Evolutionary Psychology and Human Reasoning: Testing the Domain-Specificity Hypothesis through Wason Selection Task

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Abstract

The better performance in the selection task with deontic rules, compared to the descriptive version, has been interpreted by evolutionary psychologists as the evidence that human reasoning has been shaped to deal with either global or specific deontic norms. An alternative hypothesis is that the two types of rules have been embedded in two different forms of reasoning, about and from a rule, the former demanding more complex cognitive processes. In a between-subjects study with 640 participants we manipulated the content of the rule (deontic vs. social contract vs. precaution vs. descriptive) and the type of task (reasoning about, traditionally associated to indicative tasks, vs. reasoning from, traditionally associated to deontic tasks). Results showed that the better performance is independent of the content of the rule and is associated to the "reasoning from" task.

Keywords: selection task; deontic reasoning; domain-general reasoning; domain-specific reasoning; evolutionary psychology.

Introduction

The "easiness" to reason with deontic norms (i.e. the norms that establish what is required, prohibited or allowed to do in certain circumstances) has been largely used as a piece of evidence supporting the idea of the domain-specific nature of mind. This hypothesis has been strongly sustained, among others, by evolutionary psychologists, according to which the development of highly specialized cognitive abilities have improved the environmental fitness and phylogenetic evolution of human species. Some scholars (e.g. Barrett & Kurzban, 2006; Cosmides, 1989; Cosmides & Tooby, 2013) posit that such abilities are managed by modules, i.e. computational units that process domain-specific information, and claim that the human mind is massively modular. Other scholars (e.g. Ariew, 1999; Cummins 1996, 2013) sustain that domain-specific abilities are not predetermined by modular activity, but by canalization, a process which biologically prepares the human mind to be particular sensitive to specific environmental stimulations and favors the acquisition of solutions and expertise that have been particularly adaptive during phylogenetic development. Both these approaches, albeit based on a different conception of the human mind, share the assumption that it is better equipped for reasoning with general (e.g. Cummins 1996, 2013) or specific (e.g. Cosmides, 1989; Cosmides & Tooby, 2013) deontic norms rather than with epistemic concepts (i.e. the concepts related to knowledge and belief).

Experimental evidence achieved mainly by means of the selection task (Wason, 1966) is thought to support this claim. In the original formulation, this task consists in selecting the states of affairs necessary to determine the truth-value of a descriptive (or indicative) rule expressed through the conditional statement "if p then q". Four double-sided cards are presented, conveying on one face the information of presence/absence of the antecedent (p or not-p) and on the other face the same information about the consequent (q or not-q). The cards are shown only by one side (the visible faces are p, not-p, q, not-q) and participants have to indicate which ones need to be turned over to determine whether the rule is true or false. According to propositional logic, the correct response is to select only those cards that would entail the combination apt to make the rule false, i.e. p and not-q. Selecting other cards is insufficient or useless.

The percentages of correct solutions with the original formulation of the task are very low, between 4% and 30%, regardless of the abstract/thematic content of the rule and its familiarity/unfamiliarity. A great improvement, between 65% and 80%, has been documented when conditional rules express deontic norms and it is required to identify potential violators (see for review, Beller, 2008; Cosmides & Tooby, 2013; Cummins, 1996; Stenning & Lambalgen, 2008). The enduring debate about the implications of these findings regards the legitimacy to infer specific mental structures devoted (e.g. Cosmides 1989; Cummins, 1996) or developed (e.g. Cheng & Holyoak, 1985) to process classes of rule-governed actions. From an opposed perspective, the supposed content-sensitiveness of human reasoning is instead ascribed to the formal differences between deontic and epistemic reasoning (e.g. Buller, 2005; Chater &

Oaksford, 1996; Oaksford and Chater, 1994; Perham & Oaksford, 2005; Stenning & Lambalgen, 2008).

Although the domain specificity hypothesis had been advanced from an ontogenetic perspective by Cheng & Holyoak (1985) with the pragmatic reasoning schemas theory, it has been strongly advocated by the evolutionary perspective. Cummins (1996, 2003, 2013) postulates the existence of a specific deontic reasoning, evolutionarily canalized and responsible for the management of any rule that constrains social behavior. Deontic reasoning emerges early in development and seems to be ubiquitous. However, some findings (e.g. Dack & Astington, 2011) question this assertion.

On the contrary, the followers of the massive modularity hypothesis (e.g. Cosmides, 1989; Fiddik, Cosmides & Tooby, 2000) posit that neurocognitive modules are specialized to reason only about specific deontic domains that particularly favored human evolution, like social exchange and hazard management. According to these authors, social exchange, or reciprocation, is the foundation of social cooperation and is common in all cultures. Reciprocation is expressed through social contracts, conditional rules of the form "If you take benefit P, then you must satisfy requirement Q". Selection tasks embedded in social exchange scenarios, requiring to detect violators of social contracts, produce very high rates (up to 80%) of selecting *p* and *not-q* cards. Nevertheless, according to social exchange theory (SET), the selection of these cards is not the result of formal logical inferences, but of a "look for cheaters" algorithm, a subroutine of the social exchange module, that identifies those who take the benefit (*p* card) without satisfying the requirement (*not-q* card) as potential violators of the social contract. Empirical evidence of this claim is that, presenting switched social contract rules of the form "If you satisfy requirement P, then you are entitled to receive benefit Q", participants continue to select the cards corresponding to potential cheaters, in this case, *not-p* and *q* (Cosmides, 1989; Gigerenzer & Huge, 1992). Some empirical evidence (see for a review Cosmides & Tooby 2013) documents that the ability to detect cheaters is already present in 3-4 year old children, is cross-cultural, and discerns between unintentional and intentional violations (Cosmides, Barrett & Tooby, 2010), but the latter finding is at least questionable (Matarazzo & Ferrara, 2008).

Alongside with reciprocation, the human mind would be also equipped with a module dedicated to hazard management, another crucial skill for human survival and evolution. According to the hazard management theory (HMT), another algorithm, similar to the "look for cheaters" one, detect violators of precautionary rules of the form "If you engage in hazardous activity P, then you must take precaution Q". Neuroimaging studies seem to support that reasoning with social contracts and precautionary rules is governed by two separate systems (Fiddick, Spampinato & Grafman, 2005). A third assumed module, the altruism detection module, has received mixed empirical evidence

(Oda, Hiraishi, & Matsumoto-Oda, 2006; Thompson *at al*. 2015).

On the opposite side, a large number of scholars, sharing a domain-general conception of human reasoning, have advanced alternative hypotheses to account for the different performance in descriptive and deontic selection tasks, grounded on the consideration that the two tasks have a dissimilar structure and rely on different inferential processes.

According to Fodor (2000) and Buller (2005), indicative and deontic conditionals have different logical operators (dyadic vs. monadic) and consequently entail different inferences. Indeed, in the deontic rule "If you want p, then you must do q", the non-compliance of *not-q* cases is implicitly conveyed by the mandatory requirement of action *q*, given the occurrence of *p*. Instead, the selection of *non-q* in indicative selection tasks, requires a more complex falsificationist strategy grounded on the inference that "If *p* then *q*" is false when the negation of consequent implies the affirmation of antecedent.

From a Bayesian approach, the optimal data selection theory (Chater & Oaksford, 1996; Oaksford & Chater, 1994; Perham & Oaksford, 2005) also posits that descriptive and deontic selection tasks are solved by using different strategies that rely on distinct probabilistic models. In descriptive tasks the most rational answer consists in selecting *p* and *q* cards because, under the assumption that these instances are more rare than their respective contrast classes *not-p* and *not-q* (rarity assumption), they convey the bigger expected information gain to establish the truth value of the rule. Instead, in deontic tasks participants choose the cards maximizing expected utility. Depending on the perspective participants are requested to assume, the most useful cards are *p* and *not-q* or *not-p* and *q*. Deontic tasks are less complex in mathematical terms than descriptive ones and therefore are simpler to resolve.

Other researchers (Jackson & Griggs, 1990; Noveck & O'Brien, 1996; Stenning & Lambalgen, 2008) focus on the different status of the rules presented in descriptive or in deontic tasks, entailing two different forms of reasoning. In descriptive tasks, it is required to settle the uncertainty of the rule: participants don't know whether the rule is true or false, and have to reason about it, by selecting instances necessary to determine its true value. Instead, in deontic tasks, participants reason from the rule, accepted as true, to detect instances that could violate it. A descriptive task is a "test rule" task that requires to reason about a rule, the second one is a "violation control" task that requires to reason from a rule. The empirical evidence they obtained supports that reasoning from a rule is easier than reasoning about a rule, irrespective of the rule content.

From a methodological point of view, some authors (e.g. Carlisle & Shafir, 2005; Noveck & O'Brien, 1996; Noveck Mercier, & Van Der Henst, 2007; Sperber & Girotto, 2002) have remarked that the high rate of predicted responses in deontic or social contract tasks was due to some spurious aspects included in scenarios in which the rules were

embedded, e.g. the presence of explicit negations, the abundance of information, the instructions focused on "looking for violators". After controlling for these aspects, the correct responses considerably decrease.

Another relevant objection has been advanced against the assumption that selecting *not-p* and *q* cards with the switched social contract rules is an evidence supporting the "content logic" of social exchange. Wagner-Egger (2007) noted that deontic rules are actually biconditional (hence bidirectional): so, the point of view adopted by the participants (e.g. promisor or promisee) determines the direction in which the rule is interpreted. Indeed, presented in a neutral context, these rules elicit high rates of *p* & *q* and "all cards" answers, respectively the most frequent and the logically correct response in a biconditional selection task.

In our opinion, the difference between the two types of reasoning (about vs. from a rule), although not extensively investigated, represents a key way to contrast the predictions of domain-general vs. domain-specific approaches to human reasoning. Indeed, if human reasoning is sensitive to formal aspects, then reasoning from a rule should produce more correct responses than reasoning about a rule, which is a more difficult cognitive process, irrespective of the rule contents. On the contrary, if human reasoning is sensitive to content aspects, as evolutionary, domain-specific approaches posit, then deontic rules should elicit more correct (from the content perspective) answers than descriptive rules, irrespective of the type of reasoning.

However, it should be noted that conditionals with deontic rules are generally presented (but see Noveck & O'Brien, 1996 for an example of exception) in the "reasoning from" form, while conditionals with descriptive rules are presented in the "reasoning about" form, thus getting entangled in the same formulation content of rule and form of reasoning. This study aimed to disentangle these two aspects.

Experiment

In this study we compared the divergent expectations derived from the domain-specific vs. domain-general approaches to human reasoning by using Wason selection task. Through a 2x4 design, we contrasted two types of tasks – one based on reasoning about a rule and the other based on reasoning from a rule – with four types of rules: general deontic norm, social contract, precaution and descriptive. To our knowledge, this is the first study that systematically compares descriptive and deontic (in a broad sense) rules, by requiring both to reason about and from them. A previous study (Ferrara & Matarazzo, 2010) had compared these four rules but only in the "reasoning from" modality. In the present study, in the reasoning about (R.A.) tasks, the status of the rule was uncertain and the participants had to select the instances necessary to determine whether it was true or false or whether it was in force or not. In the reasoning from (R.F.) tasks, it was required to establish whether the rule was respected or not, by assuming the point of view of a checker. All the tasks

were built so that the correct response was to turn over *p* and *not-q* cards.[1]

The contrasting hypotheses tested in this study are the following: according to massive modularity theories, such as SET and HMT, the rules of social contract and precaution in "reasoning from" task should elicit the highest number of correct responses; according to the "deontic specificity" theory (such as Cummins' theory), all three deontic rules presented in "reasoning from" modality should elicit better performance than the descriptive rule. According to domain generality theories, there should be no difference in the number of correct answers between the four rules, but the R.F. tasks should elicit more *p* & *not-q* answers than the R.A. ones, irrespective of the rule type. In fact, regardless of the content, establishing the truth value or the being in force of a rule should involve the same type of metareasoning and therefore these tasks should be more difficult than a simple deductive task not requiring any form of metareflection, such as establishing if a rule has been respected or not[2].

Although evolutionary psychologists, and more generally domain-specific theorists, are not interested in detecting potential content effects with rules presented in the R.A. modality, we suppose that the same hypotheses advanced for the R.F. tasks could be extended also to the R.A. tasks. Indeed, we assume that if human reasoning is largely or fully content dependent, then it should be easier to identify the cases that disconfirm a rule (or a precautionary measure) concerning relevant areas such as social exchange or health prevention rather than a descriptive rule in a not relevant area. Since in this study these cases corresponded to *p* and *not-q* cards, we expected that such response would be more frequent if the participants reasoned in a domain-specific rather than in a domain-general way.

Design and Participants

The 2 x 4 experimental design involved the manipulation of two between-subjects variables: type of task (reasoning about vs. reasoning from a rule) and type of rule (social contract, general deontic, precaution, descriptive). Six hundred and forty undergraduates (336 females, 304 males) of the Universities of Naples and Salerno took part in the experiment as unpaid volunteers. They were aged between 18 and 35 years (M = 22,67; SD = 3,25) and had no specific knowledge of logic or psychology of reasoning. Participants were randomly assigned to one of the eight experimental conditions (n = 80 for each experimental condition).

Materials and procedure

All selection tasks were built so as to keep under control the factors that could create spurious differences in the results, i.e. due to the instructions or characteristics of the materials, and not to reasoning per se. They were all embedded in similar scenarios placed in a common setting, a fictional

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[1] Note that for the Bayesian approach, the most rational response
[2] In the Introduction, the rationale of the predictions of the Bayesian approach about the two types of tasks is depicted.

African country (Derhoto), had a similar length, and gave only the information necessary to make the story in which the rule was included credible. The instructions were presented in a neutral way, without contextual cues inducing to believe that they were false (in the "reasoning about" conditions) or that they had been violated (in the "reasoning from" conditions) in order to avoid any strong pragmatic influence on the results. The statements with which the rule was expressed had a conditional form and not a biconditional one: the consequent could be derived by multiple antecedents and not by a unique antecedent, as it usually happens in tasks with deontic or social contract rules. Finally, in the cards to be selected there were no explicit negations.

In order to control that the information in the tasks was well understood, a preliminary study with 140 undergraduates of the Universities of Naples and of Salerno was conducted. Participants read the scenarios embedding the selection task and answered questions aimed to investigate whether the difference between the four rules (descriptive, deontic, social contract, precaution) and the difference between the two types of reasoning (about or from the rule) were clear, whether the rules were understood as being conditional and not biconditional, and whether the scenario protagonist could build from the information presented in the story some preliminary beliefs about the truth/untruth of the rule or the likelihood that it had been violated. Since the results corroborated the correct operationalization of the above-mentioned features, the main experiment was carried out.

The reasoning from (R.F.) versions of the tasks shared the same structure. Participants were invited to select the card or the cards (each card representing one person) necessary to find out whether the rule was respected or not.

For the brevity's sake, we only give two instances of R.F. tasks, with social contract and descriptive rules[3].

In the social contract task the rule was: "if a person works as a safari guide, then that person must hold the special driving license Z". The scenario informed that being a safari guide was considered a desirable and well-paid job (hence a benefit); the special license Z, allowing to drive all types of buses, was very hard to obtain (hence requiring a cost), and it was mandatory for safari guides but optional for other bus drivers. The cards presented were: a person working as safari guide, a person working as an ambulance driver, a person holding the special driving license Z, a person holding the normal driving license. In the R.F. descriptive task, the protagonist was a member of the fictional Koofi tribe, who, after a long absence from his country, wants to find out whether young people respect or not the traditional rule: "if a person belongs to the Koofi tribe, then that person has war symbol tattoos". The scenario explained that the members of the Koofi tribe traditionally had only war symbol tattoos, while the other tribes could have all sorts of tattoos, together with war symbols. The four cards were: a person belonging to the Koofi tribe, a person belonging to

the Tumi tribe, a person with a sword tattoo, a person with a flower tattoo.

In the reasoning about (R.A.) versions of the tasks, participants were asked to select the card/cards necessary to establish whether a particular rule, presented in the affirmative form, was true or false. In all scenarios it was specified that the protagonist was uncertain about the truth value of the rule or about its being in force. Also for R.A. tasks we only present the descriptive and social contract instances. The descriptive task had the same rule, the same cards and a very similar scenario as the R.F. version. In this case the protagonist was a foreign journalist that wanted to ascertain whether his impression that the members of the Koofi tribe had only weapon tattoos was true or false. In the R.A. social contract task, a shepherd of the Koofi tribe wanted to find out whether it was true or false that "if a shepherd feeds his flock on Tumi lands, then that shepherd must pay 20 deru". Grazing among the neighboring tribes had always been free, the social organization of the tribes being based on mutual aid and on fair social exchange, but shepherds usually left a symbolic offering ranging from 5 to 20 "deru" (the local currency) depending on their economic possibilities. The cards presented were: a shepherd grazing on Tumi land, a shepherd grazing on Songhi land, a shepherd leaving 20 deru, a shepherd leaving 5 deru. Note that the obligation to pay for grazing would be contrary to the principle of mutual aid on which the social exchange of the tribes was based: in such a way, we created the motive for establishing whether the rule was in force or not.

Results

Overall, fifteen different types of answers were obtained through the eight experimental conditions: however, only three answers reached a percentage higher than 10% and were retained for data analysis: p & not-q, p & q, and p.

The other types of answers, most of them lower than 4%, were assembled in the "other" category. So, four categories of answers were considered for data analysis (See Table 1). Given the features of our experimental design and the nature of data (i.e. a design with two independent variables and with nominal scales), an appropriate statistical analysis is multinomial logistic regression (Hosmer, Lemeshow, & Sturdivant, 2013).

It was performed on the answer as dependent variable, with "other" as reference category, and the rule and task as predictors. We tested preliminarily a model with the two main effects, -2LL = 111.95; χ^2 (12) = 68.37; p < .001; Nagelkerke pseudo R^2= .11, and then the model with the interaction. The interaction effect was not significant, χ^2 (9) = 9.374; p = 404.

The results were the following: a) with the R.F. tasks, there was an increased likelihood that the answers were p & not-q rather than "other", B = 1.09; OR = 2.97; Wald test = 24.48; p <.001, and p rather than "other", B = .830; OR = 2.29; Wald test = 13.73; p <.001; b) with the social contract rule, the likelihood that the answer was p rather than "other" increased, B = .742; OR = 2.1; Wald test = 5.67; p <.05.

[3] All materials can be asked by writing to Olimpia Matarazzo

Table 1: Frequency and percentage of the answers in the eight experimental conditions.

Experimental Condition	Answers				
	p & not-q	p & q	p	other	Total
R.F social contract	32 (40%)	5 (6,3%)	29 (36,3%)	14 (17,4%)	80
R.A social contract	12 (15%)	24 (30%)	20 (25%)	24 (20%)	80
R.F deontic	30 (37,5%)	14 (17,5%)	22 (27,5%)	14 (17,5%)	80
R.A deontic	17 (21,3%)	25 (31,2%)	13 (16,3%)	25 (31,2%)	80
R.F. precaution	21 (26,3%)	11 (13,7%)	19 (23,8%)	29 (36,2%)	80
R.A. precaution	15 (18,8%)	12 (15%)	11 (13,8%)	42 (52,4%)	80
R.F. descriptive	26 (32,5%)	13 (16,3%)	18 (22,5%)	23 (28,7%)	80
R.A. descriptive	13 (16,3%)	20 (25%)	16 (20%)	31 (38,7%)	80

R.A.= reasoning about, R.F. = reasoning from

These results corroborated the hypothesis of the domain-general theories: the main effect due to the task showed that for the four types of rules, reasoning from - rather than about - a rule increased the likelihood of *p & not-q* and of *p* answers; the only effect due to the rule was the increased likelihood of *p* answers with the social contract. No interaction moderated these main effects. So, no further investigation of the data was needed. Nevertheless, following the suggestion of the reviewers to further explore the results, we performed a chi square only on the four R.A. conditions, crossing the four types of rules with the four categories of answers, in order to investigate whether the most frequent answer was *p & p*, as largely documented in literature. As expected from the previous analysis, the result of the test, $\chi^2 (9) = 15.99; p = .067$, was not significant, showing that there was no different distribution of the answers between the four type of rules. Furthermore, a chi square performed on the marginal totals of the four categories of answers, $\chi^2 (3) = 33.67; p < .001$, showed that the most frequent answer was the category "other" and that there was no significant difference between *p & not-q*, *p & q*, and *p* answers.

Discussion of results

The results show that reasoning from a rule, rather than reasoning about a rule, increases the likelihood to produce correct responses (*p & not-q*), irrespectively of the type of rule presented. Moreover they show that the likelihood of the incomplete response *p* increases with the R.F. tasks and, independently, with the social contract rule, the latter being the only effect due to the rule. These findings are in line with the general domain hypothesis about human reasoning by supporting the idea that the processes required to establish the truth value or the being in force of a rule are highly structured and involve meta-reasoning abilities in order to test a general hypothesis from particular cases. On the contrary, checking whether a rule is respected or not is a task that does not posit any question about the status of the rule, but only a question about the correspondence between the rule and its specific instances. Note that also the authors who do not assume the above mentioned falsificationist perspective, as for example Oaksford and Chater (e.g. 2009), who adopt a Bayesian approach, sustain the idea that deontic reasoning (from a rule) is a different process from indicative reasoning (about a rule). The former would be a decision making process based on the expected utility entailed in a violation search, in the context of enforcing the rule; the latter would be a probabilistic reasoning based on the information gain search (e.g. Oaksford & Chater, 1994; Perham & Oaksford, 2005). The former should produce *p* and *not-q* as modal response, in the context of enforcing the rule (as in R.F. task); the latter *p* and *q*. However our results do not corroborate this prediction (largely reported in literature), by showing no difference between *p & not-q*, *p & q*, and *p* answers in reasoning about a rule.

The predictions of the domain specificity hypothesis are not corroborated by our results: the only difference due to the rule effect concerns the likelihood of *p* response, but no difference has been found between the four rules (social contract, deontic, precaution, and descriptive) as regards *p & not-q* answer, either in R.A. or in R.F. If the domain specificity hypotheses had been corroborated, then this type of response would have been more likely with general (according to deontic specificity theory) or specific (according to SET and HMT theories) deontic conditionals rather than with the descriptive ones. No evidence for neurocognitive modules or for specific deontic reasoning has emerged from our study.

Nevertheless, a further analysis of our results also casts doubt on the sustainability of the domain general hypothesis. Firstly, the overall percentage of *p & not-q* responses in "reasoning from" tasks (34,1%) is low, irrespectively of the rule content, and discordant from the one usually reported in literature (but see Oda *et al.*, 2006, for similar percentages). This finding disconfirms the predictions of both domain-general and domain-specific approaches to reasoning, which assume a higher frequency of this type of responses, associated to a "rule-violation check" in deontic ("reasoning from") tasks. Furthermore, the great dispersion of the responses - as documented by the extent of the "other" category - suggests that many participants had poorly understood the task and tried to give a response in any case, just to comply with the experimental instructions.

Our findings imply that the high percentage of correct answers found in deontic tasks are due to pragmatic factors, such as the presence of explicit negations, the wealth of information conveyed by the scenarios, the presence of instructions that explicitly demand to look for the potential rule violators. In our study, these factors were controlled for in order to disentangle them from the structure and content aspects of reasoning. So, our tasks were above all reasoning

tasks. Our results are in line with those studies (e.g. Carlisle & Shafir, 2005; Noveck *et al.* 1996; 2007) showing that by controlling for the above-mentioned pragmatic factors, the performance in deontic or in social contract tasks worsens. On the whole, these results suggest that human reasoning is largely context dependent and that the high performance attributed to a specific domain or to specific reasoning modules is probably due to these extra reasoning factors.

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