

Can emotion recognition be taught to children with autism spectrum conditions?

Journal:	<i>Philosophical Transactions B</i>
Manuscript ID:	RSTB-2009-0191
Article Type:	Review
Date Submitted by the Author:	24-Jul-2009
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Issue Code: Click here to find the code for your issue.:	EMOTIONS
Subject:	Neuroscience < BIOLOGY
Keywords:	autism spectrum, children, emotion recognition



Draft July 21st, 2009

Invited submission for the special issue of Proceedings of the Royal Society, Series B,

edited by Robinson, P, and El Kalioubi, R.

**Can emotion recognition be taught to
children with autism spectrum conditions?**

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Abstract

Children with autism spectrum conditions (ASC) have major difficulties in recognizing and responding to emotional and mental states in others' facial expressions. Such difficulties in empathy underlie their social communication difficulties that form a core of the diagnosis. In this paper we ask if aspects of empathy can be taught to young children with ASC. We review a study that evaluated *The Transporters*, an animated series designed to enhance emotion comprehension in children with autism spectrum conditions (ASC) (Golan et al, in press). Children with ASC (4-7 years old) watched *The Transporters* everyday for 4 weeks. Participants were tested before and after intervention on emotional vocabulary and emotion recognition at 3 levels of generalization. The intervention group improved significantly more than a clinical control group on all task levels, performing comparably to typical controls at Time 2. Discussion centres on how vehicles as mechanical systems may be one key reason why *The Transporters* caused the improved understanding and recognition of emotions in children with ASC. The implications for the design of autism-friendly interventions are also explored.

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3 Can empathy be taught? This turns out to be both a philosophical and a practical problem,
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5 because it is relevant to both our definition of empathy, and to how we approach those
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7 people in the population who – for whatever reason – do not develop empathy in the usual
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9 way. In this paper, we begin with a definition of empathy, and argue that at least one of the
10
11 two major ‘fractions’ of empathy is amenable to teaching. We then summarize an experiment
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13 that evaluates a new method designed to teach this element of empathy to young children
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15 with autism who – for largely genetic reasons – have specific difficulties in developing
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17 empathy.
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32 *What is empathy?*
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50 We define empathy as the ability to attribute mental states to others, and to respond with an
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52 appropriate emotion to the other person’s mental states (Baron-Cohen and Wheelwright,
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54 2004). This definition of empathy suggests the two main ‘fractions’ of empathy are a
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56 ‘cognitive’ component (the recognition of another person’s mental state) and an ‘affective’
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58 component (the emotional reaction to another person’s mental state). The cognitive
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60 component is sometimes also called a ‘theory of mind’ (Dennett, 1980). (See Figure 1)

insert Figure 1 here

51 Mental states include thoughts and emotions, thoughts being traditionally fractionated into
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53 beliefs, desires, intentions, goals, and perceptions (Dennett, 1980; Baron-Cohen, 1995).
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55 Emotions are traditionally fractionated into 6 ‘basic’ emotions (happy, sad, angry, afraid,
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57 disgusted, and surprised) (Ekman, 1999), and numerous ‘complex’ emotions. Complex
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59 emotions involve attributing a cognitive state as well as an emotion, and are more context and
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culture dependent (Griffiths, 1997). The basic emotions are held to be so because they are

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universally recognized and expressed in the same way. This distinction, however, is not without its critics, since it may be that more emotions are universally recognized and expressed than these 6 but have been overlooked because of how expensive, time-consuming, and difficult cross-cultural research is (Baron-Cohen et al, 2006). Indeed, research into complex emotions (usually towards developing taxonomies) has been mostly language and culture specific (Ortony, Clore & Foss, 1987; Storm & Storm, 1987). Our own work suggests that in the English language, there are at least 412 distinct emotions and related mental states (each with their own descriptor that is not just a synonym for another emotion) that are recognizable by independent judges within the UK (Baron-Cohen, Golan et al, 2004; Golan and Baron-Cohen, 2006).

Having defined empathy into at least two major fractions, we turn now to the question of the 'teachability' of empathy. Some individuals in the population may be delayed in the development of empathy, for different reasons. These include people with autism spectrum conditions (ASC) who for neurological - and ultimately genetic - reasons have difficulties in putting themselves into someone else's shoes and knowing how to respond to another's feelings, in real time. Since such deficits may have a significant impact on their social functioning, this raises the challenge of whether aspects of empathy can be facilitated or taught to individuals with ASC. We will summarize some evidence that the first component of empathy – cognitive empathy – can indeed be taught. This task is made easier through the design of educational resources (including computer-based methods) that tap into systematic areas of interest, characteristic of autism, that are therefore intrinsically motivating. Whilst we do not rule out that the second component of empathy – affective empathy – can be taught, it remains the case that all efforts have so far been focused on the cognitive fraction, so that it is unknown if the second could also be taught.

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10 *Empathy and Systemizing in Autism Spectrum Conditions*
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16 People with ASC have social-communication difficulties alongside circumscribed interests
17 ('obsessions') and a strong preference for sameness and repetition (APA, 1994). Underlying
18 these characteristics are difficulties understanding the emotional and mental states of others
19 (Baron-Cohen, 1995). Individuals with ASC have difficulties recognizing emotions from facial
20 expressions, vocal intonation, body language, separately (Baron-Cohen et al., 2001; Hobson,
21 1986a; Hobson, 1986b; Yirmiya et al., 1992), and in context (Golan, Baron-Cohen & Golan,
22 2008; Klin et al., 2002). Although some individuals with ASC recognize basic emotional
23 expressions (Baron-Cohen, Spitz & Cross, 1993; Grossman et al., 2000), difficulties in
24 identifying more complex emotions persists into adulthood (Baron-Cohen et al., 2001; Baron-
25 Cohen, Wheelwright & Jolliffe, 1997; Golan, Baron-Cohen, & Hill, 2006).
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43 The emotion recognition difficulties are in part the result of altered face processing (Dawson
44 et al., 2004; Klin et al., 2002), which itself may be due to a failure to interpret the mentalistic
45 information conveyed by the eyes (Baron-Cohen, 1994). Others' facial expressions may also
46 be less intrinsically rewarding. Children with ASC show reduced attention to faces and to
47 eyes in particular (Swettenham et al., 1998). The result of this reduced experience with faces
48 is that children with ASC thus do not become 'face experts' (Dawson, Webb, & McPartland,
49 2005). For example, whilst the typically developing brain shows an electrophysiological
50 response to upright faces called the N170 wave form, the autistic brain shows a reduced
51 N170 (Grice et al., 2005).
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7 In contrast to their difficulties in emotion recognition, individuals with ASC have intact or
8 even enhanced abilities in 'systemizing' (Baron-Cohen, 2002; Baron-Cohen, 2006).
9 Systemizing is the drive to analyze or build systems, allowing one to predict the behaviour of
10 the system and control it. Systems may be mechanical (e.g., vehicles), abstract (e.g., number
11 patterns), natural (e.g., the tide), or collectible (e.g., a library classification index). The
12 'obsessions' or narrow interests of children with ASC cluster in the domain of systems
13 (Baron-Cohen & Wheelwright, 1999). These include vehicles, spinning objects and
14 computers, all of which are attractive to individuals with ASC. At the heart of systemizing is
15 the ability to detect patterns or rules of the form 'if a, then b'. The systemizing theory of
16 autism relates this affinity to their systematic and predictable nature. In the study
17 summarized later in this paper, we illustrate how these special interests can be harnessed
18 when teaching children with ASC, using computer-based or multimedia formats, to keep
19 them intrinsically motivated.
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41 The systemizing theory of autism has been supported by different studies: children with ASC
42 have been found to out-perform matched controls on tests of 'intuitive physics' (Baron-
43 Cohen et al, 2001), and adults with ASC were at least intact on such tests (Lawson, Baron-
44 Cohen & Wheelwright, 2004), as well as on other tests that involve excellent attention to
45 detail (Happe & Frith, 2006; Mottron et al., 2006), a prerequisite for good systemizing
46 (Baron-Cohen, 2008; Jolliffe & Baron-Cohen, 1997; O'Riordan et al., 2001; Shah & Frith,
47 1983). In addition, individuals with ASC score above average on the Systemizing Quotient
48 (SQ), a self-report (or parent-report) measure of how strong one's interests are in systems
49 (Baron-Cohen et al 2003; Wheelwright et al, 2006; Wakabayashi et al, 2008; Auyeung et al,
50 in press).
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7 If children with ASC possess intact or enhanced systemizing skills, it may be possible for
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9 them to use such skills to facilitate their empathy, particularly in the cognitive component of
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11 emotion recognition. Lego® Therapy (Owens et al, 2008) is an example that encourages
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13 young children with ASC, to build Lego® models in groups of 3, thereby gaining
14
15 opportunities for social interaction. Children participating in Lego® Therapy are intrinsically
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17 motivated by Lego® because it involves constructional systems. Whilst Lego® is not directly
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19 relevant to the focus of this special issue on 'affective computing', it is indirectly relevant
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21 because (like computers) Lego® can be assembled in predictable and repeating sequences.
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29 A method that is far more directly relevant to affective computing as applied to autism is the
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31 *Mind Reading* DVD. This comprises educational software that was designed to be an
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33 interactive, systematic guide to emotions (Baron-Cohen, Golan, et al. 2004)
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35 (www.jkp.com/mindreading). It was developed to help people with ASC learn to recognize
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37 both basic and complex emotions and mental states from video clips of facial expressions
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39 and audio recordings of vocal expressions. It covers 412 distinct emotions and mental states,
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41 which are organized developmentally and classified taxonomically to be attractive to a mind
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43 that learns through systemizing. The principle behind this was that individuals with autism
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45 may not learn to recognize emotional expressions in real time during live social situations
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47 because emotions are fleeting and do not repeat in an exact fashion, which may reduce the
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49 number of opportunities to systematically learn from repetition. Putting emotions into a
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51 computer-based learning environment enables emotions to be played and replayed over
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53 and over again in an identical fashion, such that the learner can have control over their
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55 speed and the number of exposures they need in order to analyze and memorize the
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57 features of each emotion.
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7 Furthermore, since emotions vary depending on who is expressing them, in the real world it
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9 can be difficult to see what defines each specific emotion. *Mindreading* helps its users
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11 overcome this problem by having each of the 412 emotions portrayed by 6 different actors
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13 (male and female, old and young, different ethnicities), to facilitate learning to recognize
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15 emotions independently of the identity of the person expressing that emotion. In addition,
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17 in the real world emotions can appear unlawful (some people smile when they are happy,
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19 other people smile when they are pretending to be happy, and yet others are happy when
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21 they are not smiling at all) so *Mindreading* imposes some lawfulness onto emotions by
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23 assigning a clear label to each emotional expression, including masked, or insincere
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25 emotional expressions (e.g., emotions in the 'sneaky' category). Finally, emotions in the real
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27 world can be hard to classify so *Mindreading* offers the user a pre-designed classification
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29 system, to assist in finding patterns among inherently unpatterned emotional information.
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38 Using *Mind Reading* over a 10 week intervention (2 hours usage per week), individuals with
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40 ASC improved in their ability to recognize a range of complex emotions and mental states
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42 (Golan & Baron-Cohen, 2006). In a follow-up conducted one year after the completion of the
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44 intervention period, individuals with ASC who used *Mindreading* reported of an improved
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46 ability to form friendships and relationships, and increased awareness of the importance of
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48 emotions and emotional expressions in everyday life, improving their understanding of
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50 emotions and their corresponding expressions, and affecting their ability to function socially
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52 (Golan & Baron-Cohen, 2007). This is an encouraging result because it suggests that at least
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54 one cognitive component of empathy can be taught, and that it may have a long term effect
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56 and affect social functioning. It is not known if such improvement would be seen if the
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58 intervention was shorter in duration, or if the users had not just autism but additional
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3 learning difficulties (below average IQ). Finally, it could reasonably be objected that learning
4 to recognize emotions in the simplified context of a computer screen, devoid of the 'noise'
5 of a real social situation like a school playground or a birthday party or an argument, is likely
6 to be both simplified and therefore easier to achieve. This objection is important since it
7 raises the question of whether such learning from 'artificial' contexts generalizes to more
8 natural settings. Guarding against the risk of artificiality, *Mindreading* used real faces rather
9 than cartoon or schematic faces. However, future work using the *Mindreading* DVD could
10 assess the benefits of a longer intervention than just 10 weeks. The DVD could also be used
11 with more interactive teaching methods such as discussion of each emotion in small groups,
12 or as part of dramatic role-play.
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30 Difficulties with generalization have been found both in computer-based intervention
31 programmes (Bölte et al, 2002; Silver & Oaks, 2001) and in social skills training courses
32 (Barry et al., 2003; Bauminger, 2002). The limited effectiveness of these interventions could
33 be related to a lack of intrinsic motivation, since they utilize explicit rather than implicit
34 teaching methods. The study reviewed next and reported in detail elsewhere (Golan et al, in
35 press) evaluates the effectiveness of another DVD, this time an animation series created to
36 motivate young children with ASC to learn about emotions and facial expressions by
37 embedding them in a world of mechanical vehicles. Although this animation series is not
38 computer-based (it can be watched on a regular TV or DVD player), it is again relevant to the
39 notion of 'affective computing' in that emotional expressions are grafted onto vehicles that
40 move *systematically*. Once again, it harnesses the predictability of systems.
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7 *The Transporters DVD*
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12 This DVD was again based on the premise that the reason children with ASC love to watch
13 films about vehicles (according to parental report) may be because they are strong
14 'systemizers' (Baron-Cohen, 2006, 2008). That is, they are drawn to predictable, rule-based
15 systems, whether these are repeating mathematical patterns, or repeating electrical
16 patterns (e.g. light switches), or repeating patterns in films. Kanner's first descriptions of
17 autism drew attention to their "need for sameness" and their "resistance to change"
18 (Kanner, 1943). At the core of autism may be an *ability* to deal effortlessly with systems
19 because they do not change and produce the same outcome every time; and by the same
20 token, a disabling *difficulty* to deal with the social world because it is always changing
21 unpredictably and because the outcome is different every time.
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40 According to the hyper-systemizing theory (Baron-Cohen 2006), vehicles whose motion is
41 determined only by physical rules (such as vehicles that can only go back and forth along
42 linear tracks) would be much preferred by children with autism over vehicles like planes or
43 cars whose motion could be highly variable, moving at the whim of the human driver
44 operating them. In vision neuroscience this relates to the distinction between physical-
45 causal/mechanical motion (Michotte, 1963) vs. animate/biological motion (Castelli et al.,
46 2000; Premack, 1990). The former requires intuitive physics (Saxe, Carey & Kanwisher, 2004;
47 Wellman & Inagaki, 1997) whilst the latter requires intuitive psychology, in particular the
48 ability to detect others' goals, desires and intentions (Baron-Cohen, 1995).
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3 We therefore created a children's animation series, *The Transporters*
4 (www.thetransporters.com), based around eight characters who are all vehicles that move
5 according to rule-based motion. Onto these vehicles we grafted real-life faces of actors
6 showing emotions. We tested whether creating an autism-friendly context of predictable
7 mechanical motion could render facial expressions of emotion more learnable and increase
8 the motivation to learn them. The different toy vehicles (two trams, two cable cars, a chain
9 ferry, a coach, a funicular railway, and a tractor) had motion that was constrained in a linear
10 manner (all the vehicles moved on tracks or cables).
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26 *The Transporters* is a high-quality 3D children's animation series and consists of fifteen five-
27 minute episodes, each of which focuses on a key emotion or mental state. This is relevant to
28 this Special Issue's focus on 'affective computing' in exploiting a cutting-edge graphic
29 animation technique called 'live action'. This allowed real human faces to be superimposed
30 on animated vehicles. Using real faces was a design feature again chosen to maximize
31 generalization to the real social world. The fifteen key emotions depicted on the vehicles are
32 *happy, sad, angry, afraid, disgusted, surprised, excited, tired, unfriendly, kind, sorry, proud,*
33 *jealous, joking* and *ashamed*. The emotions selected include the six 'basic' emotions (Ekman,
34 1999), emotions that are more 'complex' but still developmentally appropriate (e.g. *jealous,*
35 *proud, ashamed*), and emotions and mental states that are important for everyday social
36 functioning (e.g., *kind, unfriendly, tired, joking*). These emotions were chosen because
37 typically developing children recognize and understand these between 2-7 years of age
38 (Bretherton & Beeghly, 1982; Ridgeway, Waters & Kuczaj, 1985).
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In the study by Golan et al (in press), three groups were assessed twice: at Time 1 and then 4 weeks after at Time 2. In each assessment participants were tested at 4 levels of

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3 generalization, one testing participants' emotional vocabulary, and the other three testing
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5 their ability to match a socio-emotional situation to the appropriate facial expression. Level
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8 1: *Emotional Vocabulary*: Participants were asked to define 16 emotion words and give
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10 examples of situations that evoked them. These were the 15 key emotions from the series
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12 (see above), in addition to *worried*. Level 2: *Situation-Facial Expression Matching*: This was
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14 tested using three tasks, each consisting of 16 items (one for each emotion). Each item
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16 included a photo depicting a scene with a short description.
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23 The three tasks represented 3 levels of generalization: (a) *Familiar close generalization*:
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25 Participants had to match familiar situations taken from the intervention series to facial
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27 expressions of familiar characters from the series. (b) *Unfamiliar close generalization*:
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29 Participants had to match novel situations with novel expressions from *The Transporters*
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31 characters. These expressions were **not** shown by these characters in the intervention series.
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34 (c) *Distant generalization*: To test generalization to facial expressions that are not attached
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36 to vehicles, participants had to match novel situations with novel expressions using a
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38 selection of human non-*Transporters* faces taken from the *Mind Reading* software (Baron-
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40 Cohen et al., 2004) .
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45 Examples of items from Levels 1 and 3 are shown in Figure 2.
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52 insert Figure 2 here
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58 Three groups took part in the study: an ASC intervention group, an ASC control group, and a
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60 typically developing control group. Participants in the two clinical groups were randomly

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3 assigned and took part according to the following test conditions: (1) *ASC intervention*
4 *group*: The parents of 20 participants were given the intervention series and DVD guide to
5
6 use with their child at home. Children were asked to watch at least 3 episodes per day over a
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8 period of four weeks. (2) *ASC control group*: 19 participants did not participate in any
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10 intervention during the 4-week interval, except for their standard school curriculum. One
11
12 participant dropped out of the study after the first session. (3) *Typical control group*:
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14 Eighteen participants were recruited for this group. The three groups were matched for sex,
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16 age, and verbal ability (using the (British Picture Vocabulary Scale (BPVS)) (Dunn, Whetton &
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18 Burley, 1997).
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28 At Time 1, there were significant differences between groups on the emotional vocabulary
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30 task and on the three Situation-Expression Matching tasks. These differences were due to
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32 the significantly higher scores of the typical controls on all tasks compared to the two clinical
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34 groups, which did not differ from each other. Analysis of results after Time 2 testing revealed
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36 significant Time by Group interactions, with the ASC intervention group showing significant
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38 improvement across all task levels between Time 1 and Time 2. Furthermore, this
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40 improvement was comparable to levels of performance found in the typical control group. In
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42 contrast, the ASC and typical control groups showed no significant improvement on any of
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44 the tasks between test sessions. These effects are illustrated in Figure 3.
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50 insert Figure 3 here
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52 53 **Implications** 54 55

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59 The study we have reviewed (reported in detail in Golan et al (in press)) investigated the
60 effectiveness of individual use of *The Transporters* animated series (with parental support)

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3 over a four week period. The results show that use of the DVD led children with ASC to
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5 improve significantly in their emotion comprehension and recognition skills on tasks
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7 including the emotions presented by *The Transporters*: from the same level of ability seen
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9 with the ASC control group at Time 1, to a level that was indistinguishable from the typically
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11 developing group at Time 2.
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19 The improvement of the intervention group was not limited to tasks that required close
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21 generalization; these participants were also able to generalize their knowledge to perform at
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23 the level of typical controls on the distant generalization task, which required emotion
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25 recognition from naturalistic clips of human characters that were not attached to vehicles.
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27 *The Transporters* may have facilitated generalization because the series was designed using
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29 intrinsically motivating media, such that the children enjoyed watching the vehicles whilst
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31 learning about emotions from real faces grafted onto them (incidental rather than explicit
32
33 learning). *The Transporters* used characters and an environment that appealed to a
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35 preference for order, systems, and predictability that is characteristic of ASC. Anecdotal
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37 evidence from the parents of the intervention group suggests that their children became
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39 more willing to discuss emotions, and became more interested in facial expressions. Parents
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41 also noticed a change in their children's behaviour, and in their ability to interact with
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43 others. Such anecdotal changes need formal evaluation.
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53 We expect the integration of *The Transporters* with other educational or therapeutic
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55 methods for children with ASC may improve its effect even further. We conclude that the
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57 use of systemizing as an intrinsically motivating method for learning about empathy allows
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59 affective information, that would otherwise be confusing, to become more intelligible and
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appealing to the autistic mind.

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9 If *The Transporters* is having such a positive effect on the learnability of emotional
10 expressions by children with ASC, might there be other ways to harness the same preference
11 for systemizing in the teaching of emotions to these children? Clearly vehicles are not the
12 only kind of systems that children with autism enjoy, and others might include robots
13 (Dautenhahn and Werry, 2004), or rules (Hadwin et al, 1996). We see these sorts of
14 interventions as part of an adaptation of the mainstream environment to be more suited to
15 people with autism, and such environmental adaptations need not be restricted to the
16 teaching of emotions. An example outside the emotional domain might involve sensory
17 perception, where people with ASC may experience hypersensitivity (Ashwin et al, 2009;
18 Baron-Cohen et al, 2009). In this case, as with the use of specifically oriented media for the
19 teaching of emotions, classrooms may need to be specially designed to ensure information,
20 that may otherwise be easily processed by the neurotypical brain, is not over stimulating
21 and therefore aversive to the autistic brain. We cannot expect learning to proceed smoothly
22 or even to occur at all if the information is in a form that causes distress or is even painful.
23 We conclude that a little empathy on the part of designers of educational resources may
24 therefore facilitate the development of empathy in children with autism.
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Author Note

All the authors were affiliated with the Autism Research Centre at University of Cambridge during the study. This work was conducted in association with the NIHR CLAHRC for Cambridgeshire and Peterborough NHS Foundation Trust. Parts of this paper appeared in the Journal of Autism and Developmental Disorders (Golan et al, in press). We are grateful to Yael Granader, Suzy McClintock, Kate Day, and Victoria Leggett for help with data collection, and to Gina Owen and Kimberly Peabody and Ben Weiner for useful discussions. Ofer Golan now holds a position at Bar-Ilan University, Faculty of Social Sciences, Department of Psychology in Israel. We are grateful to Culture Online and the Department for Culture, Media and Sport (DCMS) for funding, and to Catalyst Ltd and Culture Online (particularly Claire Harcup, Paul Bason, Khairoun Abji, and Jon Drori) for their production of the film. We are also indebted to the families who participated in the intervention. *The Transporters* series was nominated for a BAFTA in the Children's Awards Category, November 2007.

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Figure Captions

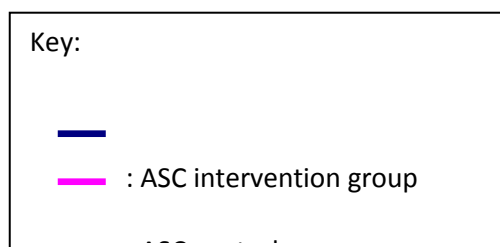
Figure 1: Fractions of empathy: taken from Baron-Cohen and Wheelwright (2004).

Figure 2. Examples of questions from two of the three emotion recognition task levels

a) Level 1 Task: Match familiar scenes from the series with familiar faces

b) Level 3 Task: Match novel scenes and faces using real human faces

Figure 3. Graphs to show mean scores (with standard error bars) for each group on the four tasks



- a) Situation-Expression Matching task – Level 1
- b) Situation-Expression Matching task – Level 2
- c) Situation-Expression Matching task – Level 3

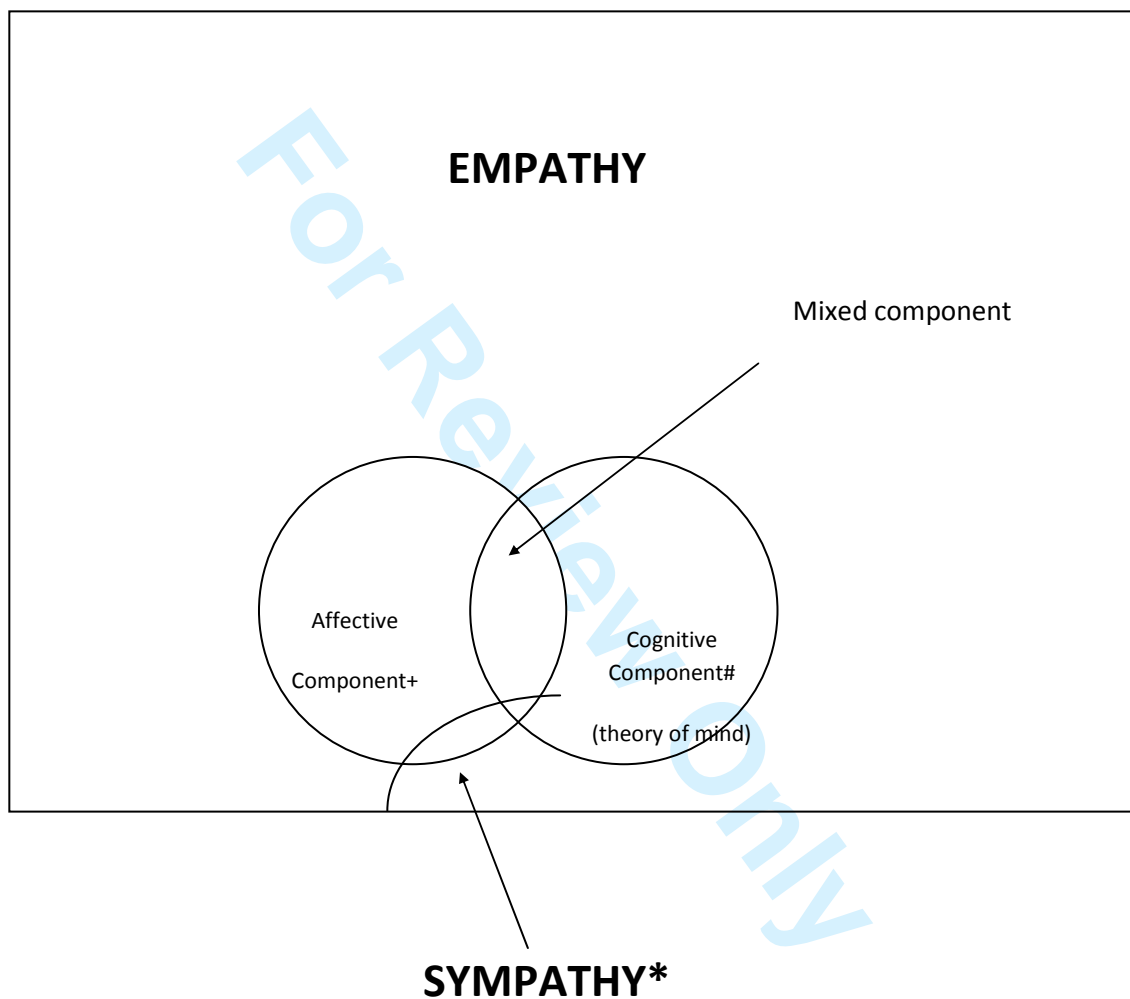
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d) Emotional Vocabulary task

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For Review Only

Figure 1:



+ Feeling an appropriate emotion triggered by seeing/learning of another's emotion.

Understanding and/or predicting what someone else might think, feel, or do.

(i) Figure 2a

4. Charlie is going to get the pieces for the new special clock.



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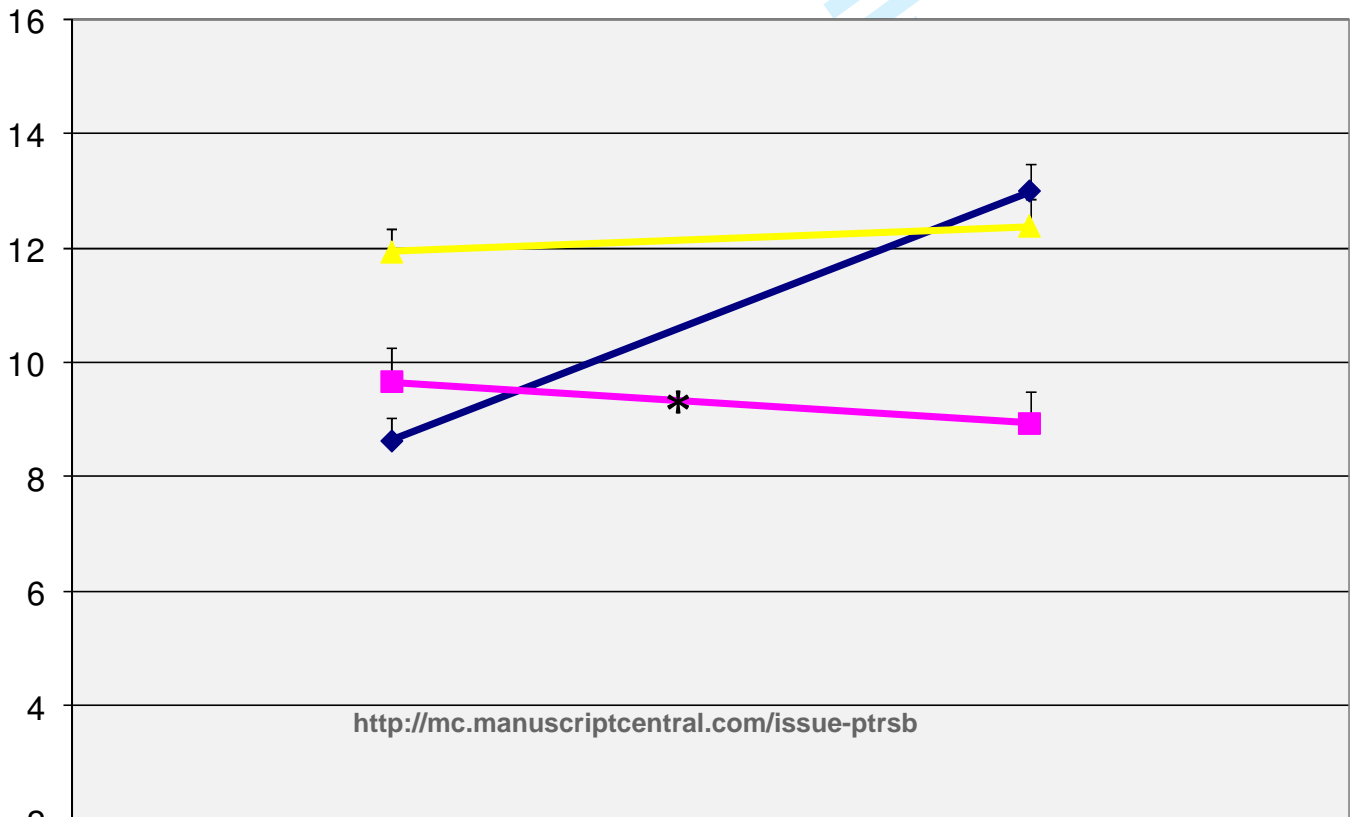
(ii) Figure 2b



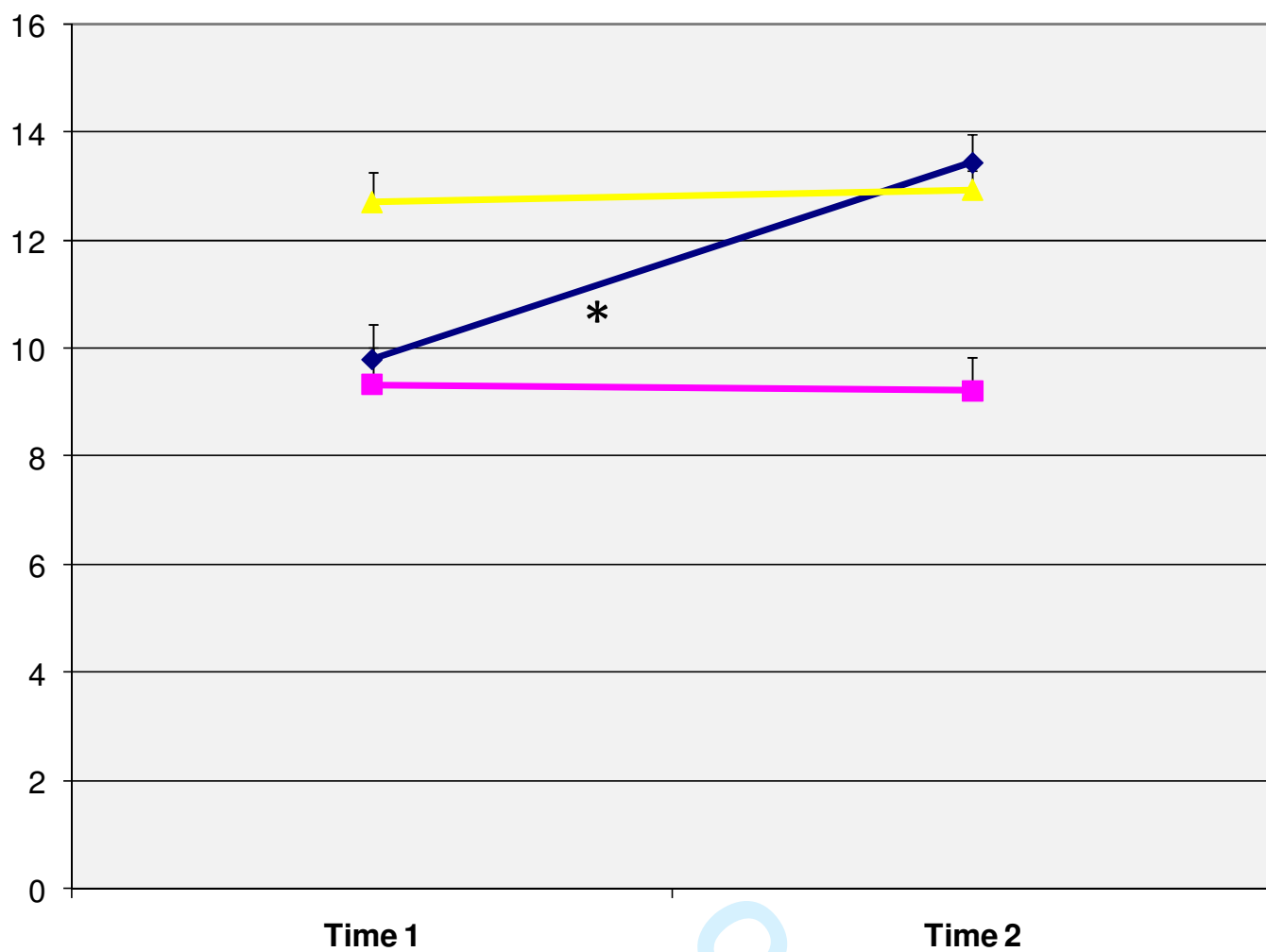
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(iii) Figure 3a



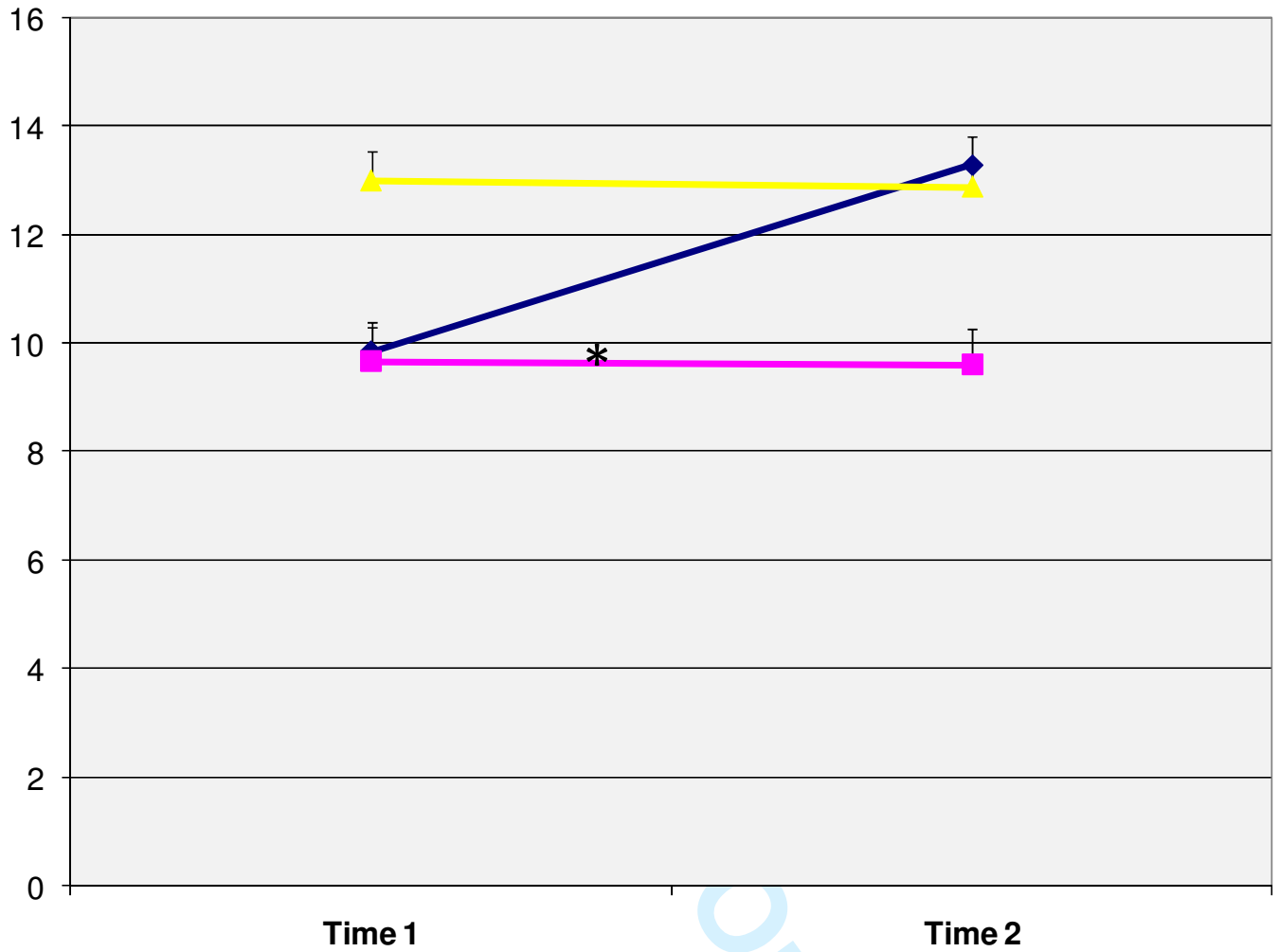
(iv) Figure 3b



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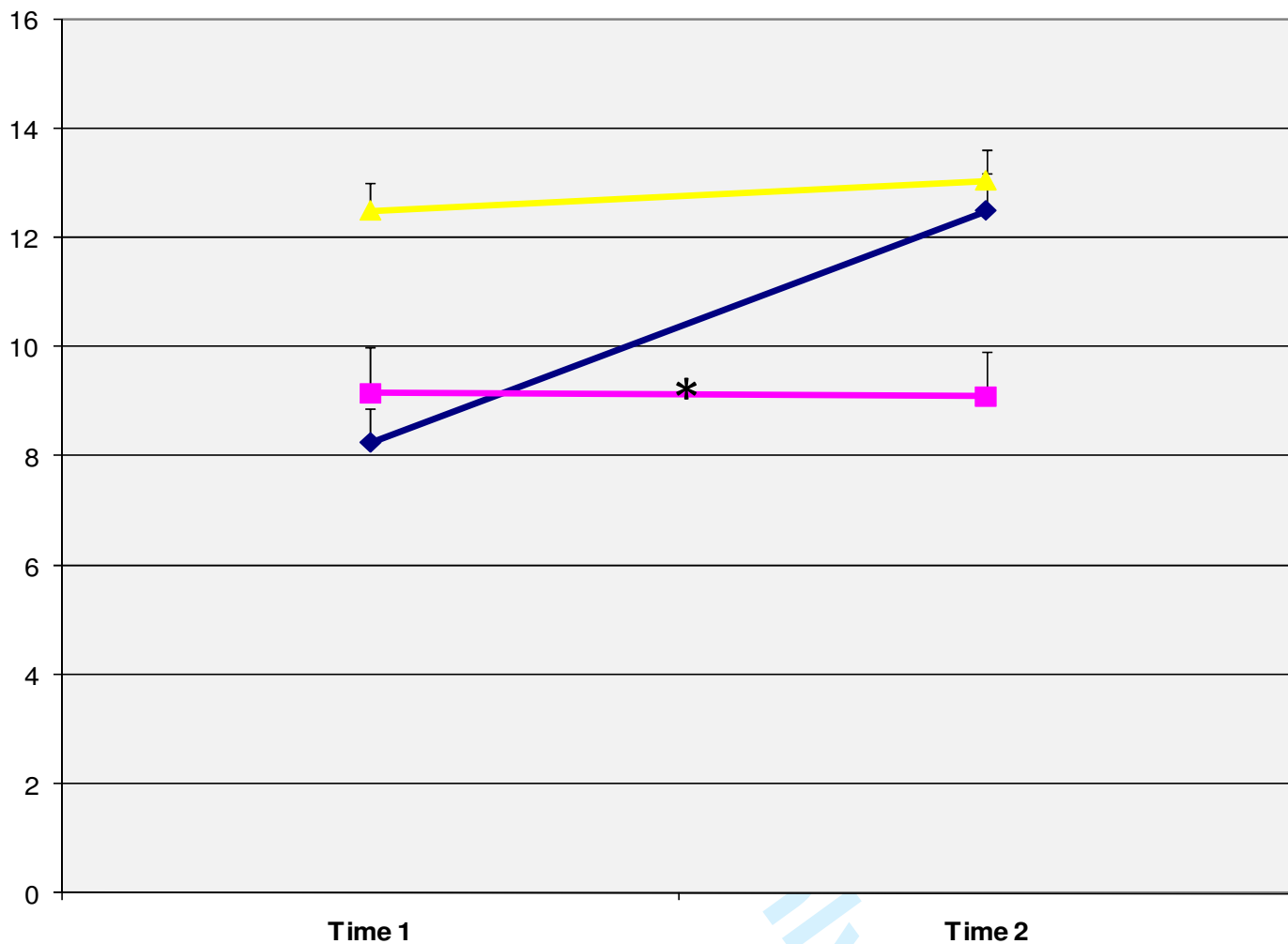
(v) Figure 3c



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(vi) Figure 3d



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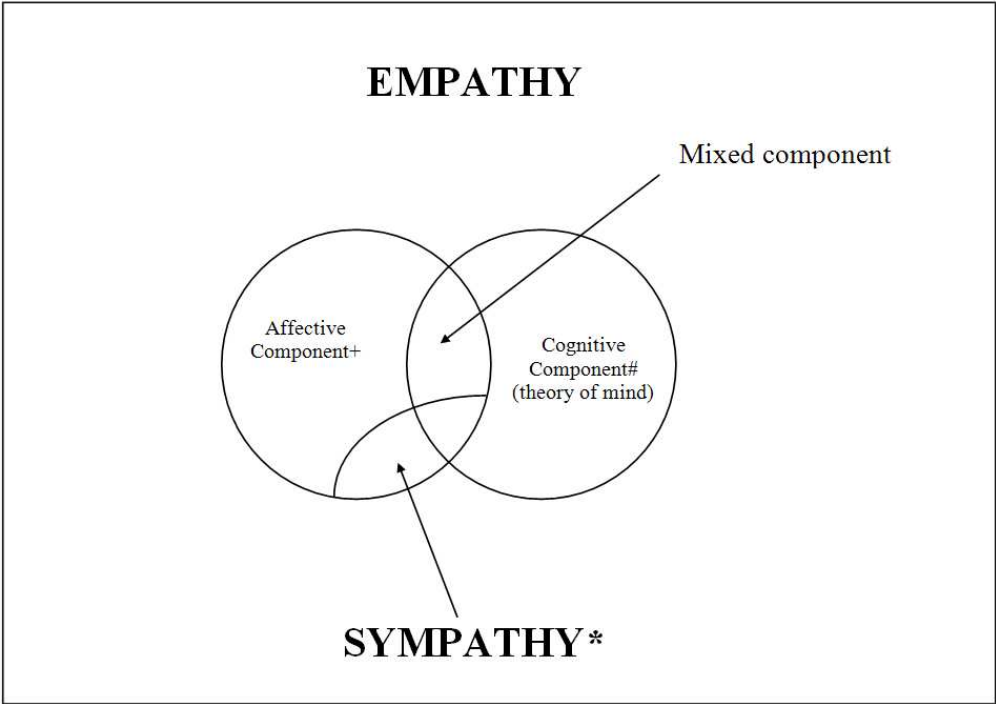


Figure 1: Fractions of empathy: taken from Baron-Cohen and Wheelwright (2004).

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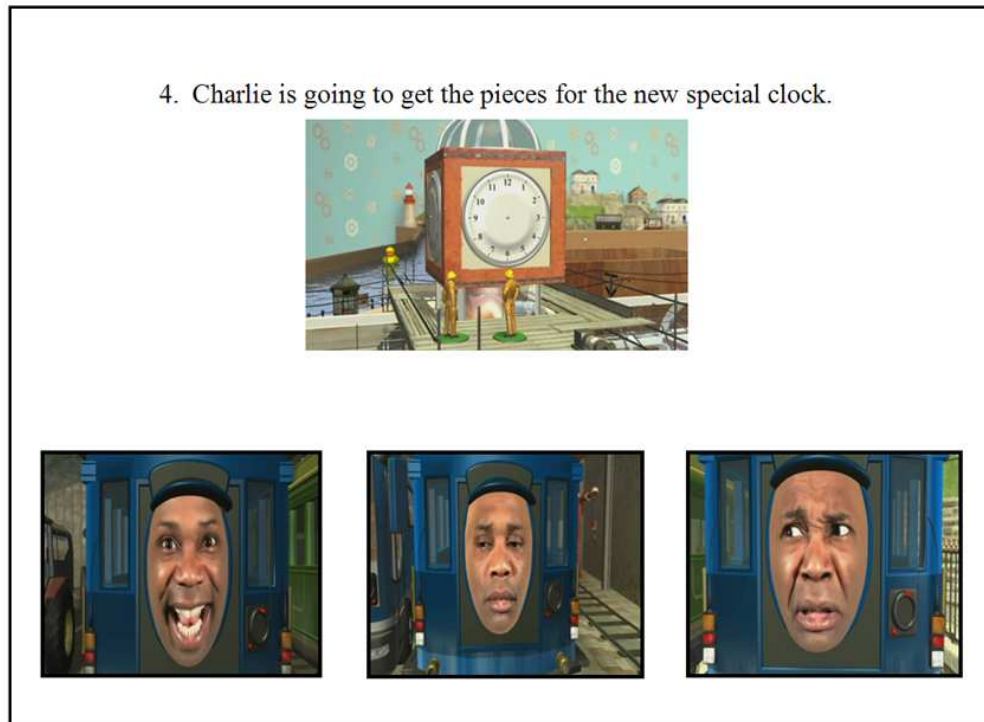


Figure 2. Examples of questions from two of the three emotion recognition task levels a) Level 1
Task: Match familiar scenes from the series with familiar faces

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Figure 2. Examples of questions from two of the three emotion recognition task levels b) Level 3
Task: Match novel scenes and faces using real human faces

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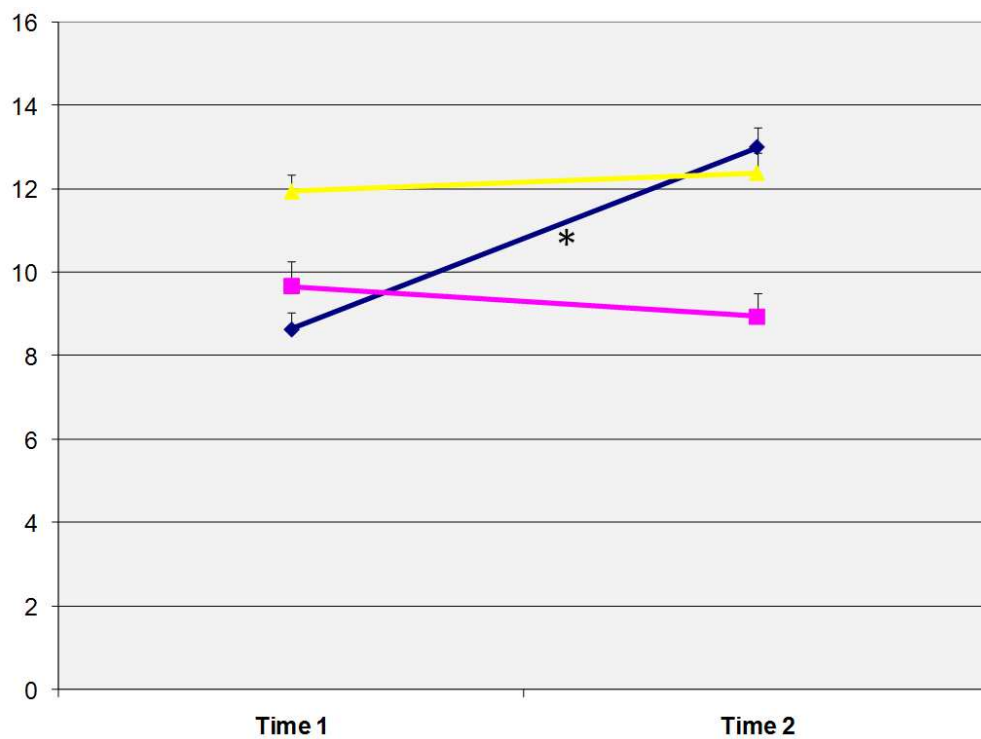


Figure 3. Graphs to show mean scores (with standard error bars) for each group on the four tasks
a) Situation-Expression Matching task – Level 1

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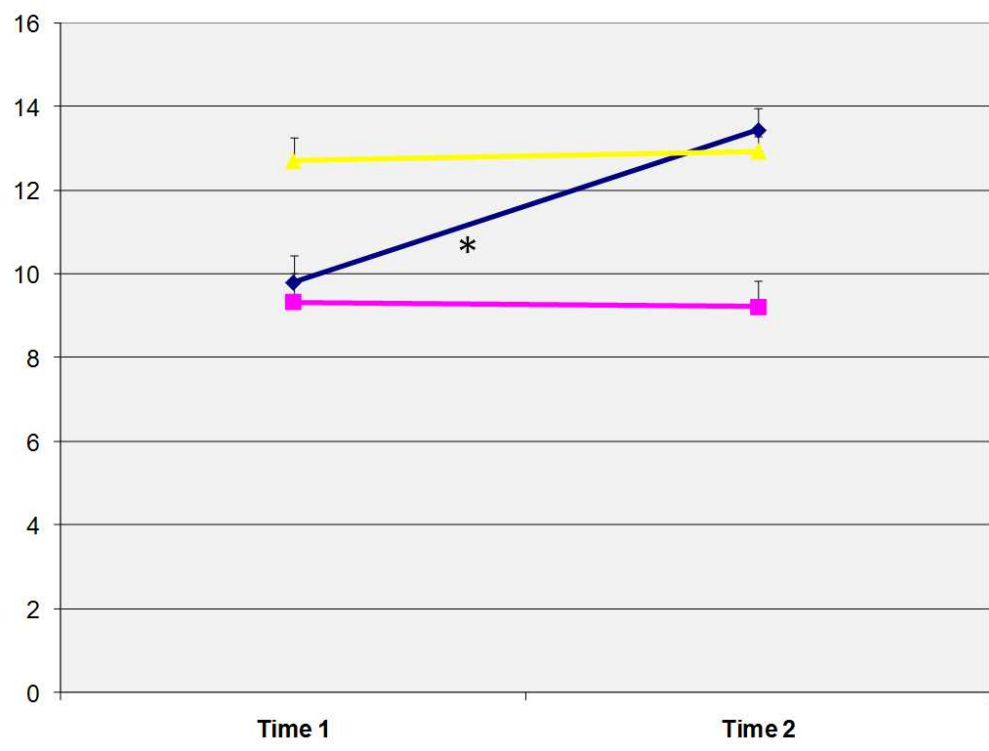


Figure 3. Graphs to show mean scores (with standard error bars) for each group on the four tasks
b) Situation-Expression Matching task – Level 2

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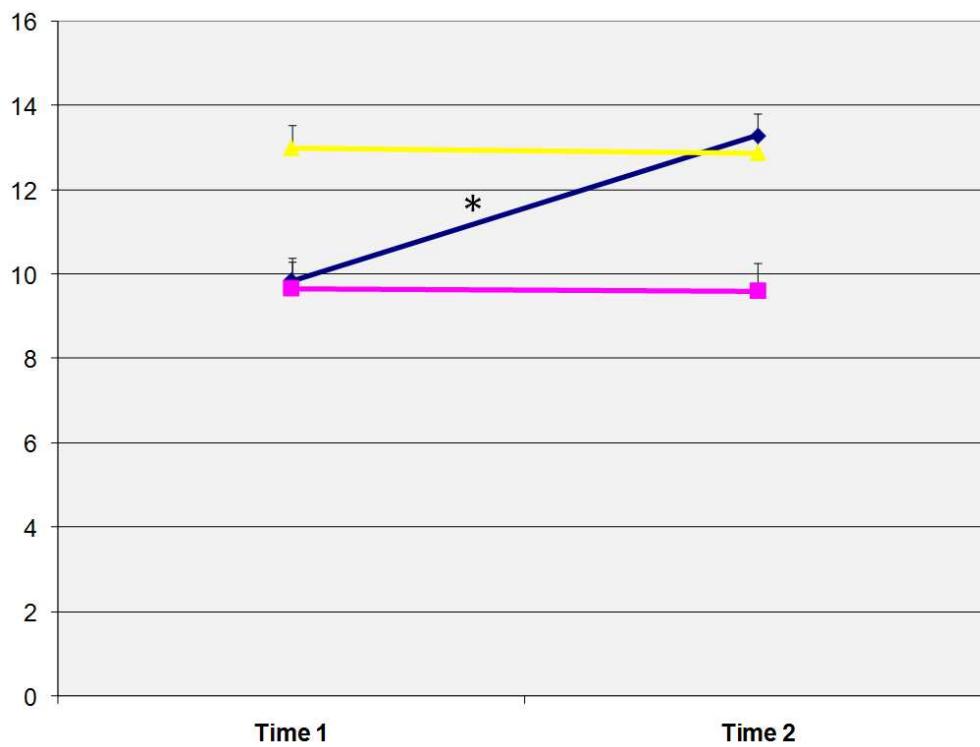


Figure 3. Graphs to show mean scores (with standard error bars) for each group on the four tasks
c) Situation-Expression Matching task – Level 3

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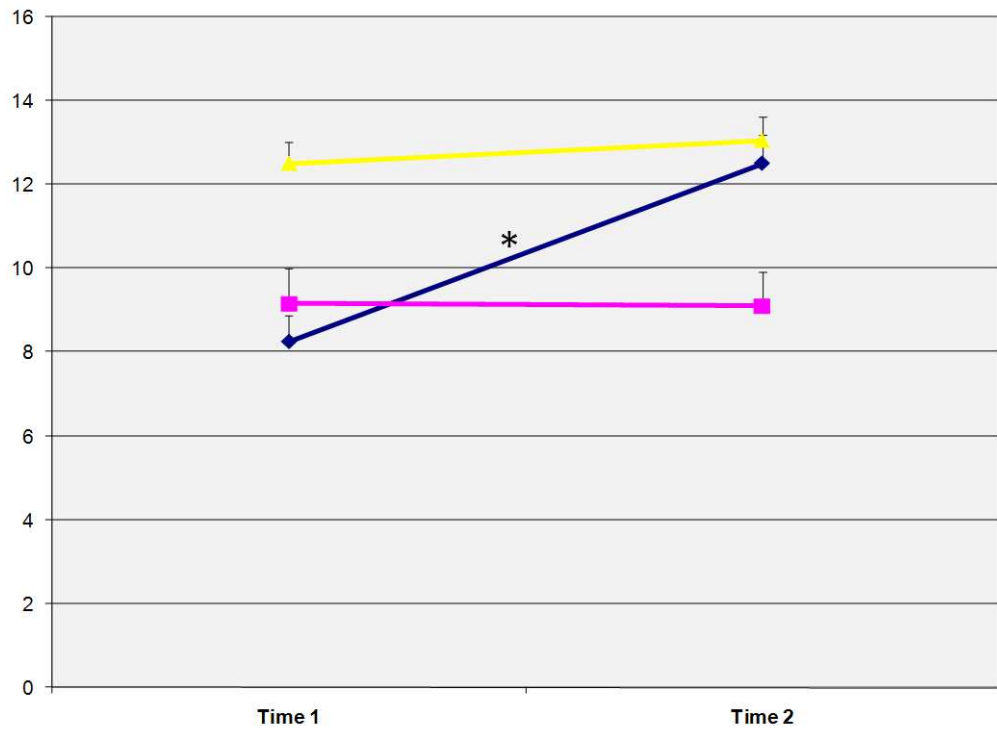


Figure 3. Graphs to show mean scores (with standard error bars) for each group on the four tasks
d) Emotional Vocabulary task

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