Deontic Reasoning Squared

Sieghard Beller (beller@psychologie.uni-freiburg.de)
Department of Psychology, University of Freiburg
D-79085 Freiburg, Germany

Abstract

The deontic square of oppositions describes relations between four deontic concepts: ban, permission, obligation, and release from obligation. It is argued that people use these relations not only when they interpret deontic social rules, but also when they reason from given rules. Data from several studies are presented that corroborate this argument.

Keywords: Deontic reasoning; social rules; deontic logic; square of oppositions.

Introduction

Robinson Crusoe, a mariner from York and the only survivor of his shipwrecked sailing vessel, lived 28 years “all alone on an uninhabited island on the coast of America, near the mouth of the great river of Oroonoque”, as we are told in the 1661 novel by Daniel Defoe. On his island, nobody dictated him what to do or not to do, and accordingly, Robinson Crusoe could act at his own discretion in each situation. This is clearly not true for us. Other than Robinson Crusoe, we live in groups with a differentiated social organization, we maintain relations of different kinds to various people, and therefore our behavior as individuals is flanked by numerous explicit and implicit social rules that impose normative constraints on our actions in favour of superordinate interests.

Hardly any field is excepted: There are rules for political events (e.g., minor children must not vote), rules that regulate our leisure activities (e.g., only with a ticket, you may enter the concert), rules that affect our mobility (e.g., car drivers must stop at red traffic lights), rules for managing hazards (e.g., protection gloves are not needed outside the danger zone, but inside), and so on. Thinking about what is forbidden or allowed, obligatory or not obligatory according to such rules is called deontic reasoning.

Acquisition of the respective rules and adequately dealing with them are so important for people’s social activities that the underlying deontic capabilities undoubtedly constitute an essential part of human social cognition. From a formal logical point of view, the four deontic modalities “ban”, “permission”, “obligation”, and “release from obligation” can be arranged in a square of oppositions (e.g., Anderson, 1956). This article addresses the question of whether these relations help us to understand how people interpret and reason from social rules. It is argued that people interpret social rules according to a small set of representational principles, that their deontic inferences from such rules generally follow logical principles, and that they in fact consider the interrelations between the four modalities as defined by the square of oppositions.

The Deontic Square of Oppositions

According to the deontic square (e.g., Anderson, 1956), four types of oppositions between the four modalities are defined (cf. Figure 1 below), which correspond to assertions typically made in deontic logics (e.g., Chellas, 1980; von Wright, 1981).

(1) Ban and obligation form a pair of contraries; only one of them may be in effect at any time. In other words: An action cannot be forbidden and obligatory simultaneously—otherwise the person is trapped in a dilemma. The two concepts are interchangeable, if both the commission of an action (X) and its omission (not-X) are taken into consideration: To be obligated to take an action then means that its omission is forbidden (i.e., ‘must X \equiv must-not (not-X)’), while a forbidden action means that its omission is obligatory (i.e., ‘must-not (X) \equiv must (not-X)’).

(2) Ban and permission as well as obligation and release from obligation are pairs of contradictories; exactly one of each pair is true in a particular situation: An action is either forbidden or allowed; it is either obligatory or not. Permission therefore corresponds to the absence of a ban (‘may X \equiv not (must-not (X))’), release from obligation corresponds to the absence of an obligation (‘need-not (X) \equiv not (must X)’), and vice versa.

(3) The two diagonals of the square connect subaltern pairs. If an action is forbidden, then it cannot be obligatory according to the contrary relation, and so its omission must be possible, meaning that the action need not be taken. Conversely, if an action is obligatory, then it cannot be forbidden, meaning that the action may be taken. Therefore, along the diagonals, the top implies the bottom as otherwise a deontic dilemma would result.

(4) Finally, permission and release from obligation are subcontraries; at least one of them holds in each situation:

- Ban contraries Obligation
  - must not

- Permission subcontraries Release
  - may

Figure 1: The deontic square of oppositions.
An action may be taken if it is not banned, it need not be taken if it is not obligatory, or both if there is no deontic rule at all.

According to the square, three mutually exclusive states are possible with regard to the commission of an action X: Action X can either be forbidden, obligatory, or indifferent (i.e., allowed, but not required). If the negations of these states are considered additionally, six deontic states result. Some authors therefore prefer a deontological hexagon (e.g., Lenk, 1974). But when taking into account that obligation is equivalent to a ban, then only two qualitatively different states remain: An action is either constrained by a social rule (forbidden/obligatory) or not constrained (indifferent).

**How People Represent Deontic Rules and How They Reason From Them**

Three groups of psychological theories on deontic reasoning have been discussed in the last two decades: evolutionary approaches, schema theory, and mental model theory. Until the present day, however, the potential of the deontic square of oppositions has not or at least not fully been exploited. After a brief sketch of the main current deontic theories, a new approach is presented that integrates the relations from the deontic square.

**Current Theories of Deontic Reasoning and the Square of Oppositions**

Approaches from evolutionary psychology focus on possible evolutionary roots of the human deontic capabilities. Several candidates have been proposed: Cooperation in groups is said to have fostered special cognitive mechanisms to detect cheaters (Cosmides, 1989) or free-riders (Hiraishi & Hasegawa, 2001) on social contract rules. dominance hierarchies are said to have fostered mechanisms for detecting what is forbidden for subordinate individuals (Cummins, 1996b), and dangerous environments are said to have fostered mechanisms for detecting and handling potential hazards (Fiddick, 2004). While these approaches differentiated several deontic domains and their possible roots in the history of mankind, they did not tackle the question of how the system of deontic modalities is semantically structured.

Pragmatic reasoning schema theory (Cheng & Holyoak, 1985; Holyoak & Cheng, 1995) explicitly refers to the four modalities of the deontic square. Cheng and Holyoak proposed two deontic schemas, one for obligation and one for permission. Each schema consists of four inference rules; one for each modality. However, both schemas make only partial use of the oppositions between the four modalities, and schemas for the modalities “ban” and “release from obligation” are missing altogether (Beller, 2008). The main reason for the success of the schema theory was its simplicity—from the perspective of the deontic square, however, the proposed schemas proved to be too simple.

The most elaborated approach in this respect is the mental model theory of deontic reasoning (Bucciarelli & Johnson-Laird, 2005). It explicitly includes the oppositions from the square, but is restricted with respect to other aspects. First, it only considers three deontic modalities—ban, obligation, and permission—corresponding to the three deontic states described above (forbidden, obligatory, and indifferent). The fourth modality is missing. Second, the mental model approach defines the meaning of deontic statements mainly in terms of permissible situations. Forbidden situations remain implicit (at least in most cases) and must be inferred from the absence of permission. But why should permission, ban, obligation, and release from obligation not be equally part of people’s mental representations of deontic rules? The restriction to permissible states appears to be quite arbitrary and is in fact not necessary.

To sum up, the deontic square of oppositions turns out to be a useful means to detect gaps in current psychological theories (see Beller, 2008, for a more detailed discussion). In the following, an approach is sketched that begins to fill these gaps. It starts with a description of the principles according to which people represent a deontic social rule, followed by an analysis of deontic inferences.

**Basic Representational Principles**

Normative social rules are intended to regulate an addressee’s actions under certain conditions. It is proposed that people’s representations of such rules follow three principles: Rules define social constraints on actions, their application conditions must be considered exhaustively, and there is a strong relation between the condition side of a rule and the action constraint (Beller, 2001, 2003, 2008).

**Constraint principle.** The four modalities ban, permission, obligation, and release from obligation all deal with establishing or lifting social constraints on actions. To cover this, deontic rules have to represent these constraints. Two of the four modalities explicitly denote a constraint: ban and obligation. As they are logically interchangeable, it is sufficient to use one of them as basic representational concept. For reasons of simplicity, the notion of a ban is taken as basic in the subsequent presentation and is represented as ‘forbidden(Action)’.

Please note that advice is not included in this representation, although this concept is sometimes regarded as part of the deontic domain. Advice refers to the evaluation of an action or its consequences as better or worse on a certain dimension. The addressee can accept it or ignore it. But, as people are not punished for ignoring an advice, this concept does not constitute a normative social constraint and therefore should be distinguished from bans and obligations.

**Exhaustivity principle.** In order to determine whether or not a particular action is forbidden in a specific situation, it is necessary to take into consideration all conditions that put a ban into force. Accordingly, people have to represent each ban together with all its conditions exhaustively; otherwise deontic inferences would not be possible. Thereby, complex sets of conditions can be represented in terms of necessity and sufficiency as a disjunction of conjunctions of single factors.

**Equivalence principle.** If all relevant conditions for a particular ban are considered, a strong relation (equivalence) between the conditions and the banned action is justified: If at least one condition is met, then the action is forbidden; otherwise it is not forbidden.
According to these principles, a deontic rule regarding one particular action can be represented by the following schema:

‘Conditions ↔ forbidden(Action)’

Corresponding with the contradictory relation of the square, a weak definition of permission is associated with this schema: An action is allowed if it is not explicitly forbidden (‘may X ≡ not (must-not (X))’).

Examples. The following examples illustrate how the proposed principles can guide people’s interpretation of deontic rules.

(E1) If a person wants to attend a concert, only one condition is typically relevant: having a ticket. In order to represent this entrance rule exhaustively, two aspects must be determined: the deontically regulated action and its conditions. In this case, the admission to the concert constitutes the deontic constraint, and having a ticket is the only condition. Connecting the condition-side and the deontic-side according to the above schema, we get the following rule:

‘¬ticket ↔ forbidden(entering)’

If the person has no ticket, then entering the concert is forbidden; otherwise it is allowed.

(E2) Sometimes, however, more than one condition has to be considered. The musicians, for instance, are typically allowed to enter the concert hall without a ticket. In order to consider this aspect as well, the deontic rule has to encompass two conjunctive conditions:

‘(¬ticket ∧ ¬musician) ↔ forbidden(entering)’

If a person has no ticket and is also none of the musicians, then entering is forbidden; otherwise it is allowed.

(E3) Spectators of soccer matches, on the other hand, are often inspected not only for their tickets but also for weapons. In order to consider this aspect, the rule has to encompass two disjunctive conditions:

‘(¬ticket ∨ weapon) ↔ forbidden(entering)’

If a person has no ticket or has a weapon, then entering is forbidden; otherwise it is allowed.

Remarks. While the condition side of a rule can involve various numbers of preconditions until the exhaustivity criterion is met, the deontic side ‘forbidden(Action)’ refers to one particular action only. Consequently, every deontically regulated action requires its own rule.

The schema above uses “ban” as basic deontic concept, which represents an action constraint explicitly. From a formal point of view, however, each of the other three modalities could equally be used to represent a corresponding constraint—at least implicitly—if it is combined with the exhaustivity and equivalence principle. The simple ban rule (E1), for instance, is equivalent to the following permission:

‘ticket ↔ permitted(entering)’

Depending on which deontic aspect a person focuses on—ban, permission, obligation, or release from obligation—the representation of the deontic rule may look differently, but the basic construction principles are the same. In Beller (2001) and Beller (2003) it is shown how these principles can be implemented in a mental models framework.

Finally, it is clear that deontic rules do not describe which action a person actually takes or which conditions actually hold in a specific situation. As long as people have the freedom of will and the possibility to commit or omit an action, they can conform to a rule or violate it. Therefore, the ban ‘he or she must not do X’ does neither imply ‘not-X’ nor ‘X’, and the same holds for the other modalities.

Two Perspectives: Process and Achievement. The deontic modalities captured in the square of oppositions can be interpreted in two different ways. Regarded as process, the modalities can be understood as acts that change an existing set of deontic rules by extending or restricting them (e.g., Alchourrón & Bulygin, 1981). Forbidding an action enacts a new ban or extends the condition side of an existing ban so that the particular action is forbidden under a wider range of conditions. Permitting an action complementarily lifts a ban or removes conditions, thereby allowing an action that was previously banned under these conditions. Since being obligated to carry out an action means being not allowed to omit it, the acts of obligation and release from obligation can be handled analogously. This process perspective corresponds with a strong definition of the modalities. The achievement perspective, on the other hand, corresponds with the question of which implications result from an established set of deontic rules: Which actions are forbidden and which are permitted, which are obligatory and which are not obligatory in a particular situation? Note that in this case the focus changes from the agent, who establishes, modifies, or lifts a deontic rule, to the patients of this rule and to deontic inferences about their behavior (cf. Bender & Beller, 2003).

Deontic Inferences

The deontic schema ‘Conditions ↔ forbidden(Action)’ supports three types of inferences: Forward inferences and two types of backward inferences.

Forward inferences are inferences from the condition side of a rule to the deontic status of the regulated action. The conditions of a ban are either fulfilled or not fulfilled. (a) If the conditions are fulfilled then the ban applies. (b) If the conditions are not fulfilled, then the regulated action is permitted according to the equivalence principle and the contradictory relation.

Consider the ticket example (E1). The following statements can be derived from this ticket rule by forward inferences: Given that a person has no ticket, this person must not enter (or must stay outside, according to the interchangeability of the modal terms) and, according to the subaltern relations, he or she need not enter (or may stay outside). A
person with a ticket may enter (or need not stay outside), and, as there is no obligation to enter, this person need not enter (or may stay outside).

**Backward inferences** are inferences from the action side of the rule to the condition side and may occur in two types.

Deontic-to-factual inferences are derived from a deontic statement about the regulated action. The action is either deontically constrained or not. (c) If an action is banned then the conditions of the ban are fulfilled as otherwise the action would be allowed. (d) If a potentially banned action is not forbidden then the conditions of the ban are not fulfilled.

Suppose you know that ban (E1) applies to a person so that entering is forbidden. From this you can conclude that the condition is fulfilled; in other words: If a person must not enter (or must stay outside), then this person has no ticket. Analogously, suppose you know that ban (E1) does not apply to a person (entering is not forbidden). From this you can conclude that the condition of the ban is not fulfilled; in other words: If a person may enter (or need not stay outside), then this person has a ticket.

The second type of backward inferences may be called factual-to-deontic inferences. They are derived from information on whether or not the deontically regulated action is taken. (e) If a banned action is taken, then the conditions of the ban must not be fulfilled as otherwise the rule would be violated. (f) If the banned action is not taken, then the conditions may but need not be fulfilled—at least as long as these conditions do not concern actions that are deontically regulated by another rule.

If a person in example (E1) enters the concert, then he or she must not be without a ticket (or must have a ticket), as otherwise the ticket rule would be violated. If the person stays outside, he or she may, but need not be without a ticket (or need not have a ticket). Note that the modal terms “must not”, “must”, “may”, and “need not” are used here in a purely deontic sense, that is, with reference to the underlying social rule, but not in an epistemic sense. They imply neither that the respective person has in fact a ticket nor that the person has no ticket.

**Empirical Evidence**

From developmental data we know that children begin to understand the meaning of deontic rules from a very early age onwards. Modal expressions with deontic meaning appear at the age of two-and-a-half years in children’s speech production (e.g., Bliss, 1988; Stephany, 1986; Wells, 1979), and from three years up they are already quite competent in detecting violations of deontic rules (e.g., Cummins, 1996a; Harris, Núñez & Brett, 2001; O’Brien, Dias, Roazzi & Cantor, 1998). However, a full comprehension of the system of the four deontic modalities is the result of a process of several years (e.g., Bascelli & Barbieri, 2002; Hirst & Weil, 1982) that is not yet finished at the age of twelve (Coates, 1988). Moral dilemmas, in the tradition of the developmental psychologist Lawrence Kohlberg, have provided an important source of insight into people’s moral beliefs and how they weigh conflicting deontic rules (see, e.g., Colby & Kohlberg, 1987; Kohlberg, Levine & Hewer, 1983), but these studies do not tell us enough about how people cognitively represent a single rule and about the inferences people draw from a consistent set of rules.

An early piece of evidence for the proposed representational and inferential principles can be found in a study of Klaczynski and Narasimham (1998). They found that people tend to go beyond the explicitly mentioned conditions of a deontic rule, if they possess additional knowledge about alternative conditions. In other words, people indeed consider all factors, which they regard as deontically relevant, exhaustively in their mental representation of the rule.

Some indirect pieces of evidence from the selection task paradigm, which requires people to identify cases of rule violation, were discussed in a former paper (Beller, 2001). More direct evidence is provided by two recent studies on conditional promises and threats (Beller, 2002; Beller, Bender & Kuhnmünch, 2005). A conditional promise, for example, has the form “If you do P for me, then I will reward you with Q”. It was found that people interpret the deontic aspect of such speech acts according to the exhaustivity and equivalence principle: Their deontic inferences correspond to a social rule that obligates the speaker to cooperate if and only if the addressee previously cooperated:

'cooperation Adressee ↔ forbidden¬cooperation Speaker' 

The obligation to cooperate is associated with a corresponding permission (“must X” implying “may X” according to the subaltern relation), and, in the absence of the obligation, cooperation was regarded as not necessary but as allowed (indifferent). This pattern of results could also be confirmed in a cross-cultural study with participants from Germany, China, and the Kingdom of Tonga (Beller, Bender & Song, in press).

Finally, the most direct evidence of the proposed principles is provided by three experiments that were explicitly designed to examine people’s understanding and inferential use of conditional permissions and obligations. Experiment 1 with N = 33 participants is reported in detail in Beller (2003), experiments 2 and 3 with N = 102 and N = 60 participants are reported in Beller (2008).

All three experiments used deontic scenarios that were analogous to the examples (E1), (E2), and (E3) above. In one scenario, “having a ticket” was the only condition for admission to a concert (cf. E1), in two other scenarios a second condition was introduced: either an alternative condition (“being a musician”; cf. E2) or an additionally necessary condition (“having no weapons”; cf. E3).

The participants were required to solve two types of tasks: reformulation tasks and inference tasks. The reformulation task required participants to choose the best reformulation of the complete deontic rule among some given reformulations with either an equivalence relation or a simple conditional relation between the condition side of the rule and the deontic constraint. According to the proposed representational principles, participants should choose a biconditional reformulation in each scenario. The inference tasks implemented each of the six types of inferences (a) to (f) in two modes, using either the modal “must” or the modal “may”. According to the proposed inferential principles, participants should manage both, forward and backward inferences from the
Table 1: Aggregated results of three experiments.

<table>
<thead>
<tr>
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<th>Experiment 1</th>
<th>Experiment 2</th>
<th>Experiment 3</th>
<th>Weighted mean</th>
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<td>interchangeability of the deontic modals</td>
<td>forward inferences</td>
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Sources: Experiment 1 is reported in Beller (2003), experiments 2 and 3 are reported in Beller (2008).

deontic rule, and they should regard corresponding formulations with “may” and “must” in the two parallel task modes as deontically interchangeable with “may enter” being equivalent to “need not stay outside” and “must not enter” being equivalent to “must stay outside”. The aggregated results are presented in Table 1.

Reformulation of the rule: The relation between the condition side of the respective deontic rule and the regulated action was predominantly reformulated as an equivalence (84.6% across the three experiments), independent of the number and type of conditions in the respective the scenario. This provides clear evidence for the equivalence principle and also demonstrates that the participants regarded the given conditions as an exhaustive description of the rule.

Inferences from the rule: It was first checked whether the participants correctly applied the rules of interchangeability of the deontic modals. Across the three experiments, a very high consistency between deontically corresponding pairs of tasks was found (82.1%). As expected, participants regarded the deontic operators “must” and “may” to a large degree as logically interchangeable. Forward inferences from a deontic rule also followed the deontic prediction to a very large extent (85.9% deontic answers), and backward deontic-to-factual inferences appeared to be equally easy (87.4% deontic answers). Only the backward factual-to-deontic inference tasks were solved with less accuracy (63.4% deontic answers).

Discussion

Taken together, the reported data show a fairly consistent picture: Participants interpreted the deontic rules according to the exhaustive and equivalence principle, their inferences systematically followed logical principles, and they considered the logical interrelations between the four deontic modalities, in particular, they regarded deontically corresponding expressions as interchangeable. All in all, the experiments attest people a high deontic competence.

One discrepancy from the deontic prediction demands further explanation: In the three reported experiments from Beller (2003) and Beller (2008), the backward factual-to-deontic tasks were solved to a less degree according to the deontic predictions than the forward tasks and the corresponding backward deontic-to-factual tasks. What might have caused this difference? The participants’ written explanations suggested two distinct reasons.

Remember that the backward factual-to-deontic tasks require people to draw a deontic inference from information on whether or not the deontically regulated action is taken (inferences (e) and (f)). For instance, if a person in example (E1) enters the concert, then he or she must have a ticket as otherwise the deontic rule would be violated. In this case, some people seemed to confuse deontic necessity with epistemic necessity. The mere fact that a person enters the concert includes the possibility that this person has no ticket (thereby violating rule E1). In this case, having a ticket is not a necessary implication of entering the concert, although for guests it is a deontically necessary condition for being allowed to enter.

According to Johnson-Laird (1978), modal terms have not per se a deontic or an epistemic meaning, but obtain the respective reading in the context in which they are applied. The deontic meaning results from a connection to a deontic norm. Such a connection is inevitably established in drawing a forward inference or a backward deontic-to-factual inference from the proposed schema of a norm, as thereby either the condition side of the norm or the deontic regulation is instantiated. This is not the case for backward factual-to-deontic inferences. Here, it is up to the reasoner to decide whether he or she connects the fact “a person enters the concert” to the context of factual possibilities, which includes the possibility that this person has no ticket, or to the context of deontic possibilities, which excludes this possibility for guests.

The second case is different. If a person in example (E1) stays outside, then he or she may, but need not have a ticket. Here, some participants took people’s intentions into consideration. People who are outside but want to attend a concert need a ticket, while those who stay outside for other reasons do not need one. As long as this motivational background
remains unclear, it cannot be decided whether a ticket is deontically necessary.

It was argued that children grasp significant aspects of the deontic system at a very early age, but it takes them several years to comprehend it entirely. Yet they learn how to interpret and to reason from deontic rules, and as adults they are able to do this with remarkable precision. Over the years, many rules are internalized to such a large degree that people mostly follow them without external control. It is therefore not unlikely that even Robinson Crusoe, alone on his island, still obeyed some of the rules he grew up with.

Acknowledgements
I am grateful to Andrea Bender and four anonymous reviewers for valuable comments on an earlier version of this paper.

References


