Think About It: Cognitive Load and the Trolley Scenario as an Analogue of Gun Violence

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ABSTRACT. Moral dilemmas present an opportunity to examine the impact of distance on the acceptability of violent actions. The high-distance trolley and low-distance footbridge scenarios contrast low- and high-distance killing situations. Using these dilemmas, I tested the mitigating effect of distance on the acceptability of violence. Following a cognitive load task, decision-making centers in the brain switch from rational to emotional. Using the high-distance trolley and low-distance footbridge scenarios, I tested the impact of cognitive load and distance on the acceptability of the decision to kill 1 person, saving 5. When cognitive load increased, the acceptability of the decision to kill decreased in the trolley scenario, but not in the footbridge scenario, $F(1, 106) = 4.68, p = .033, \eta^2_p = 0.042$. Results suggested that, by depleting the rational brain with the cognitive task, the emotional brain made the decision not to kill. This research may be extended to gun violence because the presence of a gun typically places a shooter at a higher distance from a victim, which is analogous to the distance in the trolley scenario. Consequently, as in the trolley scenario, the acceptability of gun violence may be reduced as cognitive load is increased.

Multiple studies have assessed moral reasoning through the trolley and footbridge scenarios. These scenarios involve having to choose between saving five lives and saving one life. This problem is posed to the participant in two different contexts. In the high-distance trolley scenario (Foot, 1967), the participant imagines pulling a switch, which will result in saving the lives of five men, while leading to the death of one man who is standing on the tracks at some distance away from the participant. In the low-distance footbridge scenario (Thomson, 1985), the participant imagines sacrificing the life of a man by pushing him off a bridge to save the lives of five other men standing on the tracks below. Typically, participants are more willing to throw the switch in the trolley scenario and sacrifice one life to save five than they are to push the man off the bridge in the footbridge scenario to achieve the same utilitarian outcome of sacrificing one to save five.

Navarrete, McDonald, Mott, and Asher (2012) elaborated on the trolley scenario by adding a second condition. In the first condition, the participant had to pull the switch to achieve the utilitarian outcome of killing one to save five. In the second condition, the switch had already been pulled, and so the utilitarian result of killing one to save five would be achieved without participants’ involvement. Participants who had to pull the switch experienced significantly higher signs of distress than those who could have achieved the same utilitarian outcome by doing nothing.

Navarrete et al. (2012) also increased the ecological validity of their study by designing a virtual-reality trolley scenario. The trolley scenario is often given in a written transcript format. In this

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format, approximately 90% of participants report that they would pull the switch. However, it may be easier for individuals to say that they would pull the switch on a questionnaire when they are isolated from the reality of the situation than to actually pull it. In the virtual reality reenactment, participants had to physically pull the switch to reach the utilitarian outcome. Navarrete et al. (2012) found that approximately 89% of participants were willing to pull the switch.

Bleske-Rechek, Nelson, Baker, Remiker, and Brandt (2010) used two studies to analyze the impact of sex, age, romantic involvement, and genetic relatedness on the willingness to act in the trolley scenario. They found that the higher the relatedness of the victim, the less likely participants were to pull the switch to sacrifice them. They found the opposite for age: the younger the victim, the less likely the participant was to pull the switch. When the victim was a romantic partner, both men and women typically refused to pull the switch.

Gikara, Farnsworth, Harris, and Fiske (2010) supported these results in their investigation of the effects of the victim’s in-group or out-group status relative to the participant. Participants were more likely to sacrifice an out-group member than an in-group member. Shallow, Iliev, and Medin (2011) examined the effect of the number of deaths caused by the participant’s utilitarian action. They had four levels that each participant evaluated: push intervention, where the five could be saved by pushing a single person off a bridge; switch intervention, where the five could be saved by redirecting the trolley onto a different track, but two people die; switch intervention, where the five could be saved by redirecting the trolley onto a different track, but four people die; and omission, where doing nothing indirectly caused five people to die. Pushing was viewed as the most difficult decision even when pulling the switch caused four deaths. There was no significant difference between killing two with the switch and killing four.

This created what Cushman and Greene (2012) called the dual process model. Moral dilemmas create tension between two distinct processes: the rational choice of saving the many versus the emotional choice of not wanting to kill. No matter the choice, part of the brain will be dissatisfied. The above research has helped to demonstrate this. In Bleske-Rechek et al.’s (2010) study, the added variable of relatedness tipped the scale in the dual process model. It increased the emotionality of the decision, thus exhausting rationality. This allowed for the deontological result that, the more related the victims were to the participant, the less likely the participant was to be willing to pull the switch and sacrifice them. This is true for many moral dilemmas. Rational and emotional processes are at a stalemate until other factors (relatedness, number of victims, methodology, and especially distance from victims) tip the scales.

The dual process model can be thought of as similar to a camera (Greene, 2014). There is an automatic mode (emotional/affective) and a manual mode (rational/cognitive). The automatic mode requires little thought and exists as a fallback when the manual mode, which can be difficult in conflicting situations such as moral dilemmas, becomes exhausted. A neurological basis for this theory shows that activation in the ventral striatum and the ventral medial prefrontal cortex was associated with the automatic/affective processes, and the dorsolateral prefrontal cortex was associated with the manual/cognitive processes (McClure, Laibson, Loewenstein, & Cohen, 2004).

Scans using fMRI have shown increased brain activity in regions dealing with emotions for close proximity or more personal moral dilemmas such as the trolley scenario. These brain regions include the medial prefrontal cortex and the amygdala (Greene, Nystrom, Engell, Darley, & Cohen, 2004; Greene, Sommerville, Nystrom, Darley, & Cohen, 2001). Participants in the footbridge scenario who were more willing to perform the utilitarian action showed increases in brain regions associated with cognitive control including the dorsolateral prefrontal cortex and regions in the inferior parietal lobe (Bunge & Wallis, 2007; Miller & Cohen, 2001). This was supported by Bartels (2008) who found that individuals with a more rational and less intuitive thinking style were more likely to make utilitarian judgments and by Hardman (2008) who found that individuals who scored high on a cognitive reflection test were approximately twice as likely to approve the use of a human trolley stopper in the low-distance footbridge scenario. The cognitive reflection test asked participants questions such as, “A bat and a ball cost $1.10. The bat costs $1.00 more than the ball. How much does the ball cost?” It aimed to assess the impulsive versus reflected-upon response (Frederick, 2005). The impulsive response would be 10 cents, but with reflection, the correct response was realized to be 5 cents.

Because it was clear that cognition played a role in moral dilemmas, it was important to understand...
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between the affective and cognitive processes

when deciding on moral dilemmas (Greene et al., 2008). By applying Shiv and Fedorikhin’s (1999) interactive model of cognitive processes, a possible explanation can be formed. The footbridge scenario displays higher levels of affective processes because the conflict involved in the dual process model interferes with the cognitive processes. Affective and cognitive processes are at a standstill, but the lack of distance adds an emotional component, thus straining and overpowering the cognitive resources necessary to make a rational utilitarian decision. This allowed the decision to be affectively influenced. Thus, when no other factor is involved, the footbridge scenario will show affective deontological results. This is further supported by Koenigs et al. (2007) who found that patients with brain lesions in the ventromedial prefrontal cortex, which is connected to emotional decision making (McClure et al., 2004), made surprising utilitarian judgments in moral dilemmas such as the footbridge scenario that tend to display deontological results. This implied that neural structures play a key role in deontological decision making.

By adding the cognitive load factor as Greene et al. (2008) did, cognitive processes were distracted and/or depleted, but because the norm for the footbridge scenario starts with cognitive processes distracted and/or depleted (from the internal conflict posed by the dual process model), it would be difficult to see a significant difference in choices. However, a difference was apparent in the length of time it took participants to make the choice. Going back to Greene’s (2014) metaphor, the brain became too exhausted from fighting with the manual mode of the camera, and so it reverted back to the automatic mode. The few who still chose the utilitarian act were probably those described by Bartels (2008), who naturally had a stronger rational way of thinking.

These studies also brought up the interesting point of what is happening to the cognitive processes that allows for the affective to surface. Shiv and Fedorikhin (1999) and Greene et al. (2008) were unclear about whether cognitive load tasks deplete cognitive resources or distract them. Greene et al. (2008) implemented the cognitive task simultaneously with the measurement of the dependent variables, in essence distracting the participants. The similarity in the results of Shiv and Fedorikhin (1999) when the cognitive task was implemented before the measure of the dependent variable provided evidence that depletion, as well as distraction, of cognitive resources

the factors associated with the decision-making process. Shiv and Fedorikhin (1999) investigated affective and cognitive processes in decision making. They argued that the cognitive (rational) processes could be distracted, at which point decision making would revert back to affective (emotional) processes. This phenomenon was illustrated in their 1999 study where participants who repeated a seven-digit string of numbers (high cognitive load with low cognitive resources) chose chocolate cake over fruit salad; but participants who repeated a two-digit string of numbers (low cognitive load with high cognitive resources) chose fruit salad over chocolate cake. After they recited the memorized string of numbers to the researcher, participants made their decision as part of a “reward” for participating in the study. Shiv and Fedorikhin argued that participants under high cognitive load had fewer cognitive resources left to allocate to decision making, allowing the affective processes of the brain to make the unhealthy choice, whereas participants under low cognitive load made the healthy choice because they could allocate cognitive resources to the task at hand.

Shiv and Fedorikhin (1999) suggested an interactive organization of decision-making processes in the brain, in which cognitive decision-making processes usually predominate. However, when these processes are exhausted and/or distracted, people fall back on affective processes. When cognitive load is low, and therefore resources are high, the cognitive processes maintain control.

This reasoning may help explain the results of Greene, Morelli, Lowenberg, Nystrom, and Cohen (2008), in which cognitive load increased judgment time in high-stakes moral dilemmas, but had little effect on the type of decision made (utilitarian vs. deontological). Green et al. (2008) looked at high-stakes moral dilemmas (footbridge scenario), which were shown to be conflict-inducing in participants in previous research. Greene and colleagues argued that cognitive processes govern utilitarian judgments and affective processes govern nonutilitarian decisions. Thus, increasing cognitive load by requiring participants to acknowledge fives in a random sequence of numbers streaming across the top of the computer screen, in which the footbridge scenario is presented, increases judgment times. This is because the cognitive load task depleted cognitive resources that were necessary in determining the morally acceptable decision.

The dual process model talks of conflict between the affective and cognitive processes
occurred in both situations. If results were achieved solely with distraction, then cognitive resources would be restored (and a healthy choice would be made) once the cognitive task was completed (the number string recited). However, the apparent lag in the return of cognitive function (choosing the chocolate cake) implied that the resources were not immediately restored and were depleted instead. The combination of this depletion factor and the distance factor associated with the trolley and footbridge scenarios will extend our understanding.

Although much research has focused on the low-distance scenarios (footbridge), I focused on high-distance scenarios (trolley), to address the relative ease of distance killing. Grossman (1996) described this high-distance effect in his book, *On Killing: The Psychological Cost of Learning to Kill in War and Society*. He created a spectrum of weapons used in combat including their respective kill distances and provided evidence that the farther the killer is from their victim, the easier it is to kill. This could well be connected to events such as school shootings. Notably they are shootings and not stranglings or stabblings. This also has implications for military drones or bombers. How easy is it for someone sitting in a control center thousands of miles away from a war site to press one button that destroys an entire city within seconds? Grossman (1996) argued that, as distance increases, the resistance to kill decreases.

Weapons such as guns, drones, or bombs, similarly augment the distance from the victim as in the trolley scenario. The ease with which people pulled the switch or trigger can be unnerving. The goal of my research was to allow for a more thorough understanding of the cognitive and neurological processes involved in this high-distance decision making. By introducing a cognitive load task to the trolley scenario, I expected cognitive processes to be depleted. This would force participants to rely on affective processes, which were connected with lower acceptability of the utilitarian action of pulling the switch. Thus, this would lower the acceptability of killing from a distance.

In the present study, I hypothesized that there would be a main effect for distance. Participants in the trolley scenario condition would report higher acceptability of sacrificing one life to save five than those in the footbridge scenario condition.

In addition, I believed that there would be an interaction effect between distance and cognitive load. Participants in the trolley scenario condition with a higher cognitive load were expected to rate acceptability significantly lower than participants in the trolley scenario condition with a lower cognitive load. However, a significant difference between the high and low cognitive load conditions was not expected in the footbridge scenario condition.

**Method**

**Participants**

Participants were a convenience sample of 71 women, 33 men, and 6 unspecified (they chose not to disclose their sex; *N* = 110). Most were psychology students at a small rural liberal arts college in the Northeast. Participants received course credit for participation. Participants ranged from 18 to 42 years of age, with a median of 18. The mean GPA for participants was 3.2 (*SD* = 0.36). Most participants were Christian (51.4%) followed by nondenominational (44.1%), Jewish (2.8%), and Buddhist (1.8%). Data were not collected regarding ethnicity.

**Measures**

Modified versions of the trolley scenario (Foot, 1967) and footbridge scenario (Thomson, 1985) were used to assess the acceptability of aggressive acts. The high-distance trolley scenario involves pulling a switch to cause the utilitarian end and the low-distance footbridge scenario involves pushing a man to cause the utilitarian end. The participants read a scenario in third person featuring the actor named Sam. In each scenario, Sam killed the one to save the five, be that by pulling the switch or pushing the man. Third person was used, as opposed to first person, in an attempt to model previous studies (Schwitzgebel & Cushman, 2012). Participants rated the acceptability of the action taken in their scenario on a 6-point Likert-type scale ranging from 1 (extremely unacceptable) to 6 (extremely acceptable) to avoid neutral answers.

The computer program Dual N-Back (2011) was used to manipulate cognitive load on visual working memory. The Dual N-Back game field is a box separated into smaller squares by lines creating a 3 x 3 grid. During the game, an image is shown in one of the nine game squares. The participant must find a match between the current position of the image to the position shown one, two, or any number of steps earlier. If there is a match, the participant must press the corresponding match key (the letter A) on the keyboard. The more past steps the participant must remember, the higher the cognitive load. For purposes of this study, only Level 1, one step back (low cognitive load), and...
Level 2, two steps back (higher cognitive load), were used. The Dual N-Back is scored by percentage of correct responses (no response and a false positive are treated the same). The possible results range from 0% (none correct) to 50% (all correct). The scores do not range to 100% because the game has a built-in auditory working memory task that was ignored (the volume was turned off), accounting for the other 50%. The Dual N-Back has been shown to reduce the resources available for conscious and/or cognitive decision making, forcing decision making to rely on information provided by the unconscious and/or affective areas of the brain (Creswell, Bursley, & Satpute, 2013).

Procedure
After institutional review board approval (CSCIRB14: 05) was granted, participants were randomly assigned their cognitive load condition and distance (trolley or footbridge scenario) condition. They were taken into a computer lab where they completed the corresponding level of the Dual N-Back two separate times; totaling 42 to 48 trials (The game at Level 1 has 21 trials, Level 2 has 24 trials, thus 42–48 total). This would allow participants to become acquainted with the game. However, the two scores were averaged together so that any practice effect would be minimized. To reduce the interval between the cognitive task (Dual N-Back) and the acceptability test (trolley or footbridge scenario), participants were asked to record their own scores on the Dual N-Back. The researcher monitored as the scores were recorded. Immediately after the Dual N-Back, participants completed the third-person trolley or footbridge scenario.

Results
A 2 (distance) x 2 (cognitive load) Analysis of Variance (ANOVA) was conducted to test the main effects and the interaction effect of distance and cognitive load on acceptability. The main effect for distance was significant, $F(1, 106) = 32.53$, $p < .001$, $\eta^2_p = 0.24$, supporting the first hypothesis in that participants in the high-distance condition ($M = 4.00, SD = 1.17$) scored acceptability higher than participants in the low-distance condition ($M = 2.61, SD = 1.43$). The interaction effect between distance and cognitive load was also significant $F(1, 106) = 4.68$, $p = .033$, $\eta^2_p = 0.042$ (see Figure 1). This supported the second hypothesis that participants in the high-distance condition with high cognitive load ($M = 3.63, SD = 1.09$) would score acceptability lower than participants in the low cognitive load, high-distance condition ($M = 4.48, SD = 1.12$). Additionally, participants in the in the low-distance condition with high cognitive load ($M = 2.75, SD = 1.54$) scored acceptability higher than participants in the low cognitive load, low-distance condition ($M = 2.52, SD = 1.37$).

A binary logistic regression was used to further examine the predictive power of distance, cognitive load, and the interaction of distance and cognitive load on the binary split of the acceptability variable (1–3 = low acceptability, 4–6 = high acceptability). There was a significant difference in the probability to find the moral dilemma acceptable as distance, cognitive load, and the interaction between distance and cognitive load changed, $G(3) = 22.43$, $p < .001$. Distance was found to be the most significant in predicting acceptability ($\beta = 2.54$, $p < .001$). The interaction between distance and cognitive load ($\beta = -1.38, p = .11$), and cognitive load ($\beta = 0.61, p = .33$), were not significant, but showed similar trends to the ANOVA.

Discussion
The present study had two main foci: (a) to replicate the results previously shown by Greene et al. (2008) and (b) to extend these results by analogy to gun violence. As previously mentioned, Greene et al. (2008) focused mainly on scenarios that I have chosen to call low-distance scenarios. These are scenarios such as the footbridge scenario that tend to evoke strong emotions in participants, increasing decision-making difficulty. When cognitive load was introduced in Greene et al.’s (2008) study (simultaneous digit search task) and the present study (Dual N-Back task), little difference was seen in change of the acceptability of killing because few were willing to push the man off the bridge.

This can be explained through Shiv and Fedorikhin’s (1999) analysis of decision making. When resources are high (no cognitive depletion), people tend to make rational utilitarian decisions of choosing the many over the few, but when resources are low, people tend to make the automatic emotional deontological decision by allowing people to die without taking action. In these low-distance scenarios, decision-making difficulties stem from conflict between the automatic emotional and reflective cognitive, decision-making brain centers. This conflict depletes the cognitive brain’s resources as described by Cushman and Greene’s (2012) dual process model. When a
cognitive task is introduced (e.g., Dual N-Back), this merely depletes cognitive resources further. Thus, there was little change in the acceptability of killing the man on the bridge because decision-making processes were already being controlled by the automatic emotional processes of the brain. The key difference that cognitive load makes is in the high-distance trolley scenario. In the trolley scenario, cognitive resources are still relatively high because the greater distance between the killer and the victim reduces the emotionality involved. Consequently, there was a greater range of cognitive process depletion available in the trolley scenario, and this was the source of the interaction effect in my results.

Although many authors have focused on low-distance scenarios, I felt that more attention should be paid to high-distance scenarios due to their realistic similarities to real life situations in which people demonstrate an apparently callous disregard for human life. By agreeing with the utilitarian result created in these scenarios, participants are performing an action that involves taking another’s life. The ease with which participants pull a switch to take a life in the trolley scenario is disturbing to say the least. It is as disturbing as the apparent ease with which some people pull a trigger to take a life.

Extending this research by analogy to gun violence is important because it is not ethical to experiment on gun violence. Consequently it is vital to identify laboratory research paradigms that simulate factors associated with such violence. Analogues are difficult to identify, but the trolley scenario seems to have promise for representing an important dimension of the gun violence problem: distance between victim and killer. I wanted to investigate the power of the trolley scenario to elucidate this aspect of the gun violence problem.

Uniform Crime Report data from the Federal Bureau of Investigation provided another view of the relationship between distance and violence. These data showed how killing methodologies, which directly affect distance between victim and killer, are related to crime rates. The number of homicides committed each year is drastically higher with a gun than any other weapon. In 2011 alone, there were 8,583 homicides committed with a firearm, compared to 1,694 with a knife, or 728 with personal weapons such as hands or fists (“Murder Victims by Weapon, 2007–2011,” 2012). This, along with data collected from moral dilemmas such as the trolley scenario, has supported the theory that distance facilitates violent actions. The trolley scenario is not a perfect methodological match to situations involving gun violence, but it does provide a potentially useful analogue to important dimensions of this troubling social problem.

One other methodological concern has come to my attention. As mentioned earlier, participants completed a manipulation check for the effectiveness of the cognitive load variable by self-reporting their Dual N-Back scores. Self-reports can be influenced by social-desirability bias. I did not believe this would substantially influence my results for two reasons. First, participants were unaware of what their scores meant. The game frame that they were on did not explain the meaning of the reported numbers; it simply displayed them on the screen after the task was completed. Second, participants in the high-cognitive load condition reported very low Dual N-Back scores; they did not appear to be trying to make themselves look good. Consequently, I did not feel that self-reporting of Dual N-Back scores gave a false impression of the effectiveness of my cognitive load manipulation in this study.

There are several considerations I am making for future studies. To operationalize cognitive load, I chose a visual working memory task. This was due to past research that supported this model (Creswell et al., 2013; Greene et al., 2008). I now think it would be interesting to see how other working memory tasks may affect moral dilemmas. The Dual N-Back has the option of an auditory task as well as the visual one. Perhaps, by combining the two, a different level of cognitive load could be achieved. Also, by randomly assigning participants to different types of working memory tasks (visual,
auditory, combination, etc.) personal bias to one form or the other may be minimized. Some participants may be more adept at visual tasks, and thus would not feel the same cognitive load depletion effect as others who are less skilled in that area. Although I focused mainly on decreasing utilitarian results in the present study, I think that there would be great utility in analyzing methods to overcome the affective influence in high-stakes moral dilemmas in order to increase utilitarian results. Glucose has been seen to reactivate the dorsolateral prefrontal cortex, increasing performance in bikers (Chambers, Bridge, & Jones, 2009). The dorsolateral prefrontal cortex is also one of the regions in the brain associated with utilitarian judgment (Bunge & Wallis, 2007; Miller & Cohen, 2001). By introducing a glucose variable into the model, it may be possible to increase utilitarian decisions in high-stakes dilemmas, further increasing our understanding of decision making within moral dilemmas.

My intention was to develop an analogue for investigating some of the factors associated with gun violence by demonstrating how the trolley scenario models the distance dimension of gun violence. In addition, I have demonstrated how understanding the factors influencing the utilitarian decision to kill are similar for the participant who throws the switch to save five individuals by killing one, and the individual with a gun who is distant enough from their target to make an intentional and rational decision to kill. I believe that the trolley scenario contains additional possibilities for explicating relationships associated with gun violence such as the need of police officers and soldiers to kill in the line of duty, and I expect to investigate these with future research.

References

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