CHAPTER

9

Using New Technology to Teach Emotion Recognition to Children with Autism Spectrum Disorders

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Children and adults with autism spectrum disorder (ASD) have difficulties with *cognitive empathy*, that is, understanding and recognizing what other people might think or feel. This is sometimes referred to as difficulties with theory of mind or degrees of "mindblindness" (Baron-Cohen, 1995). In this chapter we address the question of whether one aspect of empathy (emotion recognition) can be taught using new technologies and why such platforms as computer-based or film-based media might be particularly autism-friendly methods for such teaching. We begin with a definition of empathy. The chapter next reviews the empathy difficulties in autism, the systemizing strengths in autism, and the role of technology in autism

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education. We then summarize an experiment that evaluates a new technology designed to teach this element of empathy to young children with autism. Teaching cognitive empathy to children with ASD is important if they are to achieve greater skills in their social relationships and thus lead to the benefits of greater social inclusion.

WHAT IS EMPATHY?

We define empathy as the ability to attribute mental states to others and to respond with an appropriate emotion to the other person's mental states (Baron-Cohen & Wheelwright, 2004). This definition of empathy suggests that the two main fractions of empathy are a cognitive component (the recognition of another person's mental state) and an affective component (the emotional reaction to another person's mental state). The cognitive component is sometimes also called theory of mind (Dennett, 1989).

Mental states include thoughts and emotions. Thoughts are traditionally fractionated into beliefs, desires, intentions, goals, and perceptions (Baron-Cohen, 1995; Dennett, 1989). Emotions are traditionally fractionated into six basic emotions (happy, sad, angry, afraid, disgusted, and surprised; Ekman, 1999), as well as numerous complex emotions that are acquired at different points in childhood (Baron-Cohen, Golan, Wheewright, Granadar, & Hill, 2010). Complex emotions involve attributing a cognitive state as well as an emotion and are more context and culture dependent than basic emotions (Griffiths, 1997). The basic emotions are held to be so because they are universally recognized and expressed in the same way. It may be that more emotions are universally recognized and expressed than these six, but have been overlooked, possibly because of how expensive, time-consuming, and difficult cross-cultural research is. Indeed, research into complex emotions (usually toward developing taxonomies) has been mostly language and culture specific (Ortony, Clore, & Foss, 1987; Storm & Storm, 1987). Our own work described the development of the emotional lexicon in the English language (Baron-Cohen et al., 2010), suggesting there are at least 412 distinct emotions and related mental states (each with its own descriptor that is not just a synonym for another emotion) that are recognizable by independent judges within the United Kingdom (Baron-Cohen, Golan, Wheelwright, & Hill, 2004).

Having defined empathy into at least two major fractions, we turn 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 ASD 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 ASD. We 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 ASD, that are therefore intrinsically motivating. Although we do not rule out that the second component of empathy, affective empathy, can be taught, there is little research in this area to date.

People with ASD have social-communication difficulties alongside circumscribed interests (obsessions) and a strong preference for sameness and repetition (American Psychiatric Association, 1994). Underlying these characteristics are difficulties understanding the emotional and mental states of others (Baron-Cohen, 1995). Individuals with ASD have difficulties recognizing emotions from facial expressions, vocal intonation, and body language separately (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Golan, Baron-Cohen, & Hill, 2006; Hobson, 1986a, 1986b; Yirmiya, Sigman, Kasari, & Mundy, 1992) and in context (Golan, Baron-Cohen, & Golan, 2008; Klin, Jones, Schultz, Volkmar, & Cohen, 2002). Although some individuals with ASD recognize basic emotional expressions (Baron-Cohen, Spitz, & Cross, 1993; Grossman, Klin, Carter, & Volkmar, 2000), difficulties in identifying more complex emotions persist into adulthood (Baron-Cohen, Wheelwright, & Jolliffe, 1997; Golan et al., 2006).

EMPATHY DIFFICULTIES IN AUTISM SPECTRUM DISORDER

The emotion recognition difficulties are in part the result of altered face processing (Dawson et al., 2004; Klin et al., 2002), which in itself may be due to a failure to interpret the mentalistic information conveyed by the eyes (Baron-Cohen, 1995). Others' facial expressions may also be less intrinsically rewarding. Children with ASD show reduced attention to faces and to eyes in particular (Swettenham et al., 1998). The result of this reduced experience with faces is that children with ASD thus fail to become "face experts" (Dawson, Webb, & McPartland, 2005). For example, whereas the typically developing brain shows an electrophysiological response to upright faces called the N170 wave form, the autistic brain shows a reduced N170 (Grice et al., 2005).

SYSTEMIZING STRENGTHS IN AUTISM SPECTRUM DISORDER

In contrast to their difficulties in emotion recognition, individuals with ASD have intact or even enhanced abilities in "systemizing" (Baron-Cohen, 2002, 2006). Systemizing is the drive to analyze or build systems, allowing one to predict the behavior of the system and control it. Systems may be mechanical (e.g., vehicles), abstract (e.g., number patterns), natural (e.g., the tide), or collectible (e.g., a library classification index). The so-called obsessions or narrow interests of those with ASD cluster in the domain of systems (Baron-Cohen & Wheelwright, 1999). These include vehicles, spinning objects, and computers, all of which are attractive to individuals with ASD. At the heart of systemizing is the ability to detect patterns or rules of the form "If a, then b." The systemizing theory of autism relates this affinity to their systematic and predictable nature. In the study summarized below, we illustrate how these special interests can be harnessed when teaching children with ASD, using computer-based or multimedia formats, to keep the children intrinsically motivated.

The systemizing theory of autism has been supported by different studies: Children with ASD have been found to outperform matched controls on tests of intuitive physics (Baron-Cohen, Wheelwright, Spong, Scahill, & Lawson, 2001), and adults with ASD were at least intact on such tests (Lawson, Baron-Cohen, & Wheelwright, 2004), as well as on other tests that involve excellent attention to detail (Mottron, Dawson, Soulieres, Hubert, & Burack, 2006), a prerequisite for good

systemizing (Baron-Cohen, 2008; Jolliffe & Baron-Cohen, 1997; O'Riordan, Plaisted, Driver, & Baron-Cohen, 2001; Shah & Frith, 1983). In addition, individuals with ASD score above average on the Systemizing Quotient (SQ), a self-report (or parent-report) measure of how strong one's interests are in systems (Auyeung et al., 2009; Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003; Wakabayashi et al., 2007; Wheelwright et al., 2006).

TEACHING EMPATHY SYSTEMATICALLY

If children with ASD possess intact or enhanced systemizing skills, it may be possible for them to use such skills to facilitate their empathy, particularly in the cognitive component of emotion recognition. Indeed, various intervention programs could be viewed as tapping systematic skills and interests in order to teach empathy and social skills. Here we review a few published examples.

LEGO Therapy (Owens, Granadar, Humphrey, & Baron-Cohen, 2008) is an example that encourages young children with ASD to build LEGO models in groups of three, thereby gaining opportunities for social interaction. Children participating in LEGO Therapy appear to be intrinsically motivated by LEGO presumably because it involves constructional systems that can be assembled in predictable and repeating sequences.

Another interesting example comes from the field of robotics. Since children with ASD presumably find the systematic motion and structure of robots more predictable and therefore less confusing than humans, and since robots can be designed to have simplified facial features and increase the children's attention to these features (Dautenhahn & Werry, 2004; Michaud & Théberge-Turmel, 2002), robots could be used as another way of teaching empathy to children with ASD (see Chapter 5). Indeed, through child–robot interaction, various social and communication skills of children with ASD, such as joint attention, turn taking, sharing, and greeting, have been shown to improve (Robins, Dautenhahn, Boekhorst, & Billard, 2005). Since robots are highly lawful mechanical and/or electronic systems, their use in teaching social skills in ASD is another clear example of harnessing systemizing to make empathy more autism friendly.

Computer programs provide another good example of the use of systematic preferences when teaching empathy. The computerized environment is predictable, consistent, and free of social demands. Users can work at their own pace and level of understanding, and lessons can be repeated over and over again until mastery is achieved. In addition, interest and motivation can be maintained through different and individually selected computerized rewards (Golan, LaCava, & Baron-Cohen, 2007; Moore, McGrath, & Thorpe, 2000). For these reasons, dozens of computer programs and web sites have been created to teach various skills to children with ASD. Regrettably, however, most have not been scientifically evaluated, leaving parents or persons on the autistic spectrum unable to judge if these are of any significant benefit. Some of the computerized programs teaching empathy-related skills that have been evaluated include Bölte et al.'s FEFFA, teaching emotion recognition from still pictures of facial expressions and strips of the eye region (Bölte et al., 2002); Sliver and Oaks's Emotion Trainer, teaching emotion recognition of basic emotions from facial expressions (Silver & Oakes, 2001); Tanaka et al.'s Let's Face It, teaching emotion and identity recognition from facial expressions (Tanaka et al., 2010); and

Beaumont and Sofronoff's Junior Detective program, which combines computer-based training with group training in order to teach social skills to children with ASD (Beaumont & Sofronoff, 2008).

Mind Reading DVD

Our own attempt at harnessing systematic skills to teach empathy to individuals with ASD via the computer is the *Mind Reading* DVD, a piece of educational software (Baron-Cohen et al., 2004; http://www.jkp.com/mindreading). See Figure 9.1.

This program was designed to be an interactive, systematic guide to emotions. It was developed to help people with ASD learn to recognize both basic and complex emotions and mental states from video clips of facial expressions and audio recordings of vocal expressions. It covers 412 distinct emotions and mental states, organized developmentally and classified taxonomically to be attractive to a mind that learns through systemizing. The principle behind this was that individuals with ASD may not learn to recognize emotional expressions in real time during live social situations because emotions are fleeting and do not repeat in an exact fashion, which may reduce the number of opportunities to systematically learn from repetition. Putting emotions into a computer-based learning environment enables emotions to be played and replayed over and over again in an identical fashion, such that the learner can have control over their speed and the number of exposures needed for the learner to analyze and memorize the features of each emotion.

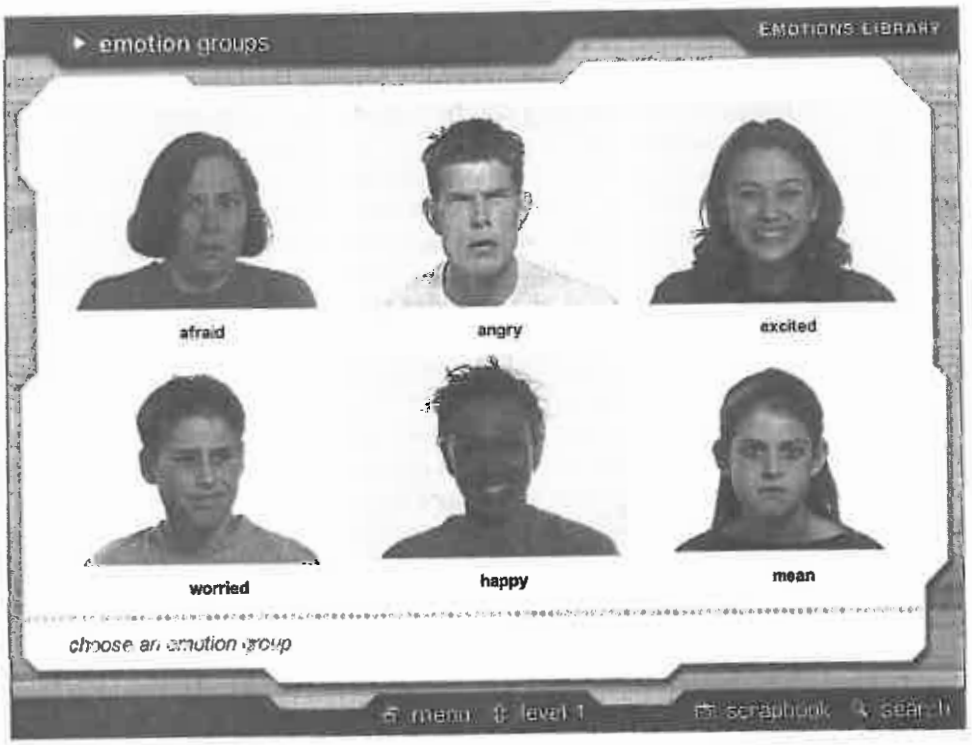

Figure 9.1. A screenshot from the emotions library of the *Mind Reading* DVD.

Furthermore, since emotions vary depending on who is expressing them, in the real world it can be difficult to see what defines each specific emotion. *Mind Reading* helps its users overcome this problem by having each of the 412 emotions portrayed by six different actors (male and female, old and young, different ethnicities) to facilitate learning to recognize emotions independently of the identity of the person expressing that emotion. In addition, in the real world, emotions can appear inconsistent (some people smile when they are happy, other people smile when they are pretending to be happy, and yet others are happy when they are not smiling at all), so *Mind Reading* imposes some laws onto emotions by assigning a clear label to each emotional expression, including masked or insincere emotional expressions (e.g., emotions in the "sneaky" category). Finally, emotions in the real world can be hard to classify, so *Mind Reading* offers the user a predesigned classification system to assist in finding patterns among inherently unpatterned emotional information.

Using *Mind Reading* over a 10-week intervention (2 hours' usage per week), individuals with ASD improved in their ability to recognize a range of complex emotions and mental states (Golan & Baron-Cohen, 2006). Follow-up questionnaires were filled in by 18 participants with ASD 1 year after completion of the intervention period. Participants who used *Mind Reading* reported improved ability to form friendships and relationships and increased awareness of the importance of emotions and emotional expressions in everyday life, improved understanding of emotions and their corresponding expressions, and an enhanced ability to function socially (Golan & Baron-Cohen, 2007). These findings have been replicated with children in the United States, supporting the cross-cultural validity of this intervention (LaCava, Golan, Baron-Cohen, & Myles, 2007; LaCava, Rankin, Mahlios, Cook, & Simpson, 2010). These are encouraging results because they suggest that at least one cognitive component of empathy can be taught, and that it may have a long-term effect that facilitates social functioning. It is not known if such improvement would be seen if the intervention were shorter in duration, or if the users were not just persons with ASD but had additional learning difficulties (e.g., below-average IQ). Finally, it could reasonably be objected that learning to recognize emotions in the simplified context of a computer screen, devoid of the "noise" of a real social situation like a school playground or a birthday party or an argument, is likely to be simplified and therefore easier to achieve. This objection is important because it raises the question of whether such learning from artificial contexts generalizes to more natural settings. Guarding against the risk of artificiality, *Mind Reading* used real faces rather than cartoon or schematic faces. However, future work using the *Mind Reading* DVD could assess the benefits of a longer intervention than just 10 weeks. The DVD could also be used with more interactive teaching methods, such as social skills groups, or as part of dramatic role play. Other limitations of the *Mind Reading* DVD are that the videos use actors rather than real-life recordings and that the background of each video is a white screen (thus lacking real-world context). Although these design features have their advantages, it may be that future technologies could expand on this earlier design.

Difficulties with generalization from taught material to everyday life have been found in computer-based intervention programs (Bölte et al., 2002; Silver & Oaks, 2001) and social skills–training courses (Barry et al., 2003; Bauminger, 2002). The limited effectiveness of these interventions could be related to a lack of intrinsic

motivation, given that they utilize explicit rather than implicit teaching methods. In the study reviewed next, we attempted to rely on intrinsic motivation of children with ASD through the use of animated vehicles.

The Transporters DVD (Animation Series)

This study (reported in detail in Golan et al., 2010) evaluates the effectiveness of an animation series created to motivate young children with ASD to learn about emotions and facial expressions by embedding them in a world of mechanical vehicles. Again, this series is based on the premise that the reason children with ASD love to watch films about vehicles (according to parental report) may be because such children are strong systemizers (Baron-Cohen, 2006, 2008). That is, they are drawn to predictable, rule-based systems, whether these are repeating mathematical patterns, repeating electrical patterns (e.g., light switches), or repeating patterns in films. Kanner's first descriptions of ASD drew attention to their "need for sameness" and their "resistance to change" (Kanner, 1943). At the core of ASD may be an ability to deal effortlessly with systems because they do not change and they produce the same outcome every time; by the same token, there is a disabling difficulty to deal with the social world because it is always changing unpredictably and because the outcome is seldom the same every time.

According to the hypersystemizing theory (Baron-Cohen, 2006), vehicles whose motion is determined only by physical rules (e.g., vehicles that can only go back and forth along linear tracks) would be much preferred by children with ASD over vehicles like planes or cars, whose motion could be highly variable, moving at the whim of the human driver operating them. In vision neuroscience, this theory relates to the distinction between physical-causal or mechanical motion (Michotte, 1963) versus animate or biological motion (Castelli, Happé, Frith, & Frith, 2000; Premack, 1990). The former requires intuitive physics (Saxe, Carey, & Kanwisher, 2004; Wellman & Inagaki, 1997), whereas the latter requires intuitive psychology, in particular the ability to detect others' goals, desires, and intentions (Baron-Cohen, 1995).

We therefore created a children's animation series, *The Transporters* (http://www.thetransporters.com), based around eight characters who are all vehicles that move according to rule-based motion (Figure 9.2).

Onto these vehicles we grafted real-life faces of actors showing emotions. We tested whether creating an autism-friendly context of predictable mechanical

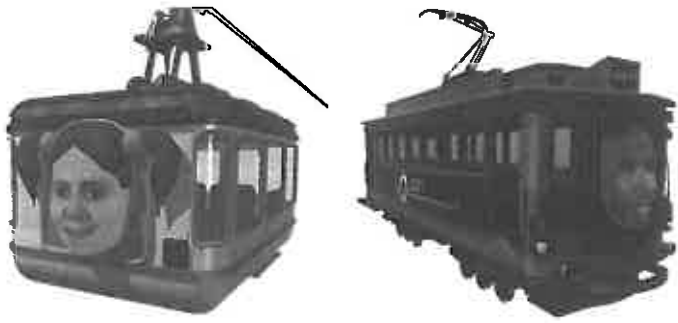

Figure 9.2. Characters from *The Transporters* DVD.

motion could render facial expressions of emotion more learnable and thus increase motivation to learn them. The different toy vehicles (two trams, two cable cars, a chain ferry, a coach, a funicular railway, and a tractor) had motion that was constrained in a linear manner (all the vehicles moved on tracks or cables).

The Transporters is a high-quality 3-D children's animation series and consists of 15 five-minute episodes, each of which focuses on a key emotion or mental state. The 15 key emotions depicted on the vehicles are *happy, sad, angry, afraid, disgusted, surprised, excited, tired, unfriendly, kind, sorry, proud, jealous, joking,* and *ashamed.* The emotions selected include the six basic emotions (Ekman, 1999), emotions that are more complex but still developmentally appropriate (e.g., *jealous, proud, ashamed*), and emotions and mental states that are important for everyday social functioning (e.g., *kind, unfriendly, tired, joking*). These emotions were chosen because children who are typically developing recognize and understand these emotions when they are between 2 and 7 years of age (Bretherton & Beeghly, 1982; Ridgeway, Waters, & Kuczaj, 1985).

In the study by Golan et al. (2010), three groups were assessed twice: at Time 1 and then 4 weeks after at Time 2. In each assessment, participants were tested at four levels of generalization, one testing participants' emotional vocabulary, and the other three testing their ability to match a socioemotional situation to the appropriate facial expression. At Level 1, Emotional Vocabulary, participants were asked to define 16 emotion words and give examples of situations that evoked them. These were the aforementioned 15 key emotions from the series, in addition to *worried.* At Level 2, Situation–Facial Expression Matching, matching of situation and expression was tested using three tasks, each consisting of 16 items (1 for each emotion). Each item included a photo depicting a scene with a short description.

The three tasks represented three levels of generalization: 1) *Familiar close generalization:* Participants had to match familiar situations taken from the intervention series to facial expressions of familiar characters from the series. 2) *Unfamiliar close generalization:* Participants had to match novel situations with novel expressions from *The Transporters* characters. These expressions were *not* shown by these characters in the intervention series. 3) *Distant generalization:* To test generalization to facial expressions that are not attached to vehicles, participants had to match novel situations with novel expressions using a selection of human non-*Transporters* faces taken from the *Mind Reading* software (Baron-Cohen et al., 2004). Examples of items from Levels 1 and 3 are shown in Figure 9.3.

Three groups took part in the study: an ASD intervention group, an ASD control group, and a typically developing control group. Participants in the two clinical groups were randomly assigned and took part according to the following test conditions: 1) *ASD intervention group*: The parents of 20 participants were given the intervention series and DVD guide to use with their child at home. Children were asked to watch at least three episodes per day over a period of 4 weeks. 2) *ASD control group:* During the 4-week interval, 19 participants did not participate in any intervention except for their standard school curriculum. 3) *Typical control group:* For this group, 18 participants were recruited. Using the British Picture Vocabulary Scale (BPVS), researchers matched the three groups for sex, age, and verbal ability (Dunn, Whetton, & Burley, 1997).

At Time 1, there were significant differences between groups on the emotional vocabulary task and on the three Situation-Expression Matching tasks.

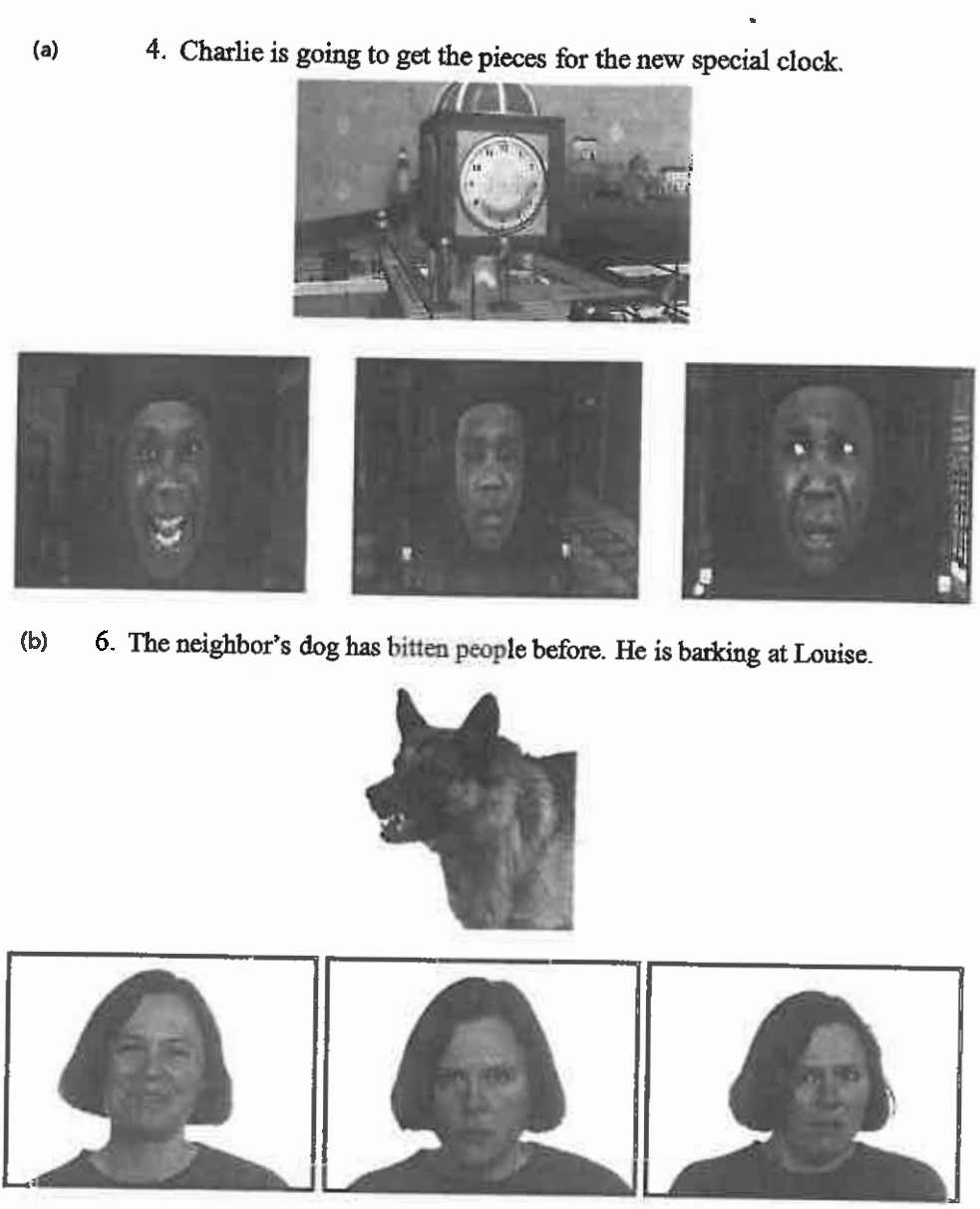

Figure 9.3. Examples of questions from two of the three emotion recognition task levels. (a) Level 1 task: Match familiar scenes from the series with familiar faces. (b) Level 3 task: Match novel scenes and faces using real human faces. (From Baron-Cohen, S., Golan, O., & Ashwin, E. [2009]. Can emotion recognition be taught to children with autism spectrum conditions? *Proceedings of the Royal Society, Series B* [Special issue], 364, 3567–3574.)

These differences were due to the significantly higher scores of the typical controls on all tasks compared to the two clinical groups, which did not differ from each other. Analysis of results after Time 2 testing revealed significant Time × Group interactions, with the ASD intervention group showing statistically significant improvement across all task levels between Time 1 and Time 2. Furthermore, this improvement was comparable to levels of performance found in the typical control group. In contrast, the ASD and typical control groups showed no statistically

significant improvement on any of the tasks between test sessions. These effects are illustrated in Figure 9.4.

The study we have reviewed (reported in detail in Golan et al., 2010) investigated the effectiveness of individual use of *The Transporters* animated series (with parental support) over a 4-week period. The results show that use of the DVD led children with ASD to improve significantly in their emotion comprehension and recognition skills on tasks including the emotions presented by *The Transporters*:

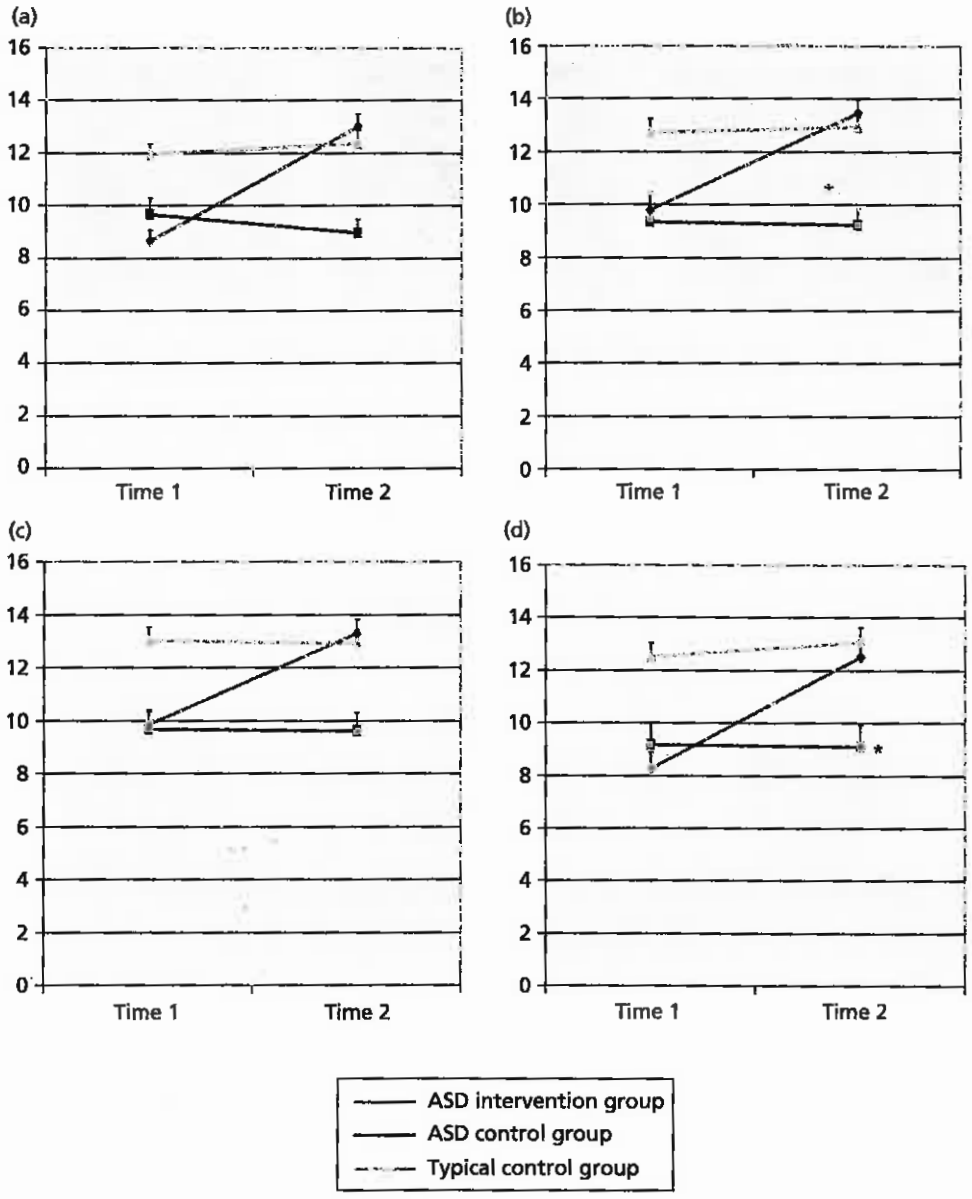

Figure 9.4. Graphs to show mean scores (with standard error bars) for each group on the four tasks. (a) Situation-Expression Matching task—Level 1. (b) Situation-Expression Matching task—Level 2. (c) Situation-Expression Matching task—Level 3. (d) Emotional Vocabulary task. * $p < 0.001$.

from the same level of ability seen with the ASD control group at Time 1, to a level that was indistinguishable from the typically developing group at Time 2.

The improvement of the intervention group was not limited to tasks that required close generalization; these participants were also able to generalize their knowledge to perform at the level of typical controls on the distant generalization task, which required emotion recognition from naturalistic clips of human characters that were not attached to vehicles. *The Transporters* may have facilitated generalization because the series was designed using intrinsically motivating media, such that the children enjoyed watching the vehicles while learning about emotions from real faces grafted onto them (incidental rather than explicit learning). *The Transporters* used characters and an environment that appeal to a preference for order, systems, and predictability that is characteristic of ASD. Anecdotal evidence from the parents of the intervention group suggests that their children became more willing to discuss emotions and became more interested in facial expressions. Parents also noticed a change in their children's behavior and in their ability to interact with others. Such anecdotal changes need formal evaluation.

We expect that the integration of *The Transporters* with other educational or therapeutic methods for children with ASD may improve its effect even further. We conclude that the use of systemizing as an intrinsically motivating method for learning about empathy allows affective information, which would otherwise be confusing, to become more intelligible and appealing to the autistic mind.

CONCLUSIONS

If *The Transporters* is having such a positive effect on the learnability of emotional expressions by children with ASD, might there be other ways to harness the same preference for systemizing in the teaching of emotions to these children? Clearly, vehicles are not the only kind of systems that children with ASD enjoy; others include robots (Dautenhahn & Werry, 2004) or rules (Hadwin, Baron-Cohen, Howlin, & Hill, 1996). We see such interventions as part of an adaptation of the mainstream environment to be more suited to people with ASD, and such environmental adaptations need not be restricted to the teaching of emotions. We conclude that a little empathy on the part of designers of educational resources may therefore facilitate the development of empathy in children with ASD.

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