suggests that given the diversity of autistic spectrum conditions, a variety of approaches need to be applied, however a visually orientated approach is paramount to success.

This statement is supported by the autistic author of 'Thinking in Pictures', (Grandin, 2006):

> *I translate both spoken and written words into full-colour movies, complete with sound, which run like a VCR tape in my head* (Grandin, 2006, p.9)

Grandin (2006) feels that words are like a second language and from a very young age, resorted to creating a picture in her mind's eye. This technique allows for translation of the social world and enhances social interactions and communication.

Relevant theories of autism:

The mind is comprised of beliefs, desires, emotions, perceptions, and intentions otherwise known as cognitions. These internal processes are externalised through facial expressions. Theory of mind is the ability to attribute these mental states to others and the self in order to understand and predict behaviour (Baron-Cohen, 2009). Many autists fail to read facial expressions which contain visual emotional cues; thus the ability to attribute mental states is impaired, leading to a deficit in 'Theory of Mind' (Gopnik, Capps & Meltzoff, 2000). Baron-Cohen, Leslie and Frith (1985) suggested that children with autism have a severe deficit in their 'theory of mind' (ToM), resulting in social interaction difficulties and impaired ability to recognise facial affect. If a child is unable to comprehend that other people do not think and feel exactly as they do, their world can seem a bewildering place and maladaptive behaviours can ensue.

The revised theory discussed in Baron-Cohen's book 'mindblindness' (Baron-Cohen, 1995) suggests that retrospective studies highlight that even infants show antecedents to ToM. Dawson and Osterling (1994) demonstrated that it was possible to identify infants who were subsequently diagnosed with autism, by watching video recordings of their 1st birthday party. The TD child would use social referencing to determine how to behave when faced with candles on a birthday cake, whilst the children with autism failed to attend to faces. This lack of joint attention indicates a reduced desire, or ability to understand that although they do not know what to do in social situations, the adult does, which suggests a deficit in the ability to infer mental states.

By about the age of four most TD children are proficient in the 'false belief' test (Wimmer & Perner, 1983). In the 'false belief' test, the children are told a story: Maxi places a sweet in a kitchen cabinet and leaves the room. While he is outside playing, his mum moves his sweet into a drawer; Maxi returns to get his sweet. The child participant is asked where they think Maxi will look for his sweet, in the cabinet or the drawer? Most TD children understood that Maxi didn't personally witness the switch, therefore Maxi would look in the cabinet. Baron-Cohen (1993) found that regardless of cognitive ability and age, as many as 80% of children with autism would say the drawer and fail the 'false belief' task. Furthermore Hadwin & Perner, (1991) found that the majority of TD 5 year olds understand the results of mistaken beliefs; they appreciate that Maxi is surprised that the sweet is not where he left it. For individuals with autism, they failed to adopt Maxi's perspective, indicating a lack of awareness of another person's emotional state; Baron-Cohen (1995) claims that this lack of emotion recognition has a profound impact upon social interactions throughout their lifespan.

The 'mindblindness theory' however is only relevant to the social interaction difficulties experienced by individuals with autism and is not exclusive to autism; many schizophrenics fail to achieve ToM (Sarfati, Passerieux and Hardy-Baylé, 2000). Furthermore, many autists claim they are bewildered by their own thoughts and feelings when confronted with certain situations; subsequently they may respond inappropriately (Grandin, 2006).

Although the 'ToM' theory (Baron-Cohen *et al*, 1985) gives a comprehensive account of perspective taking or 'cognitive empathy' (Davis 1994), it fails to account for the response element of empathy. Davis (1994) referred to the emotional reaction to another person's state of mind as 'affective empathy'. Baron-Cohen (1995) addressed these issues and suggested that although many autistic individuals struggle with 'cognitive empathy' (CE) they may have a surfeit of 'emotional (or affective) empathy' (EE) and called this the 'emotional imbalance hypothesis' (EIH). Baron-Cohen (1995) claims that although the person is emotionally aroused, the lack of cognitive empathy prevents them from responding effectively. Furthermore, hypersensitivity to emotion could be a contributing factor in social withdrawal in an attempt to reduce stimulation.

The theory of mind approach also fails to offer an explanation for repetitive behaviours, narrow interests or fascinations. Research shows that autists show a fascination for predictable patterns, rules and movement (Auyeung, Wheelwright, Allison, Atkinson, Samarawickrema, Baron-Cohen, 2009). The empathising-sytemising (E-S) theory incorporates the EIH and addresses other aspects of autism

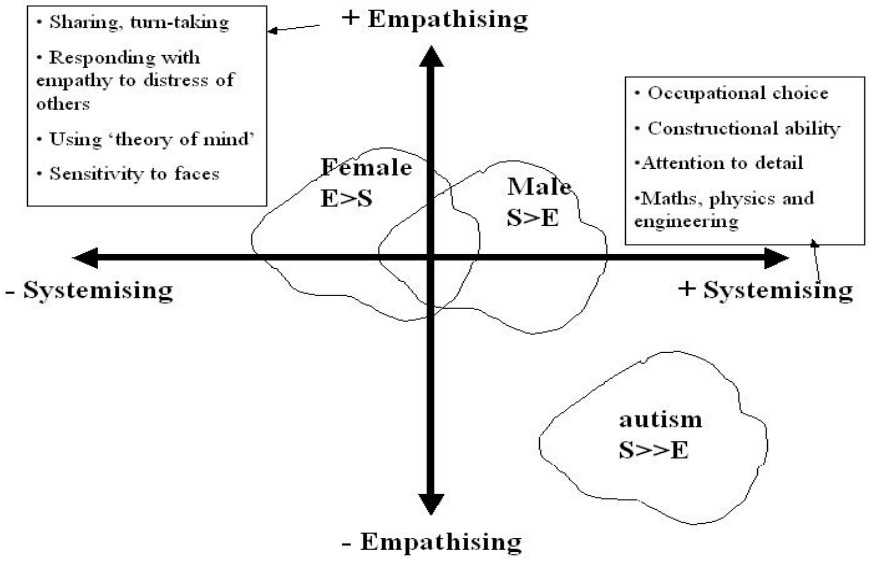
such as being resistant to change, attention to details and the lining up of object (Baron-Cohen, 2009) states that these are all forms of 'Systemising', which is:

> *The drive to analyse or construct systems. These might be any kind of system. What defines a system is that it follows rules, and when we systemize we are trying to identify the rules that govern the system, in order to predict how that system will behave* (Baron-Cohen, 2009 p.71).

Providing there is a logical, predictable relationship between 'a' and 'b' such as Greenford is next to Northolt on the Central line, Baron-Cohen suggests it can be classified as a system. Baron-Cohen (2003) claims there are many types of systems relevant to autism such as collectable systems: dinosaurs or fossils; numerical systems: train timetables or calendars or natural systems such as space or geology. If individuals with autism take comfort from systemising, then it is feasible that attending to the human eyes may be disturbing due to their unpredictable, relentless movement.

Evidence for the E-S theory comes from several studies. 8-11 year old children with Asperger's scored significantly higher on a purpose made physics test than their *older* TD peers (Baron-Cohen, Wheelwright, Scahill *et al,* 2001 cited in Baron-Cohen, 2009). It is also clear that many autists are exceptionally gifted at spotting embedded figures which is an example of heightened attention to detail (Joliffe & Baron-Cohen, 1997). The weak central coherence theory (Frith, 1989) suggests that repetitive behaviour shown by autists reflect the inability to disengage attention, however the E-S theory proposes that the behaviour is present due to the desire to systemise. Baron-Cohen (2003) subsequently developed a questionnaire which has been found to reliably measure sytemising (SQ) and empathising quotients (EQ). Surveys revealed that individuals with high-functioning autism or Asperger's scored statistically higher on the SQ and lower on the EQ than the general population (Baron-Cohen *et al.,* 2003). Although the SQ is unsuitable for individuals at the lower functioning end of the spectrum, picture sequencing tasks supported the systemising theory (Baron-Cohen, 2009). The E-S theory has now been superseded by the extreme male brain theory (Baron-Cohen, 2002). All the elements of the E-S theory remain, however research revealed that whilst females scored high on EQ and low on SQ, males showed the reverse pattern. Many autists however, scored extremely high on the SQ and extremely low on the EQ. These findings are demonstrated in Figure 1.

Figure 1: Visual representation of the Empathising / Systemising dimensions (Baron-Cohen, 2002 in Ward, 2009).



Interventions designed to enhance emotion recognition:

Baron-Cohen and colleagues (2004) found over a thousand emotion related words contained in the English dictionary. Synonyms were extracted and subsequently, 412 diverse human emotions and mental states were identified (Baron-Cohen *et al.*, 2004). As a result, a computer software package called 'mindreading' was created. The software contains an emotions library of video clips, portrayed by ethnically diverse actors of all ages. Stories, lesson plans and quizzes allow the user to appraise different emotions (Baron-Cohen, Golan, Wheelwright, & Hill, 2004). There is however, an important aspect of communication that tends to be overlooked when constructing interventions aimed at enhancing emotion recognition; research on body language has demonstrated that emotions are easier to recognise when accompanied by whole bodily expressions (Van den Stock, Righart, & de Gelder, 2007). The 'Mindreading' intervention video clips only show the heads and shoulders of the actors.

Evaluation studies of 'Mindreading' revealed that ASC adults improved their emotional recognition capabilities using the software, but only when presented with previously learnt stimuli. The participants did not show a significant improvement when generalising their newly acquired skill to novel stimuli. The authors felt this was due to the fact that the learning of the facial affect and voice intonation were independent of each other, thus resulting in disconnected context. When the subjects were presented with holistic stimuli, they failed to generalise (Golan, Baron-Cohen, Wheelwright, & Hill, 2006).

Decades of research has identified generalisation difficulties in the ASC population. Bolte and colleagues (2002) developed a computer based programme to teach recognition of facial affect to ASC adults. The experimental group showed significant improvement when tested using stimuli contained in the programme (Bolte, Feineis-Matthews, Leber, Dierks, Hubl & Poustka, 2002), however subjects failed to show significant improvement when tested using an established tool (International Affective Picture System: Lang & Greenwald, 1988). These generalisation difficulties have also been found in social skills training courses aimed at emotion recognition in autism (Bauminger, 2002). A recent meta-analysis of social skills interventions highlighted repeated failure of successful generalisation beyond the therapeutic setting. They did highlight however, that those interventions administered in the child's regular classroom sustained greater behavioural results in real-life interactions (Bellini, Peters, Benner & Hopf, 2007).

There is evidence that a social skills intervention using LEGO reduces maladaptive behaviour and increases social interaction skills that could be generalised to various aspects of daily life (LeGoff & Sherman 2006). Owens and colleagues (2008) claim that the success of the intervention is due to the intrinsically motivating, systemising qualities of LEGO (Owens, Granader, Humphrey & Baron-Cohen, 2008). Longitudinal research has indicated that the benefits of LEGO therapy last for many years (LeGoff & Sherman 2006).

Baron-Cohen (2009) suggests that the cognitive aspect of empathy can be targeted and enhanced through specific interventions based on systemising. His research team maintain that "cognitive empathy can indeed be taught" (Baron-Cohen, Golan and Ashwin, 2009, p. 3568), however interventions which aim to address these specific emotion recognition difficulties of ASC children are sparse. Dawson *et al.* (2005) suggest that interventions designed to enhance facial recognition could provide a valuable contribution to neuroscience and autism research:

> *studies that examine the impact of early intervention on face processing in autism would not only have important implications for designing improved interventions but would also shed light on the nature of neural abnormalities in autism* (Dawson, Webb and McPartland, 2005 p.418).

The team at the national Autism Research Centre in Cambridge developed a DVD called the 'Transporters' (Golan *et al.,* 2009) which works on a similar premise to Thomas the Tank Engine. All the vehicles move on tracks or in a predictable manner, thus following the 'systemising' rules. Dynamic, expressive human faces of diverse age, gender and ethnicity are superimposed onto the engines in an attempt to entice the children to attend to faces. The characters remain silent so that the children refrain from focusing on the mouth area. In order to bring the scene to life, the episodes are narrated by the actor Stephen Fry, who names and describes the presenting emotions. The whole series covers ashamed, jealous, joking, sorry, proud, kind, unfriendly, excited, tired, disgusted, surprised, sad, angry, afraid and happy; these are complex emotions, mental states (Baron-Cohen *et al.,* 2004) and the six basic emotions as defined by Ekman and Friesen (1971). There are 3 accompanying quizzes of increasing difficulty which relate to scenes from the episodes; visual rewards are presented upon correct identification. There is also an accompanying

leaflet which offers suggestions on how to maximise learning impact through discussion about the function and consequences of emotions.

Preliminary research has found that a group of 4-7 year old ASC children, showed significant improvement in emotional recognition and vocabulary understanding following exposure to the 'Transporters' DVD for 4 weeks (Golan *et al.*, 2010). The children in the ASC intervention group showed 3 levels of emotion recognition generalisation (familiar; using characters from familiar scenes from transporters; unfamiliar; using characters from unfamiliar scenes from transporters and distant generalisation using novel, video clips of humans). A TD and an ASC control group (matched for age, gender and verbal ability) did not participate in the intervention and showed no significant improvement at any level. The improvement in the distant generalisation task showed no correlation with age, gender or verbal ability. The research was conducted in the child's home environment where the child was permitted to watch the DVD an infinite amount of times, which may have convoluted the results. The authors suggest:

> *a closer investigation in future studies of the quantity, regularity, and nature of the episodes watched by the children may teach us more about their learning styles and may reveal why some children improve more than others* (Golan et al., 2010 p.269)

The current study:

The original study by Golan et al., (2010) was an early intervention as it was conducted on 4-7 year olds with autism. The current study aimed to evaluate the impact of the 'Transporters' intervention on emotion recognition skills, in 7-11 year old children with autism. In contrast to previous studies, the intervention was regimentally implemented in an educational establishment. An autistic experimental group (n=9) watched the 'Transporters' DVD (Golan *et al.,* 2010), 5 days a week, for 4 weeks, whilst an autistic control group (n=8) and a TD control group (n=8) received no intervention. All children were given pre and post intervention assessments to determine their ability to define and recognise the 16 specific emotions covered by the 'Transporters' intervention.

The following predictions and hypotheses have been formulated in light of the literature review:

Prediction 1: The autistic experimental group's mean score for emotion recognition will show a significantly greater increase from time 1 to time 2 than the autistic control and TD control groups' mean score.

Prediction 2: The autistic experimental group's mean score for vocabulary will show a significantly greater increase from time 1 to time 2 than the autistic control and TD control groups' mean score.

H^{1a}: There will be a significant interaction effect of timepoint (time 1 to time 2) and the developmental groups' (autistic experimental, autistic control, TD control) mean scores for emotion recognition.

H^{0a}: There will not be a significant interaction effect of timepoint (time 1 to time 2) and the developmental groups' (autistic experimental, autistic control, TD control) mean scores for emotion recognition.

H^{1b}: There will be a significant interaction effect of timepoint (time 1 to time 2) and the developmental groups' (autistic experimental, autistic control, TD control) mean scores for vocabulary.

H^{0b}: There will not be a significant interaction effect of timepoint (time 1 to time 2) and the developmental groups' (autistic experimental, autistic control, TD control) mean scores for vocabulary.

METHOD:

Design:

The randomised controlled trial followed a 2 x 3 mixed design with the first factor between-subjects and the second factor within-subjects. The *developmental group* was the between subjects variable which consisted of 3 levels: an autistic experimental group; an autistic control group and a typically developing (TD) control group. *Timepoint* was the within subjects factor which consisted of 2 levels: Pre-intervention/time1 and post intervention/time2. *Emotion recognition* was the first dependent variable which was a measure of how many correct emotions were identified and *vocabulary* was the second dependent variable which was a measure of how many relevant emotional words were defined and contextualised correctly. The autistic experimental group participated in the 'Transporters' intervention for 4 weeks between assessments whilst the control groups received no intervention. Two 3x2 repeated measures analysis of variance (ANOVA) statistical tests were used to analyse the data and Bonferroni post hoc procedures were requested.

Most of the children find it difficult to retain concentration during the afternoon; therefore all participants were assessed at both stages during the morning to ensure continuity and control for fatigue. Another potentially confounding variable when working with children with ASC is anxiety levels, therefore care was taken to observe behavioural indicators prior to and whilst working with the children.

Order effects were controlled by counterbalancing the order of questions in the vocabulary assessment. For the emotion recognition assessments, 2 matched tools were constructed. Half of the participants in each developmental group were assessed with Emotion Recognition assessment 1 (see appendix 1), whilst the remaining participants were assessed using number 2 (see appendix 2). This process was reversed at time 2.

Participants:

Autistic experimental and autistic control group: *Experimental:* n=9 children (8 male and 1 female) mean age in years = 10.21 *Autistic control*: n=8 (7 male and 1 female) mean age in years = 10.54. The children were aged between 8 and 11 years old. The experimental group of children and some of the autistic control children were recruited through the author's place of work which is a mainstream school with a special resource provision (SRP) for children with Autism. The remainder of the autistic control group were recruited through the author's previous place of employment at another mainstream primary school. Levels of functioning were not measured statistically, however all children were mainstream educated which ensures they meet specified criteria for mainstream inclusion. Participatory inclusion criteria stipulated that all children in the autistic intervention and autistic control group must hold a clinical diagnosis of moderate to high functioning autism (including Asperger's) in conjunction with a statement of special educational needs (SEN). Participants who had previously received regular exposure to the 'Transporters' or were currently participating in interventions specifically targeting emotion were excluded. Participants who had access to the SRP were assigned to the experimental group due to practical application considerations and the remainder were assigned to the autistic control group.

TD control group: Convenience sampling recruited n=8 typically developing children, with a mean age in years = 9.72. These children were matched to the autistic experimental group for age and gender (7 male and 1 female). The children attend various primary schools and none of them have a statement of special educational needs. The parents confirmed that no direct family members held a diagnosis of ASC.

Ethical clearance: The study raised ethical considerations as the ASC children are a special population and below the age of 18, however all children were familiar with the researcher. As a result, full permission was obtained from the Thames Valley University Ethics committee; the Manageress at the SRP; the Headmaster at the mainstream primary school and the participants' parents (see appendix 3 for an example of the parental consent form). The right to withdraw at any time and a statement of anonymity was included in the letter.

Materials:

An assessment log (see appendix 4) was used to manually record the participant's answers and relevant demographics and a *viewing register* (see appendix 5) enabled the experimenter to ensure exposure was equal throughout the experimental group. A *whiteboard* was used to screen the *'Transporters' DVD* (Golan, Humphrey, Chapman, Gómez de la Cuesta, Peabody, Weiner, Lever, Harcup, & Baron-Cohen, 2009). An example of a scene taken from the 'Transporters' DVD is shown in figure 2.

Figure 2: Example of a scene from the 'Transporters DVD'

Measures:

Emotion Recognition Assessment Construction:

A laptop computer was used to administer the emotion recognition assessments which were compiled by the current report's author. 2 files were constructed which were matched for difficulty. These assessment tools were based on previous research by Golan *et al.* (2010) which utilised a similar instrument. Video clips of the 16 target emotions were extracted from the files of the Mindreading DVD: Teaching emotion-recognition to people with autism spectrum conditions (Golan, Wheelwright, Baron-Cohen, 2002) and inserted into a Microsoft Word document. For each emotion being tested, 3 video clips of the same actor were arranged in a row; the video clips depicted the target emotion, opposite emotion and a similar emotion. The files were hyperlinked in order to initiate play and a statement was written below each set of 3 clips; the statement was indicative of a scenario that may invoke the emotion being tested. A wide variety of actors were chosen to reflect the diversity of ethnicity and age present in the human population. The assessment tools were submitted to a panel of 8 colleagues who certified the face validity of the target expressions. They were also asked to evaluate the statements in order to determine whether they would evoke the target emotion; a minimum ratio of 7:1 was required for inter-rater reliability. One set of video clips were removed from assessment 1 as only 5 judges concurred that the target emotion was adequately represented by the facial expression and three statements were changed as they were considered vague and could evoke alternative emotions. The judges were teachers or teaching assistants who specialised in working with children with autism. A speech and Language Therapist was consulted to certify that the statements were appropriately worded to ensure all participants would be able to comprehend the sentiment. An example of a set of three video clips and statement are shown in figure 3.

Figure 3: Example of stimuli used in emotion recognition assessment procedure (for still representations of the file, see appendix 1 and 2)

Tomorrow is Carly's birthday. She will get lots of presents.

Procedure:

For the *vocabulary* assessment, participants from all 3 developmental groups were asked to define and contextualise the 16 emotions and mental states covered by the 'Transporters' DVD (ashamed, joking, jealous, sorry, proud, tired, unfriendly, excited, afraid, disgusted, surprised, happy, sad, angry, kind and worried). For the *emotion recognition* assessment, participants from all 3 groups were shown a set of 3 dynamic video clips which played automatically upon clicking the hyperlink. The relevant statement was read aloud by the researcher. The participant was asked to point to the still image of the clip that represented the facial expression that reflected how the person might be feeling. This was repeated for all 16 emotions. No feedback on accuracy was given, however positive praise was offered for behaviour.

Every school day, for 4 weeks, participants in the autistic experimental group watched three 5 minute episodes of the 'Transporters' DVD, as a group, on a smart board in a classroom at the SRP. Some of the children struggled to maintain concentration when all 3 episodes were presented consecutively, therefore from the 3rd day onwards, a fruit break was given after the first 2 episodes.

The 'Transporters' DVD provides an easy or hard interactive quiz which was activated following each episode. The attending adult used the hard quiz and asked the children to indicate which character experienced the emotion in question; a choice of 3 characters was offered. A short discussion ensued, linking the emotions to real life situations. A viewing schedule was constructed and a register was taken of all children present; absent children viewed the missed episodes, undertook the quiz and entered into a group discussion about the target emotion as soon as time allowed. The schedule ensured that each child viewed the same combination of episodes allowing for a measurement of exposure. The emotion recognition and vocabulary assessments were repeated within 2 days after cessation of the intervention for the experimental group. The TD and Autistic control groups did not participate in the 'Transporters' intervention, or any other intervention, for 4 weeks following their initial assessments at time 1, until after they were re-tested as close to 29 days as possible at time 2.

RESULTS*:*

Preliminary tests of data:

An unrelated t-test confirmed that there was no significant difference between the two autistic groups' pre-test mean scores. This was carried out in order to ensure the groups were matched for emotional recognition deficits ($t(15) = .105$ $p = .92$ns) and vocabulary understanding ($t(15) = .187$ $p = .854$ns). Given that the sample of participants was fairly small, the Shapiro-Wilk test was conducted to determine whether the original data was normally distributed. The pre-test emotional recognition data was not significant therefore normality was assumed. The pre-test vocabulary data however, showed a slight deviation from normality and was significant at the $p<.05$ level. A Kruskal-Wallis Test was considered to analyse the vocabulary data, however the ANOVA is quite robust and is still valid if there are only slight departures from these two assumptions. No transformation of scale was made and the decision to proceed using an analysis of variance (ANOVA) statistical test was made.

Inferential Statistics:

The data was collated and input into SPSS version 17. The emotion recognition and vocabulary mean scores were analysed using 2 separate, mixed model 3x2 ANOVAs with developmental group (autistic experimental, autistic control and typical control) as the between participants factor and time point (time 1 and time 2) as the within participants factor. The developmental groups' mean scores for the emotion recognition assessments at time 1 and time 2 are displayed in *Table one* and the developmental groups' mean scores for the vocabulary assessments at time 1 and time 2 are displayed in *Table two.*

Table One: Descriptive statistics showing the 3 developmental groups' mean scores and standard deviations on an emotional recognition assessment at Time 1 and Time 2:

Maximum mean score = 16

	Time 1		Time 2	
Developmental Group	*M*	*SD*	*M*	*SD*
Autistic Experimental	9.89	2.98	14.78	1.09
Autistic Control	9.75	2.37	9.88	2.17
TD Control	15.13	.84	15.25	.89

Table one demonstrates that the experimental and autistic control groups' mean scores for the emotion recognition assessment are relatively similar at time 1. The TD control group's mean score at time 1 is much higher than both autistic groups, indicating superiority in emotion recognition. Time 2 mean scores for emotion recognition show a minimal increase in the Autistic control group from time 1, however the experimental group's has increased considerably and is now slightly lower than the TD control group's mean score for emotion recognition, which is close to ceiling. The standard deviation indicates how much variance is found within the group's scores. Table one indicates there is substantial variance shown in the emotion recognition scores for both autistic groups at time 1 in comparison to the TD group at time 1; this suggests that all participants within the TD group scored between 14 and 16, whereas both autistic groups had a greater dispersion of scores. There is little change in variance from time 1 to time 2 for the autistic control and TD control groups' emotion recognition scores; however the autistic experimental group's standard deviation score has decreased. This reduction in variance for the autistic experimental group, combined with the substantial increase in their emotion recognition mean scores, suggests that the lower scoring individuals at time 1 have substantially improved their emotion recognition skills following the intervention.

Table Two: Descriptive Statistics showing the 3 developmental groups' mean scores and standard deviations for the vocabulary assessment at Time 1 and Time 2:

Maximum mean score = 16

	Time 1		Time 2	
Developmental Group	*M*	*SD*	*M*	*SD*
Autistic Experimental	13.33	2.29	15.22	1.39
Autistic Control	13.13	2.30	13.25	2.05
TD Control	15.00	.93	15.63	.74

Table two demonstrates that the autistic experimental and autistic control groups' mean scores for the vocabulary assessment are relatively similar at time 1, whilst the TD control group's mean score is slightly higher. Time 2 vocabulary mean scores show a minimal increase in the Autistic control group's mean score from time 1; a medium increase in the TD group's mean score and a relatively larger increase in the autistic experimental group's mean score for vocabulary from time 1. Table two also shows substantial variance in the vocabulary scores for both autistic groups at time 1 in comparison to the TD group at time 1; this suggests that all participants within the TD group scored between 14 and 16, whereas both autistic groups had a greater dispersion of scores. There is little change in variance from time 1 to time 2 for the autistic control and TD control groups' vocabulary scores; however the autistic experimental group's standard deviation score has decreased. This reduction in variance for the autistic experimental group, combined with the substantial increase in their vocabulary mean scores, suggests that the lower scoring individuals at time 1 have substantially improved their ability to define relevant emotions following the intervention.

Emotion recognition: There was a between subjects, significant main effect of the developmental group variable on emotion recognition scores (F [2,22] = 18.47, p<.001). Post-hoc analyses using Bonferroni procedure showed that the TD control group scored higher on the emotion recognition assessment than the autistic control group (p <.001) and the autistic experimental group (p = .009) and that the autistic experimental group scored higher on the emotion recognition assessment than the autistic control group (p= .023). There was also a significant main effect of time point on emotion recognition, (F [1,22] = 31.77 p<.001). More importantly, the interaction between developmental groups and time point was also highly significant (F [2,22] = 28.40 p<.001). A visual representation of this interaction effect is demonstrated in Figure 4:

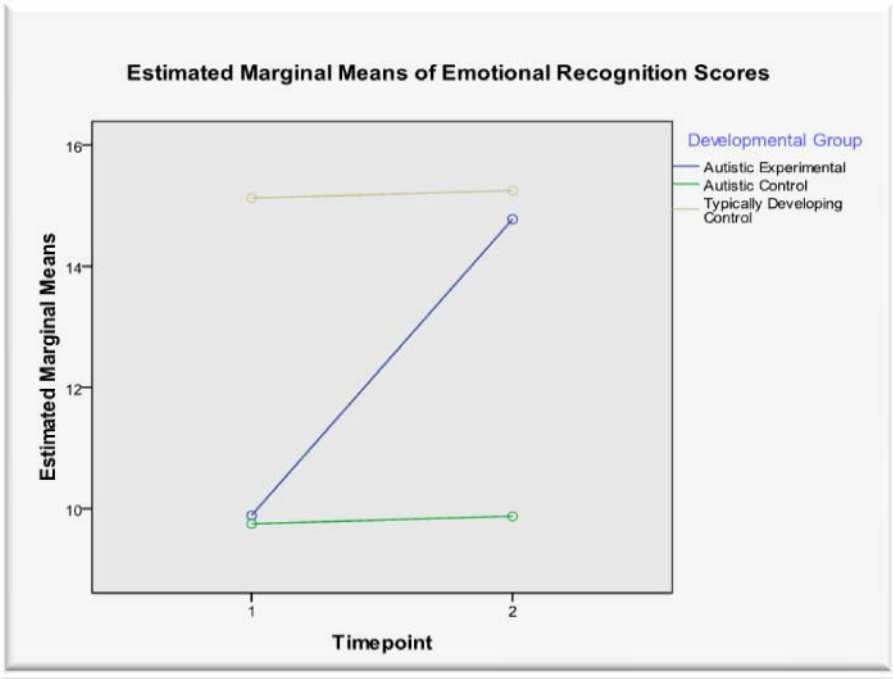


Figure 4: Line graph to show the emotional recognition mean scores for developmental groups in conjunction with the time point variable

A visual inspection of the line graph as shown in Figure 4, illustrates the relatively similar emotion recognition, mean scores for the two autistic groups prior to the intervention. It also shows parallel lines, with minimal increase, for the TD group and autistic control group; however the autistic experimental group's line is diagonal. The line graph shows a substantial improvement in emotional recognition scores for the autistic experimental group from time 1 to time 2, whilst the control groups' remained almost static. This interaction effect between developmental group and timepoint was investigated further using related t-tests to test for simple effects. As predicted, these analyses showed that the difference in emotional recognition scores between time 1 and time 2 for the autistic experimental group was significant with an associated t-value of ($t(8) = -6.49$ $p<.001$), whilst the TD and Autistic control groups' T-tests were non-significant ($t(7)= -.552$ $p=.598$ and $t(7) = -.357$ $p=.732$ respectively).

Vocabulary task: There was a trend towards a significant main effect of the developmental group variable on vocabulary understanding scores (F [2,22] = 3.34, $p=.054$), however the Bonferroni post hoc procedure did not reveal a statistical difference between developmental groups and only confirmed the trend towards significance between the TD group and the autistic control group $p=.051$ (SPSS version 17 does not recognise this as significant). There was no significant difference between the autistic experimental group and the autistic control or TD groups. There was also a significant main effect of time point on vocabulary scores, (F[1,22] = 14.31 $p<.05$). Additionally, the interaction effect between developmental groups and time point was significant (F[2,22] = 5.27 $p<.05$). A visual representation of this interaction effect is demonstrated in figure 5:

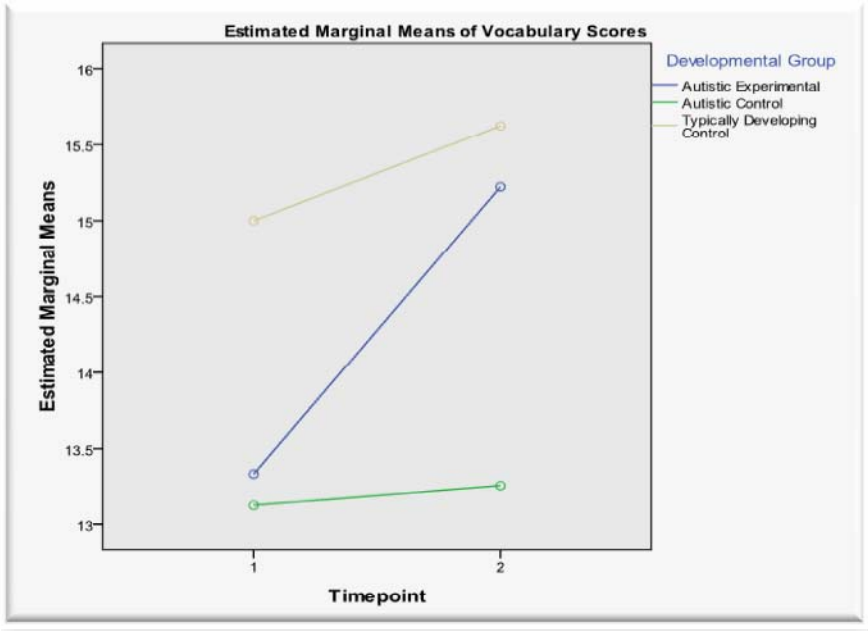


Figure 5: Line graph to show the vocabulary task mean scores for developmental groups in conjunction with the time point variable.

A visual inspection of the line graph as shown in Figure 5, illustrates the close proximity of time 1 vocabulary assessment mean scores for the 2 autistic groups in relation to the TD control group, indicating that both autistic groups had similar levels of relevant vocabulary understanding prior to the intervention. The graph also shows

an increase in mean vocabulary scores for all 3 groups, however the experimental group showed a steeper incline. The interaction effect between developmental groups and timepoint was investigated further using related t-tests to test for simple effects. These analyses showed that as predicted, the autistic experimental showed a significant increase in vocabulary understanding from time 1 to time 2; this was significant with an associated t-value of ($t(8) = -3.21$ $p<.05$). Surprisingly, the TD control group also showed a significant increase in vocabulary understanding from time 1 to time 2 ($t(7) = -2.38$ $p=.049$). There was no significant increase for the autistic control group ($t(7) = -1.0$ $p=.088$). As the test for simple effects for the experimental group was significant and the autistic control group was non-significant suggests that the intervention was successful in creating a better understanding of the relevant vocabulary. However, there was a significant result for the TD control group also; these results will be discussed further.

DISCUSSION:

The key aim of the current report was to establish whether the 'Transporters' intervention was capable of enhancing emotion recognition in 7-11 year-old children with autism, when implemented in an educational establishment. The results revealed a massive improvement in the autistic experimental group's ability to recognise specific emotions and mental states following participation in the 'Transporters Intervention'.

Vocabulary assessments:

Both the autistic experimental group and the TD control group significantly improved their mean scores for the *vocabulary assessment* from time 1 to time 2. However, there was no significant improvement in *vocabulary* understanding for the autistic control group. These findings allow the acceptance of the hypothesis H^{1b} which states that there will be a significant interaction effect of timepoint (time 1 to time 2) and the developmental groups' (autistic experimental, autistic control and TD control) mean scores for vocabulary. However it does not support the prediction that there will be a significant improvement in vocabulary understanding for the autistic experimental group, but not for the autistic control group or the TD control group. The significant improvement in vocabulary understanding for the TD group could be attributed to practice effects as the children were asked to define and contextualise each relevant emotion at time 1 and time 2. It is possible that the TD group were motivated to ask an adult what a particular word meant which was reflected in the improved scores at time 2. Given the significant improvement in the TD group, it is not possible to categorically state that the significant improvement seen in the autistic experimental group is due to the 'Transporters' intervention. However, given that there was no significant difference between the 2 autistic groups' mean scores for vocabulary at time 1 but a significant improvement for the autistic experimental group only, it could be inferred that the autistic children were not motivated to seek an understanding of the words they did not know, therefore the significant improvement for the autistic experimental group could tentatively be attributed to the 'Transporters' intervention. Furthermore, the effect size for the autistic experimental group was much larger than that of the TD control group.

Emotion Recognition assessments:

As predicted, the results show that the mean score for the autistic experimental group on the *emotion recognition assessment* significantly increased with time, whilst there was no significant improvement of *emotion recognition* for the autistic control group or the TD control group. These findings allow the acceptance of the hypothesis H^{1a} which states that there will be a significant interaction effect of timepoint (time 1 to time 2) and the developmental groups' (autistic experimental, autistic control and TD control) mean scores for emotion recognition. The high significance of the interaction effect, combined with the selective significant simple effects for the autistic experimental group only is almost certainly due to participation in the 'Transporters' intervention and not due to chance. Furthermore, the autistic experimental group's emotion recognition and vocabulary understanding skills are now in line with their TD peers.

General Discussion:

The findings from the current study support previous research by Golan *et al.* (2010) claiming that the 'Transporters' intervention is successful at facilitating enhanced emotion recognition and increased understanding of specific emotional words. Drawing on previous literature, the discussion will focus on the reasons for this success.

Evidence suggests that people with autism adopt a visual learning style from a very young age (Mesibov *et al.* 2004; Grandin, 2006; Rao and Gagie, 2005). They are hypersensitive to visual sensory input, showing preference for objects (Webb *et al.,* 2006; Hobb *et al.* 2006) but repeatedly fail to attend to faces (Dawson, Webb and McPartland, 2005). The 'Transporters' intervention is a visually stimulating programme with dynamic, expressive human faces superimposed onto moving objects; the preference to attend to objects could have facilitated attention to the faces of the characters. Research has suggested that children with autism refrain from facial attention and eye contact due to the complexity of movement of the eyes (Baron-Cohen, 1995; Dawson *et al*., 2005). The faces on the 'Transporters' move methodically and only show one emotion at a time. The expression is dynamic but remains stable until the next scene is shown. There is no real transformation from one emotion to another, therefore the face actually moves in a more predictable manner which sustains attention; this allows time for emotion recognition processing which has been shown to be much slower in children with autism in relation to TD peers (Bal *et al*, 2009).

The current study only evaluated the impact of distant generalisation as this is a more desirable skill for the real world. The assessments were conducted using unfamiliar dynamic video clips of human actors which were not contained in the DVD. Previous studies have shown difficulty in generalising emotion recognition from familiar to unfamiliar stimuli (Bolte *et al*, 2002; Golan *et al*., 2006; Frith, 1991), however the improved ability to recognise emotions using novel stimuli in the autistic intervention group in the current study showed that the 'Transporters' facilitates this level of generalisation; this concurs with the claim made by Golan *et al.,* (2010). Furthermore, the meta-analysis evaluating generalisation success in verbally based social skills interventions suggested widespread failure (Bellini *et al,* 2007). The current study required the children to watch the DVD and participate in a group

discussion about context, causes etc., so it could be assumed that the combination of visual representations and verbal contextual information facilitates generalisation. Future research could examine if the 'Transporters' could be as successful in enhancing emotion recognition without the discussion; however the narrator does consistently contextualise the scene.

The 'Transporters' series resembles the concept of Thomas the Tank which is extremely popular amongst ASC children (NAS, 2001). Both sets of vehicles move in a predictable manner which reflects the premise of the 'E-S Theory' (Baron-Cohen *et al.,* 2003; Baron-Cohen, 2009). Given the popularity of Thomas, it may be assumed that the systemising element could be the key to sustaining attention long enough to observe facial expression in the 'Transporters'. In conjunction with the systemising qualities of the vehicles, the faces have an element of predictability. Given the massive improvement shown in recognising emotions in novel stimuli however, this is obviously not a drawback for generalisation.

The current study was conducted on older children in order to establish a ceiling age of effectiveness and desirability of the 'Transporters' intervention. Dawson and colleagues (2005) suggested that early intervention is crucial in utilising the plasticity of the brain (Dawson, Webb & McPartland, 2005), the results from the current study showed that all children in the autistic experimental group made improvement in vocabulary understanding and emotion recognition skills, indicating that the intervention is successful at least up to the age of 11. Observations during the exposure stage however found that the combination of older age and higher functioning autism, led to diminished desire for repetition of the DVD; this was not observable for lower functioning older children or higher functioning younger children.

Limitations of the current study are that specific measures of cognitive function or verbal ability were not used to match the participants, however previous research found no correlation with emotion recognition and intelligence (Baron-Cohen, Wheelwright, Hill, Raste & Plumb, 2001). The study by Golan and colleagues (2010) also found no correlation between verbal ability and the ability to recognise emotions from novel stimuli (Golan *et al.,* 2010). Due to practicality reasons, the autistic participants were not randomly assigned to the experimental or control groups which may have affected the results due to the exposure to different educational environments, however the participants were matched for emotion recognition and vocabulary understanding at the start of the study.

Future research could focus on evaluating the effects of using the 'Transporters' DVD without using the quiz or the discussion; this would tease apart the contribution of contextual information and the systemising qualities of the series. Some children were noted to keep referring to the 'Transporters' when engaging in social interactions, this was eventually superseded by referring to the emotion itself. These ad-hoc observations indicate an ability to recognise and contextualise the emotion in a naturalistic environment. Therefore follow up assessments at 6 months would establish the stable impact of the intervention and could systematically analyse the behavioural impact on everyday social interactions. It was also observed that whilst the characters were on the screen, some of the children mimicked the facial expressions in a very mechanical way, using trial and error until they felt the correct expression was displayed; this could be an area for future investigation. Given the overall success of the 'Transporters', future interventions could be aimed at the

higher functioning, older children by using more suitable characters such as robots, Ben 10 or Pokémon type characters and a wider range of emotions could be addressed.

In conclusion, the ‘Transporters’ intervention was extremely successful in enhancing emotion recognition in children with autism aged 7-11 years. It appears that systemising can facilitate empathising in an educational environment. The intervention period was extremely short and a routine was successfully adhered to within an educational establishment. Given the minimal disruption to the curriculum, education departments should seriously consider implementing the intervention for all children who show socio-emotional difficulties.

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