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Excavating the Foundations: Cognitive Adaptations for Multiple Moral Domains

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Abstract
Do humans have cognitive adaptations for detecting violations of rules in multiple moral domains? Previous research using the Wason Selection Task has provided evidence for domain-specific mechanisms for detecting violations of social exchange and hazard precaution rules. The present study investigates whether similar evidence can be found for mechanisms for detecting violations of rules relating to soliciting aid, maintaining coalitions, and navigating hierarchies. Participants ($n = 887$) completed one of seven Wason Selection Tasks—five sociomoral tasks (exchange, hazard, aid, coalition, and submission) and two controls (descriptive and general deontic). Participants also completed the short form Moral Foundations Questionnaire (MFQ) as a self-report measure of five corresponding sets of moral values. The study found that, as predicted, performance on all five sociomoral tasks was significantly better than performance on the two control tasks. However, there was no relationship between task performance and corresponding moral values. These results provide initial evidence for cognitive adaptations for detecting violations of rules relating to providing aid, maintaining coalitions, and submitting to authority. We outline how future research might provide additional tests of this theory, and thereby further extend our understanding of the foundations of human sociomoral reasoning.

Keywords Evolutionary psychology · Cheater-detection · Deontic reasoning · Hazard precaution · Wason Selection Task · Moral foundations · Moral psychology

Introduction

Do humans have cognitive adaptations for detecting violations of rules in multiple moral domains? According to evolutionary psychology, natural selection has equipped the human mind with specialized information-processing mechanisms for solving the problems of survival and reproduction that were recurrent in the lives of our hunter-gatherer ancestors (Barkow et al. 1992; Cosmides and Tooby 2013). These include social problems such as engaging in reciprocal social exchange (Cosmides and Tooby 2005), avoiding infectious diseases (Tybur et al. 2013), soliciting aid from sympathetic others (especially kin) (Lieberman et al. 2007), forming and maintaining coalitions (Kurzban et al. 2001), and navigating status hierarchies (Cummins 2015).

Previous research using the Wason Selection Task (Wason 1968) has provided evidence for cognitive adaptations in two of these problem domains—social exchange and hazard avoidance. The present paper investigates whether similar evidence can be found for mechanisms for detecting violations of rules relating to soliciting aid, maintaining coalitions, and navigating hierarchies. The paper also investigates whether there is a relationship between performance on these social rule violation tasks and a corresponding set of moral values.

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Previous Research on the Detection of Rule Violations Using the Wason Selection Task

Much previous research on logical and social reasoning has employed versions of the Wason Selection Task. This task presents participants with a conditional rule of the form "If P, then Q" and four double-sided "cards" representing instances of P, not-P, Q, and not-Q. It asks them to identify instances where the rule may have been violated by specifying which cards need to be turned over. The logically correct answer is always the P and not-Q cards, because the P card could have not-Q on the reverse (thereby violating the rule) and the not-Q card could have P on the reverse (also violating the rule). Cards with not-P or Q on the front cannot violate the rule because whatever is on the other side would be consistent with the rule. For example, if the rule was "If a card has a vowel on one side, then it has an even number on the other," and participants were presented with four cards ("A," "B," "2," "3"), the correct answer would be to "turn over" cards "A" and "3" (Wason 1968).

Previous research with this task has shown that the detection of rule violation depends very much on the rule's content. For example, rules such as "If I eat salad, then I drink water" elicit a relatively low percentage of correct answers (5–30%), whereas structurally equivalent rules such as "If a letter weighs two ounces, it must have 44 cents postage" elicit a high percentage (~75%; reviewed in: Cosmides 1985). Cosmides proposed that this "elusive" content effect could be explained by an evolved "cheater-detection" mechanism.

Cheater Detection

Game theory suggests that in order to maintain social exchange—the mutually beneficial reciprocal exchange of resources—it is necessary for cooperators to identify and avoid "cheats," individuals who take the benefit of others' cooperation without paying the cost of cooperating themselves (Axelrod and Hamilton 1981; Trivers 1971). Primate and paleoanthropological evidence suggests that social exchange has been a recurrent feature of the social lives of humans since their last common ancestor with chimpanzees 6 million years ago (Jaeggi and Gurven 2013), and there is tentative evidence of trade between human groups from 82,000 years ago (Bouzouggar et al. 2007). These considerations led Cosmides and colleagues to hypothesize that the human mind had been equipped with mechanisms for detecting cheats and to predict that individuals would exhibit enhanced performance detecting violations of rules in Wason Selection Tasks framed as social contracts (Cosmides 1985, 1989). Subsequent experiments demonstrated that, as predicted, people were proficient at detecting violations of social exchange rules—which take the form "If you take the benefit (of cooperation), then you must pay the cost (provide a benefit in return)," for example "If you borrow the car, then you must fill it with petrol." But people were less proficient at detecting violations of logically equivalent abstract or descriptive rules, such as "if a person is a biologist, then that person enjoys camping" (for a review of this work, and a response to criticisms, see: Cosmides and Tooby 2005).

Further experiments went on to exclude alternative explanations for this "content effect." Contrary to the theory that the content effect could be explained by familiarity with, or experience of, the rule, the same effect occurred with unfamiliar rules (set in unfamiliar cultural contexts). Contrary to the theory that the content effect could be explained by social exchange rules triggering more logical thinking, switched social contracts ("If you pay the cost, then you take the benefit") led participants to look for cheats in the (logically incorrect) place (see also: Gigerenzer and Hug 1992). Contrary to the theory that the content effect could be explained by the action of a mechanism designed to detect violations of social rules in general (as opposed to one specific to social exchanges: Cheng and Holyoak 1985, 1989; Manktelow and Over 1991), such "deontic" rules, that do not relate to a specific adaptive problem, do not elicit the effect. And although it has been demonstrated that Wason content effects can be produced by manipulating "relevance"—domain-general logical pragmatic factors related to discourse (Sperber et al. 1995)—these effects do not, by themselves, rule out domain-specific effects of social exchange (Fiddick et al. 2000).

More recent research has tested additional hypotheses regarding the design of the putative cheater-detection mechanism: as predicted, cheater detection is enhanced when: (a) the violation of the rule confers a *benefit* on the cheat, (b) when cheating is *intentional* (as opposed to accidental), and (c) the cheat has the *ability* to cheat (Cosmides et al. 2010).[1]

Avoiding Hazards

Another problem recurrent over the course of human evolutionary history has been the avoidance of hazards, including toxins, pathogens, and infectious diseases (Tybur et al. 2009; Tybur et al. 2013). This led Fiddick and colleagues to hypothesize that the human mind had also been equipped with mechanisms for detecting potential hazards and to predict that individuals would exhibit enhanced performance detecting violations of hazard precaution rules. Consistent with this prediction, ~75% of participants were able to correctly detect violations of rules that take the form "If you engage in hazardous activity P, then you must take precaution Q," such as "If you

[1] Other lines of evidence are consistent with cheater-detection being an evolved component of human psychology include: social contract content effects have been demonstrated early in development (Harris et al. 2001) and across cultures (Sugiyama et al. 2002); and a neurological case-study with an individual with focal frontal-lobe brain injury suggests that this ability may be subtended by specific cognitive-neural processes in particular brain areas (Stone et al. 2002).

go hunting, then you must wear these bright orange jackets to avoid being shot" (Fiddick et al. 2000) or "If you make poison darts, then you must wear rubber gloves" (Fiddick 2004). Unlike the case with social exchange rules, enhanced performance on precautionary rules does not depend on intent (accidental dangers are just as dangerous). Consistent with this experimental finding, a neuro-imaging study showed higher activation in brain regions associated with "theory of mind" for the interpretation phase of exchange rules, but not for precaution rules (Ermer et al. 2006).

Present Study

If selection for social exchange has favored the evolution of cognitive adaptations for detecting cheats, and selection for hazard avoidance has favored the evolution of cognitive adaptations for detecting hazards, then it is possible that selection may have favored the evolution of similar cognitive adaptations for detecting violations of rules in other recurrent problem domains, including soliciting aid, maintaining coalitions, and navigating hierarchies.

Soliciting Aid

Humans are an inherently social species (Shultz et al. 2011), who owe their success in large part to their ability to solicit and provide aid to family, friends, and other group members (Hammerstein 2003; Tomasello and Vaish 2013). Indeed, the capacity to feel sympathy seems to have evolved precisely in order to detect others' suffering and motivate altruism (Hublin 2009; Preston and de Waal 2002; Van Lissa et al. 2017). Effectively eliciting such altruism depends on being able to identify and distinguish those who are likely to be helpful and those who are not. Thus, we hypothesize that natural selection has equipped the human mind with adaptations for detecting unhelpful people, and we predict that individuals will show enhanced performance when detecting violations of rules along the lines of "If a person encounters someone in need, then they must help them."

Previous research using Wason Selection Tasks has shown that people are good at detecting altruists in the context of social exchange (that is, people who pay the costs without taking the benefit) (Brown and Moore 2000; Oda et al. 2006; cf. Cosmides and Tooby 1992; Fiddick and Erlich 2010). However, previous research has not looked at whether people are good at detecting non-altruists more generally, outside the context of social exchange, as we do here.

Maintaining Coalitions

Mutualisms arise when individuals benefit more by working together than they do by working alone (Connor 1995). These situations differ from social exchanges in that there is no uncertainty about the transfer of benefits, often because they occur simultaneously, and hence no possibility of free-riders. For this reason, mutualisms are modeled not as prisoner's dilemmas, but as coordination problems (Lewis 1969; Schelling 1960)—including "stag hunts" (Skyrms 2004) and soldier's dilemmas (Clutton-Brock 2009)—and the ensuing relationships are referred to as friendships, alliances, and coalitions (Tooby and Cosmides 1996).

Forming coalitions for the purpose of collaborative hunting (Alvard 2001; Alvard and Nolin 2002) and competing with rival coalitions (Wrangham 1999) is another recurrent feature of the social lives of humans and their recent ancestors (Harcourt and de Waal 1992). This selection pressure has equipped humans with psychological adaptations for detecting coalitions from patterns of behavior and other cues of group membership (Kurzban et al. 2001; Pietraszewski et al. 2015; Tooby and Cosmides 2010), for spontaneously forming coalitions, and acting to benefit them at the expense of others (Balliet et al. 2014; Sherif et al. 1954/1961; Tajfel 1970). Because maintaining the integrity of coalitions depends on being able to identify and distinguish members of the "ingroup" from members of the "outgroup," we hypothesize that natural selection has equipped the human mind with adaptations for detecting who is in a given coalition and who is out, and we predict that individuals will show enhanced performance when detecting violations of rules along the lines of "If a person is a member of a coalition, then he must exhibit the appropriate membership cues."

Previous research using Wason Selection Tasks has shown that people are good at detecting out-group members who free-ride on benefits provided by an ingroup (Hiraishi and Hasegawa 2001; Oda et al. 2006). Also, research using logical syllogisms has shown that people are good at using cues to infer coalition membership, especially when the cue is unique and intentional (Brase 2001). However, previous research has not used Wason Selection Tasks to investigate whether people are good at detecting individuals who violate rules regarding the display of appropriate coalition cues.

Navigating Hierarchies

Finally, like many other social animals, ancestral human groups featured status hierarchies in which low-status individuals defer to high-status individuals, thereby reducing the costs of interpersonal conflict (Cummins 2015; Mazur 2005; Preuschoft and van Schaik 2000).

Successfully navigating such hierarchies involves tracking who respects and who disrespects whom. Thus, we hypothesize that natural selection has equipped the human mind with adaptations for monitoring relative status and especially changes in status, and we predict that individuals will show enhanced performance when detecting violations of rules

along the lines of "If a person sees a high-status individual, then he must show respect."

Previous research using Wason Selection Tasks has shown that people are good at detecting lower-ranking cheats who disobey instructions or violate duties (Cummins 1999). However, previous research has not used Wason Selection Tasks to investigate whether people are good at detecting individuals who violate rules regarding appropriate displays of respect.

Thus, this evolutionary perspective suggests that the human mind may possess cognitive adaptations for detecting not only violations of social exchange and hazard rules but also violations of rules relating to providing aid, maintaining coalitions, and submitting to authority—the enhanced ability to detect unhelpful individuals (who do not help those in need), traitors (who betray their groups), and rebels (who do not respect their superiors). And if so, then we might expect individuals to exhibit superior performance on Wason Selection Tasks relating to not only social exchange and hazard precaution but also soliciting aid, maintaining coalitions, and submission to authority, relative to performance on descriptive and general deontic rules.

The Social and the Moral

Another branch of recent research in moral psychology has argued that the evolved psychological mechanisms responsible for social, cooperative, and altruistic behavior also give rise to "moral" thought and behavior, and that different (suites of) adaptations give rise to different types of morality (Curry 2016; Haidt and Kesebir 2010; Rai and Fiske 2011).

For example, Haidt and colleagues have argued that when people make moral decisions they rely on five "moral foundations" relating to five different types of social behavior (Graham et al. 2011; Haidt and Kesebir 2010). They argue that adaptations for engaging in reciprocal social exchange have given rise to a moral foundation of "fairness," relating to the virtues of "fairness and justice" and "individual rights and equality." Adaptations for avoiding infectious diseases have given rise to a moral foundation of "purity," relating to the virtues of being "chaste, spiritually minded, pious," and the vices of "lust, gluttony, greed, and anger." Adaptations for caring for offspring have given rise to a moral foundation of "care," relating to "virtues such as kindness and compassion and also in corresponding vices such as cruelty and aggression." Adaptations for forming and maintaining coalitions have given rise to a moral foundation of "ingroup," relating to "virtues such as loyalty, patriotism, and heroism" and vices such as betrayal and treason. Adaptations for navigating social hierarchies have given rise to the moral foundation of "authority," relating to "respect, awe, and admiration toward legitimate authorities" and "virtues related to subordination: respect, duty, and obedience" (Haidt and Graham 2007). This approach has been used to create a Moral Foundations Questionnaire (MFQ), which measures the degree to which individuals consider each type of behavior morally relevant and morally good (Graham et al. 2011).

If the psychological mechanisms that give rise to social thought and behavior are the same as those that give rise to moral thought and behavior, then we might expect the two to be related; in other words, we might expect the ability to detect violations of a social rule to be related to the moral endorsement of that rule. Individuals who are more likely to notice violations of a given rule may profess greater support for its enforcement. Or individuals who benefit from, value, and profess greater support for, a given rule might be more motivated to, and more adept at, spotting individuals who violate it. Or responses to both tasks might be the product of some third variable—proficiency and detecting social exchange violations, and professed support for the principle of reciprocity may reflect market integration (Henrich et al. 2005). For this reason, the present study also took the opportunity to investigate whether correct performance on a social Wason Selection Task is positively related to endorsement of the corresponding moral foundation.

Method

Participants and Sample

Participants were recruited from Amazon's Mechanical Turk. In order to ensure the quality of the data, the Mechanical Turk sampling specifications were set so that all subjects had successfully completed at least 100 tasks in the past and had at least a 95% task approval rate. All participants were from the USA and had indicated that English was their first language. Subjects who chose to complete the task on the Mechanical Turk platform were directed to Qualtrics.com where the experiment was hosted. Participants were paid $0.40. Four subjects did not complete the MFQ questions and so were dropped from the final sample.

Procedure and Design

Participants completed one of seven novel Wason Selection Tasks and the short form of the MFQ. Task, order of task and questionnaire, and order of items within the task and questionnaire were all presented in random order.

Wason Selection Tasks

There were seven Wason Selection Tasks—five domain-specific sociomoral tasks (exchange, hazard, aid, coalition, and submission) and two controls (descriptive and general deontic).

All tasks were constructed from a general story about a basketball team called the Rangers—involving elements such as

players, coaches, and jerseys—and consisted of a vignette, a rule, and the image of four cards corresponding to the P, Q, not P, and not Q choices (see Table 1, and Appendix A). In all social tasks (1–5, 7) participants were asked to adopt the perspective of a Rangers staff member monitoring the behavior of the players. These tasks were similar in terms of information about agency, intent and ability to violate the rule, and a familiar context. However, unlike the exchange and hazard tasks, the three novel social tasks (aid, coalition, and submission) did not contain a benefit, or an explicit hazard, in the antecedent clause of the rule. In the descriptive control task, (6) participants were asked to adopt the perspective of a local sports reporter.

Exchange

In order to engage in social exchange, individuals must be able to detect and avoid cheats (who take the benefit without paying the cost). Thus, in this task, participants were told that some players were violating the rule that, in order to enjoy the benefits of club membership, they must pay their membership fees. Following Cosmides (1989), the task emphasized that "membership of the Rangers" (P) was a benefit, by describing them as a "winning team" with an enthusiastic staff and by stating that players enjoy being part of the team.

Hazard

In order to protect their health, individuals must be able to detect and avoid hazards such as "dirty" individuals who do not maintain their personal hygiene. Items involving "sweat" and "body odor" are the highest loading items on the on the "pathogen disgust" subscale of the Three-Domain Disgust Scale (Tybur et al. 2009). Thus, in this task, participants were told that some players were violating the rule that, if their sports jersey was dirty, they must wash it. Note that in this case, unlike the social exchange rule, the antecedent clause "having a dirty jersey" (P) has no obvious benefit to the protagonist.

Aid

In order to effectively solicit aid, individuals must be able to detect and avoid unhelpful individuals (who do not help when they can). Thus, in this task, participants were told that some players were violating the rule that if they see a player get injured, they must help other injured teammates. Again, note that, unlike the exchange and hazard tasks, the antecedent clause "seeing an injured player" (P) has no explicit cost or benefit to the protagonist.

Coalition

In order to maintain coalitions, individuals must be able to detect and avoid "traitors" (who leave or otherwise weaken the coalition). Thus, in this task, participants were told that some players were violating the rule that, if they play for the Rangers, they must wear specific team colors. Note that, in contrast to the exchange task, the antecedent clause "being a member of the team" (P) was portrayed as a cost (because the Rangers were a losing team, and some players were thinking of leaving).

Submission

In order to navigate hierarchies, individuals must be able to detect "rebels" (who do not submit or show respect to authority). Thus, in this task, participants were told that some players were violating the rule that, if they see the coach, they must show respect. Again, note that, unlike the exchange and hazard tasks, the antecedent conditional clause "seeing the coach enter the court" (P) has no particular benefit or cost.

Descriptive Control

In this task, participants were asked to adopt the perspective of a local sports reporter, who had come to watch the players and check whether it is the case that, if they play for the Rangers, they wear specific team colors. Thus, the task was similar to the coalition task, except that the motivation for why players might violate the rule was omitted from the story, and because the rule was not deontic, the word "must" was omitted.

General Deontic Control

In this task participants were told that some players don't feel like following a rule regarding team uniform—that, if they wear white socks, they must wear white shoes. This rule was predicted to be culturally familiar given the ubiquity of requirements to match colors particularly in the domain of sports. In this case, the antecedent (P) and consequent (Q) clauses have no obvious costs or benefits. This task was based on a general permission schema, associating a general action and pre-condition required in order to satisfy it (Cheng and Holyoak 1985).

Moral Foundations Questionnaire

Participants completed the 22-item short form of the MFQ (Graham et al. 2011) as a measure of moral relevance and moral judgment in five domains: fairness, purity, care, ingroup, and authority.[2]

[2] The questionnaire includes four items from each of the five domains, plus two dummy items that serve as attention checks.

Table 1 Wason selection tasks

	Adaptive problem	Moral foundation	Rule	P	nP	Q	nQ
1	Exchange	Fairness	If someone plays for the Rangers, then they must pay a membership fee.	Plays for Rangers	Doesn't play for Rangers	Paid for membership	Did not pay for membership
2	Hazard	Purity	If a player has a dirty jersey, then that player must wash it.	Has dirty jersey	Has clean jersey	Washed his jersey	Did not wash his jersey
3	Aid	Care	If a player sees a teammate get injured, then he must help the teammate.	Saw injured teammate	Did not see injured teammate	Helped teammate	Did not help injured teammate
4	Coalition	Ingroup	If someone plays for the Rangers, then they must wear a green jersey.	Plays for Rangers	Doesn't play for Rangers	Wears green	Wears blue
5	Submission	Authority	If a player sees the coach entering the court, then that player must respectfully stand up.	Saw coach enter	Didn't see coach	Stood up	Didn't stand up
6	Descriptive		If someone plays for the Rangers, then they wear a green jersey	Plays for Rangers	Doesn't play for Rangers	Wears green	Wears blue
7	Deontic		If a player wears white socks, then he must wear white shoes.	Had white socks	Had blue socks	Had white shoes	Had blue shoes

Results

The final sample size was $n = 887$ (388 females; mean age = 33.9; SD = 12.12). The percentage of correct responses to each of the Wason Selection Tasks is displayed in Fig. 1.[3] Descriptives for the MFQ are given in Table 2. Point-biserial correlations between Wason performance and MFQ are given in Table 3.

Visual inspection (Fig. 1) of the Wason results suggested that participants were more likely to respond correctly to the adaptive social problem tasks than to either of the two control tasks. Correlations between task performance and the corresponding MFQ domain were small and for the most part negative.[4]

To fully test our hypotheses, we conducted a series of hierarchical logistic regression analyses in R 3.3.0, comparing models with χ^2 difference tests. For each model, the dependent variable was whether the participant gave the logically correct answer to the Wason task (the "P" and "not-Q" cards only). Independent variables were Wason task type (a 7-level categorical variable) and MFQ scores. We used "effects coding" (Cohen et al. 2003, p. 321) to test whether one group of conditions differs significantly from another group of conditions. Specifically, we tested whether: (1) the experimental sociomoral conditions differed from the control conditions, (2) whether the experimental conditions differed from one

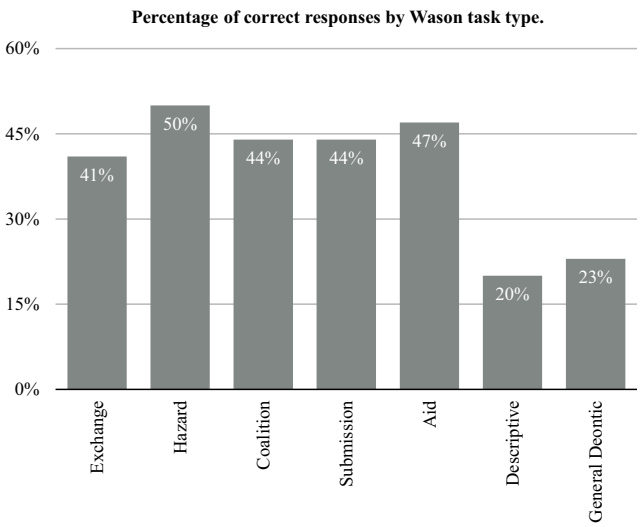

Fig. 1 Percentage of correct responses by Wason task type

[3] There are 16 possible responses to a Wason Selection Task: (1) no cards; (2) P; (3) nP; (4) Q; (5) nQ; (6) P and nP; (7) P and Q; (8) P and nQ (the correct answer); (9) nP and Q; (10) nP and nQ; (11) Q and nQ; (12) P, nP and Q; (13) P, nP, and nQ; (14) P, Q, and nQ; (15) nP, Q, and nQ; (16) all cards. Hence, the probability of giving the right answer by chance is 1/16 = 6.25%.

[4] A reviewer asked whether there are sex differences in Wason task performance. For example, given a coalitional context, men might exhibit a higher correct response rate compared to women, given that men faced greater selection pressures to form and maintain coalitions during intergroup conflict (Wrangham and Peterson 1996) and given that men which generally display greater ingroup favoritism are more discriminating and hostile towards outgroup members (Navarrete et al. 2010) and display greater repugnance and hostility towards ingroup defectors (Boyd et al. 2003). After conducting a moderation analysis for sex differences, we found a significant sex moderation effect of the coalition vs submission conditions, but in the opposite direction. Specifically, women were *more* adept at detecting violations of the coalition rule, whereas men were more adept at detecting violations of the submission rule. Because the moderation effect was in the opposite direction of what was argued and because the fit of the sex-moderated model was worse than that of model 2 (see Table 4, model 4), we proceeded with the hypothesized analyses.

Table 2 MFQ subscales: means, standard deviations, and alphas

	Mean	SD	sk	sk/2*se	ku	ku/2*se	α	
Fairness	4.77	0.74	− 0.59	− 3.61	0.78	2.37	0.67	Questionable
Purity	3.38	1.27	− 0.13	− 0.81	− 0.81	− 2.47	0.85	Good
Care	4.63	0.83	− 0.50	− 3.07	− 0.06	− 0.20	0.70	Acceptable
Ingroup	3.59	0.99	− 0.08	− 0.50	− 0.41	− 1.24	0.68	Questionable
Authority	3.60	1.02	− 0.31	− 1.87	− 0.44	− 1.35	0.72	Acceptable

Range for all subscales is 1–6

another, and (3) whether the control conditions differed from one another.

Our baseline model (model 1; Table 4) regressed Wason performance on task type, to determine whether participants were more likely to respond correctly to the specific social tasks than to the control tasks. The model was significant, suggesting that Wason task type predicted performance specifically. Model 2 introduced participants' scores on the five MFQ domains as predictors, to investigate whether there was a relationship between performance on the Wason tasks and overall MFQ scores. Model 2 fits significantly better than model 1, which suggests that there is a significant relationship between task performance and MFQ scores in general. In particular, participants with greater Ingroup scores were less likely to respond correctly to whichever Wason tasks they answered. Model 3 introduced interactions between Wason task type and the MFQ scores, to investigate whether participants who answered their Wason task correctly scored higher on the corresponding moral foundation. Model 3 did not fit significantly better than model 2, and none of the interaction terms were significant. This suggests that specific MFQ scores did not significantly predict performance on corresponding tasks. We estimate that a sample of our size would have the power $(1 - \beta = 0.8)$ to detect an effect with an odds ratio as low as 1.62 which translates to a Cohen's *d* of 0.28 (a small effect size).[5]

Thus, the best-fitting model was model 2, which included only main effects of task type and the MFQ scores. Participants were more likely to respond correctly to the social Wason tasks than to either of the two types of control tasks. There were no differences in performance among the social tasks or the control tasks. Also, there was no relationship between Wason task performance and the corresponding MFQ score (Table 5).

Discussion

The present study found that people were better at detecting violations of five adaptive social rules than they were at detecting violations of two neutral control rules. These results replicate previous research demonstrating enhanced Wason Selection Task performance on social exchange and hazard precaution rules and demonstrate for the first time that this effect extends to rules relating to soliciting aid, maintaining coalitions, and navigating hierarchies.

Superior performance on these novel tasks—concerning aid, coalition, and submission—is not explained by logic alone, as demonstrated by poor performance on the descriptive task. Nor is it explained by familiarity, because all rules referred to the same, equally familiar, context. Nor is it explained by general social reasoning, as demonstrated by the poor performance on the general deontic rule task, despite their containing cues of the intention and ability of an individual to violate the rule. Nor can the results be explained as the product of the cheater-detection or hazard-precaution mechanisms. The novel rules did not have the cost-benefit structure characteristic of standard social contracts and did not involve hazards. As such, the findings provide initial evidence that, in addition to cognitive adaptations for detecting cheats and hazards, the human mind may contain adaptations for detecting unhelpful individuals, traitors, and rebels.

The study also found no relationship between Wason task performance and the corresponding moral values, as measured by the MFQ. Why might this be? One possibility is that the psychological mechanisms responsible for detecting rule violations operate independently from those responsible for moral evaluation. Perhaps the former is more cognitive and the latter more affective. Indeed, the fact that a neuro-atypical

Table 3 Zero-order correlations between moral foundation and Wason performance

		MFQ				
Wason type	*n*	Fairness	Purity	Care	Ingroup	Authority
Exchange	123	**0.10**	− 0.36	0.04	− 0.38	− 0.50
Hazard	123	0.11	**− 0.11**	− 0.08	− 0.12	− 0.11
Aid	141	− 0.11	− 0.30	**− 0.13**	− 0.49	− 0.31
Coalition	128	0.18	− 0.08	0.18	**− 0.13**	− 0.07
Submission	124	0.41	− 0.08	0.35	− 0.02	**− 0.14**
Descriptive	126	0.20	− 0.21	0.02	− 0.21	− 0.16
Deontic	122	− 0.12	− 0.12	− 0.14	− 0.20	0.00

Correlations between task and corresponding subscale are in bold

[5] The details and syntax of our power analysis simulation study are available in the supplemental materials.

Table 4 Fit and pseudo R^2 for all models

Model number	χ^2	df	AIC	R^2_L	R^2_{CS}	R^2_N	$\Delta\chi^2$
1	47.05	6	1147.84	0.04	0.05	0.07	23
2	**74.14**	**11**	**1130.75**	**0.06**	**0.08**	**0.11**	**1**
3	100.14	41	1164.75	0.09	0.11	0.15	1
4	79.14	18	1136.86	0.07	0.09	0.12	1

Model p values omitted, because all χ^2 s were significant at $p < .001$

R^2_L: Hosmer & Lemeshow, R^2_{CS}: Cox & Snell, R^2_N: Nagelkerke.

The column $\Delta\chi^2$ indicates which models, referred to by model number, were significantly different from each other (based on χ^2 -difference tests) at the $p < .05$ level. A description of model 4 is provided in endnote iv.

population, such as psychopaths which are capable of moral reasoning (Link et al. 1977), but are likely less prone to experience moral emotions, indicates that such a dissociation could exist. Another possibility is that the two sets of mechanisms are related, but that the (short form) MFQ does not provide an adequate measure of moral values, as was suggested by recent psychometric analyses (Curry et al. under review). In this light, the results of the present study could be interpreted as evidence of the MFQ's low external or predictive validity. Future research is required to test these alternative explanations of our findings.

Of course, the present study has its limits, which future research should aim to overcome. First, previous research suggests that priming the correct answers by mentioning them in the Wason Selection Task text can artificially improve performance (Fiddick and Erlich 2010). Although it is possible that this confound may partly explains some of our effects, it appears to be unlikely, because the experimental submission task did not contain such primes, but still elicited a high proportion of correct answers, and the deontological control condition did contain such primes, but elicited a low proportion of correct answers. In any case, future research should aim to exclude this confound explicitly.

A second potential limitation is that, in the descriptive control condition, participants adopted the perspective of a journalist who was not associated with the team, whereas, in the moral conditions and the deontic control, participants were asked to adopt the perspective of a team staff member, who might be construed as having a stake in the outcome of the scenario. Although we are not aware of previous work that has demonstrated such an effect, adopting the perspective of someone with a stake in the outcome might present a confound. Concern regarding this potential confound is assuaged somewhat by the fact that the journalist also had a stake in the outcome—specifically, performing his job well—and that this resulted in similar Wason performance to the deontic control, which served as a more exacting control to the sociomoral conditions. Nevertheless, future research should exclude this potential confound explicitly.

Third, it is possible that the "injury" described in the aid task triggered participants' hazard-precaution mechanisms, which would confound these two conditions. This seems somewhat unlikely, because merely *seeing* an injured player is not a hazard to the observing player and aiding an injured player is not a hazard precaution. If anything, *approaching* an injured player can be construed as the opposite of avoiding a hazard. Nevertheless, future research could try to control for this potential confound using stimuli that explicitly preclude the possibility of any danger to the protagonist.

Fourth, the level of correct responses in the present study (~45%) is relatively low compared to previous social exchange and hazard precaution studies. This

Table 5 Regression coefficients of the final model, model 2

	Estimate	SE	Odds ratio	CI 2.5%	CI 97.5%	p
Intercept	−0.39	0.55	0.68	0.23	1.99	.48
Task type						
Control vs experimental	0.33	0.05	1.40	1.27	1.55	< .001
Descriptive vs deontic	0.04	0.16	1.04	0.77	1.42	.79
Exchange & aid vs coalition & submission & hazard	0.03	0.07	1.04	0.91	1.18	.60
Aid vs exchange	−0.10	0.13	0.91	0.71	1.16	.44
Coalition & submission vs hazard	0.08	0.07	1.08	0.93	1.25	.31
Coalition vs submission	−0.03	0.13	0.97	0.75	1.25	.82
Fairness	0.15	0.12	1.16	0.92	1.48	.21
Purity	−0.04	0.08	0.96	0.82	1.13	.63
Care	0.09	0.11	1.10	0.89	1.36	.39
Ingroup	−0.36	0.11	0.70	0.56	0.86	< .001
Authority	0.04	0.12	1.04	0.83	1.30	.75

poorer performance may be the result of the M-Turk sample used in this study having less formal education than the undergraduate samples used in previous research, as well as a "noisier" testing environment, as opposed to a more controlled laboratory setting. Thus, future research should aim to replicate these effects in more controlled conditions.

Fifth, comparable performance on the five adaptive social problems could give the impression that they are in fact the result of one common mechanism rather than multiple distinct mechanisms. Again, this seems unlikely: previous research suggests that different mechanisms are involved in social exchange and hazard precaution, yet they typically exhibit similar content effects. Also, crucially, social exchange effects depend on there being a benefit to the would-be cheat, but no such benefits were available in our novel tasks. Nevertheless, future work should aim to distinguish between performances on these novel domains. This could be achieved by testing specific predictions about performance on each domain. Perhaps the group-membership of the protagonists alters performance on the aid task, lower quality coalitional cues lower performance on coalition tasks (Brase 2001), and the relative status of the protagonists alters performance on the submission task. More generally, perhaps the degree of intentional violation affects performance on all these novel tasks (Brase 2001; Cosmides et al. 2010). If a person *accidentally* fails to provide help, display the correct coalition cues, or show respect, are they still considered unhelpful traitors and rebels? Research could also look at the unique effects of personality variables on performance in diverse tasks (Fiddick et al. 2016).

Sixth, given that the short-form MFQ is not the only or best measure of moral attitudes available, future research investigating the social and the moral should employ a wider array of higher-quality measures of moral values, including the full MFQ and alternative measures (Curry et al. under review).

Seventh, the present study investigates five adaptive social problems, using standard Wason Selection Tasks. Future work could extend these findings by exploring a wider array of sociomoral domains—(such as family, bravery, bargaining, and property) (Curry et al. accepted)—and by using previously employed varieties of Wason paradigms, including culturally unfamiliar rules, switched rules, switched perspectives, diverse cross-cultural samples, and measures of neurological correlates.

All of these diverse lines of enquiry will be needed to move beyond the initial evidence presented here and make a more secure case for cognitive adaptations for multiple domains. Such research will help to further excavate and extend the foundations of social and moral psychology.

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Compliance with Ethical Standards

Conflict of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Appendix A: Full text of Wason Selection Tasks

Exchange

The Rangers are a local basketball team that has been winning a lot lately. The coach and the executive staff care about the team a great deal and try their best to help the players, and most players seem to be enjoying playing for the team this season. As the team belongs to the local sports center, there is a rule: If someone plays for the Rangers, then they must pay a membership fee. Some of the players have been avoiding paying for a membership, thinking that they could keep playing and that it could go unnoticed. You are a member of the team staff, so you are interested to see which of the players are following the rule. The cards below represent four people. Each card represents one person. One side of a card gives reliable information about whether or not the person plays for the Rangers. The other side of the same card tells you if that person paid or did not pay for a membership fee. You can use the information the cards provide to discover information about the player. Indicate only those card(s) you definitely need to turn over to see if any of these players have broken this rule: If someone plays for the Rangers, then they must pay a membership fee.

Hazard

The Rangers are a local basketball team. As players should stay clean after games, the coach and the executive staff made some rules in order to promote cleanliness. There is a rule in the team: If a player has a dirty jersey, then that player must wash it. Some of the players often neglect cleanliness and have not been washing their jerseys. You are a member of the team staff, so you are interested to see which of the players are following the rule. The cards below represent four players. Each card represents one person. One side of the card gives reliable information as to whether that player had a dirty jersey. The other side of the same card tells you whether that player has washed his jersey. You can use the information the cards provide to discover information about the player. Indicate only those card(s) you definitely need to turn over

to see if any of these players have broken this rule: If a player has a dirty jersey, then that player must wash it.

Aid

The Rangers are a local basketball team that provides a supportive social environment for its players. In order to encourage players to care for their fellow teammates, the coach and executive staff have made several rules in order to promote helping behavior. One of the rules is: If a player sees a teammate get injured, then that player must help the injured teammate. However, some of the players have been deliberately avoiding helping their fellow teammates. You are a member of the team staff, and you are interested in whether any of the players have violated this rule. The cards below represent four people. Each card represents one person. One side of the card gives reliable information about whether or not the person has seen an injured teammate. The other side of the same card tells you if that person helped or did not help his fellow teammate. You can use the information that the cards provide to discover information about that player. Indicate only those card(s) you definitely need to turn over to see if any of these players have broken this rule: If a player sees a teammate get injured, then that player must help the injured teammate.

Coalition

The Rangers are a local basketball team that has been losing a lot lately. Despite the fact that the coach and the executive staff, care about the team a great deal and try their best to help the players, some players are thinking of quitting the team in the middle of the season. There is a rule in the team: If someone plays for the Rangers, then they must wear a green jersey. As an act of rebellion, some of the players have recently been showing up to practice wearing a wrong colored jersey. You are a member of the team staff. As the jersey represents group loyalty, you are interested to see which of the players are following the rule. The cards below represent four players. Each card represents one player. One side of a card gives reliable information about whether that player plays for the Rangers or for a different team. The other side of the same card tells you the color of the jersey the player is wearing. You can use the information the cards provide to discover information about the player. Indicate only those card(s) you definitely need to turn over to see if any of these players have broken this rule: If someone plays for the Rangers, then they must wear a green jersey.

Submission

The Rangers are a local basketball team. The coach and the executive staff care about the team a great deal and try their best to help the players. Since basketball players should respect the authority of the team staff, there is a rule in the team: If a player sees the coach entering the court, then that player must respectfully stand up. Sometimes players choose to be disrespectful to the coach and do not follow the rule. You are a member of the team staff, so you are interested to see which of the players are following the rule. The cards below represent four players. Each card represents one person. One side of the card gives reliable information as to whether that player witnessed the coach entering the court. The other side of the same card tells you whether that player stood up respectfully after the coach entered the court. You can use the information the cards provide to discover information about the player. Indicate only those card(s) you definitely need to turn over to see if any of these players have broken this rule: If a player sees the coach entering the court, then that player must respectfully stand up.

Descriptive

The Rangers are a local basketball team. You are starting a job as a local sports journalist interested in different local teams and you heard from one of your colleagues that: If someone plays for the Rangers, then they wear a green jersey. As you are writing about the different sports teams in the area, you are interested to see if this rule applies for people playing for the Rangers. The cards below represent four players. Each card represents one player. One side of a card gives reliable information about whether or not the player plays for the Rangers. The other side of the same card tells you the color of the jersey the player is wearing. You can use the information the cards provide to discover information about the player. Indicate only those card(s) you definitely need to turn over to see if any of these players violate this rule: If someone plays for the Rangers, then they wear a green jersey.

Deontic

The Rangers are a local basketball team that has distinct rules regarding the uniforms they wear for their games. The team has a rule regarding the dress code for shoes: If a player wears white socks, then he must wear white shoes. Some players don't feel like following the rule and have been showing up to practice wearing shoe and sock combinations that are not in accordance with the rule. You are a member of the team staff, so you are interested to see which of the players are following this rule. The cards below represent four people who are members of the Rangers, which showed up for practice this week. Each card represents one player. One side of a card gives reliable information about whether or not a player wore white socks for practice. The other side of the same card tells you the shoe color that the player wore with his socks. You can use the information the cards provide to discover information about

the player. Indicate only those card(s) you definitely need to turn over to see if any of these players have broken this rule: If a player wears white socks, then he must wear white shoes.

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