HIGH SCHOOL EDITION
Journal of Student Research
Volume 13 Issue 3 (2024)

Emotional and Cognitive Processes in Moral Choices: A Review of the Dual-Process Theory of Moral Judgment

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ABSTRACT

The investigation of moral behavior has become prevalent in cognitive neuroscience. A prominent framework within this field is the dual-process theory. Initially proposed to address discrepancies in the trolley and footbridge dilemmas, the dual-process theory has been influential in understanding moral behavior, proposing that two systems, emotion and cognition, play distinct roles in shaping moral judgments. Emotion-driven deontological decisions are contrasted with cognition-driven utilitarian decisions. This paper will review the dual-process theory of moral decision-making, examining both its evidence and some of its key criticisms.

Introduction

Imagine you are a passenger in an autonomous vehicle. A pedestrian suddenly appears out of nowhere in front of you, but it is too late for your car to brake in time. The only way to avoid the person is to steer the car in another direction and hit some structures at the side of the road, risking your life. Otherwise, it is certain that the car will hit the pedestrian. In this dilemma, the autonomous vehicle should make a moral decision. Should it be programmed to prioritize your life or the pedestrian's? What if the pedestrian was a child or a group of people? Should the vehicle prioritize the decision that will benefit more people, or should it prioritize you, the person who paid for it?

Autonomous vehicles follow the rules that they are programmed with. So what defines the "right" set of rules, and who gets to determine this? Is there a fair way to establish what these rules should be? If autonomous vehicles were to follow widely accepted ethics, then it would be helpful to understand how the human mind works around moral dilemmas. Researchers including philosophers, psychologists, and neuroscientists have been studying the cognitive processes and neural mechanisms involved in moral decision-making, seeking to uncover the principles that guide our judgments and could potentially inform the programming of these vehicles. However, studies involving moral dilemmas are challenging due to the complexity and variability of moral judgments, which are influenced by numerous factors, including individual differences, context, and culture.

The emergence of neuroimaging methods, particularly functional magnetic resonance imaging (fMRI), has advanced the study of morality by providing insights into the neural mechanisms underlying moral cognition and decision-making. Neuroimaging methods such as fMRI allow researchers to observe brain activity and identify specific brain regions involved in a certain cognitive process. By combining neurophysiological measures with behavioral data, cognitive neuroscientists and psychologists have sought to establish relationships between neural activity and moral judgments. In addition, by using functional neuroimaging and lesion studies, researchers have attempted to identify the role of specific brain areas in moral decision-making.

The growing body of research in the neuroscience of morality has enabled a deeper understanding of how different parts of the brain contribute to complex moral evaluations and decisions. This research has not only illuminated the neural networks involved but has also provided crucial evidence for various models and theories of moral decision-making. Of numerous theories surrounding moral judgment, the dual-process theory has emerged as a prominent framework for explaining moral decision-making. This theory posits that our moral judgments are the result of two distinct processes: a fast, automatic, and intuitive system, and a slower, more deliberate, and rational system (Greene et al., 2001; Greene et al., 2004). In this paper, I will discuss the dual-process theory in detail, examining the evidence that supports the framework, including neuroimaging studies and behavioral experiments. I will also address some of the limitations and criticisms of the dual-process theory, exploring areas where further research is needed to refine our understanding of moral decision-making.

Trolley Problem vs. Footbridge Problem

First introduced by moral philosophers, the thought experiments known as the trolley and footbridge problems have captivated researchers across disciplines, from psychology to neuroscience, sparking profound inquiries into the complexities of moral decision-making (Thomson, 1985; Thomson, 1986). These dilemmas have caused controversy because, despite their similar scenarios, they elicit opposite reactions from most people. Similar to common dilemmas in moral philosophy, these scenarios require choosing between harming one person and allowing multiple people to die. In the trolley problem, a runaway trolley is on the path to kill five people. A bystander can pull a lever to divert the trolley onto a different track where it will kill one person, thus saving the five people at the sacrifice of this person. The problem asks whether it would be appropriate or inappropriate for the bystander to pull the lever. In this case, most people say that one should pull the lever (Greene et al., 2001). The footbridge problem involves the same idea of the runaway trolley on the path to hit five people. This time, however, the bystander is watching from a footbridge that stretches over the track. A large stranger stands in front of the bystander, and if pushed off the footbridge, the stranger's body would block the trolley from hitting the five people. Would it be appropriate to push the stranger off of the footbridge? Most people would answer no (Greene et al., 2001). Though both situations involve sacrificing one life for the sake of five, people generally have conflicting reactions to these problems. Then what leads to this discrepancy?

One explanation that has been provided for the discrepancy between responses to the trolley and footbridge problems is the distinction between personal and impersonal moral dilemmas (Greene et al., 2004). The criteria for a moral personal violation involves three main components: the action causes serious bodily harm, the harm is caused to a specific individual or set of individuals, and the action comes directly from the doer, rather than being a deflection of an existing threat onto a different victim. This set of criteria defines the trolley problem as an impersonal dilemma and the footbridge problem as a personal dilemma. In the trolley problem, the bystander deflects an existing harm onto another person, while in the footbridge problem, the bystander directly imposes harm onto another person. According to Greene et al., personal dilemmas elicit strong emotional responses while impersonal dilemmas are less likely to elicit a strong emotional response but rather engage rational "cognitive" processes during contemplation of such dilemmas. Greene et al. have stated that these criteria are just a potential way to sort moral dilemmas and may not be fully correct.

Dual-Process Theory

To explain why individuals tend to arrive at opposite decisions in personal and impersonal moral dilemmas, a group of researchers led by Greene proposed the dual-process theory (Greene et al., 2001; Greene et al., 2004; Greene et al., 2008). According to the dual-process theory, there are two distinct subsystems involved in moral judgment: an emotional, intuitive subsystem and a rational, deliberate subsystem. The first system relies on

one's immediate thoughts after perceiving a situation, usually involving their emotional response, automatic associations, and instincts. Meanwhile, the second system relies more on one's cognitive reflection. Greene suggested that these systems sometimes compete with each other during moral decision-making. According to Greene, a moral dilemma typically first triggers the fast, intuitive system, which generates initial judgments based on immediate and automatic responses, often overriding cognitive reflection. Subsequently, the slower, deliberate system comes into play to evaluate and potentially counter the conclusions of the intuitive system through reasoning.

Greene also suggested that these systems are associated with distinct ethical theories—the first system with deontological tendencies and the second system with utilitarian tendencies (Greene et al., 2004; Greene et al., 2008). Deontology, often attributed to philosopher Immanuel Kant, posits that the morality of an action should be based on the action itself rather than its outcome (Kant, 1785). According to deontology, certain actions are inherently wrong or immoral and cannot be justified, regardless of their consequences. On the other hand, utilitarianism, a form of consequentialism advocated by figures like Mill and Bentham, judges the morality of an action based on its outcome. Utilitarianism prioritizes the maximization of beneficial consequences based on a cost-benefit analysis, irrespective of the action taken to achieve these outcomes (Mill & Bentham, 1987).

According to the dual-process theory, the first system exhibits deontological tendencies because people's immediate responses are typically averse to harming others. For example, in the footbridge problem, most people would automatically feel repulsed by the idea of harming the stranger. This immediate negative emotional reaction would outweigh any utilitarian considerations, preventing the acceptance of trading five people for one and influencing the decision to refrain from taking any action, leading to a deontological judgment. By contrast, the second system employs cognitive resources to analyze the situation. It tends to produce more utilitarian outcomes because it involves considering which decision would objectively be more beneficial in the given situation, rather than relying solely on an instinctual response. Individuals often say that redirecting the trolley is acceptable in the trolley problem, as impersonal dilemmas do not elicit as strong of an emotional response. In the absence of strong emotional responses, cognitive reasoning predominates the decision-making process, resulting in a utilitarian decision to save five lives at the cost of one (Greene, 2007).

Additionally, the dual-process theory proposes that the second cognitive process can potentially override the deontological inclination associated with emotional responses in judgments concerning personal dilemmas (Greene et al., 2004). According to the theory, certain personal dilemmas that are particularly difficult evoke an internal conflict between emotional reactions and cognitive reasoning. This explains why some individuals judge moral violations in personal dilemmas (e.g., pushing the stranger off the bridge) to be appropriate. Such individuals would need to override their automatic emotional responses with cognitive utilitarian analysis amidst the conflict between the two systems.

Figure 1 depicts a schematic illustration of how Greene's dual-process model interprets the internal processes of a decision-maker regarding the trolley and footbridge problems. In the trolley problem (Figure 1a), the emotional system considers the action of redirecting the trolley morally permissible since it does not directly harm the victim. The cognitive system analyzes that the benefit of the action outweighs the cost, concurring with the conclusion of the emotional system. In contrast, in the footbridge problem (Figure 1b), the emotional system deems the action of pushing the stranger off the bridge as morally impermissible since it inflicts direct harm on the victim, while the cognitive system's analysis of the situation remains unchanged. This leads to a conflict between the two processes. Greene's explanation is that when there is a low emotional response or minimal conflict between emotional and cognitive processes, individuals tend to make utilitarian judgments. On the other hand, when there is a strong emotional response, people tend to make deontological judgments (Greene, 2007). During the conflict between emotional and cognitive processes, individuals would need to deploy more cognitive resources to inhibit emotional responses in order to make a utilitarian decision.

In the next sections, I will review evidence pertinent to the role of the dual-process theory in morality. Numerous studies have provided evidence interpreted to support this theory, including both neural and behavioral data.

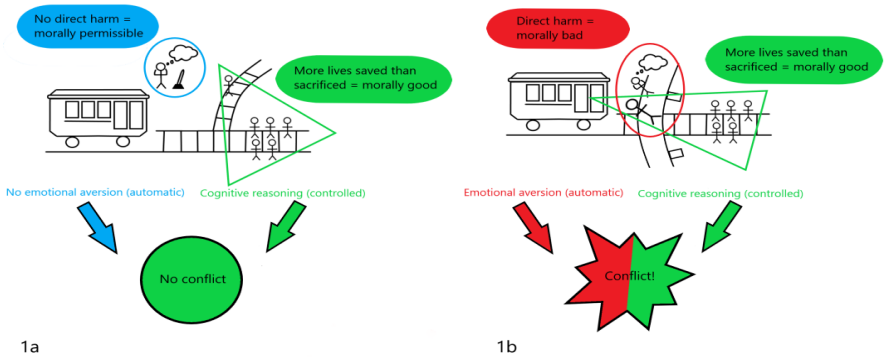

Figure 1. Illustration of the dual-process model's perspective on the psychological processes involved in the trolley and footbridge problems. (a) The processes during the trolley problem. This problem does not typically evoke a strong negative immediate emotional response, so there is no conflict with the cognitive utilitarian response. (b) The processes during the footbridge problem. The footbridge problem typically evokes a strong immediate aversive emotional response, which causes conflict between intuitive inclinations and cognitive inclinations.

Neural Evidence

Functional Neuroimaging

A tool that has become prevalent in the field of moral cognitive neuroscience is functional magnetic resonance imaging (fMRI). fMRI has widely been utilized to understand the brain regions that underlie specific functions. In studies of moral decision-making, analyses of fMRI scans have revealed patterns of brain activity associated with distinct moral choices. In a typical study that evaluates the neural correlates of moral judgment, participants' behavioral responses and brain activities are measured while they undergo different types of moral judgments (for instance, personal moral judgments and impersonal moral judgments as categorized in Greene et al., 2001).

Distinct Brain Areas Associated with Personal and Impersonal Moral Dilemmas

In studies by Greene and colleagues (Greene et al., 2001; Greene et al., 2004), it was shown that brain areas associated with emotion and social cognition, including the medial prefrontal cortex, exhibited relatively greater activity for personal moral judgments compared to impersonal moral judgments. Conversely, brain areas linked to cognitive control and working memory, such as the dorsolateral prefrontal cortex (DLPFC), displayed relatively greater activity in response to impersonal dilemmas compared to personal dilemmas. These results align with the dual-process theory as they demonstrate the differential involvement of the emotional and cognitive systems in moral decision-making. Since personal dilemmas are associated with deontological responses and impersonal dilemmas are associated with utilitarian responses, they support the theory's view that deontological judgments rely predominantly on automatic emotional processes, while utilitarian judgments rely more on deliberate cognitive processes.

Increased Dorsolateral Prefrontal Cortex Activity for Utilitarian Judgments in Personal Moral Dilemmas

Increased activity in the dorsolateral prefrontal cortex (DLPFC) has been linked to the resolution of difficult personal moral dilemmas and to increased utilitarian judgment. The anterior portion of the DLPFC, in particular, has been known for its role in abstract reasoning and cognitive control (Koechlin et al., 2003; Miller & Cohen, 2001; Ramnani & Owen, 2004). In the 2004 study by Greene et al., it was shown that the DLPFC exhibited greater activity when participants encountered difficult personal moral dilemmas compared to easier personal moral dilemmas. It was suggested that this heightened activation reflects a greater involvement of abstract reasoning and cognitive control, potentially indicating the allocation of additional cognitive resources to resolve the conflict between intuitive and rational impulses, which was described in the previous section, during decision-making in challenging moral situations. Furthermore, the researchers examined whether DLPFC activity correlated with the different moral decisions participants made. For a given set of challenging personal moral dilemmas, they separated out trials when a utilitarian or non-utilitarian choice was made on an individual participant basis and compared the neural activity associated with utilitarian judgments to non-utilitarian judgments. They found that the DLPFC was more active when participants made utilitarian decisions than when they made non-utilitarian decisions. This suggests the successful engagement of cognitive control to overcome emotional responses favoring non-utilitarian, deontological decisions amidst competition. These findings provide further evidence that cognition plays a significant role in moral decision-making, particularly in inducing utilitarian judgment.

Activity in the Anterior Cingulate Cortex During Challenging Personal Moral Judgments

The anterior cingulate cortex (ACC) is a brain region known for its function of conflict monitoring, responding to situations involving cognitive conflict or response conflict, such as in tasks like the Stroop task (Botvinick et al., 2001). As the dual-process theory postulates that difficult dilemmas (i.e., personal dilemmas) evoke internal conflict between emotional responses and cognitive reasoning, Greene and colleagues hypothesized that the ACC might also play a role in moral decision-making (Greene et al., 2004). They predicted that the ACC would show greater activity during judgments of difficult personal dilemmas compared to easy personal dilemmas, and their prediction was confirmed. This finding supports the dual-process theory and highlights the ACC's involvement in processing the conflict inherent in complex moral decisions.

Lesion Studies

Lesion studies are a type of research method used in cognitive neuroscience to investigate the functions of specific brain regions by examining the effects of brain damage or lesions on behavior and cognition. While functional neuroimaging methods that measure brain activity can demonstrate the involvement of a brain region in certain cognitive processes, they cannot establish its necessity. Conversely, lesion studies, such as studying patients with brain damage or using animal models with surgically induced lesions, can demonstrate the causal necessity of a brain region for a particular behavior or cognitive function by observing changes in behavior or cognitive deficits resulting from brain lesions (Vaidya et al., 2019). Lesion studies have also shed light on the mechanisms underlying moral decision-making, with some findings interpreted as supporting the dual-process theory.

Lesions in the Ventromedial Prefrontal Cortex and Utilitarian Judgments

Several studies have revealed atypical patterns of moral judgment behavior in patients with brain lesions in areas associated with emotional processing. One such area is the ventromedial prefrontal cortex (VMPFC). Patients with VMPFC lesions often exhibit emotional blunting and diminished empathy, yet their general intellectual abilities remain intact (Anderson et al., 2006; Barrash et al., 2000). This makes them good candidates

for investigating the influence of emotion on moral judgment. In studies involving patients with VMPFC lesions, researchers observed that these individuals were more likely to endorse utilitarian decisions (i.e., opting to inflict emotionally aversive harm for the sake of a greater good) compared to individuals with neurologically typical brains or those with brain damage in other regions (Ciaramelli et al., 2007; Koenigs et al., 2007). Greene argued that this finding corroborates their theory positing that deontological decisions are supported by emotional responses, whereas utilitarian decisions are driven by cognitive processes (Greene, 2007). He also argued that this indicates the dominance of rational, cognitive reasoning in decision-making when emotional influence is absent, assuming intact cognitive processes.

Emotional Deficits in Frontotemporal Dementia and Utilitarian Judgments

Additional evidence supporting the causal role of emotion in moral decision-making comes from another study involving patients with frontotemporal dementia (FTD) who exhibit deficits in emotional processing (Mendez et al., 2005). FTD is a neurodegenerative disorder affecting the frontal and/or temporal lobes of the brain, leading to emotional blunting as well as lack of social tact (Mendez et al., 2002; Neary et al., 1998). In the study by Mendez and colleagues (2005), they found that FTD patients exhibited higher utilitarian tendencies when given the footbridge problem compared to neurologically normal participants and Alzheimer disease patients. The researchers proposed that their result was driven by compromised emotional processing related to damage in the VMPFC caused by FTD. Similar to the VMPFC lesion cases, the data showing the utilitarian inclinations of patients with emotional blunting establishes the role of emotional processing in moral decision-making, supporting the claim of the dual-process theory that deontological judgments are influenced by emotional responses.

Basolateral Amygdala Damage and Decreased Utilitarian Judgments

More recently, a study investigated moral judgments in patients with damage to the basolateral amygdala (BLA) (van Honk et al., 2022). In rodents, the BLA is known for promoting outcome-based choice behavior and regulating the VMPFC's action-based tendencies via its inhibitory connections (Balleine & Killcross, 2006; Dilgen et al., 2013; Phillips et al., 2003; Schoenbaum et al., 2003). Given the BLA's role, van Honk and colleagues hypothesized that the human BLA would similarly influence outcome-based choice behaviors, thereby promoting utilitarian moral judgments. When presented with nonmoral, impersonal moral, and personal moral dilemmas, patients with BLA damage showed abnormally decreased utilitarianism selectively in personal moral dilemmas (i.e., making more deontological decisions) compared to neurologically healthy controls (van Honk et al., 2022). One possible explanation of these results is that dilemmas with low emotional reactions (i.e., nonmoral and impersonal moral) elicited decisions comparable to those of normal participants in BLA patients because extensive utilitarian calculation was not necessary for producing utilitarian judgments and overcoming any emotional drives. Meanwhile, personal moral dilemmas tend to evoke strong emotional responses, requiring more deliberation to overcome the deontological instinct.

Behavioral Evidence

Reaction Time (RT)

Another piece of evidence for the dual-process theory arises from behavioral studies that assess moral decision-making and other behavioral markers, such as reaction time (RT), which serve as indicators of underlying cognitive processes. RT data from moral dilemma experiments have shown that people are quicker to make deontological decisions than utilitarian decisions (Greene et al., 2001). This finding supports the notion of controlled cognitive processes driving utilitarian judgments and highlights the role of cognitive control in resolving the

competition between intuitive deontological inclinations and deliberate utilitarian inclinations. In the 2001 study by Greene et al., participants were asked to judge whether a given sacrificial decision was appropriate or inappropriate in each moral dilemma scenario. The researchers found that participants took longer to judge a sacrificial (utilitarian) decision as appropriate compared to when they deemed it inappropriate, specifically in personal moral dilemmas. Greene et al. proposed that deontological decisions, based on immediate reactions, can be judged relatively quickly. In contrast, utilitarian decisions require more time because the brain must deliberately consider the dilemma and correct the intuitive response. These findings align with the dual-process theory's proposition of two conflicting systems in moral judgment. Quicker deontological decisions suggest the dominance of the automatic, emotional system, while slower utilitarian decisions suggest the engagement of the corrective, cognitive system.

Furthermore, though indirect, a link between moral behavior (reaction time) and neural activity has been demonstrated. In the 2004 study by Greene and colleagues, personal moral judgments were categorized as "difficult" or "easy" based on reaction times (RT) for each individual participant and trial. Lower RTs indicated easier dilemmas, while higher RTs indicated more challenging dilemmas. As described in the previous section, higher activity of the anterior cingulate cortex (ACC) was observed for difficult (high-RT) trials than for easy (low-RT) trials. This result signifies that the difference in RT when making moral decisions might be due to the varying degrees of conflict.

Cognitive Load

Studies have also explored how cognitive load affects one's ability to make utilitarian decisions, suggesting the involvement of a deliberate, cognitive system in moral judgment. For example, one study showed that individuals took longer to make utilitarian decisions when under cognitive load, while the reaction time for deontological decisions remained unaffected (Greene et al., 2008). Furthermore, other studies found that cognitive load selectively decreases people's utilitarian inclinations when responding to moral dilemmas (Conway & Gawronski, 2013; Trémolière et al., 2012). The selective interference of cognitive load on utilitarian decisions, without affecting deontological decisions, offers more direct evidence of the distinct role of cognition in moral decision-making. This suggests a causal relationship between cognitive processes and utilitarian judgment.

Emotional Induction

To test the role of emotion in moral judgment, researchers have examined how inducing specific emotions (i.e., manipulating emotional responses) affects individuals' moral decisions. One study demonstrated that enhancing empathy through emotional stimulation (e.g., presenting participants with a picture of the victim involved in their decision) resulted in a higher likelihood of individuals making deontological decisions (Conway & Gawronski, 2013). Additionally, another study investigated the impact of emotions induced by external circumstances on moral judgment (Valdesolo & DeSteno, 2006). They observed that participants presented with a stimulant that increased positive emotions were more inclined to choose utilitarian responses for moral dilemmas. According to the dual-process theory, if negative emotions underlie deontological judgments, inducing positive emotions should make people more utilitarian by counteracting negative emotional responses. The findings above support the dual-process account that emotions play a distinct role in shaping moral judgment.

Traits

Further support for the dual-process theory comes from investigating the influence of traits on moral judgment. One study found that participants assessed as more empathetic tended to make more deontological decisions, whereas those who relied more on cognitive reasoning exhibited higher utilitarian tendencies (Conway &

Gawronski, 2013). This aligns with the theory that emotional and cognitive processes have distinct roles in moral decision-making.

Criticisms

While the dual-process theory has gained popularity and has been instrumental in shaping our understanding of moral decision-making, it is not without its limitations and critics. In this section, I will discuss some criticisms and counterevidence surrounding the dual-process theory.

The Issue with Double Dissociation and Non-Specificity of Brain Lesions

Moll and de Oliveira-Souza (2007) pointed out that the dual-process theory, which posits mutually competing roles of emotion and cognition that depend on the VMPFC and DLPFC respectively, can only be justified when a double dissociation is demonstrated. In other words, selective VMPFC damage should increase utilitarian choices, and selective DLPFC damage should increase deontological choices. However, there has been no such evidence of mutually exclusive processes influencing moral decision-making, though a single association can be made between VMPFC lesions and deontological decisions (Moll & de Oliveira-Souza, 2007). Moreover, Moll and de Oliveira-Souza (2007) further pointed out that some of the VMPFC patients studied in Koenigs et al. (2007) had damage that was not restricted to the VMPFC but extended to sectors of the DLPFC which are thought to be associated with utilitarian judgment. This challenges the dual-process theory's interpretation of the VMPFC lesion data.

Contradictory Behaviors in VMPFC Patients

While the dual-process theory suggests that VMPFC patients exhibit utilitarian tendencies due to emotional blunting (Ciaramelli et al., 2007; Greene, 2007; Koenigs et al., 2007), other views have attributed VMPFC patients' increased utilitarian moral choices to other symptoms of VMPFC damage (Moll & de Oliveria-Souza, 2007). In another study by Koenigs and Tranel (2007) involving VMPFC patients, participants played the Ultimatum Game where they were presented with a dilemma between an unfair but financially rewarding option (a more economically rational choice) or an option that would forgo money and punish the unfair player (a more emotional choice). VMPFC patients were more likely to choose the latter option. The dual-process theory cannot explain why VMPFC patients make more emotional choices in the Ultimatum Game but are more rational in moral decision-making. Moll and de Oliveira-Souza (2007) suggested that a selective impairment of prosocial sentiments in VMPFC patients could instead account for their contrasting behaviors.

Classification of Personal and Impersonal Moral Dilemmas

There have been disputes over how Greene defined personal and impersonal moral dilemmas in his studies. Greene distinguished between the trolley and footbridge problems by categorizing them as impersonal moral and personal moral dilemmas, respectively. He stated that impersonal moral dilemmas typically elicited utilitarian decisions, while personal moral dilemmas evoked deontological decisions (Greene et al., 2004). However, several dilemmas that follow Greene's definitions have been found not to produce the predicted outcomes (Berker, 2009; Kahane & Shackel, 2010). For example, Frances Kamm's Lazy Susan Case proposes that five people sit on a giant rotating tray that obstructs the path of a trolley. One can choose to do nothing, or they can turn the tray so that the five people will not be hit; however, the tray will then hit an innocent bystander with fatal force (Kamm, 2001). This dilemma does not necessarily elicit the non-utilitarian response even though it

fits Greene's definition of a personal moral dilemma, i.e., the dilemma involves causing serious bodily harm to a specific individual, and the harm is created by the action-doer rather than being a deflection of the existing harm posed by the trolley (Berker, 2009). This challenges the idea posited by the dual-process theory that personal and impersonal moral dilemmas correspond to deontological and utilitarian judgments, respectively. If Greene's definition of personal and impersonal moral dilemmas, as well as his categorization of different dilemmas into these categories, were incorrect, the neuroimaging and behavioral results from studies by Greene's group, which rely on these categorizations, could be deemed invalid.

Intuitive Utilitarian Judgment

The idea proposed by the dual-process theory that utilitarian decisions require slow cognitive deliberations correcting automatic deontological responses has also been challenged. In a recent study, researchers tested whether utilitarian responses indeed require corrective deliberation (Bago & De Neys, 2019). They employed a two-phase response paradigm where participants first provided initial answers to moral dilemmas under time pressure and cognitive load, followed by a final response to the same dilemmas after deliberation in the second phase. According to the dual-process theory's prediction, participants are expected to provide more deontological responses in the first phase, when cognitive resources are limited and time is constrained. They would then correct their initial responses and make more utilitarian judgments in the second phase, after deliberation. However, Bago and De Neys found that in most cases where participants selected a utilitarian choice after deliberation, they had already made the same utilitarian decision in the initial phase. This result suggests that people do not necessarily need to correct deontological responses and are capable of making utilitarian decisions "intuitively".

The Role of Emotion in Moral Decisions

Heizelmann (2018) advocates for an alternative perspective to the dual-process theory, suggesting that emotion can predict all moral judgments, regardless of whether they lean towards deontological or utilitarian outcomes. This is exemplified by scenarios like charity donations, which, while categorized as utilitarian by Greene's definition due to the sacrifice of one's resources for the greater good, often involve emotional factors such as compassion and empathy (Heizelmann, 2018; Moll et al., 2006; Rand et al., 2012). Additionally, Heinzelmann points out that utilitarianism lacks a specific association with the DLPFC and that brain regions associated with emotion were also found to be involved in utilitarian responses to personal moral dilemmas (Greene et al., 2004). Other studies have also demonstrated that utilitarian judgment is associated with emotional processes, involving brain regions such as the VMPFC, posterior cingulate cortex, and insula (Shenav & Greene, 2014; Tabibnia et al., 2008; Tricomi et al., 2010).

Conclusions

The dual-process theory has significantly advanced our understanding of moral decision-making processes by proposing two distinct systems: one intuitive and emotional, and the other deliberative and cognitive. Through neuroimaging studies, behavioral experiments, and lesion studies, researchers have provided evidence supporting the dual-process theory. The ventromedial prefrontal cortex (VMPFC), dorsolateral prefrontal cortex (DLPFC), and anterior cingulate cortex (ACC) have emerged as key brain regions implicated in moral judgment, each contributing to different aspects of the decision-making process.

However, the theory is not without its criticisms and challenges. Methodological issues as well as the lack of clear dissociations between emotional and cognitive processes raise questions about the theory's explanatory power. In addition, the dual-process theory's mapping of deontological judgment onto emotion and utilitarian judgment onto cognition has faced challenges.

Despite these challenges and alternative viewpoints, the dual-process theory remains a valuable framework for investigating moral decision-making. Future research should continue to explore the neural underpinnings of moral judgment, potentially reevaluating the validity of the dual process. Finally, a nuanced understanding of moral decision-making processes is essential for addressing real-world ethical dilemmas and promoting moral reasoning in society.

Acknowledgments

I would like to thank my advisor for her invaluable guidance and feedback, her patience and support throughout the completion of this paper, and for being an inspiration to persevere and dedicate myself fully to all my future endeavors.

References

Anderson, S. W., Barrash, J., Bechara, A., & Tranel, D. (2006). Impairments of emotion and real-world complex behavior following childhood- or adult-onset damage to ventromedial prefrontal cortex. *Journal of the International Neuropsychological Society*, *12*(2), 224-235. https://doi.org/10.1017/S1355617706060346

Bago, B., & De Neys, W. (2019). The intuitive greater good: Testing the corrective dual process model of moral cognition. *Journal of Experimental Psychology: General, 148*(10), 1782-1801. https://doi.org/10.1037/xge0000533

Balleine, B. W., & Killcross, S. (2006). Parallel incentive processing: an integrated view of amygdala function. *Trends in Neurosciences*, *29*(5), 272-279. https://doi.org/10.1016/j.tins.2006.03.002

Barrash, J., Tranel, D., & Anderson, S. W. (2000). Acquired personality disturbances associated with bilateral damage to the ventromedial prefrontal region. *Developmental Neuropsychology*, *18*(3), 355-381. https://doi.org/10.1207/S1532694205Barrash

Berker, S. (2009). The normative insignificance of neuroscience. *Philosophy & Public Affairs*, *37*(4), 293-329. https://doi.org/10.1111/j.1088-4963.2009.01164.x

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review*, *108*(3), 624. https://doi.org/10.1037/0033-295X.108.3.624

Ciaramelli, E., Muccioli, M., Làdavas, E., & Di Pellegrino, G. (2007). Selective deficit in personal moral judgment following damage to ventromedial prefrontal cortex. *Social Cognitive and Affective Neuroscience*, *2*(2), 84-92. https://doi.org/10.1093/scan/nsm001

Conway, P., & Gawronski, B. (2013). Deontological and utilitarian inclinations in moral decision making: a process dissociation approach. *Journal of Personality and Social Psychology*, *104*(2), 216. https://doi.org/10.1037/a0031021

Dilgen, J., Tejeda, H. A., & O'Donnell, P. (2013). Amygdala inputs drive feedforward inhibition in the medial prefrontal cortex. *Journal of Neurophysiology*, *110*(1), 221-229. https://doi.org/10.1152/jn.00531.2012

Greene, J. D. (2007). Why are VMPFC patients more utilitarian? A dual-process theory of moral judgment explains. *Trends in Cognitive Sciences*, *11*(8), 322-323. https://doi.org/10.1016/j.tics.2007.06.004

Greene, J. D., Morelli, S. A., Lowenberg, K., Nystrom, L. E., & Cohen, J. D. (2008). Cognitive load selectively interferes with utilitarian moral judgment. *Cognition*, *107*(3), 1144-1154. https://doi.org/10.1016/j.cognition.2007.11.004

Greene, J. D., Nystrom, L. E., Engell, A. D., Darley, J. M., & Cohen, J. D. (2004). The neural bases of cognitive conflict and control in moral judgment. *Neuron*, *44*(2), 389-400. https://doi.org/10.1016/j.neuron.2004.09.027

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*(5537), 2105-2108. https://doi.org/10.1126/science.1062872

Heinzelmann, N. (2018). Deontology defended. *Synthese*, *195*(12), 5197-5216. https://doi.org/10.1007/s11229-018-1762-3

Kahane, G., & Shackel, N. (2010). Methodological issues in the neuroscience of moral judgement. *Mind & Language*, *25*(5), 561-582. https://doi.org/10.1111/j.1468-0017.2010.01401.x

Kamm, F. M. (2001). *Morality, Mortality: Volume II: Rights, Duties, and Status*. Oxford University Press. https://doi.org/10.1093/0195144023.001.0001

Kant, I. (1785). *Groundwork for the Metaphysics of Morals*. Oxford University Press.

Koechlin, E., Ody, C., & Kouneiher, F. (2003). The architecture of cognitive control in the human prefrontal cortex. *Science*, *302*(5648), 1181-1185. https://doi.org/10.1126/science.1088545

Koenigs, M., & Tranel, D. (2007). Irrational economic decision-making after ventromedial prefrontal damage: evidence from the Ultimatum Game. Journal of Neuroscience, 27(4), 951-956. https://doi.org/10.1523/JNEUROSCI.4606-06.2007

Koenigs, M., Young, L., Adolphs, R., Tranel, D., Cushman, F., Hauser, M., & Damasio, A. (2007). Damage to the prefrontal cortex increases utilitarian moral judgements. *Nature*, *446*(7138), 908-911. https://doi.org/10.1038/nature05631

Mendez, M. F., Anderson, E., & Shapira, J. S. (2005). An investigation of moral judgement in frontotemporal dementia. *Cognitive and Behavioral Neurology*, *18*(4), 193-197. https://doi.org/10.1097/01.wnn.0000191292.17964.bb

Mendez, M. F., & Perryman, K. M. (2002). Neuropsychiatric features of frontotemporal dementia: evaluation of consensus criteria and review. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *14*(4), 424-429. https://doi.org/10.1176/jnp.14.4.424

Mill, J. S., & Bentham, J. (1987). *Utilitarianism and Other Essays*. Penguin UK.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience*, *24*(1), 167-202. https://doi.org/10.1146/annurev.neuro.24.1.167

Moll, J., & de Oliveira-Souza, R. (2007). Moral judgments, emotions and the utilitarian brain. *Trends in Cognitive Sciences*, *11*(8), 319-321. https://doi.org/10.1016/j.tics.2007.06.001

Moll, J., Krueger, F., Zahn, R., Pardini, M., de Oliveira-Souza, R., & Grafman, J. (2006). Human fronto–mesolimbic networks guide decisions about charitable donation. *Proceedings of the National Academy of Sciences, 103*(42), 15623-15628. https://doi.org/10.1073/pnas.0604475103

Neary, D., Snowden, J. S., Gustafson, L., Passant, U., Stuss, D., Black, S., Freedman, M., Kertesz, A., Robert, P. H., Albert, M., Boone, K., Miller, B. L., Cummings, J., & Benson, D. (1998). Frontotemporal lobar degeneration: a consensus on clinical diagnostic criteria. *Neurology*, *51*(6), 1546-1554. https://doi.org/10.1212/WNL.51.6.1546

Phillips, A. G., Ahn, S., & Howland, J. G. (2003). Amygdalar control of the mesocorticolimbic dopamine system: parallel pathways to motivated behavior. *Neuroscience & Biobehavioral Reviews*, *27*(6), 543-554. https://doi.org/10.1016/j.neubiorev.2003.09.002

Ramnani, N., & Owen, A. M. (2004). Anterior prefrontal cortex: insights into function from anatomy and neuroimaging. *Nature Reviews Neuroscience*, *5*(3), 184-194. https://doi.org/10.1038/nrn1343

Rand, D. G., Greene, J. D., & Nowak, M. A. (2012). Spontaneous giving and calculated greed. *Nature*, *489*(7416), 427-430. https://doi.org/10.1038/nature11467

Schoenbaum, G., Setlow, B., Saddoris, M. P., & Gallagher, M. (2003). Encoding predicted outcome and acquired value in orbitofrontal cortex during cue sampling depends upon input from basolateral amygdala. *Neuron*, *39*(5), 855-867. https://doi.org/10.1016/S0896-6273(03)00474-4

Shenhav, A., & Greene, J. D. (2014). Integrative moral judgment: dissociating the roles of the amygdala and ventromedial prefrontal cortex. *Journal of Neuroscience*, *34*(13), 4741-4749. https://doi.org/10.1523/JNEUROSCI.3390-13.2014

Tabibnia, G., Satpute, A. B., & Lieberman, M. D. (2008). The sunny side of fairness: preference for fairness activates reward circuitry (and disregarding unfairness activates self-control circuitry). *Psychological Science*, *19*(4), 339-347. https://doi.org/10.1111/j.1467-9280.2008.02091.x

Thomson, J. J. (1985). The trolley problem. *Yale LJ*, *94*, 1395.

Thomson, J. J. (1986). *Rights, Restitution, and Risk: Essays, in Moral Theory*. Harvard University Press.

Trémolière, B., De Neys, W., & Bonnefon, J. F. (2012). Mortality salience and morality: Thinking about death makes people less utilitarian. *Cognition*, *124*(3), 379-384. https://doi.org/10.1016/j.cognition.2012.05.011

Tricomi, E., Rangel, A., Camerer, C. & O'Doherty, J. (2010). Neural evidence for inequality-averse social preferences. *Nature, 463*(7284), 1089. https://doi.org/10.1038/nature08785

Vaidya, A. R., Pujara, M. S., Petrides, M., Murray, E. A., & Fellows, L. K. (2019). Lesion studies in contemporary neuroscience. *Trends in Cognitive Sciences*, *23*(8), 653-671. https://doi.org/10.1016/j.tics.2019.05.009

Valdesolo, P., & DeSteno, D. (2006). Manipulations of emotional context shape moral judgment. *Psychological Science*, *17*(6), 476-477. https://doi.org/10.1111/j.1467-9280.2006.01731.x

van Honk, J., Terburg, D., Montoya, E. R., Grafman, J., Stein, D. J., & Morgan, B. (2022). Breakdown of utilitarian moral judgement after basolateral amygdala damage. *Proceedings of the National Academy of Sciences*, *119*(31), e2119072119. https://doi.org/10.1073/pnas.2119072119