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Original Article

CHEATER DETECTION IS PRESERVED IN AUTISM SPECTRUM DISORDERS

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Abstract: The human mind is designed to function in coordination with the social and non-social environment in which our species evolved. A specialized cheater detection mechanism allows humans to be one of a very few species who engage in delayed reciprocal altruism. This mechanism is designed to be vigilant for cheaters, but to allow for honest mistakes, since incorrectly excluding a social exchange partner would be costly. People with autism spectrum disorders (ASD) are widely believed to be unable to appreciate others intentions or to use intentions in their calculations, making it likely that those with ASD would not show a difference in cheater detection based on intentionality. We tested this prediction using Wason Selection Tasks (WST) that either described an act of cheating as intentional, or described a failure to fulfill a social exchange that was an honest mistake. For both those with ASD and for the control group, the honest mistake greatly depressed performance on the WST. Either those with ASD can detect intentionality only if it is relevant to cheater detection, or past research has failed to measure the preserved intentionality detection of those with ASD.

Key Words: Cheater detection, autism, Wason selection task, intention, reciprocal altruism

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Introduction

The human mind is designed to be exquisitely coordinated with the environment in which our species evolved. Selection pressures from both the physical and the social environment have shaped the design of the mind. There is strong evidence that part of the human cognitive endowment is a cheater detection mechanism, without which delayed reciprocity would not be possible. Delayed reciprocity is rare across species since it is inherently risky: one individual has to incur a cost, with no guarantee that the expected benefit will materialize. Humans, and a very few other species, can benefit from delayed reciprocity because they can identify and remember individuals, detect violations of social contracts, and exclude cheating individuals from future encounters (Cosmides, 1989). By design, the cheater detection takes specific inputs in order for it to engage in the computation for which it was designed.

Evidence offered in support of the idea that humans have a cheater detection mechanism (Cosmides, 1989; Fiddick, 1998; Gigerenzer & Hug, 1992) has generally used the Wason Selection Task (Wason, 1966). In this task, participants are presented with a social exchange scenario that includes a conditional statement rule in the form of 'If P then Q'. Then the participants are asked to identify necessary information from an array of four choices in order to test for a violation of the rule. The scenarios in the Wason Selection Tasks that have been used in cheater detection research have prototypically involved a social contract that is agreed upon by both parties, a potential benefit to cheating, and an intentional, not accidental, act in any violation of the rule. Manipulating details of the scenario may affect whether or not the cheater detection mechanism is engaged. For example, performance increases when the content of the social exchange cues the participant to think of themselves as higher or equal ranking in social status compared to scenarios in which participants are cued to think of themselves as lower in status (Cummins, 1999). Additionally, in order to engage the cheater detection mechanism, participants must be cued to the perspective of a party that can be cheated (Gigerenzer et al., 1992).

Knowing that the actor who has failed to fulfill the social contract has acted unintentionally may mitigate the need to exclude him or her from future interactions. Reliable social exchange partners are valuable in human societies, and excluding a social exchange partner unnecessarily would be a costly mistake. Excluding someone who has acted as a cheater is beneficial, because the act of cheating predicts future acts of cheating. An honest mistake is less predictive. The adaptive problem is this: one must exclude cheaters, because the potential cost of being exploited is high, but one must not exclude those who err honestly, because a good trade partner is hard to come by. Indeed, there is some evidence that the cheater detection mechanism may not be fully activated given a WST scenario in which an innocent mistake leads to an unfulfilled contract (Fiddick, 1998).

The stimuli, in this case the scenario in the Wason Selection Task, may engage the cheater detection mechanism or not. In this study, we created a test of whether the cheater detection mechanism makes a distinction between intentional

cheating and unintentional "honest mistakes." Although an ideal design for this cognitive mechanism would be to exclude the honest from the wrath of the cheater detection mechanism, evolution has not always found the ideal design. (For example the mammalian retina is installed backwards). This study was designed to test whether the cheater detection mechanism treats violations of a social contract that are intentional as different from those violations that are honest mistakes.

Autism Spectrum Disorders

It is reasonable to suspect that the cheater detection mechanism might operate differently in those with autism spectrum disorders (ASD), especially with respect to sensitivity to intentionality. Autism is a developmental disorder characterized by three main clusters of symptoms, 1) impairment in social interaction 2) impairment in communication 3) ritualized behaviour or unusual adherence to routines (American Psychiatric Association, 1994). Critically, ASD is characterized by a lack of appreciation for others' mental states and intentions (Baron-Cohen, Leslie, & Frith, 1985; Baron-Cohen, 1995). Beaumont and Newcombe (2006) presented several tasks to participants with ASD that required an inference of mental states or intention. In one task, the participants were presented with narrative commercial advertisements and were asked about mental states of characters in those scenarios. Another task concerned reading the mind of someone based on his or her eye gazes. The results of these studies indicate that individuals with ASD have difficulty in perceiving intention and belief. We know, however, that some types of social cognition are preserved in autism. For example, those children developing with ASD may not have social cognitive deficits in relationship recognition, interpersonal reciprocity, and understanding of the animate-inanimate distinction (Baron-Cohen, 1991) and there is evidence of attachment in children with autism (Capps, Sigman, & Mundy, 1994).

The deficit of detecting intention in individuals with ASD appears to be fairly specific. Individuals with ASD are able to detect the wants and desires of another, as well as physical causality of objects and people, but are not able to detect a person's intentions (Baron-Cohen, 1995). If a person with ASD is unable to appreciate whether a character in a story has acted intentionally or mistakenly, then this factor would not be expected to affect performance on a Wason Selection Task. Given that other forms of social cognition are preserved in ASD, is possible that the cheater detection mechanism is so fundamental that it is preserved even in this disorder. If so, this would be further evidence for the modularity of the cheater detection mechanism.

The current study

The purpose of this study is to compare the performance of typically developing individuals to individuals with ASD in performance on "cheater detection" versions of the Wason Selection Task, and to compare how manipulating the apparent intention of the actor in the WST scenario affects

performance in each group. In this study, participants were given scenarios involving one of two conditions: stories about intentional cheaters and stories about those who made honest mistakes. Each task is presented such that the logical structure of the passage, the logical structure of the conditional social contract rule, and the logical conclusion to the correct answers remains the same despite changes in the intentional content. This experiment is designed to investigate the relative performance of the cheater and honest conditions between people with ASD and typical controls.

Methods

Participants

Forty adult males participated in the study. There were 20 adults with autism spectrum disorders and 20 typical control adults. The two groups were matched for sex, age, Verbal IQ, Performance IQ and Full Scale IQ, assessed using the Wechsler Adult Intelligence Scale. See Table 1 for demographic details of the groups. The ASD participants were high functioning adult males who had previously received clinical diagnoses of autism or Asperger Syndrome before entering the study, and one of the authors (MDR) confirmed their diagnoses via the Autism Diagnostic Observation Schedule (ADOS-G). The ADOS-G is a semi-structured assessment in which an experimenter interacts with a participant, leading the individual through conversation, creative activities and descriptions of books and pictures, designed to allow the experimenter to assess social and communicative skills. The ADOS is currently the diagnostic standard in autism spectrum research (Lord et al., 2000) . They were free from other known medical and psychological conditions. Participants in the control group were recruited from the community (and not on a university campus) through newspaper advertisements. Participants in both groups were financially compensated for their time.

Table 1: Chronological age and WAIS IQ scores for the ASD and control groups

	ASD (n=20)	Control group (n=20)	t
Age	29.08 (9.59) 19-53	27.26 (7.1) 18-50	t(38) =0.64 n.s.
Verbal IQ	101.8 (14.42) 78-134	101.6 (11.61) 86-127	t(38) = 0.048 n.s.
Performance IQ	91.5 (13.1) 67-109	97.1 (16.7) 68-135	t(38) = 1.18 n.s.
Full Scale IQ	96.9	100.4	t(38) = .83

	(13.0) 75-121	(13.6) 81-135	n.s.

Materials

Each participant received an instruction page and a Wason Selection Task (WST) stapled together. The instruction page showed a sample Wason Selection Task with a rule that was not a social exchange scenario as an example. The test WST was on a separate page and had a rule that was bolded and isolated from the surrounding text (see the appendix for the full text of the four tasks). Each of four stories described a social exchange scenario with appropriate social contract rules involving a "Cheater" version or an "Honest Mistake" version. In the "Cheater" condition participants were asked to look for a violation of a rule in a situation where a character may have intentionally violated the rule. In the "Honest Mistake" version the participant was asked to look for a violation of a rule given a situation where a character may have accidentally and unknowingly violated the rule. Care was taken to make the two versions of each scenario identical, except for the specific sentences that had either intent to cheat or honest mistake cues. The design was between subject, such that each person either saw a "cheater condition" or an "honest condition" and only completed one WST, since priming is known to be unavoidable on this type of WST (Fiddick, 1998). The WSTs used here were modeled after those used by Clark Barrett (personal communication) and Cosmides (Cosmides, 1989).

In addition to the match between the ASD group and the control group, participants who received the Honest Mistake problems were matched to the participants who received the Cheater problems, for VIQ, PIQ and FSIQ, as detailed in Table 2. Within each group of 10 subjects, defined by diagnosis and condition, 5 received the story about the soldiers and 5 received the story about the dinner invitation.

Table 2: WAIS IQ scores for the ASD and control groups Compared across trial type

ASD Participants	Honest (n=10)	Cheater (n=10)	t
Verbal IQ	105.2 (14.51) 88-134	98.4 (14.23) 78-119	t(18) = 1.06 n.s.
Performance IQ	89.7 (13.15) 69-105	93.3 (13.5) 67-109	t(18) = .604 n.s.
Full Scale IQ	98 (14.13) 78-121	95.8 (12.4) 75-114	t(18) = .37 n.s.
Control	Honest	Cheater	

Participants	(n=10)	(n=10)	
Verbal IQ	101.6	101.6	t(38) =
	(12.48)	(11.34)	0.0
	86-125	89-127	n.s.
Performance IQ	98.7	95.5	t(38) =
	(18.44)	(15.58)	.419
	68-138	77-117	n.s.
Full Scale IQ	96.9	100.4	t(38) =
	(13.0)	(13.6)	.257
	75-121	81-135	n.s.

Procedure

Participants were met one at a time and completed the task with no time limit. After obtaining informed consent, the experimenter told them that they would read a story and be asked a question about that story. They were asked to read the instructions carefully. Participants were asked to pretend they really had to investigate the situation and determine if the information on the other side of the pictured cards must be shown in order to see if the rule presented in the question has been broken.

Results

Each Wason Selection Task was scored as correct if the participant indicated that the "P" card and the "not-Q" card needed to be turned over (i.e., the "Is at your dinner party" and "did not bring a food dish" cards, or the "Went to the concert" and "Did not work a shift at digging ditches" cards). Performance on the "Dinner" problem and the "Soldier" problem were indistinguishable, so the problem types were collapsed into just the "Cheater" and "Honest" conditions. A difference of difference of proportions test (Blalock, 1972) showed no group by condition interaction; the two groups performed similarly on the two types of tasks ($z = .0$, n.s.). There was a significant difference between performance on the "Cheater" condition, with overall 70% correct, and the "Honest Mistake" condition, with overall 40% correct ($z = 1.91$, $\Phi = .30$, $p = .03$).

For the control group alone 5 of the 10 participants got the "Honest Mistake" condition correct, and 8 out of 10 got the "Cheater" condition correct, and the difference between the two trial types approached significance ($z = 1.41$, $\Phi = .31$, $p = .08$). For the ASD group alone 3 of the 10 participants got the "Honest Mistake" condition correct, and 6 out of 10 got the "Cheater" condition correct. A difference of proportions test showed that the difference between the two trial types approached significance ($z = 1.35$, $\Phi = .30$, $p = .09$). Figure 1 shows these data.

Discussion and Conclusions

These findings are consistent with the idea that vigilance for cheaters is greater in scenarios in which the actor is described as behaving intentionally. Accuracy on cheater detection problems was better, by about 30%, in cases where a person may have violated a social contract intentionally, compared to cases where a person is said to have made an innocent mistake. Not only is this further evidence of that the cheater detection mechanism is a specialized mechanism, but it strongly suggests that this mechanism is designed to be activated by a very specific kind of input. Much like a cone in the retina is activated only by light of a specific wavelength, or an olfactory neuron is activated only by a molecule of a particular shape, the cheater detection mechanism is activated by the suggesting of a cheater, not by the suggesting of an honest mistake. The activation of the cheater detection mechanism is very content-specific.

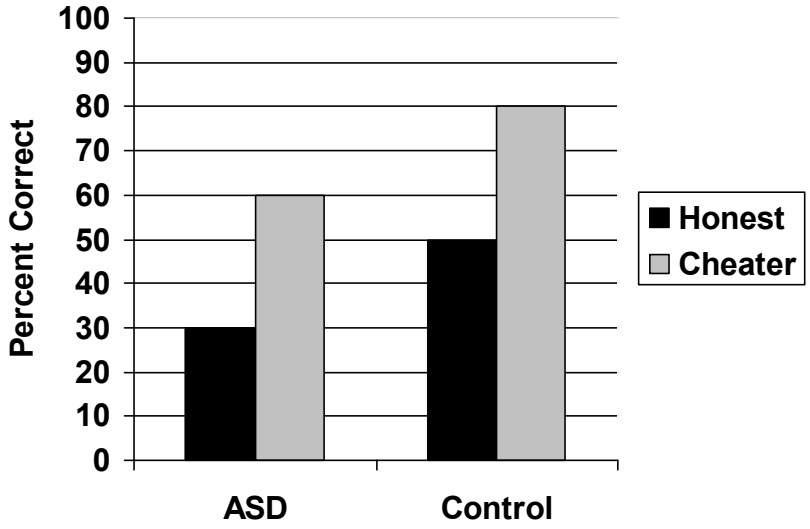

Figure 1. Proportion of subjects with and without autism spectrum disorders who answered a Cheater detection question correctly and an Honest Mistake question correctly.

Vigilance against cheaters is a signal-detection problem, and there is a cost of making errors in either direction. In order to engage in social exchange, one clearly needs to be able to identify cheaters and exclude them from future delayed reciprocity. Failing to do so would be a costly error. However, incorrectly classifying an ally as a cheater is also a costly error. Relationships are investments, and the loss of a social exchange partner is a high cost, one that one should not incur in error. For this reason, the cheater detection mechanism is designed such that it will not be activated by honest mistakes.

Our study is the first to our knowledge that has tested the Wason Selection Task using individuals with ASD and comparing their performance in this task to

that of typically developing people. There was no essential difference between performance in the ASD group and the control group with respect to intention. Although the performance was lower in the ASD group overall (despite the groups being very carefully matched on verbal IQ), there was the same 30% cost of describing the actor as making an honest mistake instead of cheating intentionally. The fact that there was an effect of intention in the control group is striking. It is not a surprise that this group can detect cheaters, since individuals with ASD can and do learn 'if-then' conditional statements and can understand what it means to abide by these social rules (Krasny, Williams, Provencal, & Ozonoff, 2003). What is surprising is the affect of intentionality on performance.

A failure to understand and appreciate the intentions of others is widely believed to be a universal characteristic of autism (Baron-Cohen, 1989; Baron-Cohen et al., 1985; Baron-Cohen, 1995; Baron-Cohen, Leslie, & Frith, 1986), so the fact that a brief verbal description of intentionality in a written scenario affects performance on a logic problem so dramatically in this group is a surprise. There are a few possible explanations for this discrepancy. First, it is possible that the cheater detection mechanism has its own intentionality detection component dedicated for use in cheater detection, and not accessible to other processes. The brain does, for some purposes, have redundant processes, so this possibility, though costly, is not outlandish. A second, more parsimonious possibility is that this method has measured intact intentionality detection in those with ASD where other methods have failed to do so. It is possible that past research that has either employed line drawings or required explicit communication about others' intentions has not been able to measures what performance on the Wason Selection Task has been able to measure. It has long been assumed that performance on deontic problems of the Wason Selection Task have relied on automatic processing that may defy explicit descriptions on the part of the subject. If this weren't the case, it would be hard to explain dramatic differences in performance on what is essentially the same logic problem, in terms of formal logic. Finally, it is possible that the Wason SelectionTask format, which differs considerably from real-time social interaction, telegraphs the intention, making it easy for those with ASD to make use of. Although the experimental design was between-subject, it is possible that participants with ASD were given information about intentionality in just the format they needed, and that this use of intentionality does not correspond with an ability to detect this information in real social situations. Indeed, it has been suggested that high functioning people with Aspergers may perform typically on "theory of mind" tests, although their ability to perceive and use theory of mind information is not evident in casual social interactions (Ozonoff, Rogers, & Pennington, 1991). Further research is necessary in order to appreciate what the current evidence of intentionality use means. Do people with autism spectrum disorders detect and use intentionality in some real-time social situations, or do they only show evidence of intentionality detection in artificial situations where alternative, more explicit strategies are available in lieu of typical intentionality detection?

The human mind is designed to have an exquisite coordination with the environment, including both the physical and the social environment. The cheater

detection mechanism is a specialized mechanism that takes a very specialized input in a specific format. The past several years have seen more and more discussion about specialized computational mechanisms and specialized learning mechanisms that make up the human mind, but our understanding has only begun to scratch the surface. Each mechanism is so specialized to solve a specific problem and to interface with the environment in such a specific way, that each mechanism will have to be characterized in detail individually.

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Appendix A

These four WST's were used in this study. There is a Cheater and an Innocent Mistake version of the "Dinner Party" story, and a Cheater and an Innocent Mistake version of the "Soldier" story.

WST 1

You decide to have a dinner party at your house tomorrow night. You plan to invite all of your closest friends to this party. However, you do not have time to clean up your house and make dinner for everyone, so you tell your friends the following rule:

If you want to come to my dinner party, you must bring a food dish to the party.

All of your friends who can go to your dinner party tell you that they can make a dish for the party. However, you know that some of them are really busy with work and do not have time to cook a dish for the dinner party tomorrow night but they really would like to go. You also know that some of your friends are not good cooks and may make an honest attempt to cook their dish but burn the food so that it cannot be brought to the party. So some of your friends may have broken this rule, you must find out if they have broken this rule.

The four cards below represent four of your friends who are at your dinner party. Each card represents one friend. One side tells you if your friend brought a dish to the party, the other side tells you if you friend could make it to your dinner party.

Indicate only those card(s) you would definitely need to turn over in order to see if these people are violating the rule.

A	Brought a food dish	B	Did not bring a food dish
C	Is at your dinner party	D	Is not at your dinner party

WST 2

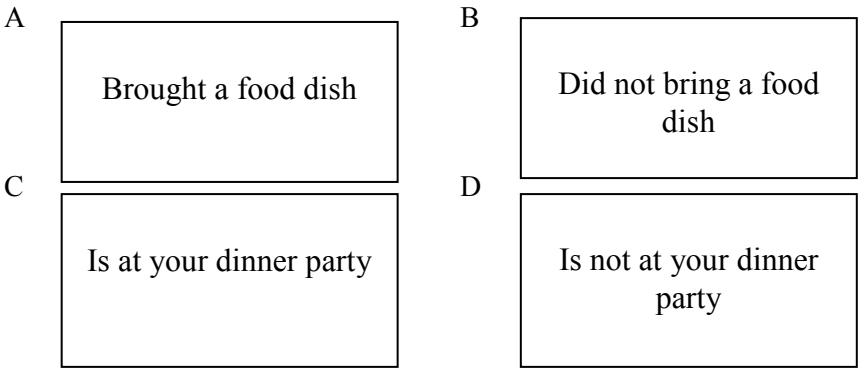
You decide to have a dinner party at your house tomorrow night. You plan to invite all of your closest friends to this party. However, you do not have time to clean up your house and make dinner for everyone, so you tell your friends the following rule:

If you want to come to my party, then you must bring a food dish to the party.

All of your friends who can go to your dinner party tell you that they can make a dish for the party. Your friends are supposed to follow this rule but you suspect that some of them will be too lazy to make food and intentionally not bring a food dish to the party. So some of your friends may have broken this rule, you must find out if they have broken this rule.

The four cards below represent four of your friends who are at your dinner party. Each card represents one friend. One side tells you if they brought a food dish, the other side tells you if you friend could make it to your dinner party.

Indicate only those card(s) you would definitely need to turn over in order to see if these people are violating the rule.



WST 3

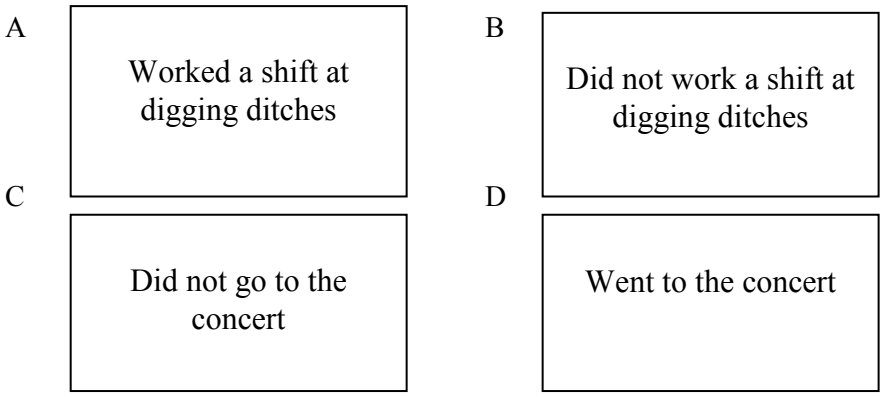
Fort Point army base is remote and isolated, and there's not even a lot to do in the nearby town. Occasionally, musicians or comedians will come and perform at the base. A band is coming to perform a show. Since he needs some ditches to be dug, the commanding officer has made a rule:

If you go to the concert, then you have to work a four-hour shift digging ditches.

The soldiers are supposed to follow this rule but you suspect that some of them were not aware of the commanding officers order to dig the ditches. They may have made an honest mistake and gone to the show without digging the ditches. So they may have broken this rule, you must find out if they have broken this rule.

The four cards below represent four soldiers. Each card represents one soldier. One side of the card tells whether that soldier went to the concert and the other side tells whether that soldier did a shift digging ditches.

Indicate only those card(s) you would definitely need to turn over in order to see if these people are violating the rule.



WST 4

Fort Point army base is remote and isolated, and there's not even a lot to do in the nearby town. Occasionally, musicians or comedians will come and perform at the base. A band is coming to perform a show. Since he needs some ditches to be dug, the commanding officer has made a rule:

If you go to the concert, then you have to work a four-hour shift digging ditches.

The soldiers are supposed to follow this rule but you suspect that some of them have skipped their duties intentionally and still went to the concert. So they may have broken this rule, you must find out if they have broken this rule.

The four cards below represent four soldiers. Each card represents one soldier. One side of the card tells whether that soldier went to the concert and the other side tells whether that soldier did a shift digging ditches.

Indicate only those card(s) you would definitely need to turn over in order to see if these people are violating the rule.