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Emotion, Belief, and the Words of the Law

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Abstract

An assertion about a fact can in principle be tested in observations. That is impossible for assertions about what is permissible or obligatory, i.e., *deontic* assertions based on moral principles, conventions, rules, or laws. Many modal logics concern these matters. But an integrated theory of emotions and reasoning predicts that emotional reactions and strength of belief should be correlated for deontic assertions, but not for factual assertions. You can be convinced that it is wrong to take paperclips from the office, and that it is right for society to provide health care for everyone, and your emotional response to these two assertions is likely to correlate with the strength of your beliefs in them. In contrast, you can be convinced both that fresh snow is white and that fossil fuels are making the world hotter, but have an emotional reaction to only the second of these assertions. Grounds for factual assertions are empirical findings. But assessments of deontic assertions depend in part on the emotions that they elicit. Previous studies have corroborated this prediction for moral claims, matters of convention, prudential rules, and personal recommendations. We report two experiments that yield the same interaction for legal pronouncements from the Italian Civil Code compared with parallel factual assertions. People like propositions they believe, and they believe propositions they like. We discuss several remaining unknowns including the potential role of emotions in *reasoning* about legal and other deontic propositions.

Keywords: emotions; beliefs; deontics; modal logics; legal pronouncements; pleasure-displeasure

Introduction

Factual assertions differ from deontic assertions, as in the contrast between *citizens pay taxes* and *citizens ought to pay taxes*. The former can be verified by appropriate observations. But the latter cannot—their truth seems to be a matter of opinion, not evidence. Logicians have long understood this difference. They have devised modal logics for epistemic possibilities, which are those dependent on knowledge of the world (see Hughes & Cresswell, 1996). And they have devised those for deontic possibilities, which are those dependent on what is permissible (see, e.g., von Wright, 1951, who devised the first of them). A key difference between these two sorts of logics is that those dealing with epistemics allow inferences such as:

It is necessarily the case that it will rain.

Therefore, *It will rain.*

Such a logic is system T, which Osherson (1976) based his pioneering psychological study on. But only the most

idealistic logician would allow the analogous deontic inference:

It is obligatory that Trump pays taxes.

Therefore, *Trump pays taxes.*

On the contrary, the major principle of deontic logics is that obligation implies permissibility, not matters of fact (see, e.g., system DT).

Deontic principles concern what is obligatory, permissible, and their respective negations. Cultural practices from politics to games are governed by deontic rules, explicit or implicit. Linguists have investigated the meanings of deontic terms such as *may* and *must* (see, e.g., Steedman, 1977). Psychologists have examined deontic versions of Wason's (1960) selection task, which examines the evidence that participants select to test a general hypothesis. A meta-analysis of over 200 experiments showed that deontic contents elicited correct selections more often than abstract contents (Ragni, Kola, & Johnson-Laird, 2018). There are over a dozen explanations of the selection task—evolution (Cosmides, 1989), probabilities (Oaksford & Chater, 1994), pragmatics (Sperber, Cara, & Girotto, 1995), and several more. The meta-analysis established that individuals err in selecting evidence, that no need exists to invoke probabilities in explaining these errors; and that any contents or instructions that make counterexamples to the hypothesis more salient increased the number of correct selections, and a computer implementation of the algorithm (described in Johnson-Laird & Wason, 1970) provided the best account of the mental processes underlying the selections of evidence. Individuals are more accurate in the deontic task because they are so familiar with counterexamples to permissions. They refute, not the deontic hypothesis, but the conduct an individual who failed to comply with it.

The theories of deontic reasoning often treat it as based on special mechanisms (cf. Almor & Sloman's, 1996, critique of Oaksford & Chater, 1994). A contrasting view is that it depends on a general inferential mechanism, which underlies all sorts of reasoning. One such approach postulates that individuals possess a mental logic consisting of formal rules of inference (e.g., Rips, 1994). The central idea of these theories is that individuals construct a formal proof that a conclusion follows from the premises. Each step in this proof depends on a formal rule of inference. Errors may occur because people do not apply a formal rule correctly (Rips, 1994, p. 153). Therefore, errors should be more likely in proofs that require a larger number of steps, or for more

complex and varied steps (ibid., p. 386). He argued that deontic inferences can be handled in his system by the addition of modal operators, similar to those proposed by logicians. However, he did concede that extending his system to account for deontic reasoning would require more than just adding a few rules (Rips, 1994, p. 336). No-one, however, has appeared to have implemented such a system.

We now turn to an alternative theory, which is also based on a general mechanism for reasoning, but that assigns different interpretations to epistemic and to deontic possibilities. It combines this account with the assumption that only epistemic possibilities are open to empirical tests. Deontic truth values in general and legal truth values in particular have no such basis. Their basis is in precepts, policies, and written law. Ultimately what matters, however, are the emotions that individuals feel about what is, and isn't, permissible or obligatory.

Why People Believe and Approve of Laws

The present theory (in Bucciarelli, Khemlani & Johnson-Laird, 2008) brings together two previous theories, one dealing with reasoning and the other dealing with emotions. The theory of mental models—the model theory, for short—postulates that individuals use their understanding of assertions to construct schematic models of the situations to which they refer (see, e.g., Johnson-Laird, Khemlani, & Byrne, 2023; Ragni & Johnson-Laird, 2020). These models are iconic in that their structures insofar as possible are the same as the situations to which they refer. Modality is built into the current model theory. For instance, a disjunction, such as:

Immigrants either find work or else they return home

has models representing a conjunction of the possibilities that hold in default of knowledge to the contrary. So, we describe these two models in the following verbal diagram:

Immigrants work

Immigrants return home

where each row denotes a model of an alternative possibility. One corollary is that individuals tend to infer from the disjunction epistemic possibilities, such as.:

It is possible that immigrants find work.

This inference is invalid in all standard modal logics dealing with epistemic possibilities, including system T, which we mentioned earlier. For a deontic claim, such as:

Immigrants are allowed to find work or to return home.

what differs is that the epistemic possibilities to which factual models refer are replaced by deontic possibilities. Hence, individuals infer from the preceding disjunction, deontic conclusions, such as:

Immigrants are allowed to find work.

Inferences of this sort are such flagrant violations of the logic of disjunctions that they are known as 'paradoxes' of free choice permissions (see Kamp, 1973). They have inspired a vast literature of attempts to explain them, either on pragmatic grounds (e.g., Kratzer & Shimoyama, 2002) or on different interpretations of deontic disjunctions (e.g., Geurts, 2005). The model theory, however, provides a pre-hoc

explanation of them: disjunctions are interpreted as conjunctions of possibilities that hold in default of knowledge to the contrary. The theory also predicts new sorts of 'paradoxes' (see, e.g., Rasga, Quelhas, & Johnson-Laird, 2022). Models are also a portal to probabilities, either those based on frequencies, or those subjective probabilities—non-numerical or numerical—that depend on the proportion of models of evidence in which they hold (Khemlani, Lotstein, & Johnson-Laird, 2015).

Subjective probabilities can be based on empirical evidence, but on what do deontic propositions depend? One source is their provenance. Humans are predisposed to believe what other humans tell them. The effect is amplified if the believer has reasons to trust the authority or credibility of the source. But, at this point, emotions enter. If you love your father and he tells you that it is wrong to eat peas with your knife, you will be inclined to believe him. Two factors are at work here: your father as a figure of authority, and your attachment to him. Edmund Gosse (1923), the author, did not lose his religious belief as a child after worshipping a chair, even though his father had told him that idolatry was the worst possible sin. But he reports that it weakened his belief in his father as an authority on such matters. But there is another sort of emotional attachment essential for determining beliefs in deontic propositions. So, we turn to a theory of emotions that is the other part of the present theory.

The communicative theory of emotions treats them as communications from one individual to another (e.g., Oatley & Johnson-Laird, 2011; Johnson-Laird & Oatley, 2021)—in expressions of various sorts, facial, vocal, and postural (see Darwin, 1872). It also treats them as internal communications in the brain, which prepare the way for thoughts and actions. These signals are innate and concern a small set of basic emotions, which include happiness and sadness, anger and fear. They can be combined with propositional information about the object or cause of an emotion, which can combine with a basic emotion to create a complex, one such as: loathing and loving, and crossness and concern. You can be happy for no reason or object of which you are aware, but loving has to have a conscious object.

The integration of the theories of reasoning and emotion yields two major principles relevant to the present investigation (Bucciarelli et al., 2008):

1. The principle of independent systems: evaluations of deontic claims and emotions depend on independent systems that operate in parallel but that can have causal influences on each other.

Humans experience emotions in many situations that have no deontic component, as, say, when we love a particular painting by Cezanne. Conversely, we may not feel an emotional response when a trivial deontic violation occurs, such as when a person uses the wrong glass to drink claret. The key extreme emotions for deontic propositions should be loathing or loving. In an idea going back to Hume (1739/1978), some theories postulate that emotions are the source of moral evaluations (e.g., Greene et al., 2001; Haidt, 2001), and some theories imply that moral evaluations are a

source of emotions (Hauser, 2006). The present theory differs from both. As an experiment bore out, some deontic situations trigger an initial emotion, and others trigger an initial evaluation (Bucciarelli et al., 2008).

The second of the theory's major principles is:

2. The principle of deontic reasoning: All deontic evaluations of particular cases depend on inferences, either intuitions alone or those followed up in conscious deliberations.

Deontic reasoning is based on the same processes as factual reasoning (Bucciarelli & Johnson-Laird, 2005). Hence, there is no special sort of legal reasoning despite the existence of many texts on the subject. When participants in an experiment had to 'think aloud' as they evaluated moral scenarios, they sometimes made immediate judgments, but their contents, like those of more reasoned judgments, showed that these judgments depended on inferences from the scenarios (Bucciarelli et al., 2008).

Subjective probabilities range from neutrality either upwards through probability to certainty, or downwards through improbability to impossibility. Emotional reactions to deontic matters range from indifference either upwards through liking to loving, or downwards through disliking to loathing. Their respective values correlate for:

- moral propositions, such as: *Immigrants who cannot find work should return to their country* (Bucciarelli & Johnson-Laird, 2019).

- social conventions, such as: *You should wait for everyone to be served before you start to eat* (Bucciarelli & Johnson-Laird, 2020).

- prudential rules, such as: *You should chew before swallowing* (Bucciarelli & Johnson-Laird, 2024).

- recommendations, such as: *You should visit museums* (Ibid.) No reliable correlations occurred for the corresponding factual propositions, which were identical apart from the replacement of the deontic verb with a factual one. As the principle of independent systems also predicts, experimental manipulations that change the emotional reaction to moral and conventional claims also change the participants' estimates of their subjective probabilities, and vice versa (Bucciarelli & Johnson-Laird, 2019; 2020).

The present experiments examined a new domain: legal principles as embodied in the Italian Civil Code, which is a translation of the Napoleon code governing private matters, such as family law, the law of property, the law of contracts, and other matters that in Anglo-American law are treated as torts. Many of its entries contain deontic assertions, such as:

Both spouses must contribute to the needs of the family according to their economic, professional and housekeeping duties.

It is easy to transform such a deontic assertion into a factual claim: one deletes the Italian word 'dovere', which corresponds to 'must'. Our experiments examined the participants' subjective probabilities for the assertions, both deontic and factual, and their emotional reactions to them. Experiment 1 tested participants who were ignorant of the source of the legal-sounding sentences. Experiment 2 tested participants who were told that they came from the Italian

Civil Code in order to determine whether their source in a third party might affect the correlation. Its origins in a legal code might weaken the correlation, but the authority of this source might strengthen it. We report these experiments separately, so it is easier for readers to understand the key results. The experiments were approved by the Bioethics Committee of the University of Turin.

Experiment 1

Participants acted as their own controls and rated both the subjective probabilities for assertions and their emotional reaction to them from loathing to loving. The deontic assertions derived from those in the Italian Civil Code, and the parallel factual ones differed only in the deletion of the modal auxiliary 'dovere,' which translates into 'must' from Italian, the language in both of our experiments. The following are examples of two pairs of legal and parallel factual assertions:

- 1) Trade union members must attend meetings of the board of directors, assemblies, and executive committees of their firms.

Trade union members attend meetings of the board of directors, assemblies, and executive committees of their firms.

- 2) The outgoing condominium administrator must return all the documentation in his possession and carry out the urgent work.

The outgoing condominium administrator returns all the documentation in his possession and carry out the urgent work.

The participants did not know the provenance of the deontic assertions.

Method

Participants Twenty students from the Faculty of Psychology of the University of Turin (18 females and 2 males: mean age: 23 years, *SD*: 1.46) gave their informed consent and voluntarily agreed to participate in the experiment in exchange for course credits. They had no previous legal experience.

Design Each participant carried out both sorts of rating, subjective probability and emotional reaction, for the two sorts of assertion, deontic and factual. We counterbalanced the order of the two sorts of rating, which were in separate blocks of trials, and the order of the two sorts of assertion, which were also in separate blocks of trials. There were accordingly four separate groups of participants in order to cross these two variables. The order of the sentences in each block was random for each participant.

Materials and Procedures The materials were 18 typical deontic assertions derived from different articles of the Italian Civil Code. They covered a variety of issues such as the mutual rights and duties of spouses, family life and the residence of the family, wills, and the supply of water to

domestic buildings. The set of parallel 18 factual assertions from which “dovere” had been deleted were generalizations in the present tense.

The experimental materials were transcribed on Google forms for remote administration. Participants received an email with instructions stating that the aim of the experiment was to investigate the strength of beliefs about various assertions and the emotions they evoked. Once participants were connected to a specific link, they received the instructions for the task.

Assessment of subjective probability: Participants were instructed to rate it for each assertion using a 5-point (Likert non-numerical) scale. The key instruction was: “Your task is to assign a probability to each assertion presented to you on a scale from ‘Impossible’ to ‘Certain’. This probability should reflect the degree to which you believe the assertion”. The scale was as follows:

- Impossible
- Improbable
- As probable as not
- Probable
- Certain

Assessment of emotion from loathing to loving: Participants were instructed to rate it for each assertion using a 5-point (Likert) scale. The key instruction was: “Your task is to rate your emotional reaction to each assertion presented to you on a scale from ‘I loathe this idea’ to ‘I love this idea’”. The scale was as follows:

- I loathe this idea
- I don't like this idea
- I am indifferent to this idea
- I like this idea
- I love this idea

Results

Figure 1 is a scattergram showing for each of the 18 legal assertions, their mean ratings on the five-point probability scale and on the five-point emotional scale. It also presents the same sort of scattergram for the 18 factual assertions. As these scattergrams suggest, the two sets of ratings correlated significantly for the legal assertions (Kendall’s $\tau = .56, p = .002$), but not for the factual assertions (Kendall’s $\tau = .17, p = .34$). We used Kendall’s τ , because it is a rank-order correlation, which is appropriate for measures with unknown distributions. Kendall’s τ for each participant had a mean of 0.42 for the legal assertions and a mean of 0.25 for the factual assertions, and the two sets of values were significantly different (Wilcoxon test, $z = 2.2, p < 0.015$, one tail).

We also examined whether the participants tended to agree in their ratings. For the legal assertions, the concordance of their ratings for the subjective probabilities of the 18 legal assertions was reliable (Kendall’s $W = .34, p < .001$), and so too was the concordance of their emotional ratings (Kendall’s $W = .46, p < .001$). They also concurred in their ratings for the factual assertions: their concordance was reliable for their

subjective probabilities (Kendall’s $W = .31, p < .001$), and it was reliable for their emotional reactions (Kendall’s $W = .41, p < .001$). The crux is that these two measures no longer correlated reliably for the factual assertions.

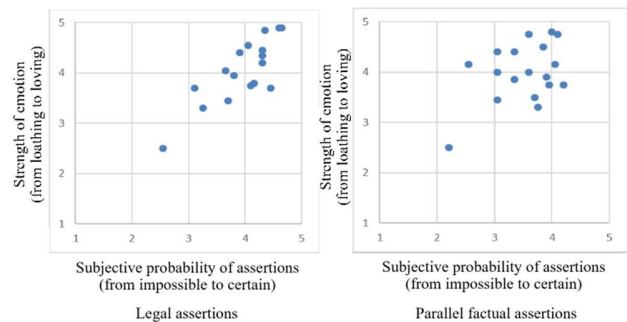


Figure 1: Two scattergrams for the results of Experiment 2 (N = 20). On the left, a scattergram for each of the 18 legal assertions based on the participants’ mean ratings on the five-point scale of non-numerical subjective probabilities from ‘impossible’ to ‘certain’ and on the five-point scale from ‘loathing’ to ‘loving’. On the right, the same sort of scattergram for the 18 factual assertions.

Experiment 2

The experiment was a replication of Experiment 1 except that the participants were informed that the deontic assertions derived from principles in the Italian Civil Code.

Method

Participants Twenty students from the Faculty of Psychology of the University of Turin (14 females and 6 males: mean age: 24 years, $SD: 1.93$) gave their informed consent and voluntarily agreed to participate in the experiment in exchange for course credits. They had no previous legal experience. None of them had taken part in Experiment 1.

Design, Material and Procedures The design, materials, and procedure were the same as in Experiment 1. The one change was in the instructions (as shown in italics): “Your task is to rate your emotional reaction (or assign a probability) to each assertion *extracted from the Italian Civil Code*”.

Results

Figure 2 is a scattergram showing for each of the 18 legal assertions, their mean ratings on the five-point probability scale and on the five-point emotional scale. It also presents a scattergram of the same sort for the 18 factual assertions. As in the previous experiment, the ratings on the two scales correlated significantly for legal assertions (Kendall’s $\tau = .36, p < .05$), but not for their matching factual assertions

(Kendall's $\tau = .17, p = .34$). For the 18 legal assertions, the participants concurred in their ratings on the scale of subjective probabilities (Kendall's $W = .29, p < .001$), and in their ratings on the emotional scale (Kendall's $W = .39, p < .001$). Likewise, for the factual assertions, they concurred in their ratings on the scale of subjective probabilities (Kendall's $W = .24, p < .001$), and on the emotional scale (Kendall's $W = .37, p < .001$). We assessed the difference between the two experiments in the sizes of their correlations. We computed the difference in them for each participant, and the mean difference was 0.21 in Experiment 1 and 0.27 in Experiment 2 (Mann-Whitney test, $z = 1.12, p > .25$).

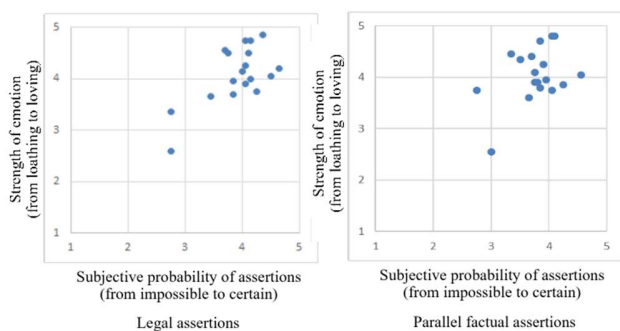


Figure 2: Two scattergrams for the results of Experiment 2 ($N = 20$). On the left, a scattergram for each of the 18 legal assertions based on the participants' mean ratings on the five-point scale of non-numerical subjective probabilities from 'impossible' to 'certain' and on the five-point scale from 'loathing' to 'loving'. On the right, the same sort of scattergram for the 18 factual assertions.

General Discussion

The results of the two experiments showed that the participants' estimates of the subjective probabilities of the legal assertions correlated with their ratings of their emotional reactions to them, but for the factual assertions, no such correlation occurred. These results bore out the integration of the mental model theory and the communicative theory of emotions (Bucciarelli et al., 2008). The results also showed that knowledge of the provenance of the quasi-legal assertions in the Italian Civil Code had no reliable effect on this correlation.

The ratings in both experiments tended to be focused around high degrees of liking and subjective probability (see Figures 1 and 2), though correlated only for the legal assertions, which concerned only obligations. Previous studies of everyday moral assertions yielded ratings at both ends of the two scales (Bucciarelli & Johnson-Laird, 2019). Laws and their factual counterparts, which correspond to compliance with them, ought to be believable and congenial. Without these attributes, legislators are unlikely to have codified them. People evaluate subjective probabilities, whether they concern deontic or factual assertions, but their emotional

reactions are grounds for deontic beliefs. Unlike factual beliefs they are not open to empirical support.

The two present experiments are correlational studies. Future studies could seek to replicate the results of the earlier causal studies (Bucciarelli & Johnson-Laird, 2019; 2020) in order to determine whether a change in the subjective probability of a legal proposition also changes the emotional reaction to it, and vice versa. So, a more credible legal principle becomes more likeable, and the converse holds.

There are three unknowns. First, no-one knows the mechanism that determines the absolute levels of assessments of belief or emotion. As we showed, a broad consensus exists amongst our participants about the assertions, deontic or factual, in our experiments. But, the concurrences could have occurred to some degree even if the absolute values of beliefs and emotions differed from one individual to another. As Figures 1 and 2 illustrate, these absolute values do differ from one law to another and from one factual counterpart to another. Second, no-one knows how beliefs and concomitant emotions translate into actions. Folk psychology (aka common sense) suggests that if you strongly believe, say, that you ought to contribute to a charity, and that you feel good about the idea, then you are likely to make such contributions—unless, like the Irish writer Bernard Shaw, you believe that the maintenance of charities is inimical to the development of a fairer society. Cross-cultural studies have shown, however, that the converse is true: if you give to charities, presumably out of a belief that you ought to, you feel good about it (Aknin et al., 2013). Third, no-one knows the effects of pertinent emotions on the accuracy of deontic reasoning. A long philosophical tradition going back to Plato treats emotions as enemies of rationality. The evidence from studies of reasoning is striking. Emotions elicited by the contents of what individuals are reasoning about increased the accuracy of their inferences, whereas independent emotions decreased it (e.g., Blanchette, 2006; Gangemi, Mancini, & Johnson-Laird, 2013). To the best of our knowledge, however, no robust evidence exists on the effects of emotions on deontic reasoning.

Conclusion

Our experiments corroborated a theory that combines one in which mental models represent assertions with one in which emotions are communications among individuals and within the brain. People like those propositions that they believe, and they believe those propositions that they like. But the correlation holds only for the words of the law, not for their factual counterparts formed by the omission of one auxiliary verb (corresponding to 'must').

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References

- Aknin, L. B., Barrington-Leigh, C. P., Dunn, E. W., Helliwell, J. F., Burns, J., Biswas-Diener, R., Kemeza, I., Nyende, P., Ashton James, C. E., & Norton, M. I. (2013). Prosocial spending and well-being: Cross-cultural evidence for a psychological universal. *Journal of Personality and Social Psychology, 104*(4), 635–652.
- Almor, A., & Sloman, S. A. (1996). Is deontic reasoning special? *Psychological Review, 103*, 374–380.
- Blanchette, I. (2006). The effect of emotion on interpretation and logic in a conditional reasoning task. *Memory & Cognition, 34*, 1112–1125.
- Bucciarelli, M., & Johnson-Laird, P. N. (2005). Naïve deontics: a theory of meaning, representation, and reasoning. *Cognitive Psychology, 50*(2), 159–193.
- Bucciarelli, M., & Johnson-Laird, P. N. (2019). Emotions and beliefs about morality can change one another. *Acta Psychologica, 198*, Article 102880.
- Bucciarelli, M., & Johnson-Laird, P. N. (2020). Beliefs and emotions about social conventions. *Acta Psychologica, 210*, Article 103184.
- Bucciarelli, M., & Johnson-Laird, P. N. (2024). Perché siamo così sicuri di avere ragione? Il ruolo delle emozioni nel mantenimento e nella revisione delle credenze. *Sistemi Intelligenti*, Anno XXXVI, vol 2, 1–20.
- Bucciarelli, M., Khemlani, S., & Johnson-Laird, P. N. (2008). The psychology of moral reasoning. *Judgment and Decision Making, 3*(2), 121–139.
- Cosmides, L. (1989). The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wason selection task. *Cognition, 31*, 187–276.
- Darwin, C. (1872/1965). *The expression of the emotions in man and other animals*. Rep. Chicago: University of Chicago Press.
- Gangemi, A., Mancini, F., & Johnson-Laird, P. N. (2013). Emotion, reasoning, and psychopathology. In Blanchette, I. (Ed.) *Emotion and Reasoning*. Hove, E. Sussex: Psychology Press.
- Geurts, B. (2005). Entertaining alternatives: disjunctions as modals. *Natural Language Semantics, 13*, 383–410.
- Gosse, E. (1923). *Father and Son*. New York: Scribner. (Originally published, 1907).
- Greene, J. D., Sommerville, R. B., Nystrom, L. E., Darley, J. M., & Cohen, J. D. (2001). An fMRI investigation of emotional engagement in moral judgment. *Science, 293*, 2105–2108.
- Haidt, J. (2001). The emotional dog and its rational tail. *Psychological Review, 108*, 814–834.
- Hauser, M. D. (2006). The liver and the moral organ. *Social Cognitive and Affective Neuroscience, 1*(3), 214–220.
- Hughes, G. E., & Cresswell, M. J. (1996). *A New Introduction to Modal Logic*. London: Routledge.
- Hume, D. (1978). *A treatise of human nature*. Second ed. Oxford: Oxford University Press. (Originally published 1739).
- Johnson-Laird, P. N., Khemlani, S., & Byrne, R. M. J. (2023). Human verifications: Computable with truth values outside logic. *Proceedings of the National Academy of Sciences, 120* (40), e2310488120.
- Johnson-Laird, P. N., & Oatley, K. (2021). Emotions, simulation, and abstract art. *Art & Perception, 9*, 260–292.
- Johnson-Laird, P. N., & Wason, P. C. (1970). A theoretical analysis of insight into a reasoning task. *Cognitive Psychology, 1*, 134–148.
- Kamp, H. (1973). Free choice permission. *Proceedings of the Aristotelian Society, 74*, 57–74.
- Kratzer, A. & Shimoyama, J. (2002). Indeterminate pronouns: The view from Japanese. In Otsu, Y. (Ed.), *Third Tokyo conference on psycholinguistics* (pp. 1–25). Hituzi Syobo.
- Khemlani, S., Lotstein, M., & Johnson-Laird, P. N. (2015). Naive probability: Model-based estimates of unique events. *Cognitive Science, 39*, 1216–1258.
- Oaksford, M., & Chater, N. (1994). A rational analysis of the selection task as optimal data selection. *Psychological Review, 101*, 608–631.
- Oatley, K. J., & Johnson-Laird, P. N. (2011). Basic emotions in social relationships, reasoning, and psychological illnesses. *Emotion Review, 3*(4), 424–433.
- Osherson, D. N. (1976). *Logical abilities in children, Vol. 4: Reasoning and concepts*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Ragni, M., & Johnson-Laird, P. N. (2020). Reasoning about epistemic possibilities. *Acta Psychologica, 208*, 103081.
- Ragni, M., Kola, I., & Johnson-Laird, P. N. (2018). On selecting evidence to test hypotheses. *Psychological Bulletin, 144*, 779–796.
- Rasga, C., Quelhas, A. C., & Johnson-Laird, P. N. (2022). An explanation of *or*-deletions and other paradoxical disjunctive inferences. *Journal of Cognitive Psychology, 34*, 1032–1051.
- Rips, L. J. (1994). *The psychology of proof*. Cambridge, MA: MIT Press.
- Sperber, D., Cara, F., & Girotto, V. (1995). Relevance theory explains the selection task. *Cognition, 57*, 31–95.
- Steedman, M. J. (1977). Verbs, time, and modality. *Cognitive Science, 1*, 216–234.
- von Wright, G. H. (1951). Deontic logic. *Mind, 60*(237), 1–15.
- Wason, P. C. (1960). On the failure to eliminate hypotheses in a conceptual task. *The Quarterly Journal of Experimental Psychology, 12*, 12–40.