Universiteit
Leiden
The Netherlands

Cognitive processes in social and moral decision making

Rahal, R.M.

Citation
Rahal, R. M. (2018, November 20). *Cognitive processes in social and moral decision making*. Retrieved from https://hdl.handle.net/1887/66826

Version:	Not Applicable (or Unknown)
License:	Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden
Downloaded from:	https://hdl.handle.net/1887/66826

Note: To cite this publication please use the final published version (if applicable).

Cover Page

Universiteit Leiden

The handle http://hdl.handle.net/1887/66826 holds various files of this Leiden University dissertation.

Author: Rahal, R.M.
Title: Cognitive processes in social and moral decision making
Issue Date: 2018-11-20

Chapter 4

Eyes on Morals:

Investigating the Cognitive Processes

Underlying Moral Decision Making via Eye tracking

This chapter is based on Rahal, R., Hoeft, L., & Fiedler, S. (in preparation). Eyes on Morals: Investigating the Cognitive Processes Underlying Moral Decision Making via Eye tracking. https://bit.ly/2JUHKUK

Abstract

How are moral decisions such as sacrificing the life of one to rescue the lives of many others formed? The Dual Process Theory (Greene et al., 2001) proposes that decisions driven by utilitarian vs. deontological moral principles are preferentially supported by deliberate vs. intuitive processes. A competing account proposes that choices would be least effortful when the choice options are readily discriminable depending on individual preferences (Kim et. al, 2018). Investigating the implications of both theoretical propositions, we report an eye tracking study, showing decision makers' attentional foci, their decision effort and conflictedness during the decision process. To study deontological vs. utilitarian decision making, we used incentivized third-party helping dilemmas, where participants decided whether to leave donations for cataract operations with a predetermined child (deontological option) or to reallocate the donation to operate a group of other children (utilitarian option). Moral preferences determined via choices in classical hypothetical trolley-type dilemmas predicted choices in the third-party helping dilemmas. Surprisingly, deontologists fixated more on operation costs than utilitarians, and less on information about the original allocation of the operation. Decision effort measured via reaction times, number of fixations and number of inspected information was lowest for participants with strong utilitarian moral preferences, while more deontological decision makers made their decisions more effortfully. Gaze patterns over the course of the decision process indicated that deontological decisions were accompanied by higher conflictedness than utilitarian choices, and that preference-consistent choices were made with less decision conflict. Implications for the theories of moral judgment are discussed.

Keywords: moral judgment, decision making, dual process theory, eye tracking

Eyes on Morals: Investigating the Cognitive Processes Underlying Moral Decision Making via Eye tracking

Moral dilemmas prevail in everyday life: Your spouse asks you if you approve of his or her outfit, your friends wonder if you like the present they gave you. Although it seems immoral to hurt others' feelings needlessly, lying seems unethical too. For their essential juxtaposition of disparate moral positions, pitting different concepts of morality against each other, moral dilemmas are used to illuminate the structure of moral decision making. What should be done, what people decide to do in moral dilemmas and why, as well as the way through which decision makers arrive at the decision to resolve the situation in one way or the other has been the object of much theorizing in philosophy, ethics and psychology. While psychological theories of moral decision making traditionally favored cognitive approaches (Kohlberg, 1963; Turiel, 2006), the 21th century witnessed a stronger emphasis on the role of emotions in moral judgment (Haidt, 2001). How to formulate a unified theory that explains all facets of moral decision making still remains an open question.

Dual Process Theory

One approach that has gained traction in the last decade is a dual-process view (Greene, 2014). It is hypothesized that patterns of judgment in moral dilemmas are supported by different and at times competing neural systems (Greene et al., 2004, 2001). One processing system is considered as automatic, efficient and reliant on emotional processes, supporting the formation of deontological judgments (Greene, 2007, 2014). The other system is considered as flexible and deliberate, leading to consequentialist decisions through conscious reasoning (Greene, 2007, 2014). These predictions have often been applied to classical moral dilemmas such as the trolley dilemma, where an uncontrolled trolley en route to kill five people can be stopped only by pressing a switch that redirects the trolley to a track where it will kill only one person (Foot, 1967). It is argued that utilitarian decisions to maximize the

number of survivors are preferentially supported by the deliberate processing system, whereas the automatic processing system supports deontological decisions to refrain from sacrificing the life of one person to save others. A slightly different dilemma situation, where the only way to stop the oncoming trolley is to push a large person off a footbridge (footbridge dilemma, Thomson, 1985), requiring greater personal force to enact the utilitarian option, would be argued to trigger stronger automatic emotional intuitions against taking this action. Consequently, more deontological decisions are to be expected in this setting (Cushman, Young, & Hauser, 2006; Greene et al., 2001).

The dual process model has found support in a number of studies ranging from cognitive, to clinical and neuropsychology. In line with the assumption that processing qualities influence moral judgments, cognitive load was found to increases response times for utilitarian decisions, but not for deontological ones (Greene, Morelli, Lowenberg, Nystrom, & Cohen, 2008; Trémolière, Neys, & Bonnefon, 2012), and to weaken utilitarian inclinations (Conway & Gawronski, 2013). Time pressure has been shown to reduce the percentage of utilitarian judgments (Suter & Hertwig, 2011). On the other hand, encouraging deliberation without time pressure strengthened consequentialist responses (Greene et al., 2009). Solving counterintuitive math problems, as well as the above-average ability to do so successfully increases the percentage of consequentialist answers (Paxton, Bruni, & Greene, 2014). In general, favoring effortful thinking is correlated with more consequentialist answers (Bartels, 2008). In contrast, favoring emotional approaches to moral dilemmas such as by increasing empathy has been shown to increase deontological inclinations (Conway & Gawronski, 2013). Further, deficits in emotional awareness have been linked to increased rates of utilitarian responses (FeldmanHall, Dalgleish, & Mobbs, 2013; Koven, 2011; Patil & Silani, 2014), and increased emotionality in participants undergoing SSRI treatment have been shown to decrease utilitarian responses (Crockett, Clark, Hauser, & Robbins, 2010). Finally, emotional blunting stemming from

frontotemporal dementia (Mendez, Anderson, & Shapira, 2005) as well as reduced inhibition following damage to the prefrontal cortex (Ciaramelli, Muccioli, Làdavas, & di Pellegrino, 2007; Koenigs et al., 2007) were shown to decrease utilitarian responses.

Despite a substantive body of research pointing towards a dual process interpretation of moral decision making, the dual process theory has encountered criticism. Some of this criticism is aimed at the methodology of fMRI-research and argues that the findings might be reconcilable with a single-track theory of moral judgment (Klein, 2011). Others argue for an integrative perspective in which the different processes do not compete but interact, for example through combining motivational or cognitive aspects to form a moral decision (Moll, De Oliveira-Souza, & Zahn, 2008). Further findings suggest utilitarian responses could be the result of impaired empathy and cognitive ability combined (Duke & Bègue, 2015). It is questioned whether the dual processes tie in intuitive vs. counterintuitive moral judgments rather than deontological vs. utilitarian judgments (Kahane et al., 2012), and if effects of cognitive load and time pressure can be replicated (Tinghög et al., 2016). Overall, interpretations favoring a dual process approach remain contested so far (for a review, see Dubljević, 2017).

Choice Discriminability Account

One point of contestation is the omission of other sources of variability from the analysis of moral decision processes. For instance, the strength of moral preferences and the resultant discriminability of the choice options in moral dilemmas is often ignored. Research in the tradition of the dual process model has focused mostly on explaining choices in the moral domain, rather than on predicting moral choices from chronically held moral preferences (i.e., decision makers' preferences about resolving moral dilemmas in line with deontological or utilitarian principles). However, it has been argued in related areas of literature that more extreme

preferences lead to faster reaction times: When more extreme preferences are held, the choice options become more readily discriminable by the decision makers, requiring less time and effort to determine the preference-consistent choice (Basten, Biele, Heekeren, & Fiebach, 2010; Bhatia & Mullett, in press; Gluth, Rieskamp, & Büchel, 2012; Krajbich, Oud, & Fehr, 2014; Ratcliff & McKoon, 2008).

In the domain of moral decision, a computational model of moral decision making based on hierarchical Bayesian inference was proposed (R. Kim et al., 2018), where choices in dilemmas involving self-driving vehicles are used to make inferences about individual decision makers' preferences, such as for saving human vs. non-human lives, or prioritizing saving children over elderly adults. Reaction time data showed fast responses in dilemmas where the choice options were easily discriminable because individuals had a strong preference for one of the choice options, and slower responses where individuals needed time to discriminate between more ambiguous choice options.

A related theoretical debate has recently emerged in the social preference literature. On the one hand, a dual process account had been proposed, where prosocial choices were argued to be intuitive (Rand et al., 2014, 2012). On the other hand, a choice discriminability perspective predicted that extreme preferences would lead to faster, less effortful decision: Decision conflict was shown to determine response times such that extremely selfish and extremely cooperative decisions, driven by extreme social preferences to cooperate or defect, were made more quickly than intermediate decisions, driven by mixed preferences (A. M. Evans et al., 2015). Moreover, decision conflict was shown to be distinct from the degree of reflection employed. Similarly, Krajbich et al. (2015) showed no reaction time differences in cooperative vs. selfish choices after taking choice discriminability into account. In other words, there are strong and increasingly prominent indications that the difficulty

of decisions and therefore the discriminability of choice options offers an explanation for choice processes competing with dual process accounts.

Here, we consider that such a choice discriminability mechanism may also be at play in the domain of moral decision making. The dual process account, supposing a positive relation between moral preferences and processing effort, might be challenged by the presence of a reverse-u-shaped relation of moral preferences on processing, where extreme deontologists and utilitarians process faster and less effortfully than mixed types. Should we find evidence for a non-linear relation of moral preferences and processing, this evidence would question the generalized formulation of the dual process theory, and advocate a more nuanced theoretical approach to moral decision making, integrating the strength of moral preferences. Here, we therefore pursue hypotheses derived from the choice discriminability account as alternatives to the dual process approach.

Eye tracking for Process Tracing in Moral Dilemmas

Despite the diverse set of methodological approaches used to test the dual process theory, there has been no direct measure to investigate the reasoning of participants during the decision making process. However, eye tracking is well suited to illuminate the information search and decision process involved in moral decision making (see Fiedler & Glöckner, 2015; Strohminger, Caldwell, Cameron, Borg, & Sinnott-Armstrong, 2014). In particular, since there is evidence suggesting that people lack introspection about their deontological patterns of judgment (Cushman et al., 2006; Haidt, 2001; Hauser, Cushman, Young, Kang-Xing, & Mikhail, 2007), using a methodology to access processes underlying moral decision making that does not rely on self-reports to illuminate decision makers' reasoning seems advantageous. To that end, eye tracking is a valuable tool for tracing information processing in an objective, unobtrusive and fine-grained manner. Investigations of information search have proven valuable for understanding decisions in a wide variety

of contexts where decision makers' own outcomes were at stake, such as risky choices (Fiedler & Glöckner, 2012; Kawakami et al., 2014; Raab & Johnson, 2007; Reisen et al., 2008). Importantly, eye tracking has also been used to understand behavior involving the wellbeing of others, for instance showing that prosocial and selfish individuals approach decisions with systematic differences in gaze patterns (Fiedler et al., 2013) or that own-race recognition bias and willingness to interact with outgroup members are predicted by systematic gaze bias at ingroup members' eyes (Kawakami et al., 2014). Here, we extend the use of eye tracking to the complex domain of moral decision making, requiring choices between deontological and utilitarian options which concern the wellbeing of others without consequences on one's own material outcomes.

By using eye tracking, we gain three features enabling us to better understand moral decision making in trolley-type dilemmas. First, we can ask where decision makers' main focus lies while they make their choice. Second, we can gain insights into the process of information acquisition, understanding how much effort decision makers invest into informing their choice. Third, eye tracking permits us to uncover the degree of conflict between the choice options experienced by the decision makers. All three insights are valuable for understanding the nature of deontological vs. utilitarian choices by observing the process that brings them about more closely.

First, regarding the *locus of attention*, using eye tracking enables us to understand which pieces of information are particularly important to decision makers while they make up their mind which option to choose. In other words, studying eye-gaze permits direct access to which pieces of information decision makers fixate more, and allows inferences on which pieces of information can be assumed carry a heavy weight for the ultimate decision. In models of comparison processes such as the attentional Drift Diffusion Model (Krajbich et al., 2010, 2012; Krajbich & Rangel,

2011), choices are assumed to be formed through a process of stochastic information accumulation for the choice options available: While gazing at a certain option, its relative decision value increases, making it more likely that the option will eventually be chosen. In other words, what is important to the decision maker is more likely to be gazed at. Several seminal studies further provided direct evidence of the relation of the number of fixations and importance (Reisen et al., 2008; van Raaij, 1977). Therein, eye-gazes offers a comparatively straightforward way to unveil what motivated a certain choice. In previous research on moral decision making, the motive that presumably drove participants' actions was often inferred from an elegant design, where in a hypothetical scenario that would pit two conflicting motives against each other, the choice revealed the underlying reasoning (Greene et al., 2004; Koenigs et al., 2007). Other designs gained insights into decision makers' motives by asking participants to provide reasons for their choices (Björklund et al., 2000; Haidt et al., 1993). By using the visual focus of decision makers' attention, a more detailed and unobtrusive impression of the most important pieces of information in their reasoning processes can be gained. In trolley-type situations, specifically, deontological and utilitarian decision makers should differ substantively in the focal points of their decision making. Deontology, by definition, puts forth the idea of judging actions based on rules. Utilitarianism, in contrast, is built on the principle of weighting outcomes. Utilitarians, while making their decisions, should therefore be more focused on outcomes, while deontologists should be more concerned with information capturing rule breaking or rule adherence.

Second, eye tracking is a valuable tool for understanding the *deliberate vs. intuitive nature* of the decision process. One line of research has aimed to infer which cognitive processes are at work during moral judgments by using neuroimaging data (for a recent overview, see Sevinc & Spreng, 2014). Another strand of research has focused on studying decision times in deontological vs. utilitarian choices to infer mental processes, with mixed results. While some research finds that deontologists

or deontological choices are faster (e.g., Ciaramelli et al., 2007; Greene et al., 2008, 2004; Kahane et al., 2012), others find no reaction time differences (e.g., McGuire, Langdon, Coltheart, & Mackenzie, 2009; Whitton, Henry, & Grisham, 2014) or the reverse effect (e.g., Killgore et al., 2007; Moore, Clark, & Kane, 2008). Here, we extend this approach by using the insights available from gaze data. Specifically, to investigate how effortfully decision makers informed their choices, we assessed how many fixations participants displayed before making their choice, and which proportion of the information available they fixated. The use of these dependent variables requires the assumption that decision makers rely on more fixations (Krajbich et al., 2010; Krajbich & Rangel, 2011) and consider more pieces of information (Fiedler et al., 2013) to reach a deliberated decision. In line with the dual process theory, it would be hypothesized that utilitarians invest more effort (i.e., fixate the available information more often, and fixate more pieces of information) into making a decision than deontologists. The competing choice discriminability account would predict that decision makers who have strong preferences for deontology or utilitarianism would be able to resolve a moral dilemma more quickly than mixed types.

Third, eye tracking permits us to develop an impression of decision makers' *conflictedness* while they form a decision. The gaze cascade effect (Shimojo et al., 2003; Simion & Shimojo, 2007) describes a phenomenon towards the end of the decision process, where decision makers' gaze is focused more strongly on the later chosen option, such that last fixations are good predictors of the subsequent decision (Krajbich et al., 2010). Here, the slope of this cascade towards the later chosen option is used as a proxy for conflictedness in the decision process. The inference that the slope of the curve indicating the proportion of gazes to the later chosen is indicative of conflictedness rests on the following argument. First, it has been demonstrated that the preferred option in a decision task receives more attention than the non-favored option (e.g., Fiedler & Glöckner, 2012; Glöckner & Herbold, 2011; for a review, see Orquin & Mueller Loose, 2013). Second, the degree to which an option is

attended to has been shown to be related to the strength of the preference the decision maker has for this option (Glaholt et al., 2009). Therefore, recording over the course of the decision process how the proportion of gazes to the choice options unfolds should allow inferences on which option is currently favored, and how strong the preference for this option is. When the proportion of gazes to the choice options remains balanced, no strong preference is assumed to have emerged, indicating that the decision maker is still undecided, while a spike of the proportion of gazes towards one option would indicate that this option is becoming more strongly favored, pushing towards a choice. Therefore, when the gaze proportion curve shows a flat slope, the decision maker is more conflicted, struggling to settle for one of the options, while a steep rise of the gaze proportion curve indicates a less conflicted decision maker.

Interpreting the dual process theory of moral judgment in terms of decision conflictedness, we assume that deontological and utilitarian decision systematically differ in the steepness of the gaze proportion curve. Deontological decision makers, who are assumed to be more intuitive in their decisions, would settle on what they perceive as the right choice more quickly. Therefore, we expect that deontologists will visually gravitate towards the later chosen option relatively earlier during the decision process, showing a steep slope of the gaze proportion curve. Conversely, we assume that more deliberative decision strategies in utilitarians will lead to them being more conflicted during the decision process, remaining undecided while comparing the options for longer. Therefore, we expect that utilitarians as more conflicted decision makers will settle on predominantly fixating the later chosen option only later in the decision process, showing a flatter slope of the gaze proportion curve. In sum, we expect that deontological decision makers will show a steeper increase in the proportion of gazes to the later chosen option, compared to utilitarian decision makers who face higher decision conflict. However, it could again be argued that the choice discriminability should be taken into account. Extreme deontologists and utilitarians,

for whom the choice options appear more discriminate, could display less decision conflict than mixed types.

In sum, our interest in the nature of moral decision making processes is threefold: to uncover which information is most important for deontological and utilitarian decision makers during the decision process, which levels of effort they invest into forming the choice, and how conflicted they are during the choice formation. Pursuing these research questions, we aim to achieve a systematic overview of the processes translating moral preferences into decisions in moral dilemmas. Therein, this paper contributes to the ongoing debate about the nature and underlying processes of moral decisions, gathering evidence regarding the dual process perspective and adding the caveat that choice discriminability may be an important, yet largely ignored determinant of moral decision processes.

Method

Beyond the substantive additions to the theoretical debate, this paper contributes an attempt at increasing the methodological diversity in moral judgment research (see Christensen & Gomila, 2012). By employing eye tracking, several methodological exigencies to avoid bottom-up capturing of attention, clouding the top-down process of cognitions driving eye-gaze we are set to study, emerge, which make the use of the traditional trolley-type dilemmas problematic. Building on a number of pilot studies,[22] we progress from the use of traditional hypothetical trolley-type scenarios, which are disassembled and visualized on the computer screen, to the development of an incentivized, non-hypothetical choice task, which offers the possibility to finely adjust and repeatedly administer moral dilemma decision situations. At the same time, this standardized task allows for increased control and

[22] The pilot studies are reported in online supplementary materials, see https://bit.ly/2JUHKUK.

clean manipulation of important design parameters of moral decisions. This strategy follows the increasing use of real moral goods in the behavioral economics literature, where decision makers' choices are implemented instead of remaining hypothetical. For instance, market interactions were shown to erode the willingness to pay for saving the lives of surplus lab mice (Falk & Szech, 2013), and the presence of social norms was shown to reduce selfish behavior when leprosy operations were at stake (Bartling & Özdemir, 2017). A third-party helping dilemma we develop based on the task structure to differentiate utilitarian vs. deontological motives introduced by Perera et al. (2015) is subsequently used here. In this task, the essential juxtaposition of deontological vs. utilitarian motivations present in trolley-type hypothetical dilemmas is captured by confronting participants with the choice between keeping a donation allocated to a certain child, for whom a vision-restoring cataract operation is financed, or reallocating the donation so that more children can be treated. Reallocating the donation conflicts with deontological preferences because the child originally designated to receive the operation would be robbed of her chance of restored vision. In turn, reallocating the donation would be in line with utilitarian reasoning, maximizing the number of children benefitting from the donation.

In line with the general hypotheses derived above, we preregistered (https://osf.io/4edhk/) hypotheses specific to the design of this incentivized third-party helping task. First, as a sanity check, we expected that more utilitarian decision makers would be more likely to make utilitarian choices to reallocate than deontologists (H1). Regarding the locus of attention, we expected that more deontological decision makers would focus more on information revealing whom the operation was originally assigned to, relative to information about the cost of the operation (H2). Regarding decision effort, we formulated hypotheses both from the perspective of the dual process theory and the choice discriminability account, for the three dependent variables (i) decision time, (ii) number of fixations, and (iii) number of inspected information. From the dual process perspective, we expected that more

utilitarian decision makers (i) take longer (H3a), (ii) show more fixations (H3b), and (iii) fixate on more pieces of information (H3c) compared to deontological decision makers. The alternative choice discriminability account leads to the predictions that decision makers with mixed moral preferences (i) take longer (H3a_alt), (ii) show more fixations (H3b_alt), and (iii) fixate on more pieces of information (H3c_alt) compared to decision makers with more extreme moral preferences. Similarly, regarding conflictedness, we made predictions from both perspectives: Following the dual process account, we expected that more utilitarian decision makers would show a flatter slope of the curve representing the proportion of gazes to the later chosen option over time (H4), compared to deontological decision makers. Following the choice discriminability account, we expected a steeper curve for decision makers with extreme compared to mixed moral preferences (H4_alt). For all analyses, we controlled for the decision makers' indecisiveness and equality-efficiency trade-off to ensure that results were driven by moral preferences and not omission bias or preference for equal distribution, as well as item-specific effects to ensure that variations in the exact donation costs were not the driver of the results. In analyses regarding decision effort and conflictedness, we further controlled for trial number to exclude fatigue effects during the course of the experiment.

Design and Participants.

One hundred and four participants (M_{age}=21.04, SD_{age}=3.37, 75 female) recruited from the Decision*Lab* subject pool in Bonn via ORSEE (Greiner, 2015) took part in this study for a payoff of 12€ per hour. Gaze and choice data was collected at the MPI Decision*Lab* in Bonn.

We ran a repeated measures design (20 target trials, 20 filler trials) with moral preference as a between-subjects continuous predictor. We varied within subjects the size of the group of recipients (3 levels: 2 vs. 3 vs. 4 children), and the cost-benefit ratio of the operation costs.

Procedure.

Personality variables were assessed in an online questionnaire administered 12 hours before the lab stage of the study, where the choices and eye-gaze in the operations task were assessed. In the online stage, participants completed an adapted version of the *rule-following* task (Kimbrough, Miller, & Vostroknutov, 2014; Kimbrough & Vostroknutov, 2016). We used this task as a proxy for deontological preferences to assess the content validity of the operations tasks. In three tasks, they sorted 18 yellow and blue balls displayed in a random order to the top or the bottom of a sorting field. Participants were told that the rule was to sort only yellow balls to the top of the sorting field, and blue balls to the bottom. In order to create temptation to not comply with the rule participants additionally learned that for each yellow ball they sorted to the top, they would earn 5¢, and for each blue ball they sorted to the top, they would earn 10¢. Participants who followed the rule more would be assumed to have higher deontological preferences.

As an additional way to assess convergent validity, we introduced participants to the *insulin task*, where they decided about reallocating donation to purchase insulin for children in 10 items, following in-depth instructions including a text explaining the importance of insulin kits for people suffering from diabetes, as well as an example task in which the choice options were explained. For each trial, participants were shown a t-shirt with a child's name on it representing a potential donation receiver. They were informed about the amount of money donated for the purchase of the insulin kit for the specific child (costs ranged between 21.50€ and 52.00€), and about the option to reallocate the donation to benefit a group of children (two, three or four) at a lower individual cost (costs ranged between 6.50€ and 41.50€). One item (21.50€ for an individual operation vs. group of two children where each kit cost 17.00€) was chosen a priori as the best match to real-life operation pricing to be implemented according to a randomly selected participants' choice.

We then assessed participants' *equality-efficiency trade-off*, which we used as control variable, in a hypothetical third-party decision task via a new measure assessing the degree to which participants follow each motivation based on Engelmann and Strobel (2004). Participants are asked to make three decisions between two options each (see Figure 11), where money is allocated between three hypothetical players (Person A, Person B and Person C). The decision makers' payoff was not affected by their choice. In each decision task, choices for each of the two options are motivated by one motivation: inefficiency aversion (option 2), and Charness-Rabin inequality (the sum of all pairwise differences between the minimum payoff and all other values, option 1). As a further control variable, we assessed *indecisiveness*, for which participants completed a 15-item scale (e.g., "I try to put off making decisions.", 1 = "strongly disagree", 5 = "strongly agree", Frost & Shows, 1993).

To assess *moral preference*, participants were then asked to make binary choices in ten high-conflict trolley-type moral dilemmas (submarine, bomb, Lawrence, vaccine, lifeboat, euthanasia, crying baby, sacrifice, vitamins, safari) taken from Greene et al. (2004) and Kahane et al. (2012). Situations and choice options were displayed on the same screen. For each dilemma, participants decided whether they preferred the deontological or utilitarian option, yielding a score of their deontological vs. utilitarian preference.

In addition, participants completed the 15-item long version of the *SVO* Slider Measure (Murphy et al., 2011), as well as other measures for an unrelated study, which are omitted from the main analyses reported here. Finally, we collected information on demographics.

In the lab stage, participants underwent a nine-point calibration procedure for the gaze measurements, followed by the *operations task* (Figure 12) with an extensive practice phase to familiarize subjects with the decision screen and the

response keys. In the *operations task*, participants decided whether to reallocate eyesight-restoring cataract operations from originally selected individual children to a group of other children. Instructions included a text explaining the nature and treatment of cataracts, as well as an example task in which the choice options were explained. Operation costs for the individual varied between 21.00 € and 54.00€. Operation costs for group members varied between 4.50€ and 106.00€ per person. As in the insulin task, one item (45.50€ for an individual operation vs. group of two children where each operation cost 23.00€) was chosen a priori as the best match to real-life operation pricing to be implemented according to a randomly selected participants' choice. After completing all 40 trials, participants were shown their choice on an item chosen a priori to be implemented. They wrote their choice on a piece of paper, which they sealed in an envelope and threw into a closed urn. At the end of the study, the choice of one participant was randomly selected for implementation.

Results

Data Pre-Processing

We defined four types of areas of interests (AOI) on the screens displaying the operation cost matrices to assess fixations. AOIs containing cost and assignment information are defined as 100x100 pixels in size. AOIs containing labels describing the cost and assignment information on the top of the decision screens are contained by AOIs of 190x100 pixels. AOIs containing information on the donation recipients are defined as 190x200 pixels in size. Fixations were identified with a 30 pixel tolerance in the summed deviation of points' maximum and minimum coordinates on the x- and y-axes and a minimum duration of 50ms (Salvucci & Goldberg, 2000). Data from one participants had to be excluded because of missing gaze recordings, and data from one additional participant was excluded because the online questionnaire data was missing.

Choices

Participants made utilitarian choices in 75.82% (*SD* = 42.83%) of cases. On the subject-level, choices were also skewed towards more extreme utilitarian choices: out of 104 decision makers, 9 chose the deontological option in more than 90% of the trials, while 52 chose the utilitarian option in more than 90% of the trials. Running a logistic mixed effect repeated measures regression, we found participants with a more utilitarian moral preference to be more likely to make a utilitarian choice (in accordance with H1, see Table 15, Model 1, and Figure 13), while controlling for their inefficiency aversion and third-party inequality aversion, as well as item-specific variation.[23]

Gaze Behavior

Regarding the *locus of attention*, we analyzed deontologists' and utilitarians' proportion of attention to information regarding operation costs and operation allocations in two mixed effects linear repeated measures regressions controlling for the decision maker's tendency to indecisiveness, equality-efficiency trade-off, as well as item-specific variation and the trial number. Regarding operation costs, more utilitarian decision makers were shown to attend less to cost information than deontologists, while the type of decision made (utilitarian vs. deontological) and the interaction of moral preferences and type of decision did not predict attention (in contrast to H2, see Table 16, and Figure 14). This pattern held both for gazes to the deontological and to the utilitarian option (see Figure 15).

---

[23] Using moral preference measured in the insulin task and the rule-following task as predictors for choices in the operations task revealed a strong positive effect of insulin-based moral preferences, but the effect of moral preferences derived from the rule-following task was non-significant (see Table 15, Models 2 and 3, and Figure B1 in the online supplementary materials). Moral preferences derived from the trolley task and the insulin task correlated positively, while the relation to the preferences measured in the rule-following task remained non-significant but negative as expected (see Table B1 in the online supplementary materials).

Regarding *decision effort*, for (i) decision times, (ii) the number of fixations and (iii) the number of inspected information, two analyses were performed. First, to assess dual process predictions, three linear mixed effect repeated measures regressions were conducted, using moral preferences to predict decision effort while controlling for indecisiveness, equality-efficiency trade-off, item-specific effects and trial. Second, to test the alternative hypothesis of a reverse-u-shaped relation of decision effort and moral type, we run three interrupted regressions, each time using a perfectly mixed moral type as the break point. Given non-normal distributions, all three dependent variables were log-transformed. Using the standard linear regression approach, results showed that utilitarians present with (i) descriptively shorter decision times (Table 17, Model 1), and (ii) less fixations overall (marginally significant, Table 18, Model 1), and (iii) inspected fewer pieces of information (in contrast to H3c, see Table 19, Model 1). Using interrupted regressions, we found among deontologists no significant differences in decision effort (Model 2 in Tables 17 through 19), while in each regression, the effect was positive. Among utilitarians, more extreme types showed significantly reduced decision effort on all three dependent variables (Model 3 in Tables 17 through 19). Given the sign reversal, this evidence could be interpreted to suggest a reverse-u-shaped relation between moral preferences and decision effort, supporting the choice discriminability account (H3a_alt, H3b_alt, H3c_alt; see Figure 16).

Regarding *conflictedness*, in a linear mixed effect repeated measures regression attention to AOIs containing information relating to the later chosen option was predicted from the proportion of decision time elapsed, moral preference and the interaction thereof, while controlling for indecisiveness, equality-efficiency trade-off, item-specific effects and trial (Table 20, Model 1). Convergent with results previously shown in the literature, participants were found to gaze more at the later chosen option as the decision progressed. In line with H4, we found an interaction effect of decision time and moral preference, suggesting a steeper rise in attention to the later

chosen side among deontologists as the decision phase progressed, compared to utilitarian decision makers (see Figure 17). However, unexpectedly, utilitarian decision makers were more likely to gaze at the later chosen side already from the beginning of the decision process, indicating gaze bias in all stages of the decision. In contrast, deontological decision makers showed an initially balanced gaze pattern and only gravitated towards the later chosen option in the end of the decision process. Therefore, although the preregistered expectation of a steeper gaze proportion curve among deontological decision makers was found, which could suggest less conflictedness, the data are more in line with the interpretation that utilitarian decision makers are less conflicted, given the omnipresent gaze bias in those choices. Additionally, we ran the same analysis predicting attention to the later chosen option from the type of decision made. We again found a main effect of decision time, and a significant main effect of the kind of choice made, indicating that utilitarian decisions were based on a more biased information search pattern towards the later chosen option. No significant interaction effect of decision time and the kind of choice made emerged (Table 20, Model 4).

To test the alternative hypothesis that extreme types show steeper rises in the proportion of gazes to the later chosen side, we ran an interrupted regression analysis predicting the attention to the later chosen side from moral preferences, separately for deontologists (Table 20, Model 2) and utilitarians (Table 20, Model 3). Results showed no indication of a sign reversal of the main effect of moral preferences, in contrast to H4_alt. Descriptively, the gaze pattern split for extreme vs. mixed types (Figure 18) suggested a clearer gaze bias towards the later chosen option at the end of the decision for extreme types' preference consistent choices. Among mixed types' utilitarian choices again presented with a clearer drifting apart than deontological choices.

Discussion

In this study, we showed four key findings. First, results showed that choices in trolley-type dilemmas were strongly related to those in the newly designed operations task. Second, unexpected differences in the locus of attention were found: deontological decision makers were unexpectedly strongly focused on the outcomes of the decisions they made, even when they made deontological choices. In turn, utilitarians were found to be more interested in the structure of ownership, and therefore in information we had expected would be more relevant for deontologists than excepted. Third, we showed that especially extremely utilitarian decision makers showed low effort when making decisions, indicated by fast reaction times, low fixation counts, and a low number of information attended to overall. Fourth, gaze bias towards the later chosen side emerged more clearly for preference-consistent choices.

Taken together, the findings provide a number of insights into the cognitive processes underlying moral decision making. First, that deontological decision makers were found to be surprisingly more focused on what we expected would be characteristically utilitarian cues than utilitarian decision makers suggests that the reasoning process of deontologists is more multifaceted than common expectations would hold. Notably, this finding relies on the use of eye tracking to identify through gaze behavior what is important to decision makers. Therefore, by using eye tracking, the present work contributing to a multi-method approach to the investigation of deontological vs. utilitarian decision making, and leverages unobtrusive processes measurement techniques to gain insights into the black box of moral decisions.

Moreover, the findings suggest that moral preferences and their interplay with choices carry an important role in cognitive processes of information search and processing, and should therefore receive more attention in future research. Decision effort was particularly low for extreme utilitarian decision makers, which is

incompatible with a dual process account of moral judgment. Instead, these findings are more in line with the choice discriminability account, suggesting that extreme decision makers require less effort to make their choices. This pattern of results suggested that extreme utilitarians required particularly little decision effort to resolve moral dilemmas. One alternative explanation could be that utilitarians had established an effortless, default response strategy in the repeated tasks they were presented with. However, this seems to be unlikely given the use of filler items which were structurally different and required a different decision. Another alternative explanation could be that the analyses were limited by the low number of extreme deontologists sampled, making it more difficult to test the choice discriminability account. Extreme deontologists were scarcer in the sample than extreme utilitarians. Potentially, this skewed distribution could be attributed to the student sample employed, whose university education may promote utilitarianism. Extreme deontology could also be a rare trait more generally, in a society where trends such as effective altruism are becoming increasingly influential. Using a sample with more extreme deontological types would be an interesting future step to clarify whether only extreme utilitarians show more effortless choice strategies, or if the choice discriminability account in full would be a better model to explain differences in effort. In sum, nevertheless, the findings indicate that the choice discriminability account offers a better explanation of the findings regarding decision effort than the dual process theory.

The findings on conflictedness during the decision process were less clear. We found that deontologists showed a steeper gaze cascade effect measuring conflictedness than utilitarians, which, in principle, is in line with the dual process predictions. However, a consistent gaze bias towards the later chosen alternative was present already from the beginning of utilitarians' decision process. One possible interpretation would be that utilitarians had preferentially sought out information about the choice option to reallocate. In other words, they could have been more likely to have their mind set on wanting to first find out about the alternative that would

reallocate donations, before seeing the exact circumstances of the decision task. In comparison, deontologists' gaze pattern suggests no such preferential attention at the beginning of the trial. When analyzing conflictedness in a more fine-grained way, findings suggested that preference consistent choices raised less decision conflict. Therein, the fine-grained analyses contrasted with the conceptions of the dual process theory, and lent support to the choice discriminability account.

Taken together, the findings on cognitive processing point to the importance of studying not only choices but choices in relation with preferences, although they provide no definitive answers about the exact relation of moral preferences, processes and choices. By and large, moral preferences were an important factor not only in determining choice outcomes, but also the cognitive processes driving these outcomes.

Beyond the substantive contribution, this work contributes to the methodological debate in moral psychology by developing a standardizable and incentivized task suitable for process investigations using a real moral good to study deontological vs. utilitarian moral decision making. Choices in this incentivized task are clearly related to the traditional hypothetical moral dilemmas, and we argue that it provides a number of advantages. For instance, the use of real moral goods is advantageous because it increases external validity and reduces measurement error. Instead of asking participants to imagine a scenario they may never have found themselves in, and to imagine what they would do in this situation, participants make choices in a concrete real-life decision setting, where they decisions are actually implemented. Using the incentivized task may further be a way to reduce unsystematic variation in response behavior by narrowing respondents' interpretative leeway, allowing better control of participants' impression of the task. In addition, the task structure of the incentivized task makes it possible to conveniently visualize the dilemmas in a way that fulfilled process tracing requirements by relying on numerical

stimuli. Finally, this task structure makes it convenient to further investigate the influence of systematically varied isolated aspects of moral dilemmas on moral decisions and the underlying cognitive processes. For instance, changes to the standardized task, such as in the efficiency of the alternatives, the group size, or the moral good in question, could be easily implemented to systematically explore situational influences on decision making and decision making processes.

In sum, this work advocates tighter control over the variations introduced into moral dilemma scenarios, and offers an option for achieving this goal by introducing an incentivized moral dilemma task. Moreover, it contributes to the multi-method assessments of decision processes in moral dilemmas, demonstrating that deontologists do more than "just" following the rules, as they also take matters of costs of their choices into account. Finally, this work suggests that increased emphasis should be placed on considering moral preferences in investigations of moral decision making, lending support to the choice discriminability account.

Tables and Figures

Table 15.

Logistic mixed effects repeated measure regressions, predicting the likelihood of making utilitarian decisions from moral preference based on the trolley task, (2) insulin, or (3) rule-following task.

	(1) Utilitarian Decision		(2) Utilitarian Decision		(3) Utilitarian Decision	
	OR	*z*	*OR*	*z*	*OR*	*z*
Moral Preference (Trolley Task)	2215.00***	4.76				
Moral Preference (Insulin Task)			3012.90***	6.622		
Moral Preference (Rule-Following Task)					0.53	-0.57
Indecision	0.47	-1.35	0.89	-0.22	0.46	-1.38
Inefficiency-inequality trade-off	0.29*	-2.45	0.80	-0.47	0.25*	-2.55
Item fixed effect	YES		YES		YES	
Constant	4.11	0.79	0.24	-0.83	523.85***	3.30
Observations	2080		2080		2080	

Note. $^{+}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 16.

Linear mixed effects repeated measure regressions, predicting the proportion of attention allocated to cost information.

	Proportion of Attention towards Cost	
	OR	*z*
Moral Preference	0.79**	-2.83
Choice (0 = deontological, 1 = utilitarian)	0.99	-0.45
Choice X Moral Preference	0.90	-1.31
Indecision	0.99	-0.34
Inefficiency-inequality trade-off	0.98	-0.74
Trial	1.00*	-2.46
Item fixed effect	YES	
Constant	4.17***	126.67
Observations	1807	

Note. $^{+}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 17.

Linear mixed effects repeated measure regressions, predicting decision time from moral preference, (1) overall, (2) for deontologists, (3) for utilitarians.

	(1) Overall : log Decision Time		(2) Deontologists : log Decision Time		(3) Utilitarians : log Decision Time	
	OR	*z*	*OR*	*z*	*OR*	*z*
Moral Preference	-0.27	-1.34	0.67	1.47	-1.13**	2.72
Indecision	0.05	0.74	-0.01	-0.13	0.03	0.37
Inefficiency-inequality trade-off	-0.05	-0.68	-0.11	-1.13	0.02	0.20
Trial	-0.01***	-9.39	-0.01***	-5.28	-0.01***	-8.99
Item fixed effect	YES		YES		YES	
Constant	1.50***	6.28	1.42***	3.68	2.16***	5.43
Observations	2056		1036		1300	

Note. Centered predictors, $^{+}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 18.

Linear mixed effects repeated measure regressions, predicting the number of fixations from moral preference, (1) overall, (2) for deontologists, (3) for utilitarians.

	(1) Overall : log Number of Fixations		(2) Deontologists : log Number of Fixations		(3) Utilitarians : log Number of Fixations	
	OR	*z*	*OR*	*z*	*OR*	*z*
Moral Preference	-0.44^{+}	-1.90	0.68	1.30	-1.54**	-3.16
Indecision	0.04	0.52	0.01	0.09	0.01	0.02
Inefficiency-inequality trade-off	-0.04	-0.54	-0.13	-1.19	0.03	0.28
Trial	-0.01***	-8.75	-0.01***	-4.63	-0.01***	-8.76
Item fixed effect	YES		YES		YES	
Constant	2.83***	10.20	2.59***	5.85	3.73***	8.02
Observations	2056		1036		1300	

Note. Centered predictors, $^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 19.

Linear mixed effects repeated measure regressions, predicting the number of inspected information from moral preference, (1) overall, (2) for deontologists, (3) for utilitarians.

	(1) Overall : log Number of Inspected Information		(2) Deontologists : log Number of Inspected Information		(3) Utilitarians : log Number of Inspected Information	
	OR	z	OR	z	OR	z
Moral Preference	-0.34^{+}	-2.36	0.28	0.91	-1.12**	-3.71
Indecision	0.05	0.94	-0.02	-0.25	0.05	0.87
Inefficiency-inequality trade-off	-0.05	-0.99	-0.09	-1.42	0.01	0.06
Trial	-0.01***	-6.72	-0.01***	-3.01	-0.01***	-7.12
Item fixed effect	YES		YES		YES	
Constant	1.54***	8.96	1.50***	5.80	2.11***	7.29
Observations	2056		1036		1300	

Note. Centered predictors, $^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 20.

Linear mixed effects repeated measure regressions, predicting attention to the later chosen side from moral preference, (1) overall, (2) for deontologists, (3) for utilitarians, and (4) overall from the kind of decision made.

	(1) Overall: log Number of Inspected Information		(2) Deontologists: log Number of Inspected Information		(3) Utilitarians: log Number of Inspected Information		(4) Overall: log Number of Inspected Information	
	OR	*z*	*OR*	*z*	*OR*	*OR*	*OR*	*z*
Moral Preference	0.08*	2.13	0.09	1.29	0.04	0.41		
Choice (0 = deontological, 1 = utilitarian)							0.06***	5.37
Time in the Decision Process	0.09***	6.88	0.11***	1.29	0.11***	4.76	0.09***	6.85
Moral Preference X Time	-0.028***	-5.20	-0.23*	-2.01	-0.35**	-3.19	-0.03	-1.16
Trial	0.01	1.44	0.01*	2.21	0.01	1.30	0.01	1.44
Item fixed effect	YES		YES		YES		YES	
Constant	0.54***	26.58	0.53***	18.18	0.54***	17.98	0.54***	26.56
Observations	14193		7406		8851		14193	

Note. Centered predictors, $^{+}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

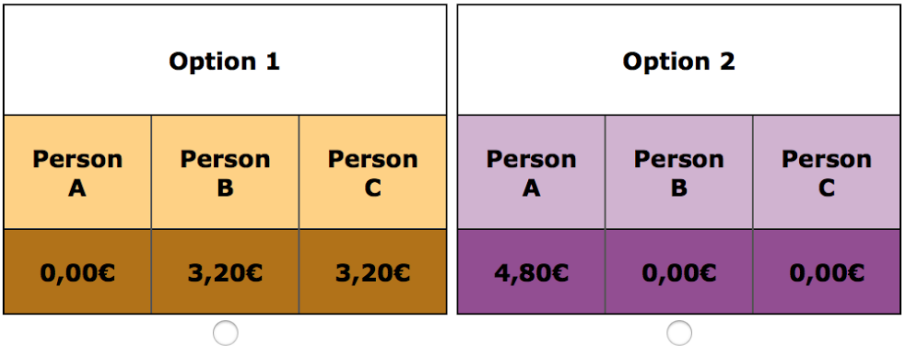

Figure 11. Example of a decision task in the measure for equality-efficiency trade-off.

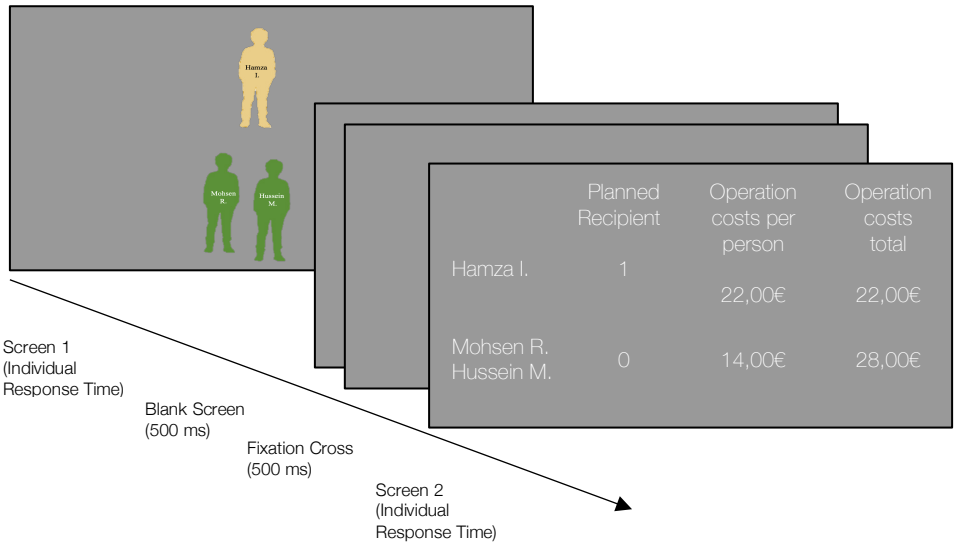

Figure 12. Example of a trial in the operations task.

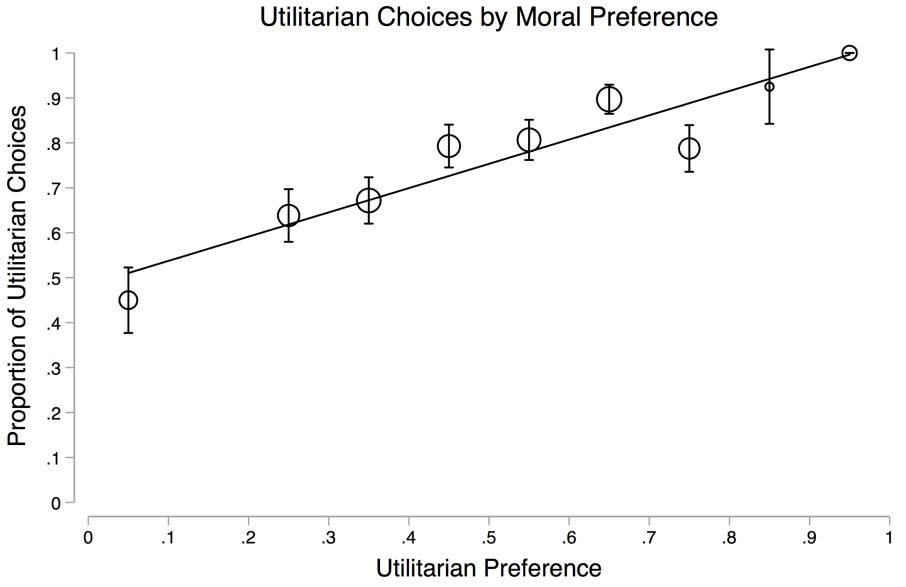

Figure 13. Relationship of utilitarian choices and moral preference, with bins representing the number of observations summarized, 95% confidence intervals and fit line.

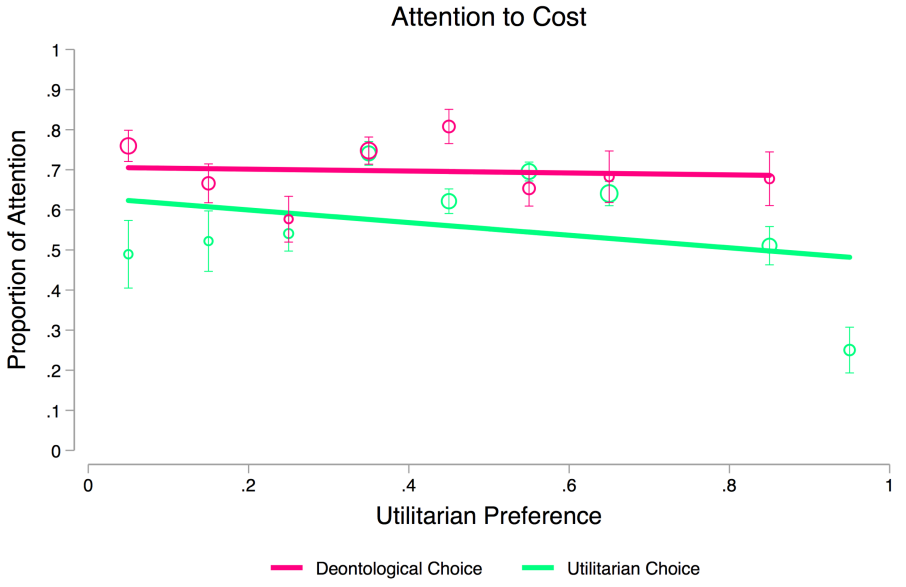

Figure 14. Proportion of attention depending on moral preferences and the type of decision made, with 95% confidence intervals and size of bins representing the number of observations summarized.

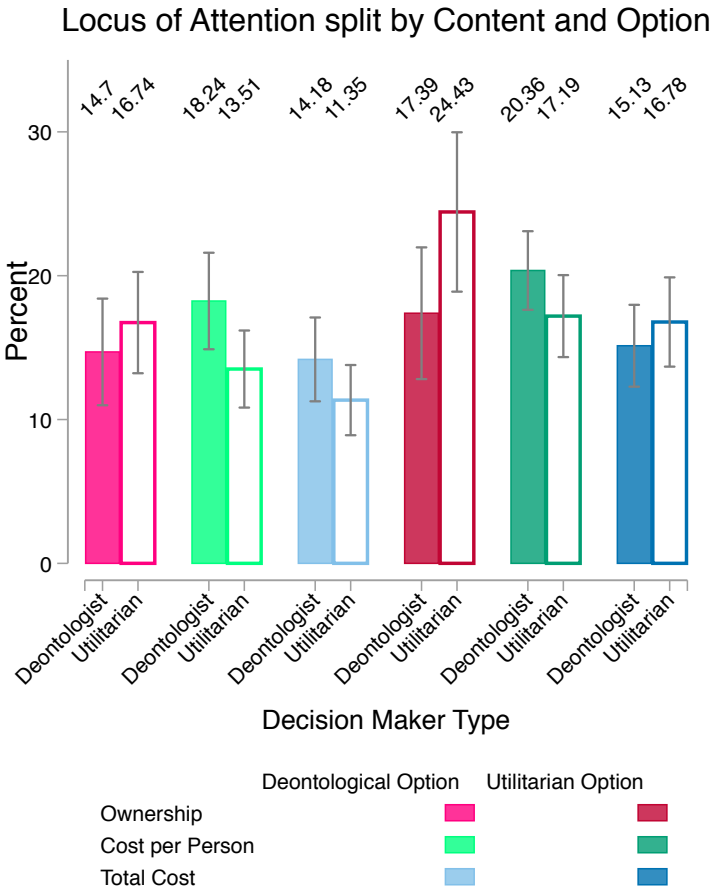

Figure 15. Attention to ownership and cost information located within the deontological vs. utilitarian option depending on moral preferences, with means and 95% confidence intervals.

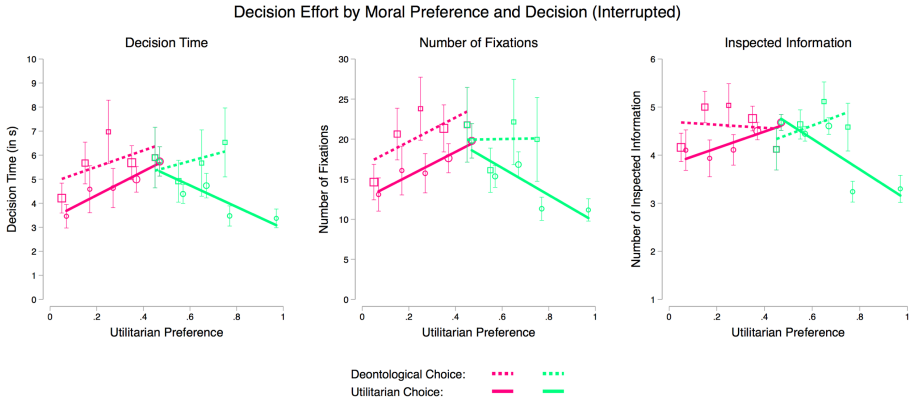

Figure 16. Decision effort depending on moral preferences and the type of decision made, with 95% confidence intervals and size of bins representing the number of observations summarized. Panel A: decision time. Panel B: number of fixations. Panel C: number of inspected information.

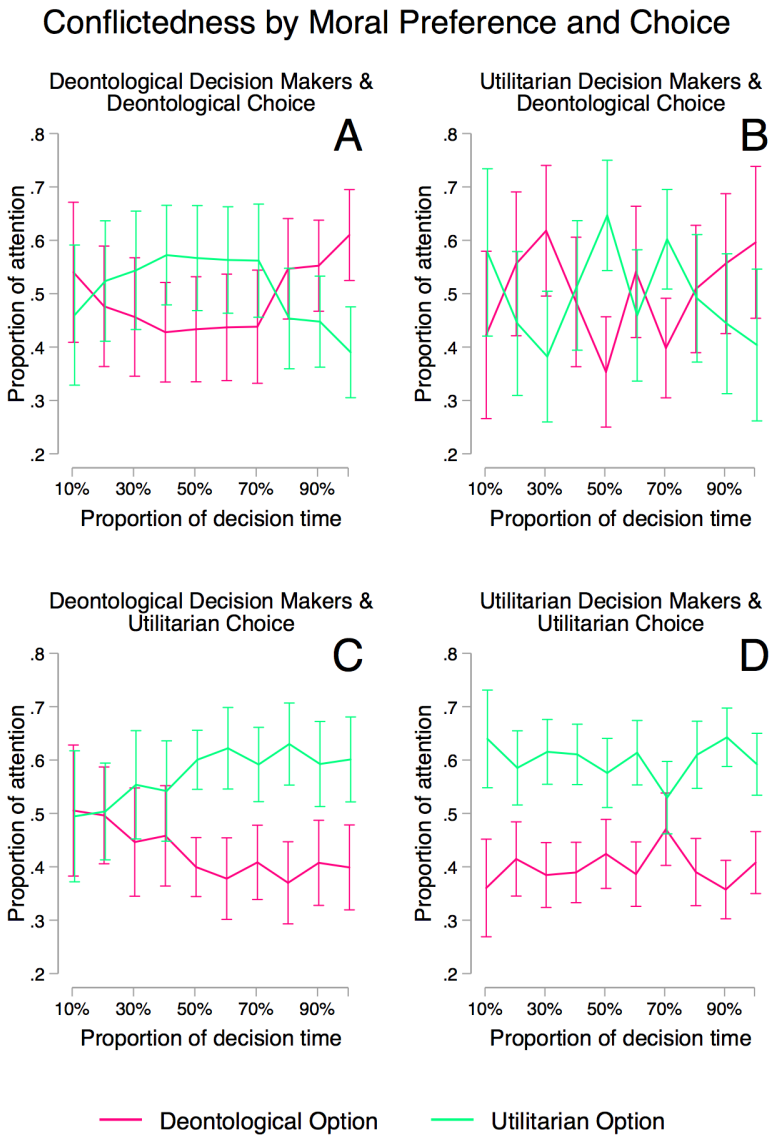

Figure 17. Conflictedness depending on moral preference and choice with 95% confidence intervals. Panel A: deontological decision makers making deontological choices. Panel B: utilitarian decision makers making deontological choices. Panel C: deontological decision makers making utilitarian choices. Panel D: utilitarian decision makers making utilitarian choices.

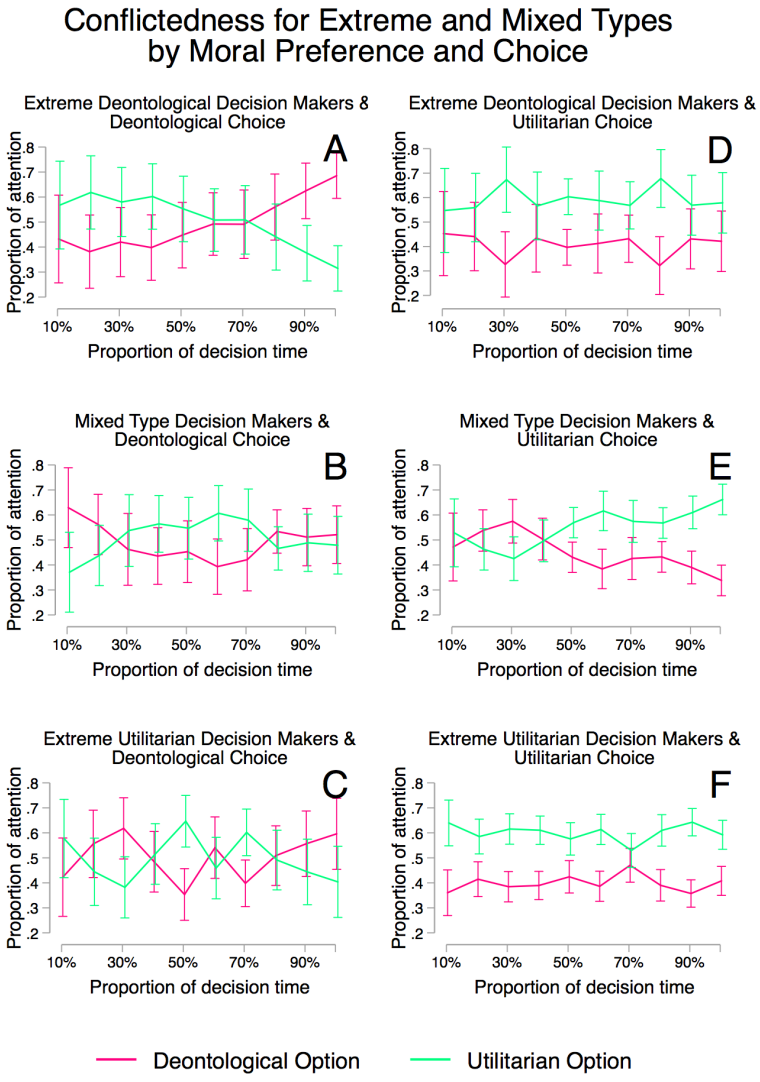

Figure 18. Conflictedness depending on moral preference and choice with 95% confidence intervals. Panel A: extreme deontological decision makers making deontological choices. Panel B: mixed type decision makers making deontological choices. Panel C: extreme utilitarian decision makers making deontological choices. Panel D: extreme deontological decision makers making utilitarian choices. Panel E: mixed type decision makers making utilitarian choices. Panel F: extreme utilitarian decision makers making utilitarian choices