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Hypothesis testing in Wason's selection task: social exchange cheating detection or task understanding

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Abstract

Recently, an evolutionary view of performance in the Wason selection task was proposed, according to which people successfully solve tasks involving social exchange situations, or cheating detection content and perspective, but fail to do so in other domains. Alternatively, we propose that performance in the Wason problem largely depends on three aspects related to how people understand the task: (1) the clarity of the rule in terms of determination and direction; (2) the nature of the alternative to the tested rule and the falsifying instance it entails; (3) the perceived relevance of looking for violation strategy. We show that Gigerenzer and Hug's improvement in performance with "cheating" compared to "no-cheating" versions can be explained by these elements of task understanding rather than by cheating. In Study 1 facilitative understanding features were removed from the cheating versions and were introduced into the no-cheating versions, without affecting the cheating (or the no-cheating) nature of the task or changing perspective. Performance levels in the original cheating and the unconfounded no-cheating versions were found to be equally high (71%), whereas the unconfounded cheating and the original no-cheating versions yielded equally low performance (30–32%). Study 2 showed that the reversal in choice patterns obtained by Gigerenzer and Hug by changing perspectives in bilateral cheating option rules can be achieved without changing perspectives. Moreover, this reversal fails to occur when perspective change does not accompany change in task understanding.

1. Introduction

The Wason selection task (Wason, 1966) is a paradigm of lay hypothesis

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testing in which subjects are presented with a hypothesis of the form "if P then Q" referring to four cards. The cards have P or not-P on one side and Q or not-Q on the other, but only one side is visible. Subjects are asked to decide which cards should be turned over in order to test the hypothesis. Wason's original task presented the rule 'every card that has a vowel on one side, has an even number on the other", with the cards E, K, 4 and 7 (Wason, 1966). The correct choice is E and 7 cards (P & not-Q), which provides a violating case, that is, a negative instance. However, this combination is chosen by only 5–10% of the subjects. Usually, subjects select only the E card or a combination of E and 4 cards (P or P & Q), which is a positive instance, that is, a case for which the rule is true. Positive instances cannot prove the truth or the falsity of the rule in the selection task, and therefore have no informational value.

Contrary to the poor performance in the original, "abstract" versions of the task, performance with some "thematic" rules was much better (e.g., the rule "If someone drinks beer then he is over 18"; Griggs & Cox, 1982). However, other thematic rules fail to facilitate performance ("if I eat spaghetti then I drink gin"; Manktelow & Evans, 1979). Many theories attempted to explain performance in the abstract version of the selection task (Evans, 1972, 1984; Johnson-Laird & Wason, 1970). Other approaches focused upon identifying the critical content feature that facilitates performance on the "thematic" versions (Cheng & Holyoak, 1985; Cosmides, 1989; Gigerenzer & Hug, 1992; Griggs & Cox, 1982; Manktelow & Over, 1991; Wason, 1983). The present study examines two recent theories that addressed the second question: Social Exchange Theory (Cosmides, 1989) and the Cheating Detection Theory (Gigerenzer & Hug, 1992).

Cosmides' "social exchange" theory (1989) suggested that people possess unique ability to identify potential deviations from social exchange contracts. Therefore, they correctely solve selection tasks involving social exchange situations but fail to test hypotheses in any other domain. Gigerenzer and Hug's (1992) "cheating detection" theory refined Cosmides' suggestion and specified that the crucial features of social exchange situations which facilitate performance in the selection task are cheating detection content and perspective. Both theories presented impressing empirical support. For instance, Gigerenzer and Hug (1992) obtained 80–90% correct performance in the cheating versions compared to 40% when the same rules were embedded in a no-cheating context. Gigerenzer and Hug (1992) particularly stressed the importance of perspective: being cued into a to-be-cheated party is necessary to facilitate performance on the task. Two possibilities are distinguished: in "unilateral cheating option rules" both the action represented by P and that represented by Q are performed by the same party. In these rules, only one party can cheat. Gigerenzer and Hug (1992) showed that cueing subjects into a "to-be-cheated" party facilitated P and not-Q selection, whereas cueing the subject into a "not-to-be cheated party" did not have a facilitating effect. In "bilateral cheating option rules"

action P and action Q are to be performed by different parties and thus both parties can cheat and be cheated. In these cases it was shown that subjects selected P & not Q combination or not-P and Q combination, depending on the perspective they assumed.

Both theories advanced an evolutionary view of human mind, postulating that human reasoning was shaped during the hunter-gatherer era, and that it operates according to some innate "Darwinian algorithms". Whereas social life in that area was based on exchange, an algorithm evolved that was especially designed to deal with social exchange contracts, or, more specifically, with possible violations of these contracts. Social exchange and cheating detection theories maintain that people solve the selection task using this algorithm, and reject the idea that people apply general hypothesis testing strategies to solve the task. Thus, any interpretation based on logic or general reasoning processes is rejected. For instance, Cosmides (1989) states her goal as deciding "if reasoning is governed by a logical procedure or by a 'look for cheaters' procedure" (Cosmides, 1989, p. 199). She resolves the issue in support for the latter, concluding that "the mental processes involved appear to be powerfully structured for social contracts, yet weakly structured for other elements and relations drawn from common experience" (Cosmides, 1989, pp. 262–263). Similarly, Gigerenzer and Hug (1992) state that some of their results are especially important because: "First, they rule out one alternative interpretation of the results: . . . namely, that social contracts . . . somehow facilitate logical reasoning" (Gigerenzer and Hug, 1992, p. 156). The last point is worth emphasizing: in social exchange and cheating detection theories content is not seen as a means to facilitate reasoning. Instead, a fixed algorithm is suggested, connecting specific stimulus property (social exchange or cheating detection) with a particular response (looking for people who enjoyed the benefit, but didn't pay the cost). These theories seem to "bypass" the logical mechanism, depicting general hypothesis testing strategies as largely irrelevant for performance on the selection task.

In this paper we suggest an alternative account for the results obtained by Cosmides (1989) and Gigerenzer and Hug (1992). We explain performance on the task using the same general cognitive factors that affect everyday hypothesis testing and understanding of rules. We closely examine Gigerenzer and Hug's (1992) materials, and show that they are confounded, so that cheating and no-cheating versions differ in many important respects unrelated to the cheating manipulation. We interpret these differences as potentially affecting understanding of the task in a way that can enhance or reduce performance. Finally, we conduct two studies to unconfound the materials, and show that cheating detection content and perspective are neither necessary nor sufficient to facilitate performance on the selection task. Study 1 refers to cheating context manipulation and to perspective change in unilateral cheating option rules. Study 2 addresses the case of perspective change in bilateral cheating option rules.

2. Wason's selection task as an everyday hypothesis-testing situation: understanding the task

When testing hypotheses in the selection task, people operate in the same way they do when solving everyday problems and understanding everyday situations (Klar, 1990; Klayman & Ha, 1987; Kruglanski, 1989). Three related aspects of task understanding are identified as crucial for enhancing performance on the selection task: (1) Is the rule interpreted according to the requirements of formal logic? (2) Does the context supply a clear alternative to the rule and imply P & not-Q as the relevant violating instance? (3) Is looking for violation relevant or useful in the task's context? We suggest that these features of the task rather than social exchange or cheating detection content are responsible for the high performance rates obtained by these paradigms.

2.1. Understanding the rule: determination and direction

In formal logic, "if P then Q" has a sole interpretation as depicting a situation where P necessitates the occurrence of Q (a deterministic link from P to Q), but not vice versa (the link from Q to P is undefined). An everyday interpretation may deviate from the normative in both determination (i.e., understanding the rule as probabilistic) and direction (understanding the rule in a reversed form).

(*a*) *Misunderstanding determination*

In many everyday situations "If P then Q" signifies probabilistic rather than deterministic relation. For instance, "if someone eats spoiled food, then he becomes ill" may mean that this is usually, but not always, the case (Chapman & Chapman, 1959). In probabilistic interpretation, "negative instances" (cases in which people ate spoiled food but did not become ill) cannot falsify the rule, and therefore bear little informational value for its test. The notion that people may interpret material implication as probabilistic received little attention in connection to the selection task (but see Pollard & Evans, 1981; Van-Duyne, 1976).

(*b*) *Misunderstanding direction*

"If P then Q" can be reversed and understood as signifying "if Q then P". For instance, people can reverse "if someone eats spoiled food, then he becomes ill" and infer "if someone is ill that means he ate spoiled food". Sometimes both the original and the inverted rules are assumed to be true, resulting in a biconditional interpretation (sometimes called "illicit conversion"). At other times only the inverted rule is assumed to hold (confusion of the inverse). Biconditional interpretation of "if–then" rules is a widely discussed phenomenon in syllogistic reasoning (Chapman & Chapman, 1959; Dickstein, 1975; Newstead, 1990). In relation to the selection task,

biconditional interpretation was suggested to account for the commonly occurring Q selection (Johnson-Laird & Byrne, 1992; Margolis, 1987; Wason & Johnson-Laird, 1970). Misunderstanding of both determination and direction is also possible (e.g., understanding the rule as probabilistic and biconditional: it is usually the case that when I eat spoiled food I become ill, and it is usually true that when I'm ill it is because I ate spoiled food). It is also possible that in some cases people are not able or willing to choose between possible interpretations, and therefore resort to a loose understanding like "there is some unspecified relation between P and Q".

2.2. Construing the alternative: is there a clear alternative and does it entail P & not-Q as the violating instance?

In formal logic, there is only one alternative to an "if P then Q" rule, which is the complementary possibility "there is an instance of P & not-Q". Therefore, in the normative model, the P & not-Q combination is the sole falsifying instance. In everyday life alternatives depend on the context. In natural discourse, each statement implies a "counterfactual possibility" that is being qualified or denied (Kahneman & Miller, 1986). An assertion of the form "if P then Q" has many counterfactual options, and consequently, may have many possible falsifying instances. For instance, "if I eat spoiled food, then I become ill", can have as counterfactuals any of the following possibilities: (a) that I am ill for another unspecified reason (in which case the falsifying instance is not-Q & P); (b) that I'm ill because of eating a specific kind of food, spoiled or unspoiled (in which case a specific not-Q & P combination is the violating instance); (c) that I can eat spoiled food without getting ill (a violating instance: P & not-Q); (d) that there is no relation between eating spoiled food and becoming ill (no specific violating instance). Some of these interpretations do not coincide with formal logic.

2.3. Adopting a testing strategy: how useful or relevant is falsification?

In the normative model, a rule of the form "if P then Q" is proved false by finding a case when the rule does not hold (P & not-Q). In the selection task, finding such a falsifying instance is the only way to test the truth of the rule. Positive instances (P and Q) bear no informational value, and cannot prove the truth or the falsity of the rule. However, in everyday life concentrating on positive versus negative instances may depend on the relative efficiency of the positive versus negative tests, on the "mental set" the subject may have when approaching the task and on the maturity of the rule or the hypothesis.

(a) Efficiency of positive versus negative test

Sometimes, negative testing (falsification) is less efficient than positive testing (confirmation) (Klayman & Ha, 1987). This is the case when people

believe that violation is impossible or unlikely in the situation depicted by the rule. Another case when falsification is not an optimal strategy is when the set represented by not-Q is much larger than P or Q sets. Thus, looking for healthy people to test the hypothesis "if someone eats spoiled food, then he becomes ill" is far from being efficient (Klar, 1982). Generally, it can be said that card selection depends on its perceived utility where utility is defined as the product of the values of the expected outcomes and their estimated probabilities (Kirby, 1994).

(*b*) *"Looking for violation" set*

The context of a selection task may induce the goal of finding a violation (e.g., find a cheater in order to punish him) but alternatively it can induce other goals like finding a confirming evidence, (e.g., find an obedient person in order to award him a prize). We assume that card selection depends on the construal of the goal of the search. Research on the selection task addressed this issue under the name of "falsification instructions" or "detective set". Yachanin and Tweney (1982), Griggs (1984), Valentine (1985) and Yachanin (1986) suggested that performance is enhanced when subjects are directly instructed to falsify the rule or are cued into the perspective of a detective or a police officer who looks for "law violators". Enhanced performance was found with still other fault seekers (Light, Girotto, & Legrenzi, 1990). In those studies that varied instructions (falsification versus confirmation) or perspective (e.g., "detective set" versus others) it was found that these manipulations enhanced performance only when used with content that produces independent facilitating effects. This unexplained interaction can be readily interpreted within the proposed model: falsification instructions can enhance P & not-Q selection only once P & not-Q is identified as the only relevant violating case (condition 2.2 above).

(*c*) *Maturity of the hypothesis*

Suppose a doctor is interested in the relation between eating spoiled food and illness. He has an initial hypothesis that if someone eats spoiled food then he becomes ill. It would be natural to begin by examining people who ate spoiled food and ill people (positive instances) to get some initial support for his hypothesis and learn about these phenomena. Testing negative instances of healthy people to see if they have eaten any spoiled food would be bizarre. Generally, when one wants to form an initial impression or collect evidence about the possibility of some newly proposed regularities, one initially seeks positive instances. Negative instances become relevant only when the relation is established (Holyoak & Spellman, 1993).

In sum, as a "formal hypothesis tester" people are supposed to (a) understand the rule as material implication, (b) consider "there are instances of P & not-Q" as the only viable alternative and infer P & not-Q as the only relevant violation, and (c) choose falsification as the appropriate

testing strategy. However, as everyday hypothesis testers, people may (a) understand the rule as implying a reversed, biconditional and/or a probabilistic relation, (b) assume that instances other than P & not-Q combination violate the rule, or (c) fail to appreciate the need to look for that violating instance.

3. A task-understanding analysis of Gigerenzer and Hug's materials

We propose to explain the effects obtained by Gigerenzer and Hug (1992) and Cosmides (1989) in terms of task understanding instead of content terms. Gigerenzer and Hug (1992) presented 12 tasks: six manipulated cheating versus no-cheating content; three manipulated perspective in unilateral cheating option rules; and three manipulated perspective in bilateral cheating option rules. We apply the three task understanding principles described above to analyze the confounding elements in "the cassava" task, used by Cosmides (1989) and Gigerenzer and Hug (1992). Then, we refer more briefly to the confounds in other tasks manipulating cheating versus no cheating content and perspective in unilateral cheating option rules. Bilateral cheating option rules are discussed next. The full description of several tasks as they appear in Gigerenzer and Hug (1992) and Cosmides (1989) are presented in the Appendix.

3.1. The "cassava root" task

This task was originally presented by Cosmides (1989), and it was replicated by Gigerenzer and Hug (1992). The rule was "If a man eats cassava root, then he must have a tattoo on his face". Cards showing "has a tattoo", "has no tattoo", "eats cassava root" and "eats molo nuts" were presented. The context story tells about the Kulumae tribe, the inhabitants of Maku island. On this island, cassava root and molo nuts are the only available kinds of food. Among the Kulumae, a married man is indicated by a tattoo on his face.

The cheating version

In this version, subjects were told that cassava root is a tasty, nutritious and rare aphrodisiac, while molo nuts taste bad, are common, not nutritious, and have no "magic properties". The elders of the Kulumae tribe have made the rule in order to ration the rare cassava root for the married and prevent premarital sex. Subjects are cued into the perspective of a Kulumae member, whose duty is to enforce the law, that is, check if any of the Kulumae men had violated it. It is said that unmarried people may desire the root, because Kulumae men are "very sensual".

The no-cheating version

This version cued the subject into the perspective of an anthropologist, who learns from his colleague's report that the rule holds among the Kulumae. His colleague did not speak the local language, and he wants to know whether this is really the case. He finds out that cassava grows primarily in the south, whereas molo nuts, which are equally available, nutritious and tasty, usually grow in the north. The single live in the north, but when married, they are indicated by a tattoo, and usually move to the south. The rule, it is said, holds because people eat what is more available for them. Four Kulumae are seated in the center of the island and each of them eats food he has brought from his home.

3.1.1. Understanding the rule

(*a*) *Determination*

In the no-cheating version, a non-deterministic interpretation of the rule is possible because the suggested contingency between living place and eating certain food is explained by relative availability. Moreover, the words "primarily" or "usually" that are used through the story, strongly suggest a probabilistic interpretation. Contrary to this, the cheating version blocks the non-deterministic interpretation of the rule by clarifying that the rule is strict and bears no exceptions.

(*b*) *Direction*

In the no-cheating version, the rule can be readily interpreted as a biconditional: if Kulumae people eat what is more available to them, then a Kulumae with a tattoo (who lives in the north) should eat cassava (that grows in the north), and a Kulumae with no tattoo (who lives in the south), should eat molo nuts (that grow in the south). Contrarily, the cheating version suggests a situation that makes it clear that unmarried Kulumae desire the tasty, rare aphrodisiac (cassava) but no one desires the common, bad tasting, and non-nutritious molo nuts. In that way, a biconditional interpretation is blocked.

3.1.2. Construing the alternative

In the no-cheating version the implied alternative is unclear: is there no relation between having a tattoo and the preferred kind of food (no specific violating instance), is it that Kulumae with no tattoo eat cassava root (violating instance: P & not-Q) or maybe that Kulumae with a tattoo eat molo nuts (violating instance: not-P & Q)? Consequently, there is uncertainty regarding which violating instance is to be sought. Contrary to this, the cheating version specifies that "Your job is to catch men whose sexual desires might tempt them to break the law" (Cosmides, 1989, p. 264). This clarifies that the violating combination is an unmarried Kulumae that eats the aphrodisiac cassava root.

3.1.3. Adopting a testing strategy

Looking for violations is far from being the most obvious thing to do in the no-cheating version. The anthropologist who comes to an unknown island would probably like to establish whether there is "a kernel of truth" in the proposed rule. Moreover, because the hypothesis was proposed by a colleague that did not speak the local language, his conclusion may seem premature. In that situation, it is reasonable to look first for positive instances. Contrarily, the cheating version provides the relevance of falsification by the perspective of someone whose responsibility is to find "law breakers".

In sum, the cheating and no-cheating versions, which are supposed to differ only in the cheating content feature, seem to suggest different understanding of the rule, different violating instances and different testing strategies.

3.2. Other tasks manipulating cheating versus no-cheating content and perspective

All of Gigerenzer and Hug's (1992) manipulations of cheating versus no-cheating content (the following tasks: "Duiker" [2] "Overnight" [3] "Grover" [4] "Winner" [5] and "Dealer" [6])[1] and perspective change in unilateral cheating option tasks (the tasks: "Post office" [10], "Cholera" [11], and "Drinking" [12]) are confounded in the same manner as the "Cassava root" task ([1]) that is analyzed above. The no-cheating versions of these rules suggest non-deterministic (tasks 1, 2) or biconditional (tasks 1, 10) interpretation. The no-cheating version of tasks 2, 3, 4 and 5 explicitly suggest alternatives other than P & non-Q. For instance, in the no-cheating version of the "overnight" task, ("If someone stays overnight in the cabin then that person must bring a bundle of wood from the valley"), it is said that "rather than the hikers, the members of the Swiss Alpine club, who do not stay overnight, might carry the wood" (Gigerenzer & Hug, 1992, p. 143). This alternative points to not-P & Q as a relevant violating instance. In other tasks (1, 6, 10, 11, 12), the no-cheating version implicitly suggests a violating instance other than P & not-Q by allowing for biconditional interpretation of the rule (tasks 1, 10), or proposing "no relation" as the likely alternative to the rule (tasks 6). In still other tasks (tasks 11, 12) the meaning of the four cards was obscured. The no-cheating versions of tasks 1–6 introduce a perspective of a "wondering visitor", interested in finding out how things are organized (e.g., a visitor from another country, a journalist), thereby suggesting confirmation rather than falsification as the required strategy. Contrary to these, the cheating versions of the same tasks

[1] The task numbers (in brackets) represent the original task numbers as listed by Gigerenzer and Hug (1992, Table 1, p. 136). A full description of this task can be found in the Gigerenzer and Hug paper.

clearly suggested a unilateral and deterministic rule, pointed to P & not-Q as the only relevant violating case and presented looking for violation as essential to the task.[2]

3.3. Bilateral cheating options tasks

The case of bilateral cheating option rules (the tasks: "Day off" [7], "Pension" [8], and "Subsidy" [9]) is straightforward. All three rules suggest a biconditional interpretation (if and only if) and thus have two possible violating combinations: P & not-Q and not-P & Q. The perspective makes only one of these salient, relevant and interesting. For instance, the "Day off" rule [7] was "If an employee works on the weekend, then that person gets a day off during the week". It was explained that working on the weekend is a benefit for the employer but a cost for the employee, and that getting a day off is a benefit for the employee and a cost for the employer. This clearly implies that getting a day off during the week requires working on the weekend. This reversed interpretation can be assumed in addition to the original one, resulting in a biconditional interpretation, where both P & not-Q and not-P & Q combinations violate the rule. In the employee's perspective it was reasonable to look for a case where the day off was not given, although the workers deserved it (P & not-Q). In the employer's version it was reasonable to look for a worker that got a day off without deserving it (not-P & Q). Similar analysis can be applied to the "pension" rule and the "subsidy" rule.

Because the materials Gigerenzer and Hug (1992) employ are confounded, their results cannot unequivocally support the proposed cheating detection hypothesis. Our aim is to unconfound their results and show that cheating detection content and perspective are neither *sufficient* nor *necessary* to yield P & not-Q selection on Wason's task. In relation to cheating versus no-cheating content and perspective manipulation, we propose two different tests (Study 1). First, we unconfound the cheating versions, to test the sufficiency of cheating. We change the cheating versions in a way that makes the normative interpretation less obvious, by suggesting additional violating instances or introducing a situation in which the rule can be interpreted in a non-deterministic way. This is done without changing perspective or affecting the cheating nature of the task. The devices we use are similar to those used by Gigerenzer and Hug (1992) in their no-cheating versions. We predict decrease in performance in the unconfounded cheating versions compared to the original cheating versions. Cheating detection theory would predict the same high performance rates as in the original cheating version because the cheating element is still present in the task. Second, we unconfound the no-cheating versions, to test the necessity of

[2] A detailed analysis of the apparent effects of the three task understanding factors on tasks 2–12 in Gigerenzer and Hug (1992) can be obtained from the present authors.

cheating. We do this by introducing cognitive properties that enhance normative interpretation of the rule, the violating instances and the required testing strategy (see also Fiedler & Hertel, 1994; Manktelow & Over, 1991; Pollard, 1990; on the necessity issue regarding social contract contents). This is done without changing perspective or affecting the no-cheating nature of the task. We predict enhanced performance compared to the original no-cheating version. Cheating detection theory would predict the same low performance as in the original no-cheating version. Regarding perspective change in bilateral cheating option rules (Study 2), we show that: (a) the results obtained by Gigerenzer and Hug (1992) by changing perspectives can be achieved by other means that help to identify the relevant violating case; (b) perspective change is not sufficient to change selection pattern in the expected way. It fails to produce this effect when it does not indicate P & not-Q as the only relevant violation in one perspective, and not-P & Q as the only relevant violation in the other perspective (see Light, Girotto, & Legrenzi, 1990; Girotto & Light, 1992; Politzer & Nguyan-Xuan, 1992; Platt & Griggs, 1993; for related points on the meaning of perspective in bilateral deontic rules).

STUDY 1: CHEATING VERSUS NO-CHEATING CONTENT AND PERSPECTIVE

4. Method

4.1. Subjects

One hundred and seventy-one economics undergraduates (92 male, 79 female), studying at Tel-Aviv University participated in the study. The students ranged in age from 19 to 33 (mean 24.19 years).

4.2. Materials

Five tasks were used, each in four versions: (1) the original cheating version, adopted from Gigerenzer and Hug (1992); (2) an unconfounded cheating version; (3) the original no-cheating version, adopted from Gigerenzer and Hug (1992); (4) an unconfounded no-cheating version.

In all four versions of each task the same rule and the same cards were used. The cheating and no-cheating versions were adopted from Gigerenzer and Hug (1992) with slight changes adapted to Israeli subjects. The unconfounded cheating version added to the original cheating version elements which blocked the correct interpretation of the rule and the correct identification of the violating instance. Some of these elements were introduced by Gigerenzer and Hug (1992) in their no-cheating versions. The

unconfounding did not change perspective and did not affect the cheating nature of the original versions. The unconfounded no-cheating versions introduced clarifying features into the original no-cheating versions. This was done without altering cheating content or perspective. Following is a detailed description of the four versions of the "Grover" task. A detailed description of other tasks is reported in the Appendix.

The "Grover" rule was "if a student is to be assigned to Grover High School, then the student must live in Grover city". Cards showing "lives in Grover", "lives in Hanover", "assigned to Grover High school", "assigned to Hanover High School" were presented. It was told that Grover and Hanover are neighboring cities, each of which has a high school. The rule was said to regulate assignment to the high schools.

The cheating version

This version is described as follows: "Parents in Grover city spend a lot of money on Grover High School, whereas parents in Hanover, although equally prosperous, never wanted to spend much money on Hanover High School. Consequently, children at Grover High School get a better education. The subjects were cued into the perspective of a supervisor at the local Board of Education, who checks whether any one of four volunteers to the Board of Education – who assigned their own teenagers to the two high schools – has violated the rule" (Gigerenzer & Hug, 1992; pp. 143–144).

The unconfounded cheating version

This version introduced a slight variation to the original cheating version. It was said that the volunteers may have assigned their own sons and the sons of other volunteers working with them. Moreover, some volunteers hate each other. In that version, cheating is expected and is sought out, but, unlike in the original cheating version, it is not clear who cheated and how. The subject suspects cheating and is cued into the same perspective as in the original version, but the suspected cheating can be revealed in instances other than P & not-Q.

The no-cheating version

This version is described as follows: "The subject was cued into the perspective of a representative of the German government who visits the USA. The representative is informed that in the USA the quality of a school depends heavily on the willingness of a community to spend money on schools, and the case of Grover High School and Hanover High School is presented as an example. Parents in Grover city have always cared about the quality of their schools, including Grover High, and have been willing to pay for it. In contrast, the parents in the neighboring town of Hanover have never wanted to spend the money. Consequently, the quality of Grover High is much better than Hanover High. The representative wonders how students are assigned to the two schools, given the different willingness to

pay for education. A colleague suggests the rule as a plausible assignment rule created by the local board of education, given that situation. The context story also mentions two other possible assignment rules: assignment by the student's ability and achievement only, and assignment by the spatial distance between a student's home and school. The context story said that the representative is interested in checking the validity of the rule suggested" (Gigerenzer & Hug, 1992, p. 144). We changed this slightly by replacing "German government representative" with "Israeli government representative".

The unconfounded no-cheating version

This version cued the subject into the same perspective as the original version. It was told that the visiting Israeli representative learns about the assignment rule, that Grover is a rich place, and Hanover is a poor neighborhood. He is involved in the busing problem in Israel, and therefore is interested in how children of the poor area may feel in the school of a rich neighborhood. Therefore, he would like to find a child for whom the rule is violated. The misleading alternatives presented in the original no-cheating version were deleted. This version unequivocally identifies the relevant violation that is being looked for as a child of a poor neighborhood assigned to a rich neighborhood school. Cheating content or perspective are not introduced.

4.3. Procedure

Subjects participated in large groups, on four different occasions. Each subject received a booklet with instructions on the first page, followed by two or three selection tasks. Each task was presented on a separate page, and subjects were instructed not to return to a task after proceeding to the following one. Task presentation order and task combinations were randomized. Only one version of the same task was presented to each subject.

5. Results

Three predictions were tested: First, we expected to replicate the results of cheating detection theory (Gigerenzer & Hug, 1992). Specifically, we predicted that cheating versions would yield higher performance rates compared to no-cheating versions. Second, we expected reduced performance rates in the unconfounded cheating versions compared to the original cheating versions. Third, we predicted better performance on the unconfounded no-cheating versions compared to the original no-cheating versions.

X^2 (two-tailed) tests were performed for each problem to test each of the three hypotheses. Corresponding performance rates and patterns of card

Table 1
Percentages of selections patterns in Study 1

	N	P & not-Q	P alone	P & Q	P, Q & Not-Q	All four	Not-P & Q	Other
1. Grover								
(a) Original cheating	*(20)*	80	10	5	0	0	0	10
(b) Unconfounded cheating	*(19)*	20	15	25	0	5	0	35
(c) Original no-cheating	*(22)*	32	18	9	0	14	5	22
(d) Unconfounded no-cheating	*(22)*	64	5	5	5	0	0	21
2. Cassava								
(a) Original cheating	*(21)*	81	5	5	0	0	0	9
(b) Unconfounded cheating	*(22)*	41	18	9	0	0	9	23
(c) Original no-cheating	*(19)*	26	16	16	0	0	5	37
(d) Unconfounded no-cheating	*(19)*	58	21	0	5	0	5	11
3. Overnight								
(a) Original cheating	*(21)*	76	0	10	0	0	0	14
(b) Unconfounded cheating	*(22)*	45	23	5	0	9	5	13
(c) Original no-cheating	*(21)*	57	5	14	0	5	0	19
(d) Unconfounded no-cheating	*(20)*	85	0	5	0	0	0	10
4. Dealer								
(a) Original cheating	*(23)*	52	17	0	13	0	0	18
(b) Unconfounded cheating	*(26)*	19	4	12	4	4	31	26
(c) Original no-cheating	*(24)*	25	12	21	17	0	0	25
(d) Unconfounded no-cheating	*(23)*	74	9	4	0	0	0	13
5. Cholera								
(a) Original cheating	*(22)*	64	9	5	0	0	0	22
(b) Unconfounded cheating	*(19)*	26	32	16	0	0	0	26
(c) Original no-cheating	*(22)*	18	9	9	0	0	32	32
(d) Unconfounded no-cheating	*(20)*	75	5	5	0	0	5	10

choices are presented in Table 1. A replication of Gigerenzer and Hug's results was obtained in "Grover". X^2 $(1, n = 43) = 9.82$, $p < .01$; "Cassava" X^2 $(1, n = 40) = 12.03$, $p = .001$ and "Cholera" X^2 $(1, n = 44) = 9.40$, $p < .01$ tasks. The "Overnight" task did not reach significance, although results were in the expected direction. Cheating: 76%; no-cheating: 57%, X^2 $(1, n = 42) = 1.71$, $p = .190$. The "Dealer" task approached significance X^2 $(1, n = 47) = 3.67$, $p = .055$. As predicted, performance rates in the unconfounded cheating versions of all five tasks were significantly lower compared to the original cheating versions of the same tasks. For the "Grover" task X^2 $(1, n = 40) = 3.55$, $p < .001$; for the "Cassava" task X^2 $(1, n = 43) = 7.21$, $p < .01$; for the "Overnight" task X^2 $(1, n = 43) = 4.24$, $p < .05$; for the "Dealer" task X^2 $(1, n = 49) = 5.85$, $p < .05$; for the "Cholera" task X^2 $(1, n = 41) = 5.71$, $p < .05$. Finally, and also as predicted, significant facilitation effects were obtained in the unconfounded no-cheating versions compared to the original no-cheating versions in all five

tasks. For the "Grover" task X^2 $(1, n = 44) = 4.46$, $p < .05$; for the "Cassava" task X^2 $(1, n = 38) = 3.89$, $p < .05$; for the "Overnight" task X^2 $(1, n = 41) = 3.84$, $p < .05$; for the "Dealer" task X^2 $(1, n = 47) = 11.24$, $p < .001$; for the "Cholera" task X^2 $(1, n = 42) = 5.71$, $p < .001$.

We averaged performance rates in parallel versions of the five tasks. The average percentage of subjects that correctly selected P & not-Q cards was as follows: on the cheating versions: 71%; the unconfounded cheating: 30%; the original no-cheating: 32%; and the unconfounded no-cheating: 71%. Two points should be noted: Firstly, performance on the unconfounded cheating versions is comparable to that of the original no-cheating versions (30–32%). This implies that cheating is not sufficient to yield correct performance. Secondly, performance in the unconfounded no-cheating versions reaches the high level obtained with the original cheating versions (71%). Apparently, cheating is not necessary to yield correct performance. Performance rates obtained in our sample are lower than those obtained by Gigerenzer and Hug (usually around 80–90%), and are comparable to those obtained by Cosmides (usually around 70%).

Generally, the results reveal that cognitive features related to task interpretation, and not cheating content and perspective, facilitate performance on the selection task.

STUDY 2: BICONDITIONAL CHEATING OPTION RULES

In biconditional cheating option rules two different parties perform the two parts of a social exchange (Gigerenzer & Hug, 1992), so that both sides can cheat and be cheated. For instance, in the rule "If you pay you get the product" the buyer can be cheated if he pays but doesn't get the product, and the salesperson can be cheated if he gives the product but does not get the money. Subjects cued into these perspectives are supposed to look for one cheating possibility and ignore the other. In their studies, Gigerenzer and Hug show exactly this pattern of choice reversal; when cued into the perspective of one party (i.e., the buyer) subjects choose P & not-Q cards, but when cued into the perspective of the other party (i.e., the sales person), they choose the not-P & Q cards. We proposed that Gigerenzer and Hug's (1992) biconditional cheating option rules are interpreted as biconditionals, which means that both the P & not-Q combination and not-P & Q combination constitute possible violations. Assuming one perspective makes only one of these possibilities relevant. We hypothesize that perspective change is neither necessary nor sufficient to obtain this shift in response pattern. The insufficiency of perspective was previously suggested by Girotto and Light (1992), who proposed that perceived plausibility of the violation is a crucial factor in facilitating performance. Along the same line, the fact that perspective change is not necessary to shift performance was previously shown by Light, Girotto, and Legrenzi (1990). They obtained a

shift in children's selection patterns by using a third party perspective and manipulating the plausibility of different violations. Accordingly, we hypothesize that: (1) when both violating instances are made relevant, changing perspective does not produce shift in selection pattern; (2) it is possible to produce a shift in selection pattern similar to that of Gigerenzer and Hug (1992) without changing perspectives. Both these predictions deviate from cheating detection theory.

6. Method

6.1. Subjects

One hundred and sixteen psychology undergraduates (89 female, 27 male) at Tel-Aviv University served as subjects. Their age ranged from 19 to 31 (mean 24.16).

6.2. Materials

We used two biconditional cheating option tasks. One was a variation of a task introduced by Gigerenzer and Hug (1992), and the other was a new one. Each task had six versions. The version used the same rule and the same four cards. Versions 1 and 2 replicate Gigerenzer and Hug's perspective change manipulation. We expected to replicate the shift in selection pattern from P & not-Q to not-P & Q. Versions 3 and 4 use the same perspectives as versions 1 and 2, but make both kinds of violation relevant. It is expected that no shift in selection pattern will occur. Versions 5 and 6 both use the same third party perspective, but make either P & not-Q violation or not-P & Q violation relevant. It is expected that a shift in selection pattern will occur. Following is a brief description of the six versions of the "Day off" task. The "Salary raise" problem is presented in the Appendix.

The "Day off" task

The "Day off" rule was, "if an employee works on the weekend then he gets a day off on Monday". Cards showing "worked on the weekend", "didn't work on the weekend", "worked on Monday", "didn't work on Monday" were presented. It was explained that working on the weekend is a benefit for the firm but is a cost for the employees, and that getting a day off is a benefit for the employees and a cost for the firm. This rule was a variation of Gigerenzer and Hug's "Day off" rule.

Perspective change

The first two versions manipulated perspective in a way similar to Gigerenzer and Hug's (1992). Version 1 cued the subject into the perspective

of an employee who considers working on the weekend, and suspects that in the past workers were cheated and didn't get what they deserve. Version 2 cued the subject into the perspective of an employer that suspects that workers of the plant cheat the firm and take benefits they don't deserve.

Unconfounding perspective change

The next two versions used the same perspectives as versions 1 and 2, but made both violation types relevant. Version 3 cued the subject into the perspective of an employee, that is concerned with the possibility of a violation of the given rule. He is said to worry about the possibility that some workers don't get what they deserve, while others get benefits without paying the cost. Version 4 cued the subject into the perspective of an employer who has the same "bilateral" concerns.

Manipulating selection pattern without perspective change

Versions 5 and 6 were designed to show that it is possible to obtain a shift in selection pattern without changing perspective. Both versions used the same third party perspective of a student that is interested in cases when rules are violated in working places. Then, two possibilities were introduced: in version 5 it was said that the student is interested in situations where workers don't get what they deserve according to the rule; in version 6 it was said that the student is interested in cases when the workers get more than they deserve.

6.3. Procedure

Subjects participated in a large group. Each subject received a booklet with instructions on the first page, followed by two selection tasks: a "Day off" task and a "Salary raise" task. Each task was presented on a separate page, and subjects were instructed not to return to a task after proceeding to the following one. Presentation order and version combinations were counterbalanced.

7. Results

Three predictions were tested. First, we expected to replicate Gigerenzer and Hug's (1992) results. We expected to obtain high P & not-Q selection rates and low not-P & Q selection rates for version 1 of both tasks, and a reversed pattern for version 2 of both tasks. Second, we expected this pattern not to be found in versions 3 and 4, that use the same perspectives as versions 1 and 2, but make both combinations relevant violating cases. Third, we expected that versions 5 and 6 yield the same response pattern as versions 1 and 2, although they did not use perspective change. Table 2

Table 2
Percentages of selection patterns in Study 2

Task	Version	*N*	P & not-Q	not-P & Q	P & Q	P alone	All four cards	Other
Day off	1. Original: employee	*(18)*	67	6	0	11	0	16
	2. Original: employer	*(19)*	8	58	0	0	5	29
	3. Unconfounded: employee	*(18)*	17	17	11	6	22	27
	4. Unconfounded: employer	*(17)*	0	24	18	6	29	23
	5. Third party: P & not-Q relevant	*(19)*	58	0	5	16	0	21
	6. Third party: not-P & Q relevant	*(22)*	0	50	23	5	18	4
Salary raise	1. Original: employee	*(17)*	65	6	6	6	6	11
	2. Original: employer	*(18)*	6	39	6	11	6	32
	3. Unconfounded: employee	*(18)*	39	0	17	0	28	16
	4. Unconfounded: employer	*(19)*	5	6	16	0	42	31
	5. Third party: P & not-Q relevant	*(18)*	44	11	22	0	0	23
	6. Third party: not-P & Q relevant	*(18)*	11	50	17	0	6	16

presents percentage of subjects that selected P & not-Q, not-P & Q, and other card patterns in each version of the two tasks.

Gigerenzer and Hug's (1992) results with perspective change were replicated in both tasks. Version 1 yielded more P & not-Q responses (67% for the "Day off" task; 65% for the "Salary raise" task) than not-P & Q responses (6% in both tasks). Version 2 showed the opposite pattern (58–39% not-P & Q responses versus 0–6% P & not-Q responses). Versions 3 and 4, that used the same perspectives as versions 1 and 2 (respectively), but introduced both P & not-Q and not-P & Q as relevant violations, did not yield the same response pattern as versions 1 and 2. In version 3, which used the same perspective as version 1, selection of P & not-Q was reduced (from 67% to 17% in the "Day off" task, X^2 $(1, n = 36) = 9.26$, $p < .01$; for the "Salary raise" this decrease did not reach significance: 65% versus 39%, X^2 $(1, n = 35) = 2.33$, $p = .127$). In version 4, which used the same perspective as version 2, selection of not-P & Q was reduced (from 58% to 25% in the "Day off" task, X^2 $(1, n = 36) = 4.36$, $p < .05$; from 39% to 5% in the "Salary raise" task, X^2 $(1, n = 37) = 6.17$, $p < .01$). Versions 5 and 6 show the same response pattern as versions 1 and 2, although they did not introduce perspective change. Version 5 yielded more P & not-Q responses (58% in the "Day off" task; 44% in the "Salary raise" task) than not-P & Q responses (0 in the "Day off" task; 11% in the "Salary raise" task). Version 6 yielded the opposite pattern: more not-P & Q responses (50% in both tasks) than P & not-Q responses (0 in the "Day off" task; 11% in the "Salary raise" task). Selection rates of P & not-Q in versions 5 did not differ from version 1 (58% compared to 67%, X^2 $(1, n = 37) = 0.30$, $p = .58$ for the "Day off" rule; 44% compared to 65%, X^2 $(1, n = 35) = 1.45$, $p = .23$ in the "Salary raise"). Selection rates of not-P & Q in version 6 did not differ from version 2 (50% compared to 58%, X^2 $(1, n = 41) = 0.26$, $p = .61$ for the "Day off" rule; 50% compared to 39%, X^2 $(1, n = 36) = 0.45$, $p = .50$ for the "Salary raise").

In general, selection patterns in the original perspective change (versions 1, 2) did not differ from no-perspective change versions (5 and 6), but differed considerably from the unconfounded perspective change versions (3 and 4). These results imply that perspective change in bilateral cheating option tasks is neither necessary nor sufficient for shifting responses between P & not-Q and not-P & Q.

Gigerenzer and Hug (1992) report 70–80% of P & not-Q selections and around 60% of not-P & Q selections in the appropriate versions. Our replication yielded a mean of 66% P & not-Q for versions 1 of the two tasks, and a mean of 50% of not-P & Q selections for versions 2 of the two tasks. The somewhat higher rate of P & not-Q responses compared to not-P & Q responses is evident in both samples. As Gigerenzer and Hug (1992) suggest, this may be because some subjects select the logically correct P & not-Q combination regardless of content.

GENERAL DISCUSSION

We suggested three aspects that are crucial in understanding the Wason selection task in a way that facilitates performance: (a) the clarity of the rule in terms of determination (does it suggest deterministic relation?) and direction (does it prevent confusion of the inverse and biconditional interpretation?); (b) the nature of the implied alternative, and the falsifying instance it entails (is the P & not-Q combination suggested as the relevant violating instance?); (c) the perceived relevance of looking for violation. A task is interpreted in accord with the normative model if and only if the rule is understood as unidirectional and deterministic, P & not-Q combination is considered to be the only relevant violating instance, and looking for violations is adopted as the testing strategy. However, in everyday hypothesis testing this is not warranted. Our results support the notion that Gigerenzer and Hug's (1992) findings could be attributed to these general properties of task understanding rather than to cheating detection content and perspective. Cheating versions were unconfounded by introducing elements that obscured the normative interpretation, and no-cheating versions were unconfounded by introducing facilitating elements. In Study 1 we showed that these manipulations reduced performance in the cheating versions, and enhanced performance on the no-cheating versions. Performance levels in the unconfounded no-cheating versions reached the high level of cheating versions (both cheating and no-cheating: 71%). Performance rates in the unconfounded cheating were as low as in the original no-cheating versions (30–32%). In Study 2 we showed that the reversal in choice patterns obtained by Gigerenzer and Hug (1992) by shifting perspectives in bilateral cheating option rules, fails to occur when perspective shift does not accompany change in the relevance of different violating instances. Moreover, this reversal can be obtained without shifting perspectives. The results of both studies imply that cognitive interpretational properties of the task explain the results demonstrated by Gigerenzer and Hug (1992).

As noted above, some previous theoretical approaches applied interpretational accounts to explain syllogistic reasoning in general (Henle, 1962) and performance in the selection task in particular (Evans, 1984; Griggs, 1984; Margolis, 1987; Johnson-Laird, 1983; Johnson-Laird & Byrne, 1991). Our approach is closely related to Johnson-Laird and Byrne's (1991) "mental models" theory (see also Johnson-Laird, 1983). According to this theory, people represent the content of the premises of a reasoning problem in "mental models". Subsequently, reasoners focus on what is being represented in their models. In the mental model of an "if P then Q" rule, "P and Q" and "Q alone" cases are represented. Falsifying instances are not explicitly represented, but are supposed to be "fleshed out" in the process of reasoning. Some content and context elements help in this process of fleshing out (Johnson-Laird & Byrne, 1991; Legrenzi, Girotto, & Johnson-

Laird, 1993). It should be noted, however, that within this model only the normatively correct alternative can be fleshed out, that is, P & not-Q or both this and not-P & Q (if the rule is interpreted as a biconditional). Contrary to this, our model assumes that subjects can consider other, contextually defined violating instances as well.

By refuting cheating detection and social exchange as inadequate accounts of performance in the selection task, we do not suggest that reasoning is "formal" or "content-independent". There is no doubt that response patterns on the selection task differ considerably and systematically depending on the type of content. Yet, the content feature that produces these effects should not necessarily be identified in content-related terms. Content may be an important way to affect cognitive factors, but there is no fixed link between some types of content (e.g., cheating detection) and response patterns. The cheating situation is usually an efficient way to produce interpretation of the task situation that coincides with formal logic, but it does not necessarily have this property, and is by no means the only way to do so. It should be noted that performance in the selection task was enhanced by manipulating non-content factors. For instance, Griggs (1989), following Margolis' theory (1987), manipulated "scenario ambiguity", the possibility of biconditional interpretation of the rule, and the possibility of matching. He obtained 80% of correct selection on the task. Wason and Green (1984) demonstrated facilitation in a reduced array selection task (RAST) using unified representation (when p and q are incorporated in the same stimuli) compared to disjoint representation. Recently, Kirby (1994) showed card selection to depend on set size. A detailed examination of these finding within our theoretical approach is beyond the scope of this paper. Suffice it to say that all these factors can be interpreted as facilitating understanding of the rule or its possible violating instances but they cannot be incorporated into a content dependent model, such as cheating detection theory. The sufficiency of the cheating content was challenged by Girotto, Gilly, Blaye, and Light (1989), who showed that implausible deontic rules fail to facilitate children's performance on the selection task.

Finally, the issue of functionality and adaptation has to be addressed. Cheating detection and social exchange theories argue that content-specific mechanisms are more adaptive than a general logic mechanism. We doubt that a general reasoning mechanism is less "adaptive" or may have less evolutionary value than a specified cheating detection algorithm (for similar points see Cheng & Holyoak, 1989; Pollard, 1990). We can only ponder about what life was like in a hunter-gatherer's society, during the long years which have supposedly shaped human mind. However, it seems reasonable to assume that for people of this era (as well as people in any other time) survival was dependent upon solving problems of a non-social type, that were unrelated to cheating. For example, they may have had to develop ways to decide which herbs are edible and which are not, whether a certain river is too deep to cross, whether a certain tool is suitable for a specific use,

etc. For these issues people had to develop a general hypotheses testing capacity and not just an algorithm for detecting cheaters in social exchange situations.

APPENDIX: DESCRIPTION OF PROBLEMS

I. Additional problems used in study 1

1. Cassava (Task 1 of Gigerenzer & Hug, 1992)

The "Cassava" rule was "If a man eats cassava root, then he must have a tattoo on his face". Cards showing "has a tattoo", "has no tattoo", "eats cassava root" and "eats molo nuts" were presented.

The cheating version

This version was described as follows: "You are a Kulumae, a member of a Polynesian culture found only on Maku Island in the Pacific. The Kulumae have many strict laws which must be enforced, and the elders have entrusted you with enforcing them. To fail would disgrace you and your family.

Among the Kulumae, when a man marries, he gets a tattoo on his face; only married men have tattoos on their faces. A facial tattoo means that a man is married, an unmarked face means that a man is a bachelor.

Cassava root is a powerful aphrodisiac – it makes the man who eats it irresistible to women. Moreover, it is delicious and nutritious – and very scarce.

Unlike cassava root, molo nuts are very common, but they are poor eating – molo nuts taste bad, they are not very nutritious, and they have no other interesting "medicinal" properties.

Although everyone craves cassava root, eating it is a privilege that your people closely ration. You are a very sensual people, even without the aphrodisiac properties of cassava root, but you have very strict sexual mores. The elders strongly disapprove of sexual relations between unmarried people, and particularly distrust the motives and intentions of bachelors.

Therefore, the elders have made laws governing rationing privileges. The one you have been entrusted to enforce is as follows:

'If a man eats cassava root, then he must have a tattoo on his face'.

Cassava root is so powerful an aphrodisiac, that many men are tempted to cheat on this law whenever the elders are not looking. The cards below have information about four young Kulumae men sitting in a temporary camp; there are no elders around. A tray filled with cassava root and molo nuts has

just been left for them. Each card represents one man. One side of a card tells which food a man is eating, and the other side of the card tells whether or not the man has a tattoo on his face.

Your job is to catch men whose sexual desires might tempt them to break the law – if any get past you, you and your family will be disgraced. Indicate only those card(s) you definitely need to turn over *to see if any of these Kulumae men are breaking the law*." (Cosmides, 1989, pp. 263–264).

The unconfounded cheating version

This version suggested the following situation. The cassava root tastes awful, and is a strong aphrodisiac ("it makes a man who eats it irresistible to women"). Molo nuts, on the other hand, are very tasty. (In the original cheating version cassava root had all the desirable qualities.) One cannot eat both because the combination is very dangerous. As in the original cheating version, it was told that the unmarried Kulumae desire the cassava root. It was added that married people, indicated by a tattoo on their face, do not like the cassava, not only because of its awful taste, but also because times are hard and they prefer to have small families. The elders are concerned about preventing premarital sex, and in increasing birth rates. For that, they have made the rule. The subject has the same perspective as in the original version: a Kulumae member whose duty is to enforce the law. This story retains the cheating content and perspective, but the nature of the violating instance (who is expected to cheat and how) remains unclear.

The no-cheating version

This version was described as follows: "You are an anthropologist studying the Kulumae people, a Polynesian culture found only on Maku Island in the Pacific. Before leaving for Maku Island you read a report that says some Kulumae men have tattoos on their faces, and that they eat either cassava root or molo nuts, but not both. The author of the report, who did not speak the language, said the following relation seemed to hold:

'If a man eats cassava root, then he must have a tattoo on his face.'

You decide to investigate your colleague's peculiar claim. When you arrive on Maku Island, you learn that cassava root is a starchy staple food found on the south end of the island. Molo nuts are very high in protein, and grow on molo trees which are primarily found on the island's north shore.

You also learn that bachelors live primarily on the north shore, but when men marry, they usually move to the south end of the island. When a Kulumae man marries, he gets a tattoo on his face; only married men have tattoos on their faces. A facial tattoo means that a man is married, an

unmarked face means that a man is a bachelor. Perhaps men are simply eating foods which are most available to them.

The cards below have information about four Kulumae men sitting in a temporary camp at the center of the island. Each man is eating either cassava root or molo nuts which he has brought with him from home. Each card represents one man. One side of a card tells which food a man is eating, and the other side of the card tells whether or not the man has a tattoo on his face.

The rule laid out by your colleague may not be true; you want to see for yourself. Indicate only those card(s) you definitely need to turn over *to see if any of these Kulumae men are breaking the rule*" (Cosmides, 1989, p. 265).

The unconfounded no-cheating version

This version cued the subject into the same perspective as in the original no-cheating version: that of an anthropologist visiting the island. It was told that the cassava root is rare and tasty, while molo nuts are common and nutritious, but not very tasty. (The original no-cheating version said that both were equally nutritious and tasty.) According to a previous anthropological report, Kulumae people believe that only special people, indicated by a tattoo on their face, can digest the cassava root. According to this belief, "regular" people (those who have no tattoo) become sick shortly after they eat cassava. Therefore, the rule describes the situation. The anthropologist doubts the truthfulness of that belief and wants to investigate it. Therefore, he would like to meet a Kulumae member for whom the rule has been violated. Without indicating cheating, it becomes obvious that the anthropologist would like to examine a man with no tattoo who ate cassava root.

2. "Overnight" (Task 3 of Gigerenzer & Hug, 1992)

The "Overnight" rule was "If someone stays overnight in the cabin, then that person must bring along a bundle of wood from the valley". Cards showing "brought wood", "didn't bring wood", "stayed overnight in the cabin" and "didn't stay overnight in the cabin" were presented.

The cheating version

This version explained that "there is a cabin at high altitude in the Swiss Alps, which serves hikers as an overnight shelter. Since it is cold and firewood is not otherwise available at that altitude, the rule is that each hiker who stays overnight has to carry along his/her share of wood. There are rumours that the rule is not always followed. The subjects were cued into the perspective of a guard who checks whether any one of four hikers has violated the rule" (Gigerenzer & Hug, 1992, p. 142).

The unconfounded cheating version

This version added to the original cheating version that according to the hiker's tradition, a hiker may deviate from the rule if he goes for an especially long track on the day after. In that case, he or she has to ask another hiker, who didn't sleep in the cabin, to bring wood. According to the tradition, this is supposed to be done for free, as a sign of good will and friendship among hikers. The Alpine Association suspects that some hikers take money for bringing wood. They consider this to be a rude violation of the hikers' tradition, and decide to put an end to the mess. This version suggests two deviations from normative interpretation. First, the rule is likely to be understood as implying that everyone who uses wood has to take care of wood supply, but not necessarily bring it himself. Thus, the rule in its exact phrasing can be interpreted as non-deterministic. Second, the story suggests the possibility of someone who didn't stay overnight in the cabin and brought wood (not-P & Q) as a possible violation. This is suggested in addition to the original P & not-Q violating instance. Thus, the violating combination is no longer as clear as in the original cheating version, although the problem remains that of cheating detection and the original perspective is not changed.

The no-cheating version

This version was described as follows: "Subjects were cued into the perspective of a member of the German Alpine Association who visits the Swiss cabin and tries to find out how the local Alpine Club runs this cabin. He observes people bringing wood to the cabin, and a friend suggests the familiar overnight rule as an explanation. The context story also mentions an alternative explanation: rather than the hikers, the members of the Swiss Alpine club, who do not stay overnight, might carry the wood. The task of the subject was to check four persons (the same four cards) in order to find out whether anyone had violated the overnight rule suggested by the friend" (Gigerenzer & Hug, 1992, pp. 142–143).

The unconfounded no-cheating version

This version stated hat the rule is strictly obeyed by the hikers. Only guides who are members of the Alpine Association do not have to bring wood after staying overnight in the cabin. The guides have to announce their coming a few days in advance and the association takes care of the wood supply. Subjects were cued into the perspective of a hiker that looks for professional help of a guide for a friend who is stuck in the mountains. A list of visitors is available in the cabin, with information about where each visitor is to be found, whether he or she stayed overnight in the cabin and whether he or she brought wood. The nature of the violation that should be looked for is clear, but this violation does not involve cheating.

3. "Dealer" (*Task 6 of Gigerenzer & Hug, 1992*)

The "Dealer" rule was "If a small-time drug dealer confesses, then he will have to be released". Cards showing "confessed", "did not confess", "was released" and "was not released" were presented.

The cheating version

This version was described as follows: "Subjects were cued into the role of a small-time drug dealer arrested by the police and promised that he would be released if he confessed and provided information about the 'big sharks'. Confession and information is a benefit for the police, but a cost for the dealer, who must anticipate revenge from the big sharks. Being released, on the other hand, is a benefit for the dealer. The subject's task was to check information about four similar cases that could reveal that the police had violated the rule before" (Gigerenzer & Hug, 1992, p. 146).

The unconfounded cheating version

This version cued the subject into the same perspective as the original version. It was added that the small-time drug dealer is afraid that the "big sharks" he reports about somehow prove their innocence and get released. This information obscures the nature of the violation the drug dealer fears: is it that he won't be released after confessing (P & not-Q), or that others, who did not confess, may be released as well (not-P & Q), or both? Thus, the small-time drug dealer suspected cheating, but its nature does not point to P & not-Q combination as the only relevant violating instance.

The no-cheating version

This version was described as follows: "The subject was cued into the role of a journalist who is investigating police methods in dealing with drug crimes. The rule was again identified as a social contract that the police might possibly use. The journalist was interested in finding out whether the police indeed used this unconventional social contract" (Gigerenzer & Hug, 1992, p. 146).

The unconfounded no-cheating version

This version replaced the "general wondering" situation of the journalist in the original no-cheating version with the following: the journalist is especially interested in cases in which the rule is violated according to the dealer's own request. He has heard that after confessing, some criminals become so frightened by the possibility of revenge that they prefer to stay in jail. These cases, the journalist believes, reveal some very interesting details about the underground world, and therefore seem to be an especially "hot item". He would like to meet people for whom the rule is violated. The journalist is not looking for cheaters. Nevertheless, the violating instance that is being looked for is clearly identified as P & not-Q.

4. "Cholera" (Task 11 of Gigerenzer & Hug, 1992)

The "Cholera" rule was "If a passenger is allowed to enter the country, then he or she must have had an inoculation against cholera". Cards showing "got a cholera inoculation" "didn't get a cholera inoculation", "entering" and "transit" were presented.

The "to-be-cheated party" perspective version

This version "cued the subject into the perspective of an immigration officer at the international airport at Manila, whose task is to check whether any of four passengers has violated the rule" (Gigerenzer & Hug, 1992, p. 160).

The unconfounded cheating perspective version

In this version it was told that the immigration authorities have recently received information about possible fake cholera inoculation stamps, given to tourists in the Manila airport by the local doctor. This story appeared in the original not-to-be-cheated party perspective (see below). The perspective of a to-be-cheated party (immigration official) is retained, and so is cheating detection content. However, the exact nature of the violation that is being looked for is not clear.

The "not-to-be-cheated party" perspective version

This version "cued the subject into the perspective of a passenger who makes a stop at Manila and would like to spend a few days there for pleasure. The passenger, who has no cholera inoculation, gets a hint from an informant that the first aid physician at the airport ambulance station would be willing to perform and certify an inoculation quickly – of course, for money. The passenger is not sure whether such a certificate really will be accepted by the immigration officials, and suspects a trick to make money from tourists. Therefore the passenger checks information about four other passengers who were in the same situation. The subject's task is to find out whether the rule had been violated before" (Gigerenzer & Hug, 1992, p. 160).

The unconfounded no-cheating-perspective version

This version differed from both original versions. It cued the subject into the perspective of an Israeli journalist who is interested in risk-taking behavior among young traveling Israelis. He would like to interview youths who violate the rule, which was advised by the Israeli Health Ministry for travelers to the Philippines. The journalist's position is clearly a not-to-be cheated one. Nevertheless, the context clarifies that he should look for violations of the rule, and that these violations should do with risk taking – that is, entering the Philippines with no cholera inoculation, which is P & not-Q.

II. Additional problems used in Study 2

"Salary raise"

The "Salary raise" rule was "If a worker stays in the same office more than 10 years then he gets a salary raise". Cards showing "worked 4 years", "worked 12 years", "got a salary raise", "didn't get a salary raise" were presented. It was explained that having the same worker for many years is a benefit for the office. Obviously, salary raise is a cost for the office and is a benefit for the worker.

Perspective change

Version 1 cued the subject into the perspective of a trade union member who suspects that the manager did not give the workers what they deserve according to the rule. Version 2 cued the subject into the perspective of a manager, who suspects that some workers get benefits they do not deserve.

Unconfounding perspective change

The next two versions used the same perspectives as versions 1 and 2, but made both violation types relevant. Version 3 cued the subject into the perspective of a trade union member that is concerned with both the possibility that some workers get what they don't deserve, and that other workers don't get what should be given to them. Version 4 cued the subject into the perspective of a manager that has the same "bilateral" concerns.

Manipulating selection pattern without perspective change

Versions 5 and 6 were designed to show that it is possible to obtain a shift in selection pattern without changing perspective. Both versions used the same third-party perspective of an inspector that suspects the rule is being violated, and comes to check what is going on. Version 5 specified that according to the rumours, some workers did not get what they deserve. Version 6 specified that according to the rumors, some workers get what they don't deserve.

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