Evolution and Human Behavior xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Evolution and Human Behavior

journal homepage: www.ehbonline.org

Original Article

Rethinking relevance: Repetition priming reveals the psychological reality of adaptive specializations for reasoning

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ARTICLE INFO

Article history:
Initial receipt 29 January 2016
Final revision received 28 November 2016
Available online xxxx

Keywords:
Reasoning
Priming
Social contracts
Precautions
Deontic reasoning, relevance theory

ABSTRACT

Theories advanced to explain conditional reasoning range from those that invoke inference systems that evolved for specific domains (such as social exchange, precautions, or deontic regulations) to relevance theory, a relatively domain-general account that invokes conversational pragmatics. The present research utilized a novel extension of repetition priming, in conjunction with the Wason selection task (a widely known and used task to test people's conditional reasoning), to evaluate alternative theories of human reasoning. Across five experiments, testing over 600 participants, consistent priming across selection tasks was demonstrated. The pattern of priming effects supports models of human reasoning based on specific evolved reasoning abilities, and was inconsistent with general conditional reasoning models such as relevance theory. These results also converge with neurological and clinical evidence of divided psychological processes for reasoning about relatively specific domains, based on functionally distinct inference systems.

1. Introduction

Does the human mind include cognitive adaptations for reasoning about social exchange and precautionary rules? Evidence for this claim rests heavily on studies of conditional reasoning using the Wason selection task (see, e.g., Cosmides & Tooby, 2008, 2015; Fiddick 2004, and references therein). This evidence has been challenged by Sperber, Cara, and Girotto (1995), who argue that relevance theory provides an alternative explanation for all of these results. In their view, relevance theory "explains the selection task", with no need to invoke adaptive specializations. Is that true? We report studies with the Wason selection task that are inconsistent with relevance theory, but follow from the hypothesis that the mind has specializations for reasoning about social contracts and precautionary rules.

1.1. Theories of human reasoning and the method that produces them

One of the most widely known and commonly used research methodologies to study human reasoning today is the Wason selection task (Wason, 1968). Strictly speaking, this task tests whether people recognize that, by the rules of formal logic, a conditional rule of the form, *If P then Q*, is potentially violated by instances of *P* and *not-Q*. As part of the selection task, participants are given four cards (or, more usually, pictures of cards; see Supplemental Materials, available on the journal's website at www.ehbonline.org) with information about *P* on one side and *Q* on the other. The visible sides of the four cards contain the information *P*, *not-P*, *Q*, and *not-Q*. For example, if the conditional rule is *If the wind is blowing, it will be a cool night*, then the potential cards that could be selected would be *The wind was blowing, The wind was not blowing, It was a cool night,* and *It was not a cool night.* Participants are asked to indicate the cards, and only those cards, that are necessary to check for violations of the conditional rule. Typically, fewer than 25% of participants recognize that the *P* and *not-Q* cards, and only those cards, are potential violations of the conditional rule, even when the rules deal with familiar content drawn from everyday life (e.g., Manktelow & Evans, 1979; Wason, 1983).

Although originally designed to assay people's ability to test conditional rules more generally, the Wason selection task eventually became widely employed in studies focused on aspects of people's deontic reasoning (i.e., reasoning about what is socially permitted or obligated; what one *may* do or *must* do, respectively, as opposed to reasoning about material statements of fact or other contexts). This stems, in large part, from earlier "content effects" that had puzzled reasoning researchers. Whereas most participants routinely failed to solve the task correctly when given abstract conditional rules, the majority of participants typically solved it correctly when given certain versions of the

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http://dx.doi.org/10.1016/j.evolhumbehav.2016.11.008
1090-5138/

task employing conditional obligations (e.g., Griggs & Cox, 1982). These content effects (and many novel ones) were drawn upon to support social contract theory (Cosmides, 1989) and a wide range of subsequent, evolutionary hypotheses about domain-specific, adaptive reasoning (e.g., Brown & Moore, 2000; Cummins, 1999; Fiddick, Cosmides, & Tooby, 2000; Hiraishi & Hasegawa, 2001). However, the observation that some nondeontic versions of the selection task also elicit enhanced (logical) performance led some researchers to question these proposals (Almor & Sloman, 1996; Love & Kessler, 1995; Sperber et al., 1995).

The finding that nondeontic versions of the selection task could also elicit enhanced logical performance was not actually a new finding. It had long been known, for example, that even abstract conditionals with negated consequents– *If P then NOT Q*– also tend to elicit enhanced logical performance on the selection task (Evans & Lynch, 1973). What lent weight to the newer findings of enhanced logical performance on nondeontic versions of the selection task that was relevance theory's (Sperber, Cara, & Girotto, 1995) credible, universally applicable account of high levels of logical performance on both nondeontic and deontic rules. But does relevance theory's proposed mechanism actually generalize? As it currently stands, there is actually little evidence that the proposed psychological processes operate on both deontic and nondeontic rules. Such evidence is possible to obtain using techniques such as priming methods, but those experiments have not been done to date. We undertake these studies herein. Finding that good nondeontic reasoning can prime deontic reasoning on selection tasks would be evidence supporting relevance theory's more domain-general reasoning process. On the other hand, finding that priming across selection tasks is differentially effective within narrow content types would be evidence supporting more domain-specific reasoning process.

1.2. Adaptive specializations for reasoning about evolutionarily significant domains

Toward the more domain-specific side are proposals that content effects in the selection task are due to specific abilities to reason about deontic conditionals: rules stating social regulations of what one may or must do, e.g., *If you drink alcohol, then you must be at least 21 years old* (Cheng & Holyoak, 1985; Cummins, 1996a, 1996b; Manktelow & Over, 1990, 1991). For example, Cummins (1996a, 1996b, 1999) provided an evolutionary account of such reasoning, qua deontic reasoning, that highlights the social status of interactants as an evolutionarily relevant variable. Others have proposed accounts of more narrowly specialized adaptations for reasoning about specific forms of social interaction (e.g., Brown & Moore, 2000; Cosmides, 1989; Hiraishi & Hasegawa, 2001; Thompson, Plowright, Atance, & Caza, 2015). For example, social contract theory (e.g., Cosmides, 1989; Cosmides & Tooby, 1992; Gigerenzer & Hug, 1992; Platt & Griggs, 1993) proposes that reasoning about if-then rules that have the form *If Benefit Accepted, then Requirement Satisfied* activates reasoning processes that lead people to investigate individuals who have *accepted the benefit* (to see if they failed to satisfy the requirement) and individuals who have *not satisfied the requirement* (to see if they illicitly took the benefit). In selecting the logically correct *P* and *not-Q* cards on social contract versions of the task, participants are actually choosing the adaptively correct *Benefit Accepted* and *Requirement-not-Satisfied* cards, respectively. A second, complementary proposal is that people have specific evolved abilities for reasoning about precautions (i.e., hazard management; Fiddick et al., 2000), distinct from social contract reasoning. For instance, the rule: *If you clean up spilt blood, then you must wear rubber gloves* is not plausibly interpreted as a social contract (Manktelow & Over, 1990), but in selecting the logically correct *P* and *not-Q* cards on this task, participants are focusing on adaptively significant situations of the *Hazard Exists* (spilt blood) and *not-Protected* (no gloves).

Both social contracts and precautions can be formulated as conditional permissions and obligations regulating people's behavior, stipulating what one *may* or *must* do, respectively. Hence, a common set of deontic reasoning mechanisms governing both sorts of rules has also been proposed on evolutionary grounds (Cummins, 1996a, 1996b, 1999).

Although these evolutionary proposals vary, the studies testing them with the Wason selection task have tended to follow the same methodological strategy: Construct at least two different versions of the selection task in which the formal structure of the task is held constant, while the content of a conditional rule and/or the scenario within which it is embedded is varied. The content is varied in a manner predicted to be relevant to the hypothesized psychological mechanisms. If this influences the pattern of cards that participants select, this is claimed as support for the existence of a psychological adaptation (e.g., Cosmides, 1989; Cummins, 1999).

1.3. The case for relevance theory and domain-general reasoning

A more domain-general approach claims that these content effects are better explained by factors such as conversational pragmatics (Girotto, Kemmelmeier, Sperber, & van der Henst, 2001; Love & Kessler, 1995; Sperber et al., 1995) or text processing (Almor & Sloman, 1996, 2000). Relevance theory, in particular, interprets performance on selection tasks as entirely driven by conversational pragmatics (Sperber et al., 1995). Whether or not people solve the task correctly, relevance theory argues, depends upon whether people interpret the rule employed, *If P then Q*, as precluding entities or events with the features *P and not-Q*. When the pragmatic context in which a conditional is employed induces people to represent a conditional as *There exists no [P & not-Q]* or *Instances of [P & not-Q] are forbidden*, logical performance on the selection task will increase because these forms of representation make the solution of the task (instances of *P* & *not-Q*) mentally explicit. Indeed, when *There exists no [P & not-Q]* is the most relevant interpretation of the conditional, the level of logically correct *P* & *not-Q* selections increases even when nondeontic conditionals are employed (Sperber et al., 1995).

According to relevance theory, the relevance of an interpretation is increased by the cognitive effects of a given interpretation and decreased by the cognitive effort required to derive the interpretation (Sperber & Wilson, 1986). In the case of deontic rules, the relevance of *P & not-Q* violations could be increased by reducing the cognitive effort required to explicitly represent violations; *P & not-Q* violations are already explicitly represented provided the rule is interpreted as a prohibition: *One is forbidden to P-and-(not-Q)*. The social consequences and, hence, cognitive effects, of *P & not-Q* violations are (supposedly) greater than the social consequences of rule compliance, *P & Q* (a common selection pattern on nondeontic versions of the selection task; see, however, Fiddick et al., 2000; Delton, Krasnow, Cosmides, & Tooby, 2011). However, a deeper account of the significance of rule violations compared with rule compliance is suggested by an evolutionary perspective. Monitoring and punishing violations provide negative feedback that is a more cost effective, incentive system than monitoring and rewarding compliance, which result in a less cost effective, positive feedback incentive system (Fiddick & Erlich, 2010). Hence, the main advantage of relevance theory over the evolutionary proposals is that the former potentially explains performance on both deontic and nondeontic versions of the selection task.

So far as we are aware, the only study conducted to provide positive evidence in support of the relevance theoretic account of the deontic selection task is a single experiment conducted by Girotto et al. (2001). The experiment employed a precautionary deontic rule: *If a person travels to any East African country, then that person must be immunized against cholera*. Besides the indirect evidence supplied by participants' card selections, no independent confirmation of participants' interpretations of the rule, let alone the cognitive effort and effects associated with different interpretations, was provided. Instead, Girotto et al. manipulated whether or not the rule was in effect and whether or not participants were instructed to look for violations– precisely the same sort

Please cite this article as: Fiddick, L., et al., Repetition priming reveals the psychological reality of adaptive specializations for reasoning, *Evolution and Human Behavior* (2016), http://dx.doi.org/10.1016/j.evolhumbehav.2016.11.008