



Original Articles

The influence of prior reputation and reciprocity on dynamic trust-building in adults with and without autism spectrum disorder



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ABSTRACT

The present study was designed to investigate the effects of reputational priors and direct reciprocity on the dynamics of trust building in adults with ($N = 17$) and without ($N = 25$) autism spectrum disorder (ASD) using a multi-round Trust Game (MTG). On each round, participants, who played as investors, were required to maximize their benefits by updating their prior expectations (the partner's positive or negative reputation), based on the partner's directed reciprocity, and adjusting their own investment decisions accordingly. Results showed that reputational priors strongly oriented the initial decision to trust, operationalized as the amount of investment the investor shares with the counterpart. However, while typically developed participants were mainly affected by the direct reciprocity, and rapidly adopted the optimal Tit-for-Tat strategy, participants with ASD continued to rely on reputational priors throughout the game, even when experience of the counterpart's actual behavior contradicted their prior-based expectations. In participants with ASD, the effect of the reputational prior never disappeared, and affected judgments of trustworthiness and reciprocity of the partner even after completion of the game. Moreover, the weight of prior reputation positively correlated with the severity of the ASD participant's social impairments while the reciprocity score negatively correlated with the severity of repetitive and stereotyped behaviors, as measured by the Autism Diagnostic Interview-Revised (ADI-R). In line with Bayesian theoretical accounts, the present findings indicate that individuals with ASD have difficulties encoding incoming social information and using it to revise and flexibly update prior social expectations, and that this deficit might severely hinder social learning and everyday life interactions.

1. Introduction

Trust is critical for initiating and maintaining cooperative behavior, especially in social interactions characterized by risk and uncertainty (Deutsch, 1958, 1960; Riegelsberger, Sasse, & McCarthy, 2005). Understanding the cognitive mechanisms underlying trust behavior and its disturbances is a relevant topic for research in social sciences, neuroeconomics, cognitive psychology and psychiatry. Autism spectrum disorder (ASD), a condition characterized by impairments in social interaction and communication, has often been associated with difficulties reading social information from faces and actions, including emotions, intentions, and trustworthiness traits.

1.1. Trust, reciprocity and reputation

Current research on trust has focused on the understanding of factors that signal trustworthiness and influence our decisions to cooperate, such as physical appearance, reciprocity, reputation or group membership (Boero, Bravo, Castellani, & Squazzoni, 2009; Delgado, Frank, & Phelps, 2005; Oosterhof & Todorov, 2008), while fewer studies have investigated how people use and integrate different cues of trustworthiness for decision making in a social interactive situation.

Although cooperation can produce high mutual payoffs, it involves putting at risk one's own resources, such as time, money, or health. Thus, interpersonal trust helps us to deal with the risk of defection, since we usually lack full information about the abilities and intentions of other agents. In probabilistic terms, considering another person as trustworthy means believing that the chance of him/her intending to

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act in a way that is beneficial to us is high enough to consider cooperation (Gambetta, 2000).

Direct reciprocity has been shown to be a key mechanism for creating trust and fostering human cooperation (Hoffman, Yoeli, & Nowak, 2015; King-Casas et al., 2005). In many instances of everyday life, e.g. when dealing with family members or colleagues, repeated exchanges with a partner serve as a reliable predictor of her/his trustworthiness. However, when trying out a new restaurant, going on a blind date, or dealing with an unknown merchant via e-commerce, we lack a shared history of past interactions (e.g., customer evaluations, reports on previous transactions). Reciprocity also works through reputation: it is an evolved social mechanism designed to foster cooperation in larger human groups and to regulate interactions in complex systems. Reputation is intrinsically associated with moral norms and values, and is a valid surrogate for the interaction-based personal experience. Research using trust games has found preference for partners with good reputations, that is, people are more prone to cooperate with those partners they have observed treating others generously than with those whom they have observed behaving selfishly (Wedekind & Milinski, 2000). Neuroimaging studies have revealed that reputation has a long lasting effect on the evaluation of a person's trustworthiness, as it diminishes the reliance on neurological feedback mechanisms of reward learning (Delgado et al., 2005; Fouragnan et al., 2013). Therefore, it is not surprising that many e-commerce ventures have established global market reputation systems to help their users interact when confronted with the uncertainty of anonymous counterparts over long distances (Nowak & Sigmund, 2005). Nonetheless, there is always the risk that the reputation does not reflect the partner's actual intentions, either because it is misleadingly used for spreading unfounded rumors and manipulating co-players, or because people do not always live up to their reputations as they interact with others. Hence, overall, "Tit-for-Tat" (TfT), based on reciprocation, remains the optimal behavioral strategy in repeated exchanges, as we should trust the partner only as long as she/he reciprocates, and stop reciprocating once our trust is betrayed (Axelrod, 1984). As these studies indicate, decision-making in ecological and complex social situations requires a set of cognitive functions that goes beyond the Theory of Mind (ToM), i.e. the ability to attribute beliefs and other mental states to others. Crucially, cooperation and the decision to trust others rely on the ability to integrate different types of social information and use them in a flexible and adaptive manner during ongoing exchanges.

1.2. Trust and moral evaluation in autism spectrum disorder

Impairments in social interaction and communication are core features of autism spectrum disorder (ASD) (American Psychiatry Association, 2000). Reduced trust and social reciprocity are also commonly reported in individuals with ASD (Volkmar & Klin, 2000), and associated with low levels of blood plasma oxytocin (Andari et al., 2010; Modahl et al., 1998). In a previous study, Adolphs, Sears, and Piven (2001) reported decreased responsiveness to facial cues of trustworthiness in adults with ASD during a cooperation task, while they showed preserved trustworthiness judgments on the basis of biographical stories depicting the person's lifestyle and activities. More recently, using a trust game, Ewing, Caulfield, Read, and Rhodes (2015) reported that, if explicitly prompted, children with autism, aged 6–12 years, were able to behave rationally, that is, in line with partner trustworthiness, when making investment decisions. However, when asked to evaluate trustworthiness from facial appearances, they failed to spontaneously use this information to modulate their decision in ecological contexts. Overall, these findings weaken the hypothesis of a general impairment in trust processing in individuals with ASD and support the notion that they might be unable to use trustworthiness cues from different sources of information in a consistent manner.

Diminished social cognition and behavior in people with ASD are generally described as a deficit in ToM (Baron-Cohen, 1995; Baron-

Cohen, Leslie, & Frith, 1985). Adults with high-functioning ASD, who exhibit relatively preserved explicit ToM, show difficulties in real-life situations that might reflect an inability to use information about others' intentions. As indicated by previous studies (Zalla & Leboyer, 2011), judgments of intentionality (i.e., whether an agent has acted intentionally or unintentionally) in adults with ASD may be preponderantly informed by moral evaluations of the situation rather than by intentional cues. Specifically, the intentionality judgment in adults with ASD is characterized by an overreliance on moral evaluation of the agent's blameworthy action merely based on the action outcomes (Buon et al., 2013; Zalla & Leboyer, 2011; Zalla, Sav, Stopin, Ahade, & Leboyer, 2009). Zalla, Barlassina, Buon, and Leboyer (2011) have suggested that social normative reasoning is preserved in individuals with ASD, and that their propensity to judge normative transgressions more seriously and inflexibly reflects a diminished sensitivity to the intentional properties of action, especially when rule violations bring about negative outcomes. As a result, based on these previous findings (Zalla & Leboyer, 2011; Zalla et al., 2009), one might expect that, while in typically developed individuals moral judgments and prior expectations are continuously updated by new incoming information about the agent's action, the enhanced sensitivity to negative and blameworthy outcomes biases decision-making in social interaction in participants with ASD.

1.3. A unified framework for characterizing dynamic trust-building

Recently, Bayesian models have offered a promising framework for the understanding of cognitive functioning in ASD, including abnormal social cognition, enhanced sensations, and sensory precision (Chambon, Farrer et al., 2017; Lawson, Rees, & Friston, 2014; Pellicano & Burr, 2012; Van de Cruys et al., 2014). The 'Hypo-Priors' hypothesis (Pellicano & Burr, 2012) suggests that sensory atypicalities and difficulties with social interaction in ASD can be explained by a diminished influence of top-down prior expectations, along with enhanced "bottom-up" functioning and increased reliance on sensory evidence. The Predictive Coding theory states that the prominent features of autism stem from the exuberant production of prediction errors (Lawson et al., 2014). According to this theory, cognition is modeled as a hierarchical organization in which expectations (*priors*), formulated at higher hierarchical levels, convey prediction to the lower levels of sensory signals where precision needs to be adequately attenuated. The discrepancy between these sources of information is known as 'prediction error'. Reduced adaptation to numerosity stimuli (Turi, Karaminis, Pellicano, & Burr, 2016), biological motion (van Boxtel, Dapretto, & Lu, 2016), objects (Skewes, Jegindø, & Gebauer, 2015), visual illusions (Palmer, Paton, Kirkovski, Enticott, & Hohwy, 2015) and faces (Ewing et al., 2015) have been presented as evidence for attenuated influence of priors in ASD.

In a recent study, Chambon, Farrer et al. (2017) have shown that diminished influence of prior knowledge about social intentions in adults with ASD might hinder the ability to predict individual intentions in the context of an iteratively interacting game, when direct sensory information is not available. While typically developed (TD) adults exhibited a strong initial preference for TfT cooperative intentions, over alternative (non-TfT) defecting intentions (Chambon, Domenech et al., 2017; Chambon, Farrer et al., 2017; Chambon et al., 2011), adults with ASD showed no initial preference for the TfT mode of reciprocation. Importantly, they progressively acquired a social bias through the extraction of observed regularities by means of a general probabilistic learning mechanism. Interestingly, attenuated social priors predicted the severity of clinical symptoms in the area of social interaction, while the magnitude of social learning inversely correlated with the severity of repetitive and stereotyped behaviors. These results have provided the first empirical evidence that a disturbance in the Bayesian inferential mechanism which integrates prior social knowledge and sensory information might disrupt action prediction and

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