Deontic Logic and Deontic Goals in the Wason Selection Task

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Abstract

Domain-specific approaches of the Wason selection task (WST) have postulated specifically adapted schemas or Darwinian algorithms and abandoned a normative concept of rationality. We propose a *flexible deontic logic theory* (FDL theory), which is domain-specific but normative. The test of a prescriptive rule does not involve testing its truth, as in the standard WST, but rather selecting cases in which rules are being violated or followed. Building on former theories of the WST, we argue that the checking of prescriptive rules is based on deontic logic *and* on a goal-based mechanism of focusing either on conforming cases (cooperator detection) or on deviating cases (cheater detection). Experiment 1 provides support for four deontic types of conditionals. Experiment 2 provides evidence for the postulated interaction of deontic rules and goals, including evidence for cheater, cooperator, or double focus selections (*p, q* & *non-q*). These novel results favor FDL theory and challenge both domain-specific and domain-general theories of the WST.

Introduction

Wason Selection Task

The *Wason Selection Task* (WST) (Wason, 1966) is one of the most studied and most seminal tasks in the psychology of reasoning. It has been of particular importance in the rise of domain specific theories of rationality. The WST is concerned with the testing of a hypothesis, typically a conditional in the form of "if *p* then (always) *q*". Participants are requested to test the truth or falsity of the conditional in an empirical world of four cards. The visible front sides of the four cards represent examples for all logical categories mentioned in the conditional: *p* ("A"), *non-p* ("K"), *q* ("2"), *non-q* ("7") (cf. Figure 1). On one side of each card is a *p* or a *non-p*, on the other side a *q* or a *non-q*. Participants have to select the cards they would turn over in order to test the truth or falsity of the rule.

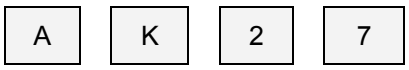

Figure 1: Cards of Wason (1966) "if there is a vowel on one side there is an even number on the other side"

The traditional yardstick with which to evaluate answers in the WSTs has been a norm of correct logical-falsificationist hypothesis testing (Popper). According to this universal norm participants should always select exactly the *p*- and the *non-q*-card, since only they may lead to a falsification of an implication as defined by formal logics.

However, from early on empirical results have shown that most participants do not act according to this norm. For example, Johnson-Laird and Wason (1970) found that 96% of the participants in their WSTs selected a wrong pattern of cards, many choosing the *p*-and-*q*-cards instead.

Domain Specific Theories and Cheater Detection

The domain-general mental model theory (MM theory, Johnson-Laird & Byrne, 1991, 2002) has tried to maintain the logical-falsificationist norm and to explain the deviations by incomplete representations of the tested rule.

Other phenomena, by which traditional domain-general theories have been challenged, are so-called content effects. Some thematic rules, such as "If I eat haddock I drink gin," did not enhance the performance, while particularly social or deontic rules, such as "If a person is drinking beer, then the person must be of full age", did.

According to Cheng and Holyoak's (1985; cf. Holyoak & Cheng, 1995) *pragmatic reasoning schema (PRS) theory*, content effects are due to specific reasoning schemas, which are linked to goals and which are based on abstractions of recurring experiences in society. Schemas do not always enhance the selection of logical patterns; they may also trigger illogical ones. In the deontic realm they proposed a permission schema and an obligation schema.

Cosmides' domain-specific *social contract (SC) theory* was even more pronounced in abandoning any normative logical basis for reasoning in the WST (Cosmides, 1989; Cosmides & Tooby, 1992; Fiddick, Cosmides, & Tooby, 2000). Instead Cosmides based her theory on a particular class of evolutionary considerations. She found evidence for either clear *p-and-non-q* selection patterns or opposed *non-p-and-q* patterns in the testing of standard or switched social contracts. This has been interpreted to count against a norm of logic and in favor of an innate and specialized module of cheater detection. Gigerenzer and Hug (1992) modified social contract theory in showing perspective effects and in dissociating the concepts 'social contract' and 'cheater detection'. They showed that "the crucial issue about social contracts is the cheating option" (p. 165).

Flexible Deontic Logic Theory

Here a *flexible deontic logic* (FDL) theory is advocated and tested. (A first test of the theory was provided by von Sydow, Hagmayer, Metzner, and Waldmann, 2005.) FDL theory can be seen as a synthesis of converging lines of research in the

WST debate. Although FDL theory owes much both to domain specific and to domain general theories of the WST, it differs from all these theories (for details: von Sydow, submitted). With respect to recent developments FDL theory combines deontic logics (Beller, 2003; cf. lately Bucciarelli & Johnson-Laird, 2005) with the concept of a flexible focus on different cells of an ought table (Sperber & Girotto, 2003; cf. Oaksford & Chater, 1994). Two experiments will be reported which dissociate FDL theory from other theories of the WST.

But firstly, we argue that the testing of descriptive and prescriptive rules have different meanings. Secondly, we advocate deontic logic as a basis for testing prescriptive rules. Thirdly, we show how the goal of the task may flexibly, though rationally, determine the focus on particular cells of an ought table.

Rules about Is and Ought

The distinction of 'is' and 'ought' has always been fundamental for philosophy. The distinction is even older than Aristotelian logic. Moreover the distinction is also essential in understanding any technical, moral or social regulatory system. Although content effects in the WST have been observed particularly for prescriptive rules, only few researchers working on the WST have recognized the importance of *normative* differences between testing prescriptive and descriptive rules.

In contrast FDL theory assumes that descriptive and prescriptive rules are normally tested differently. Firstly, only descriptive rules can be falsified empirically (Manktelow and Over, 1991). Secondly, in our view descriptive rules should be tested according to the norms of Bayesian reasoning (e.g., Oaksford & Chater, 1994, 2003; v. Sydow, 2004, cf. e. g. Evans & Over, 1996). In contrast the typical task of a tester of a prescriptive rule (as normally formulated in the WST tradition) is to search for particular cases, for instance, for cheaters. In this paper we will only be concerned with prescriptive rules.

Testing Prescriptive Conditionals by Deontic Logic

Here it is advocated that domain-specific content effects, which provide the basis for the illogical domain specific approaches of the WST, could partly be explained and systematized on the basis of a deontic logic, which analyzes logical relations between prescriptive propositions (see e.g., Hilpinen, 1981). From deontic logic additional predictions will be derived.

Although the phenomena connected to deontic reasoning have received much attention in the WST debate, deontic logic has only been exceptionally mentioned (see particularly, Manktelow & Over, 1995; Beller, 2001; von Sydow et al. 2005). In different contexts Beller (2003) and, lately, Buciarelli and Johnson-Laird (2005) introduced deontic logic more fully, distinguishing four basic kinds of conditionals on equal footing, including prohibitions (in contrast: Johnson-Laird & Byrne, 2002). Here, the postulated four kinds of conditionals will be tested on equal footing using WSTs.

FDL theory postulates that the logical structure of a deontic prescriptive rule is represented in *full ought tables.* FDL theory opposes the claim of mental model theory that *incomplete* representations are necessary to explain different selections in deontic WSTs (cf. Experiment 2). The cells of the tables represent states of affairs or actions, which can be right or wrong, allowed or forbidden. A *universal obligation* like "Thou shalt love thy neighbor as thyself" implies that it is right to love one's neighbor and wrong to hate him/her.

A *conditional obligation* "if *p* then one is obliged to do *q*" asserts that it is wrong if *p & non-q* happens. Assume that a tribal rule says "If someone is a bachelor, then each month he must bring fish to the medicine man" then it is forbidden to be a bachelor and not to bring fish to the medicine man (cf. Table 1).

A *conditional prohibition* "If someone is a bachelor, he is forbidden from going to the bath house", forbids that one is a bachelor (*p*) *and* that one goes to the bath house (*q*) (cf. Table 2).

Table 1: Ought table of a conditional obligation

Conditional obligation	Brings fish (q)	Does not bring fish ($\neg q$)
Bachelor (p)	Allowed	Forbidden
Husband (*non-p*)	Allowed	Allowed

Table 2: Ought table of a conditional prohibition

Conditional prohibition	Goes to the bath house (q)	Does not go to the bath house ($\neg q$)
Bachelor (p)	Forbidden	Allowed
Husband (*non-p*)	Allowed	Allowed

Table 3: Ought table of a conditional permission

Conditional prohibition	Eats Cassava root (q)	Does not eat Cassava root ($\neg q$)
Bachelor (p)	Allowed	Allowed
Husband (*non-p*)	Forbidden	Allowed

Table 4: Ought table of a conditional permission to refrain

Conditional prohibition	Hunts Karogi oxen (q)	Does not hunt Karogi oxen ($\neg q$)
Bachelor (p)	Allowed	Allowed
Husband (*non-p*)	Allowed	Forbidden

Moreover, one may formulate a *conditional permission* "If someone is a bachelor, then he is allowed to eat the aphrodisiac Cassava root" (Table 3) or a *conditional permission to refrain*, "If someone is a bachelor, he may refrain from taking part in hunting the dangerous Karogi oxen" (Table 4).

Although the four rules are formally conditionals, they forbid different cases in an ought table, as can be derived from deontic logics. If the task is to look for violations of the rule the forbidden cases provide the correct answers.

Flexible Focus on Cells of the Ought Table – Cheater or Cooperator Detection or Both

FDL theory for the first time combines deontic logic with the idea that different pragmatic contexts will focus people systematically on different cases (see Sperber, 2003; cf. Oaksford & Chater, 1994). The so called 'cheater detection algorithm' is, in our view, nothing but a specific focus on the

forbidden cells of an ought table. Perspective effects (Gigerenzer & Hug, 1992) may perhaps also be understood as a shift of the focus, but they are only concerned with different *cheater* cases (cf. Johnson-Laird & Byrne, 1992). In contrast, we advocate a flexible focus not only on cheater cases, but also on other cells of an ought table. In deontic contexts, checking prescriptive rules typically involves searching either for individuals who have violated the rule or individuals who have complied with the rule or even both (double focus). Depending on whether punishments or rewards constitute the current pragmatic goal, one should check for different cases (v. Sydow et. al., 2004).

For a conditional obligation in which both goals are plausible, like "if someone is a bachelor he is obliged to bring a tiger skin to the medicine man" the *p* (bachelor) and *non-q* case (brings no tiger skin to the medicine man) is the cheater focus, and *p* and *q* (brings fish) would be the cooperation detection focus. Finally the double focus on both cases should result in a *p*, *q* and *non-q* pattern (Table 5a, b, c). In contrast, for the prohibition rule "if *p* then it is forbidden to *q*" the cheater focus is on *p* & *q* and the cooperator focus on *p* & *non-q* and the double focus should lead to both selections.

The predicted interaction of focus and rule, and the double focus postulated are inconsistent both with existing domain-specific and domain-general approaches of the WST (cf. Discussion).

Table 5: (a) Cheater focus, (b) cooperator focus and (c) double focus in a conditional obligation. The circle indicates the focused cell

(a) Conditional obligation	Brings tiger skin (*q*)	Does not bring tiger skin (*non-q*)
Bachelor (*p*)	Allowed	Forbidden
Husband (*non-p*)	Allowed	Allowed

(b) Conditional obligation	Brings tiger skin (*q*)	Does not bring tiger skin (*non-q*)
Bachelor (*p*)	Allowed	Forbidden
Husband (*non-p*)	Allowed	Allowed

(c) Conditional obligation	Brings tiger skin (*q*)	Does not bring tiger skin (*non-q*)
Bachelor (*p*)	Allowed	Forbidden
Husband (*non-p*)	Allowed	Allowed

Experiment 1

In this experiment the four different kinds of basic deontic conditionals, derived from deontic logic, will be tested in a WST for the first time (cf. on other tasks Johnson-Laird & Byrne, 2005; Beller, 2003). PRS theory and SC theory have not predicted the postulated systematics. Beller's (2001) experiment was similar to ours, but did not formulate the four conditionals without negations on equal footing.

Method

Design and Participants The experiment had a between-subjects design with four conditions corresponding to the four types of conditionals, each with a different forbidden ought cell. Sixty-four students from the University of Göttingen participated in the experiment.

Materials and Procedure In all conditions participants were asked to imagine they were members of a council of elders, which had police functions. The council's purpose, they were told, was to punish those who violated the rules of the tribe. Then in the four conditions different conditional rules were presented using the statements used earlier to demonstrate an obligation, a prohibition, a permission, and a permission to refrain (Table 1 to 4). The rest of the instruction only differed in the description of the corresponding cards. Generally, four male members of the tribe were presented to the participants for possible checks. The tribesmen were represented by 4 cards, in the obligation condition, for instance, "Bachelor" (*p*), "Husband" (*non-p*), "brings fish" (*q*), and "does not bring fish" (*non-q*).

Participants had to decide which card(s) are "really needed to be turned over to test whether the rule had been followed or had been violated". They were requested to indicate all cards necessary to fulfil the given task.

Results

Table 6: Percentage of selected card combinations for the four deontic conditionals

Pattern	Cond. pro-hibition	Cond. ob-ligation	Cond. perm. to refrain	Cond. per-mission
P, *Q*	81 %	6 %	12 %	12 %
P, ¬*Q*	0 %	56 %	12 %	0 %
¬*P*, ¬*Q*	0 %	0 %	69 %	6 %
¬*P*, *Q*	6 %	0 %	0 %	56 %
Rest	12 %	30 %	6 %	24 %
n	16	16	16	16

Note. Predicted answers in darkened cells.

Table 7: Card selections for four deontic conditionals

Card selected	Cond. pro-hibition	Cond. obli-gation	Cond. perm. to Refrain	Cond. per-mission
P	87 %	87 %	19 %	31 %
¬*P*	6 %	12 %	69 %	75 %
Q	93 %	25 %	87 %	12 %
¬*Q*	12 %	81 %	12 %	87 %
n	16	16	16	16

Table 6 and Table 7 show the percentage of selected card combinations and single selected cards in the four WSTs. The predicted selections were predominant. It was possible to elicit all four kinds of card selections, *p* & *q*, *p* & *non-q*, *non-q* & *q*, and also *non-p* & *non-q*. (Statistically, each pattern in Table 6 was more frequent in the condition where it was predicted than in the second most frequent condition. Top down: $\chi^2(1) = 15.18; 6.79; 13.33; 9.31$; all $p < 0.01$.)

Experiment 2

In this experiment we aimed to test the central prediction of FDL theory that the selection patterns of checking a prescriptive conditional are determined systematically by the interaction of the type of conditional (deontic logic) and of a used focus (cheater focus, cooperator focus or double focus; cf. v. Sydow et al., 2005). The goals were directly manipulated and a double focus condition is used for which *p* & *q* & *non-q* patterns are predicted. This pattern has never been predicted to become the dominant pattern in a WST before. Moreover, a double focus condition is particularly useful for dissociating FDL theory, not only from PRS theory and SC theory, but also from MM theory.

Method

Design and Participants The experiment had a 2 (obligation vs. prohibition rule) × 3 (cheater vs. cooperator vs. double focus) between-subjects design. 120 students of the University of Göttingen participated in the experiment.

Materials and Procedure Participants were instructed to read the text carefully. As in Experiment 1 the participants had to imagine they were members of a tribal council of elders. The council is described as being generally responsible for checking whether the rules of that tribe have been followed or violated. Subsequently a particular rule was presented. (The rules and the goals were highlighted.) In the three obligation conditions the rule read: "If one is a bachelor, then this year one is obliged to bring a tiger skin to the medicine man". In the three prohibition rule conditions it read: "If one is a bachelor, then this year one is forbidden from drinking a popular fruit punch". The goals of cheater and cooperator detection were both assumed to be applicable to these rules. Then the goals were explicitly introduced (for a more indirect manipulation cf. v. Sydow et al., 2005). For the three conditions instructions read as follows. Cheater conditions: "In checking this rule you have only one goal: You should *punish those, who have violated the above rule*." Cooperator conditions: "In checking this rule you have *only one goal*. You should *reward those, who have followed the above rule*." Double focus conditions: "In checking this rule you have two goals at the same time: [First bullet.] You should *reward those, who followed the above rule*. [Second bullet.] You should *punish those, who violated the above rule*."

Four male members of the tribe were put forward for possible checks. Each of the four members of the tribe was represented by a card. Participants were instructed, that one side of each card provided information about whether the clansman is a bachelor or not, and the other side provided information whether he has brought a tiger skin (or has drunk from the fruit punch) or not.

The final instruction read: "Which card(s) do you have to turn over, to check exactly for all possible cases in which the above rule has been violated [alternatively: "followed"; "violated and followed"]. Please mark all the cards necessary." The cards read: "Bachelor" (*p*), "Husband" (*non-p*), "has brought tiger skin" (or: "has drunk from the punch", *q*), and "has not brought tiger skin" (or: "has not drunk from the punch", *non-q*).

Results

Table 8 shows for each condition the number of participants who selected particular patterns of card combinations. The predicted answers are darkened.

Table 8: Percentage of selections of cards patterns for different rules and different foci

Card pattern	Obligation rule: Cheater	Obligation rule: Double focus	Obligation rule: Co-operator	Prohibition rule: Cheater	Prohibition rule: Double focus	Prohibition rule: Co-operator
P, *Q*	10 %	5 %	50 %	85 %	35 %	20 %
P, ¬*Q*	70 %	25 %	10 %	0 %	5 %	35 %
P, *Q*, ¬*Q*	0 %	60 %	20 %	0 %	35 %	25 %
Rest	20 %	10 %	20 %	15 %	25 %	20 %
n	20	20	20	20	20	20

Note. Predicted answers in darkened cells.

Descriptively, all comparisons between conditions went in the predicted direction. This is the case as well for the *p & q* pattern, the *p & non-q* pattern and the *p & q & non-q* pattern. Table 9 additionally presents the number and percentage of participants who selected *specific* cards for each condition. Here even more clearly all predicted differences between the conditions went in the predicted direction, which indicates a corroboration of both the interaction of rule (prohibition versus cooperator condition) and focus (cooperator versus cheater focus), and the postulated 'middle position' of the double focus condition.

However, particularly in Table 6, the results in the cooperator and double focus condition of the prohibition rule are less pronounced than one may have hoped. This may be due to the term 'forbidden' in the prohibition rule which may have rendered a cheater focus more probable. This may have caused an increase of *p & q & non-q* double focus selections in the cooperator condition and an increase of *p & q* cheater selections in the double focus condition.

Table 9: Percentage of selections of single cards for different rules and different foci

Card	Obligation rule: Cheater	Obligation rule: Double focus	Obligation rule: Co-operator	Prohibition rule: Cheater	Prohibition rule: Double focus	Prohibition rule: Co-operator
P	90 %	100%	90 %	95 %	80 %	95 %
¬*P*	15 %	10 %	5 %	10 %	20 %	15 %
Q	20 %	75 %	80 %	95 %	90 %	50 %
¬*Q*	80 %	95 %	40 %	0 %	40 %	70 %
n	20	20	20	20	20	20

Note. Predicted answers in darkened cells.

If this is accepted, the statistical comparisons on the level of single cards (see Table 10) show that the main predictions are also confirmed in the prohibition rule as well. In the double focus condition there were more cheater selections (here *q*) than in the cooperator selection condition, but also more cooperator selections (here *non-q*) than in the cheater

condition. Moreover, the pattern in the obligation rule condition led to excellent results for the cheater, cooperator, and double focus conditions.

Table 10 For the obligation rule: Comparisons of the single card selections *Q* and *Non-Q*

Hypotheses of FDL	Result	Positive?
Obligation		
$f(q)_{\text{Cheater}} < f(q)_{\text{Cooperator}}$	$\chi^2_{(1)} = 14.40$, $p < .001$	yes
$f(\neg q)_{\text{Cheater}} > f(\neg q)_{\text{Cooperator}}$	$\chi^2_{(1)} = 6.67$, $p < .01$	yes
$f(q)_{\text{Cheater}} < f(q)_{\text{Double}}$	$\chi^2_{(1)} = 12.13$, $p < .001$	yes
$f(\neg q)_{\text{Cheater}} = f(\neg q)_{\text{Double}}$	exact Fisher, $p = .34$	yes
$f(q)_{\text{Double}} = f(q)_{\text{Cooperator}}$	exact Fisher, $p = 1.00$	yes
$f(\neg q)_{\text{Double}} > f(\neg q)_{\text{Cooperator}}$	$\chi^2_{(1)} = 13.79$, $p < .001$	yes
Prohibition		
$f(q)_{\text{Cheater}} > f(q)_{\text{Cooperator}}$	$\chi^2_{(1)} = 10.16$, $p < .01$	yes
$f(\neg q)_{\text{Cheater}} < f(\neg q)_{\text{Cooperator}}$	$\chi^2_{(1)} = 21.54$, $p < .001$	yes
$f(q)_{\text{Cheater}} = f(q)_{\text{Double}}$	exact Fisher, $p = 1.00$	yes
$f(\neg q)_{\text{Cheater}} < f(\neg q)_{\text{Double}}$	exact Fisher, $p < .01$	yes
$f(q)_{\text{Double}} > f(q)_{\text{Cooperator}}$	$\chi^2_{(1)} = 7.62$, $p < .01$	yes
$f(\neg q)_{\text{Double}} = f(\neg q)_{\text{Cooperator}}$	$\chi^2_{(1)} = 3.64$, $p = .057$	(yes)

Discussion

The results of Experiment 1 provide evidence that selection patterns are determined by deontic logic: The dominant selection patterns always corresponded to the forbidden cell of its respective ought table. Although the rules were all formulated in terms of a conditional, the differences between the conditions confirmed the four different kinds of card selections predicted, including *p* and *q* patterns and *non-p* and *non-q* patterns.

Experiment 2 provides novel support for FDL theory (cf. von Sydow, et al. 2005) in supporting the postulated interaction of a deontic rule and focus and additionally showing novel double focus effects. First, the two rules and the cooperator versus cheater conditions led to reversed *q* and *non-q* selection patterns. Secondly, a predicted double focus effect with a *p & q* & *non-q* selection pattern was clearly found for the obligation rule. Until now this pattern has neither been predicted to be dominant nor found to dominate any deontic WST. In the prohibition rule the data suggest that the formulation of the rule itself may have caused a shift of the focus with a tendency to add a cheater focus in the cooperator condition or to neglect the cooperator focus in the double focus condition. Nonetheless, also in these three conditions the data provided support for the postulated differences and allowed to distinguish the double focus condition from both the cooperator and the cheater detection condition. Therefore, the results corroborate FDL theory.

Moreover, the results favor FDL theory over other theories which cannot account for the results of the two experiments without modifications or extensions. The rational interaction of deontic rules and different goals of cheater and cooperator detection has not explicitly been predicted by any current theory of the WST.

SC theory (Cosmides, 1989; Cosmides & Tooby, 1992; Gigerenzer & Hug, 1992; cf. Fiddick, 2004) has postulated a cheater detection module. Although FDL theory builds on the idea that cheater detection differs from the normal testing of the truth or falsity of a descriptive rule, FDL theory differs from SC theory in advocating a flexible deontic logic of testing prescriptive rules. Experiment 1 clearly goes beyond SC theory by deriving more selection patterns from a system of deontic logic than has been predicted by SC theory. Moreover, Experiment 2 showed focus effects not only for a cheater detection focus but also for a cooperator detection focus *and* a double focus condition. SC theory cannot distinguish these three kinds of foci – either the cheater detection algorithm is triggered or not. Our results show that cheater detection seems to be explicable as an aspect of a more general strategy for focusing systematically on different cells of an ought table.

PRS theory (Cheng & Holyoak, 1985; cf. Holyoak & Cheng, 1995) proposed an obligation and a permission schema which is incoherent with formal logics. Firstly, FDL goes beyond PRS theory by deriving additional 'schemas' like a prohibition schema from deontic logic and by confirming them in Experiment 1 and 2.[1] Secondly, and more importantly, the production rules of PRS theory should always trigger particular selections, independent of a focus. Hence, PRS theory cannot account for the found focus effects in Experiment 2.

MM theory of the WST (1991, 1992, 2002) explains deviations from logically correct reasoning by postulating particular incomplete representations of conditionals. Experiment 1 is not explicable by traditional MM theory because no model for the prohibition has been proposed. The problem in formulating such a model may be that the application of the domain-general truth principle combined with the normal incomplete representation of a conditional (mainly comprising *p* & *q*) would result in an 'empty representation' – which would be absurd. Lately, Buciarelli and Johnson-Laird (2005) extended MM theory to include prohibitions (implicitly giving up the truth principle), without applying this theory to the WST. However, if applied to the WST this theory may perhaps explain the findings of Experiment 1, but the mental model component of the theory would add nothing to the explanation. In any case, MM theory (also in the advanced versions of Beller, 2001, 2003) is clearly incoherent with the results from Experiment 2. The results cannot be explained by the selective representations postulated by current MM theory (Buciarelli and Johnson-Laird, 2005). For instance, for the obligation rule the increased number of *non-q* selections both in the double focus and the cheater condition relative to the cooperator condition can be explained by a fleshed-out model. But if this is done, it becomes inexplicable why in one of the fleshed-out conditions (double focus condition) the number of *q* 'cooperator' selections is significantly higher than in the other condition (cheater condition). MM theory in its current formulation cannot account for the results of Experiment 2. The two kinds of representations of an obligation (an incomplete and a complete model) postulated by MM theory cannot be reasonably matched to the three kinds of patterns

[1] If one aims to extend PRS theory, one may add production rules like "If the precondition is fulfilled than the action is forbidden".

predicted and found by FDL theory. Hence, the results can only be explained by a focus effects on a given representation and not (only) by the selective representations postulated by current MM theory.

Relevance Theory of the WST has discussed focus effects even earlier (Sperber & Girotto, 2002, 2003; cf. Oaksford & Chater, 1994). However, relevance theory does not employ any concept of deontic logic and has not combined deontic logic with focusing. Perhaps the results may be compatible with Manktelow and Over's (1991, 1992, 1995) *decision theoretic account.* Although they have indeed made steps to incorporate deontic logic, they neither treat prohibitions nor combined deontic logic with a cooperator or a double focus. Further research is needed to understand the differences between the successful manipulation here, and their unsuccessful manipulation based on the variation of individual utilities (Manktelow & Over, 1990, 1992). Hence, the current experiment is underspecified to count as independent evidence in favor of a utility based approach. (For instance, as seen in the ultimatum game, the construction of foci needs not to be determined only by individual utility but also by considerations about justice.)

In conclusion, FDL theory may provide a rational synthesis of converging lines of research on the deontic WST. Our results favor FDL theory and challenge current domain-specific and domain-general theories of the WST.

Acknowledgements

We thank Björn Meder, Michael Waldmann, and the anonymous reviewers for helpful and encouraging comments.

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