The Capacity For Implicit Social Learning In Relation To Autistic Traits

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Abstract

People learn social cue-outcome relationships and use this knowledge to guide their behavior, even in the absence of explicit knowledge of social contingencies. The aim of the current study was to investigate variations in implicit social learning abilities between typically developed individuals with low and high number of autistic traits, as assessed by the AQ questionnaire. In the learning phase, participants repeatedly observed two different identities whose gaze direction and facial expression were manipulated to convey either a pro- or anti-social disposition toward the observer. These dispositions were determined by specific contingencies between these cues. Crucially, the participants were not aware of these contingencies (as confirmed in the debrief session). In the test phase, the participants showed specific biases in their perceptual report of morphs of the two identities, which reflected that they had implicitly learned the identities' dispositions. The results indicated that in the current paradigm others' dispositions can be learned implicitly (i.e. without awareness of the cue contingencies), and that this ability is correlated with AQ scores; participants with higher AQ scores showed less implicit social learning than those with lower AQ scores.

Keywords: Implicit learning; Autism spectrum disorder; Intuition; Social cognition; Emotional facial expression.

Introduction

People exchange large numbers of nonverbal cues, which are typically interpreted in a seemingly effortless manner. The ability to encode and decode social information is crucial to successfully navigate the social world. This social competence seems to be employed automatically and involuntarily; people have a tendency to attribute dispositional causes to non-verbal behavior in order to obtain a quick impression of other's thoughts and feelings, rather than using effortful cognitive processes and deliberate reasoning.

Implicit (social) learning is widely assumed to play a central role in social cognition and is regarded as a cognitive substrate of social intuition (Lieberman, 2000). According to Lieberman, social intuition involves making rapid judgments about the emotions, intentions or attitudes of others on the basis of learned sequences of nonverbal cues, such as subtle facial expressions and bodily gestures. People learn social cue-outcome relationships and use this knowledge to guide their behavior, even in the absence of explicit knowledge of social contingencies (Lewicki, Hill, Czyzewska, 1992). Social cues may implicitly acquire value on a short timescale, sometimes within the space of a single interaction (Heerey & Velani, 2010).

Given the importance of social intuition, an impaired ability to implicitly encode and decode social cues might result in difficulty adjusting behavior to the demands of social situations. Indeed, such an impairment has been proposed to be a crucial factor underlying the social deficiencies in autism spectrum disorders (ASD; Frith & Frith, 1999). ASD is characterized by deficits in social interaction and social communication, including nonverbal communicative behaviors. As a result, individuals with ASD are likely to misinterpret social cues and engage in socially inappropriate behavior. It has been argued that the social impairments in ASD are linked to an impaired theory of mind; the ability to understand others as intentional agents, that is, to interpret their minds in terms of intentional states such as desires and beliefs (Baron-Cohen, 2000). There are indications that social deficits seen in individuals with ASD are especially related to failure in automation of social cue processing rather than in the ability to understand intentions per se (Jellema et al., 2009; Senju, Southgate, White & Frith, 2009). This may be compensated for through deliberate reasoning about others' intentions. However, the interpretation of social cues using effortful cognitive processes would be much slower and possibly less accurate than in involuntary processing.

Nevertheless, a recent meta-analysis looking at implicit learning in individuals with ASD did not find any anomalies on a number of implicit learning tasks (Foti et al., 2014). However, the reported studies examined implicit learning in non-social domains, with tasks such as artificial grammar learning, serial reaction task or contextual cueing. There is an emerging body of research suggesting that implicit learning is not a global impairment, but rather may be found either intact or impaired depending on the type of the information to be learned (Travers et al., 2013).

The autism spectrum condition could be considered as a scale of social aptitude with autistic traits found throughout the population to differing degrees, with clinical levels of autism at the high end of this continuum (Constantino & Todd, 2003). The Autistic-spectrum Quotient (AQ) questionnaire is one of the measures that has been developed to gauge autistic traits in the population at large (Baron-Cohen et al., 2001). It is a self-report questionnaire with a maximum score of 50, where a score of 32 or higher may meet the diagnostic criteria for ASD (Baron-Cohen et al., 2001). Although not currently used as a diagnostic tool, the questionnaire has been found to be a sustainable indicator of ASD with 83% of accuracy (Woodbury-Smith, Robinson, Wheelwright, & Baron-Cohen, 2005). As typically developed individuals with relatively high levels of autistic traits are likely to share some social and cognitive deficits with individuals with ASD, it should be possible to test typically developed individuals with varying AQ scores to enhance our understanding of ASD (Hudson, Nijboer, & Jellema, 2012).

Current Study

The aim of the current study was to investigate whether implicit social learning would take place in a simple computer-based task, and whether there are variations in implicit social learning abilities in typically developed individuals that vary in autistic traits (AQ). It was hypothesized that higher AQ scores would be correlated with poorer implicit social learning. In the current study, two types of nonverbal social cues were manipulated to affect social judgments: emotional expression and gaze direction. Participants were hypothesized to implicitly learn the agent's disposition toward them on the basis of specific combinations of these two cues. The experiment consisted of an initial learning phase, followed by a test phase, in which the extent of learning was measured.

Methods

Participants

Fifty-one undergraduate students (20 women) from the University of Hull participated in the experiment in exchange for course credit. All participants provided written informed consent prior to the experiment. After exclusion of one participant (see below) the mean age of participants was 21.3 (SD=2.77).

Stimuli

Stimuli were created using Poser 7 animation software (Curious Labs, Inc., Santa Cruz, CA, & e frontier, Inc., Scotts Valley, CA). Two male identities were used named James and Simon. The characters were oriented facing the observer throughout the presentation and were depicted from the top of the shoulders upwards. The stimuli were presented on a 21 inch monitor (100 Hz refresh rate) using e-Prime software (Psychology Software Tools, Inc., Sharpsburg, PA), at a distance of approximately 50cm from the participant.

Procedure

Learning Phase The learning phase used in the current study was broadly consistent with the learning phase of the experiment conducted by Hudson et al. (2012). Participants viewed 64 clips of two different identities, 32 for each identity. Each clip consisted of 20 frames, the first and last frame were displayed for 750 ms and the other 18 frames for 30 ms each. Two facial features were manipulated: gaze direction and facial expression. Each clip started with the gaze either directed towards the participant (direct gaze direction) and then gradually averted horizontally until at a 30º angle away from the observer at the end of the clip (indirect gaze direction), or began with a 30º aversion and ended with direct gaze direction (the clip played backwards). To manipulate facial expressions, the clip began either with an identity displaying a happy expression, which gradually morphed into an angry expression, or began with an angry expression which morphed into a happy expression (clip played backwards).

Crucially, each identity portrayed a different combination of gaze direction and emotional expression, such that each could be said to have a different disposition toward the observer (Figure 1). For identity A, gaze averting away from the observer was accompanied by a change from a happy to an angry expression, while gaze movement towards the observer was accompanied by a change from angry to happy (played backward). This identity can therefore be inferred to hold a pro-social disposition toward the observer; smiling when looking at the person and frowning when looking away. For identity B, the reverse cue combinations were used and this identity can therefore be inferred to hold an antisocial disposition toward the observer.

Each identity displayed happy and angry expressions for exactly the same amount of time and looked at and away from the observer for exactly the same amount of time. This was to ensure that a social disposition could only be learnt on the basis of the specific combination of two cues; each cue on itself could not cause any social learning effects. The social disposition of the character used in the study was counterbalanced across participants; for half of the participants James was holding a pro-social disposition while Simon was holding an anti-social disposition (Experiment 1), while for the other half Simon was the pro-social and James the anti-social identity (Experiment 2).

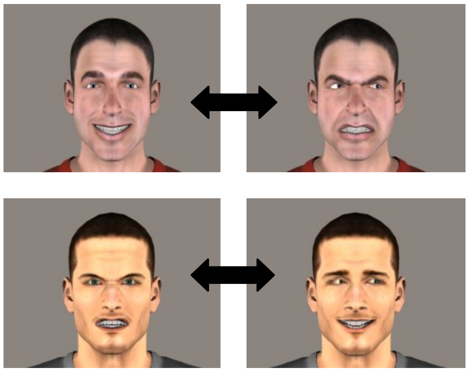

Figure 1: Pro-social and anti-social dispositions of the two identities in the learning phase of Experiment 2 (upper panels: Simon, bottom panels: James).

Debriefing Phase Directly following the learning phase, participants were required to give verbal responses to a series of questions checking whether they had picked up the cue-identity contingencies. The questions were: (1) Could you describe what you just have seen? (2) How many different identities did you see? (3) What can you tell me about their facial expressions? (4) What can you tell me about their gaze direction? (5) Did you detect certain patterns between facial expressions, gaze directions and identities? Answers were manually recorded.

Testing Phase In the testing phase, a morph of the two identities was presented in the centre of the screen, with the faces of James and Simon displaying neutral expressions on either side of the morphed identity (Figure 2). The morphed identity was either smiling or frowning, and was composed of different proportions of either, the smiling James and the smiling Simon or the frowning James and the frowning Simon. Five morph levels (proportions) were used: M1 = 60% pro-social and 40% anti-social, M2 = 55% pro-social and 45% anti-social, M3 = 50% pro-social and 50% anti-social, M4 = 45% pro-social and 55% anti-social, M5 = 40% pro-social and 60% anti-social. There were in total 20 test trials (5 morph levels x 2 emotions x 2 repetitions). Participants were required to select whether the morphed identity resembled more closely the pro-social identity (key 1) or the anti-social identity (key 2) The rationale was that when participants would have implicitly learned that identity A had a pro-social disposition and identity B an anti-social disposition toward them, then they would be more likely to judge the smiling morph as more similar to identity A, and the frowning morph as more similar to identity B, because intuitively identity A would be associated with a 'positive' and identity B with 'negative' attitude.

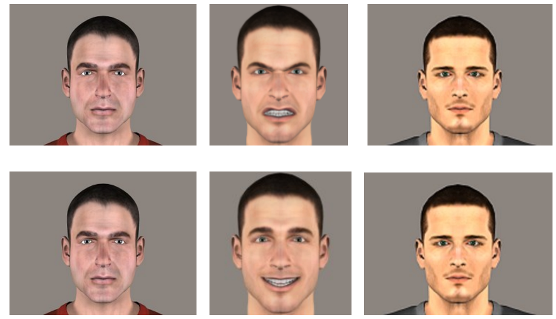

Figure 2: Two test trials are shown (top row and bottom row). The central panels show morphs consisting of 50% Simon and 50% James (M3), for angry (top) and happy (bottom) facial expressions. The morphs were flanked by James and Simon displaying neutral expressions, labeled as 1 and 2.

AQ Questionnaire At the end of the experiment, participants completed an online version of the AQ (Baron-Cohen et al., 2001).

Results

The debriefing phase indicated that one participant had discovered the cue-identity contingency and his data was removed from the analysis.

The dependent variable consisted of mean scores on the five levels of morphs used in the test phase. A score of 1 indicated that participants believed the morph resembled the pro-social identity more than the anti-social identity, while a score of 2 indicated that participants believed the morph resembled the anti-social identity more than the pro-social one.

Two separate experiments were conducted on two participant groups, none of the participants participated in both experiments. In Experiment 1, James had the pro-social disposition and Simon the anti-social disposition; in Experiment 2 the dispositions were reversed. The data from both experiments was analyzed using a 2x5x2 repeated measures ANOVA with Morph Facial Expression (happy, angry) and Morph Level (M1, M2, M3, M4, M5) as within-subject factors and Experiment (Exp1, Exp2) as between-subjects factor.

The main effect of the factor Morph Facial Expression was significant ($F_{1,48} = 6.7$, $p = .013$, $\eta p2 = .12$), with higher scores for the angry morph than for the happy morph. This indicated that implicit learning had taken place. The Morph Facial Expression x Experiment interaction was non-significant ($F_{1,48} = .30$, $p = .59$, $\eta p2 = .006$). The main effect of Morph Level was significant ($F_{4,192} = 33.4$, $p < .001$, $\eta p2 = .41$), indicating that participants were sensitive to the different morph proportions. The main effect of Experiment was non-significant ($F_{1,48} = 3.28$, $p = .076$, $\eta p2 = .064$). The remaining 2-way interactions, and the 3-way interaction, were all non-significant (all p's > .16) (Figure 3, top panel).

The mean AQ score was 15.5 (SD = 5.6), ranging from 5 to 32. A correlation analysis for the mean difference score [mean score for Happy Morph across the 5 morph proportions minus mean score for Angry Morph across the 5 morph proportions] and the individual AQ scores revealed a significant negative correlation ($r = -.287$, $p = .043$), reflecting that an increase in the level of autistic traits corresponded with a decrease in the extent of implicit social learning.

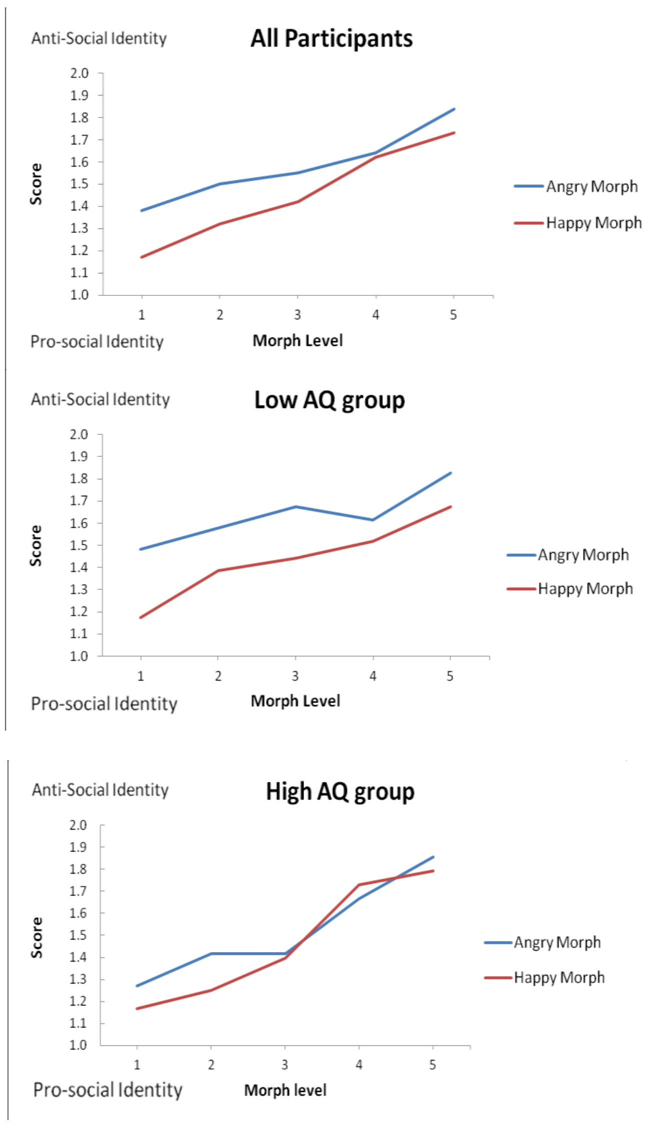

Figure 3: The mean scores for all participants in the two experiments are shown (top panel). For illustrative purposes, based on their scores on the AQ questionnaire, half of participants were allocated to a low AQ group (middle panel, M=11.5, SD=2.04) and the other half to a high AQ group (bottom panel, M=19.79, SD=4.90).

Discussion

The main finding was that in the current paradigm typically developed individuals were capable of implicit social learning. It suggests that the pro- or anti-social dispositions of another individual can be implicitly understood on the basis of specific social cue combinations conveyed in a social encounter, without one being aware of the contingencies. The implicitly learned dispositions may serve as useful predictors of an individual's future behaviour, affecting one's subsequent responses to that individual. A second important finding was that this effect is influenced by individual differences in autistic traits. Those with less autistic traits (low AQ score) implicitly learned the social dispositions better than those with more autistic traits (high AQ score). Presumably, those with lower AQ scores are better in 'picking up' the meaning of social contingencies.

It is tempting to speculate about the implications of the current findings for individuals with ASD. In line with the theory of an autism spectrum continuum (Baron-Cohen et al. 2001), extrapolation of the results of the high AQ group to individuals with ASD would suggest more severe deficits in the implicit social learning ability in ASD, which might underpin core deficits in social understanding in ASD.

According to a recent account, sensitivity to social signals such as direct eye gaze is essential for learning through social interaction (Sodian, Schuwerk & Kristen, 2015). Impaired processing of social cues in ASD could explain insufficient learning from others and the same may be expected of those with high AQ scores.

However, it is not quite clear whether individuals with high AQ scores are less receptive to social cues per se, or whether they are equally receptive, but have a diminished ability to learn associations between emotions and specific individuals. Face identity processing has been found to be impaired in people with ASD for tasks that require face memory (Weigelt, Koldewyn & Kanwisher, 2012). This deficit is much stronger when a delay intervenes between two presentations of an identity. However, in the current study the morphs in the testing phase were presented simultaneously with the faces of both identities, which should have reduced memory demand for this particular task.

It is important to note that the task employed in this study is a simple computer task, which is only a human-artefact representation of a social interaction. While the under-complexity of the experimental design allows controlling for extraneous/confounding variables, the results of the current study need to be approached with caution when generalising to naturalistic settings.

There is also a possibility that the variations in implicit learning between individuals low and high in autistic traits may be due to low-level visual learning, rather than to a form of social learning. The face configuration of a happy morph involves eyes looking at the participant and a smiling mouth, which is a closer visual match to the happy pro-social face than the angry anti-social face, which has the eyes averted. Similarly, the angry morph is a closer visual match to the angry anti-social face. If the learning occurred on the basis of the closer matching of low-level features – eye and mouth configuration – it would indicate that individuals high in autistic traits show deficits in implicit learning that are not exclusive to the social domain. Subsequent studies, involving non-social stimuli, will investigate whether the lower propensity for implicit learning in the high AQ group is specific to the social domain and does not apply to non-social learning, or whether it is a more generalised impairment.

It is as yet unknown whether the deficits in implicit social learning in the high AQ group are specific to implicit social learning and does not apply to explicit social learning. The lack of automatic processing of social cues may be compensated for through deliberate reasoning about others' intentions. For example, Senju and colleagues (2009) found a striking dissociation between implicit and explicit theory of mind; while the performance of individuals with ASD on an implicit theory of mind task revealed intriguing difference from that of controls, they showed intact explicit theory of mind. As a result, one may expect intact explicit social learning in individuals with high AQ scores. However, the interpretation of social cues using effortful cognitive processes would be much slower and possibly less accurate than in involuntary processing, which may be the primary reason for difficulties in social interactions found in ASD. Future studies should contrast the ability for implicit and explicit learning in relation to AQ scores.

In summary, this study provided evidence that people are capable of learning contingencies between social cues and use this knowledge to guide their behavior, even in the absence of explicit knowledge. Furthermore, this effect is related to individual differences in autistic traits, with individuals low in autistic traits outperforming individuals high in autistic traits. If the present pattern of results would be more profound in an ASD sample, then that might help to explain their inefficiency in using social cue-outcome relationships to modulate their behavior.

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