

# ***Traumatic Brain Injury and Abnormal Moral Judgment***

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**Abstract:** This article explains the underlying mechanism of utilitarian decisions in Traumatic Brain Injury (TBI) patients when pondering trolley-type moral dilemmas. In the first section of the literature review, definitions of TBI, utilitarianism and abnormal moral judgment have been provided. The ventromedial prefrontal cortex (vmPFC) has been identified to be undoubtedly prominent based on a discussion of the previous contradictory evidences about the brain areas involved in causing abnormal moral judgment. Subsequently, the function of vmPFC as an emotional integration station is introduced, substantiated by functional magnetic resonance imaging studies and the dual-system theory of moral decision-making. The inability or the diminished ability to feel morally-related emotions following TBI has also been considered a causal factor of endorsement to the act of harming someone directly. Finally, the author advises a few future directions to fill the gap within current knowledge and points out the limitations of thought experiments. Overall, the paper highlighted that the atypical response pattern of moral judgment in TBI patients is attributed to the failure to generate appropriate emotions in the face of moral stimuli.

**Keywords:** moral judgment, traumatic brain injury (TBI), utilitarianism

## **1. Introduction**

The paper revolves around the well-established “trolley problem”. Greene et al. demonstrated a discrepancy between people’s responses to personal and impersonal moral judgments [1]. There were two kinds of moral (personal/ impersonal) dilemmas: both ask whether to sacrifice one person to save five. The only difference was the way adopted. In the impersonal trolley dilemma, a runaway tram was hurtling towards five people tied to the tracks and would kill them unless something was done to stop it. The only way to save them was to flip a switch and divert the trolley onto a different track, killing one instead of five.

In contrast, the personal trolley dilemma posed the scenario that pushing a fat stranger off the bridge to block the railway would rescue five people who were tied up. Most people agreed with sacrificing one in the impersonal condition yet strongly objected to it in the personal condition. Apparently, hurting someone with one’s own hands made a difference, probably because it aroused more moral feelings.

Numerous research has indicated that people with TBI tend to affirm utilitarian actions on personal moral dilemmas that most neural typical people would reject. In particular, researchers pointed out this atypical pattern of moral decision-making is prevalent among people who have injured their frontal lobe. Greene et al. emphasised the importance of affect in moral judgment by

comparing functional magnetic resonance imaging (fMRI) scans under different decision-making conditions [1]. The activation of brain regions associated with emotions were found to be higher in personal moral conditions than in impersonal or non-moral conditions. Therefore, it was suggested that people with TBI experience diminished emotional responses when encountering personal moral dilemmas so that they eventually choose the most profitable option. Such abnormal moral judgment and flat affect might account for higher crime rates, substance misuse, aggressive behaviour and incarceration following TBI. For instance, a military study indicated that moderate TBI patients were 5.4 times more likely to be discharged for alcohol and substance misuse. Even a mild TBI may increase the risk by 2.6 times [2]. Nearly half of the UK's adult male prison population reported suffering from traumatic brain injury [3]. The idea that TBI may be a crime risk factor was reinforced by the fact that 70% of the prisoners had their first injury before the first offence.

This paper aims to first identify the brain regions associated with abnormal moral judgments by trying to draw a convergent conclusion from different results of TBI studies. The conclusion is that the importance of the ventromedial prefrontal cortex (vmPFC) is indisputable. Second, the author will discuss possible mechanisms underlying utilitarian preference for personal moral dilemmas. Specifically, how did the damage of vmPFC lead to moral emotion selective impairment? Current knowledge states that this region functions to integrate repulsive emotional signals in response to stimuli that further guide moral decision-making. On the other hand, damage to other brain areas related to emotions such as empathy, guilt and shame is also considered part of the neural basis behind the will of moral violation.

## **2. Literature Review**

### **2.1. Definition**

Traumatic brain injury is a sudden, external, physical assault that causes damage to the brain. Common causes of TBI are falls, traffic-related accidents, fights and assaults. There are mild, moderate and severe TBIs depending on the extent of harm. According to the Mayo Classification Scale, mild TBI is defined as less than 30 minutes of unconsciousness and post-traumatic amnesia within 24 hours. However, to be classified as moderate-severe TBI, one must lose consciousness over 30 minutes, and amnesia must exceed 24 hours. Note that the criteria may vary slightly across different studies.

Utilitarianism is a moral philosophy that proposes whether an action is right or wrong depends on its consequence. The action is correct if it brings more happiness and benefits to more people. Hence, a utilitarian would support the act of killing one to save five lives because the welfare of five people is greater than that of one person.

Most people endorsed the utilitarian option when encountering impersonal moral dilemmas whereas when it comes to personal moral scenarios, such as killing an individual with their bare hand, most people refused to engage and said it violated their moral code. The reason suggested by Greene et al. was that there were more emotion engaged in the decision-making process of personal moral scenarios than impersonal moral ones [1]. Comparatively, people who experienced TBI show the tendency to accept utilitarian choices, regardless of impersonal or personal conditions. This unusual utilitarian preference refers to what the essay called an atypical pattern of moral judgment.

### **2.2. Brain Regions Contribute to the Deficit in Moral Judgment**

Martins et al. supported the association between frontal damage and atypical choice of moral dilemmas [4]. They observed a higher proportion of affirmative responses from subjects with frontal TBI for personal moral dilemmas compared to the demographically matched comparison control group. Hence, they concluded that the prefrontal cortex is an essential regulator of moral

judgment. In particular, lesions to the orbitofrontal and medial frontal aspects appear to exert more influence than the dorsolateral part of the frontal cortex. This is consistent with the decreased activity in the dorsolateral prefrontal cortex shown in healthy participants when considering personal moral judgment because this area is involved in the rational cognitive process underlying utilitarian judgment [5].

However, a recent study by Edwards et al. found a conflicting result that people with TBI do not show deficits in personal moral dilemmas [6]. In fact, the response patterns from both TBI and control groups are very similar. The performance of individuals with TBI falls within the range of control groups from other research on personal dilemmas. This counterargument was not due to the location of the lesion. After all, all TBI patients from the Martins et al.'s sample possess significant damage to the frontal part of the brain, whereas only 62% of patients had injured frontal lobes in Edwards et al.'s study. Indeed, Edwards et al. demonstrated that the difference in practical response between the frontal damage group and the non-frontal damage groups was insignificant. Consequently, Edwards et al. argued that individuals with TBI would not necessarily have impaired moral decision-making and that the presence of frontal lobe pathologies, like bleeding or contusion, were not predictive of this deficit.

By comparing the two studies, Martins et al.'s findings could be limited in terms of their design. Although both studies used the same stimuli which is a set of 50 trolley-type dilemmas produced by Greene et al. [1]. Edwards et al. used all the 50 dilemmas, but Martins et al. selected 22 from the set. Thus, it is natural to speculate that the result obtained from using the whole set would be more accurate and precisely generalizable. Also, unlike Martins et al., Edwards et al. placed attention checks within the moral judgment questionnaire, which promoted the reliability of responses. Thus, it is possible that the subjects of Martins et al.'s study had become tired, bored, distracted, and inattentive since the task was long and repetitive. Nevertheless, Edwards et al.'s study is limited in that the researchers did not specify which part of the frontal lobe in each individual was damaged. In addition to the lower resolution of acute CT scans compared to MRI scans, the internal validity may be low. Therefore, it is not sufficient to rule out the specific role of prefrontal cortex regions in moral decision-making.

Several other brain imaging studies brought evidence to the statement that frontal lesion leads to a higher willingness to incline practical actions [5, 7-8]. Overall, most researchers emphasised the ventromedial prefrontal cortex (vmPFC) as a critical region enabling people to judge the act of directly harming a person to save more lives as morally unacceptable.

### 2.3. Exploring the Underlying Mechanism

It was stated that the atypical response pattern of moral judgment arises from moral emotion selective impairment resulted from TBI, especially injury to the vmPFC region. Patients with acquired vmPFC damage are commonly known to have blunted or flat affect. Shenhav and Greene proposed an integrative role of the vmPFC in regulating emotion to guide decision-making [9]. According to their findings, amygdala-vmPFC connectivity appeared to be the lowest for utilitarian assessments and the highest during purely emotional assessments. This means the amygdala was less reactive in evaluating utilitarian options. Note that the function of the amygdala is to generate emotional aversions to harmful actions. Then, the vmPFC is dedicated to receive those negative emotional signals from the amygdala and integrates them to guide moral judgment. Accordingly, the amygdala response and its link with the vmPFC are critical for judgment, but Shenhav and Greene did not report which region is associated with utilitarian appraisals [9]. To expand this, Hutcherson et al. supported the integration model by specifying the brain areas that reflect utilitarian or emotional assessments using the fMRI approach [10]. Again, consistent with the previous finding, emotional and utilitarian information are coded independently and passed on to

the vmPFC where they are integrated into an overall moral value judgment. The dorsomedial prefrontal cortex was shown to be correlated with utilitarian appraisals. Yet, in contrast to the previous finding by Shenhav and Greene, emotional appraisals were represented by the anterior cingulate cortex rather than the amygdala. Different experimental designs might have contributed to this discrepancy. Thus, both the anterior cingulate cortex and amygdala should be taken into account. Notably, Hutcherson et al. inferred that the dorsomedial prefrontal cortex and anterior cingulate cortex may integrate lower-level features by themselves, possibly represented in regions such as the amygdala, which could serve as relay stations that convert information into vmPFC-usable material [10]. Hence, future research could be conducted to determine the specific computations performed by these regions. To sum up, both studies highlighted the integrative role of vmPFC and the distinction between the emotional and rational systems in the decision-making process rather than a conflicting or interactive relationship.

This integration view also aligns with how emotion regulation informs moral judgment. As demonstrated by Greene et al., brain regions associated with emotions become more activated when pondering personal moral dilemmas than impersonal moral or non-moral dilemmas [1]. Furthermore, Helion and Ochsner argued emotions are not merely spontaneous reactions; they can also be controlled [11]. Individuals may adjust their automatic emotional responses to moral cues depending on the goal and end up with goal-consistent conduct. Taking the trolley problem as an example, up-regulation occurs when people were asked to imagine a person is hurting which ultimately encourages people to state that pushing a naïve individual is wrong. Conversely, picturing pulling the lever to alter the path would make people down-regulate their emotional reactions. Hence, an individual may agree with the utilitarian viewpoint that sacrificing one to save five is not so much morally condemnable.

Therefore, malfunction and dysfunction of the vmPFC would result in failure to generate appropriate emotional aversions to the perception of harming others. Patients may only rely on cognitive processes that maximise welfare and eventually make an atypical moral decision.

## 2.4. Blunted Emotion

Feeling certain emotions is critical in making morally and socially acceptable choices. Several brain lesion evidence reveals that a higher rate of utilitarian judgments may be attributed to blunted emotions because of brain injury. Patients with blunted emotions do not feel bad about killing a person with their bare hands because the outcome saves more lives. This part of the review will point out empathy, guilt and shame as the three prominent moral emotions with their potentially implicated brain regions that contribute to curb actions that directly harm an individual.

### 2.4.1. Empathy

Apart from the inherent reaction to reject harm, the capacity to empathise with other people also contributes to determining what behaviours are appropriate or inappropriate. A negative correlation between empathy traits and utilitarian preference was evidenced by Choe and Min [12]. By investigating people with alexithymia, Patil and Silani underscored the significance of empathy in moral judgment [13]. Empathy entails the ability to understand the feelings of others at a cognitive level and the ability to experience or share others' affective states on an affective level. On the contrary, alexithymia refers the inability to identify and describe one's emotions. Patil and Silani found trait alexithymia to be negatively correlated with empathy but positively associated with the acceptability of utilitarian choice in personal moral dilemmas [13]. Crucially, empathy mediated the relationship between alexithymia and the utilitarian endorsement because alexithymic personalities reported less empathic concern for others and less distress at others' suffering.

TBI in the prefrontal cortex has been confirmed may lead to a loss or reduction of empathy, which massively disturbs one from experiencing the emotions of others [14]. Even minor brain injuries could potentially impair the capacity for empathy since the severity of head injuries did not alter levels of empathy. Furthermore, the lack of a relationship between empathy and cognitive abilities implied that empathy is purely an emotional product that functions independently of cognitive processes, which is consistent with the dual systems view of moral choice [9-10]. However, given the diffuse nature of head trauma, it was unclear whether the prefrontal region directly links to empathy ability. Leigh et al. exposed that the anterior insula and the temporal pole are the most typically disrupted sites in individuals with decreased empathy in their investigation because all patients who possess temporal pole lesions performed poorly on the affective empathy task [15]. Also, the fact that all subjects with temporal pole lesions had anterior insular lesions implied that either area may have a detrimental effect on empathy.

Moreover, other empathy-related regions comprise the right prefrontal and fronto-orbito cortex, the anterior cingulate cortex and the amygdala. The vmPFC itself and the area around it are likely be involved in empathy. As mentioned, this region is thought to integrate adverse emotional reactions to harmful ideas during moral reasoning [9-10].

### 2.4.2. Guilt and Shame

Hurting someone or violating moral obligations is often linked to guilt and shame. As they are associated with increased other-oriented empathy and emotional concerns for victims, the tendency to utilitarianism might elevate if one fails to feel these two moral emotions. Family members of vmPFC patients who were more willing to agree on utilitarian options than people with intact brains reported that patients had severely reduced feelings of guilt and embarrassment [8]. In turn, the lack of these two social emotions gives rise to violation of personal moral judgment. Michil et al. studied shame- or guilt-related brain regions by adopting the fMRI paradigm while participants read sentences that evoked feelings of shame or guilt [16]. It turned out that these two emotions share some neural networks within the temporal lobe.

Both shame and guilty have separate areas of activation. Specific activities representing shame and guilt were observed in the medial and inferior frontal gyrus, the amygdala and the insula, respectively. This evidence corresponds with the role of amygdala in generating negative emotional responses to aversive stimuli and that the medial part of the prefrontal cortex serves to transport these affective signals [9]. The reason why the amygdala is not activated in the shame condition remains unknown. A possible explanation could be concerning the intense and long-lasting nature of shame due to infractions. In general, the frontal and temporal areas are responsible to generate necessary sentiments toward violations of moral norms.

Previous studies contested the statement regarding the prominent role of shame and guilt in moral decision-making. Choe and Min stresses an absence of a relationship between guilt and the proportion of practical acceptance [12]. The feeling of shame was not predictive of utilitarianism either. Thus, the researchers suggested that both guilt and shame have little or no bearing on the decision-making process because they are emotions people would feel only after doing something wrong. In line with this, inducing guilt before the judge did not relate to utilitarian inclination or the inhibition of action [17]. To sum up, more evidence reveals that guilty and shameful emotions are not deterministic in forming utilitarian choices, and are probably not even applicable to thought experiments.

## 3. Discussion

Based on the inconsistent literature over the association between regions of TBI and utilitarian



preference for personal moral dilemmas, future work should aim to find a more specific lesion pattern within the frontal lobe. Apart from the vmPFC, the orbitofrontal cortex is worth exploring, as suggested by Martins et al. [4]. There were conflicting discoveries on the reflection of emotional assessment since either the amygdala or the anterior cingulate cortex was activated. Thus, future research also needs to determine the precise computations represented in the amygdala, anterior cingulate cortex and dorsomedial prefrontal cortex as to how they coded emotional or utilitarian appraisals separately. More empirical studies should be carried out to identify regions indicated for empathy and how this signal is transported to the vmPFC to help formulate positive decisions. These further directions will allow us to gain more insights into the exact neurobiological mechanism underpinning abnormal moral judgment.

The presented knowledge has the potential in explaining the abnormal or criminal behaviours following acquired brain injury and may throw light on boosting the legal justice system as well as targeted treatments for TBI patients to prevent them from misconduct. However, it is essential to note that trolley-type dilemmas are hypothetical moral judgments that are often different from real-world moral choices with self-interest [18]. It is likely that other factors have exerted effects on decision-making. For example, the study by Edwards et al. was conducted during the COVID-19 pandemic [6]. There was a likelihood that the stressful circumstances of the pandemic may have changed the mental states of healthy subjects, leading them to incline to utilitarian options. Existing literature claim that stress can influence decision-making to a great extent. Therefore, given the difference between accurate and imagined decisions, these findings should be generalised with caution.

#### 4. Conclusion

To conclude, the author sought to understand the association between TBI and moral choices with atypical utilitarian orientation. Not all TBI will cause impairment in moral decision-making, depending on the regions that were damaged. The most likely deterministic area is the vmPFC which serves to receive and integrate emotional aversions from the amygdala in response to harmful behaviours and then apply that information to further guide moral judgment. A dual-process theory of moral decision-making stands firm, in which there are two independent processes. One is the emotional process and the other is the cognitive process which refers to utilitarian or rational thinking. This supports the importance of affect in making positive and socially acceptable decisions. Moral emotions such as guilt and shame are viewed to be associated with hurting an individual directly. However, these two are considered post-action feelings rather than those experienced during moral reasoning. While guilt and shame have limited impacts, the capacity to empathise with others was suggested to be linked with the objection to utilitarian options.

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