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Online supplement

Appendix

List of theory of mind scenarios included in the scanner task

Film scenes	Film clip 1	Film clip 2	Film clip 3
Scene 1 Standing in line	Mrs Hauser goes into the post office. Although there are people cuing, she hurries to the front of the line.	The other people are upset and tell Mrs Hauser that they are waiting too.	Mrs Hauser explains desperately that her sick child is waiting for her in the car. The other people still urge her to go to the end of the line.
Scene 2 Vegetarian dinner	Lisa has been invited for dinner at her friend's house and now looks forward to the meal.	Lisa takes a bite but then stops chewing disgusted. She asks her friend if the dish contains meat.	Lisa's friend asks apologetically whether Lisa does not eat any meat. Lisa is upset and replies that she expects her friend to know that she is a vegetarian.
Scene 3 Meeting a friend	Mr Martin is doing his weekly shopping when an old friend comes along. He asks her how she is doing.	His friend tells him that she has not been happy recently because her marriage is not going well.	Mr Martin seems shocked and says that he is very sorry to hear that. His friend replies that she does not think the relationship will last.
Scene 4 Dating	Ana waits for her boyfriend in the park.	Ana cannot see that her boyfriend is trying to play a trick on her: he sneaks up behind Ana and scares her with a loud noise. Ana gets very frightened.	Ana then turns around. When she realises that it is her boyfriend she looks relieved.
Scene 5 Waiting room	Mrs Meier reads a book in the waiting room. A man walks in and takes the seat next to her.	The man also reads something and starts laughing loudly. Mrs Meier feels disturbed and turns away from him.	The man continues laughing without noticing that Mrs Meier feels disturbed. In the end she gets angry at him.
Scene 6 Language exam	Helga is upset because she did not receive a high score in her exam. She shows her exam to a friend.	Helga's friend makes fun of her bad result.	Helga gets very angry with her friend.
Scene 7 Job interview	Kurt waits anxiously for his girlfriend, who is having a job interview.	His girlfriend arrives and looks disappointed. Kurt is worried and asks her whether the job interview did not go well.	Kurt's girlfriend starts smiling and tells him that she actually got the job.
Scene 8 Final exam	Dina is excited because she and her friend just received the results of their final exam. Her friend looks worried.	Dina opens the folder and finds out that she passed all her exams and is very happy about it.	Dinah then looks at her friend who has found out that he did not pass, which he is very disappointed about.

Fig. DS1 Arena of Emotions indirect task: example screen of one task item.

Each video item was preceded by a short written introduction, describing the context and setting of the interaction (here: a couple having breakfast, boyfriend is often jealous). After watching the first film scene (here: girlfriend finds out that her ex-boyfriend won the lottery, boyfriend reacts jealously, see upper left image), participants were asked to watch the four film scenes below and pick the best-suited option as to how the scene might continue.

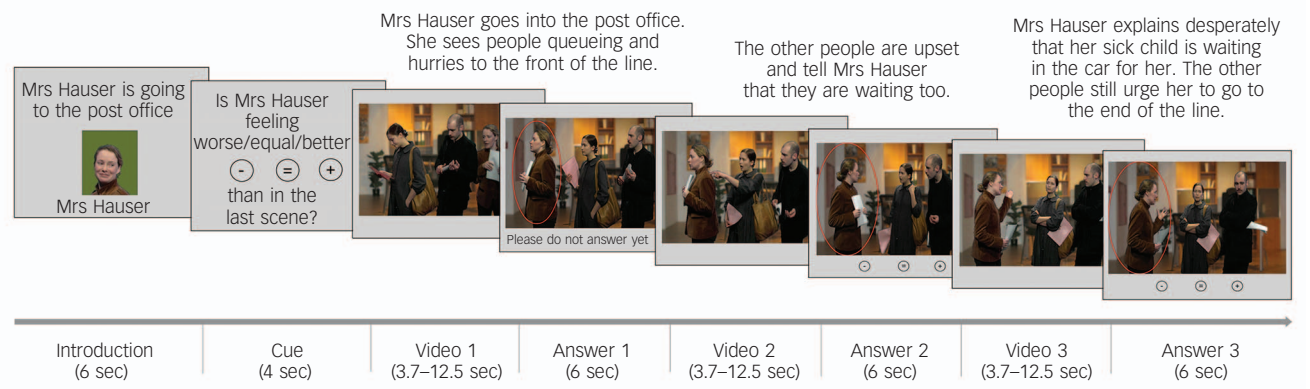

Fig. DS2 Theory of mind (ToM) paradigm: example of a ToM block.

In ToM blocks, participants judged clip-by-clip changes in the affective states of the protagonists. Participants first saw an introduction comprising the setting of the social scene and presenting the main protagonist. The following cue indicated the type of condition (ToM or physical inference). In ToM blocks, participants subsequently watched three consecutive film clips (i.e. video phases). After the first video phase participants did not have to make a judgement in the following answer phase. In the second and third answer phases, participants were asked to judge changes in affective state of the main protagonist between two consecutive video phases with a button press. Specifically, they were asked to indicate whether the main protagonist felt worse, equally well or better than in the previous film clip.

Behavioral data analysis

Composite measure: accuracy corrected reaction times

We computed a composite measure combining task accuracy and reaction time information for correct trials (crt). This composite measure was calculated by dividing response times by the fraction of trials answered correctly (accuracy). Such a combinational measure of reaction time and number of correct responses is considered to account for compensatory strategies (e.g. speed–accuracy trade-off), thereby representing a more sensitive measure of task performance.[33,48] We did not find differences between group ($F = 1.542$, $P = 0.222$) or condition ($F = 0.588$, $P = 0.448$) and no significant interaction of group and condition ($F = 0.514$, $P = 0.478$) suggesting that the conditions were similarly difficult across participants.

Region of interest eye-tracking analysis

For each actor in each video, two ROIs were defined: a rectangular ROI encompassing the head (including the upper part of the neck) and a rectangular ROI encompassing the body (including the lower part of the neck and typically ending with the lower edge of the video frame). Since the videos were dynamic, the ROIs had dynamic coordinates. The ROIs were defined by selecting head and body of the respective persons on key frames (not necessarily consecutive frames) of the video using a custom-built Matlab tool. The coordinates of the ROIs in-between key frames were linearly interpolated and the resulting videos (with rectangular ROIs visualised on each frame) were then inspected visually and corrected if necessary by introducing additional key frames mostly in periods of high motion. Care was taken to ensure that the rectangular ROIs always included the entire visible feature (head or body) and a margin around the respective feature without exceeding the video frame or overlapping with other scene features. Another virtual ROI was further used to count all valid gaze points. Due to the fact that the video scenes were filmed as medium shots, filmed from a medium distance to capture two or three actors at the same time, we were not able to define separable eye and mouth ROIs for a more fine-grained analysis.

The subsample of ASD participants with valid data ($n = 9$) included in this analysis did not differ from the control group ($n = 18$) in visual attention to the heads ($t = 0.112$, $P = 0.912$). Because of the substantial difference in sample size between groups, our results represent preliminary evidence for a similar amount of visual attention to dynamic social stimuli in individuals with ASD and healthy controls and need to be confirmed by future studies comparing a larger sample of individuals with ASD to matched healthy controls.

Additional reference

48 Sucksmith E, Allison C, Baron-Cohen S, Chakrabarti B, Hoekstra RA. Empathy and emotion recognition in people with autism, first-degree relatives, and controls. *Neuropsychologia* 2013; **51**: 98–105.