JoVE: Science Education

Using fMRI to Dissect Moral Judgment

--Manuscript Draft--

Manuscript Number:	10306
Full Title:	Using fMRI to Dissect Moral Judgment
Article Type:	Manuscript
Section/Category:	Manuscript Submission
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Psychology Education Title: Using fMRI to Dissect Moral Judgment

Overview

In examining the roles of reason and emotion in moral judgments, psychologists and philosophers alike point to the "trolley dilemma" and the "footbridge dilemma." With the trolley dilemma, most people say that it's appropriate to *pull a switch* to stop a train from hitting five people by diverting it to kill 1 person. However, with the footbridge dilemma, most people say it is inappropriate to *push a large man* off of a bridge in order to hit a train (killing him) and stop it from running into five people. Reason would dictate that in both of the foregoing dilemmas, one life should be sacrificed to save five lives. ~~However~~But ~~,~~ to many people, pushing the large man just "feels wrong" because it triggers more negative emotions than pulling a switch. I~~, *i.e.*,~~ in this case, emotion seems to trump reason.

In recent years, psychology and neuroscience ha~~s~~ves entered the debate over the roles of reason and emotion in moral judgment. ~~-~~Researchers can scan brain activity ~~of~~ as individuals make making moral judgments. ~~using functional magnetic resonance imaging (fMRI). This technology allows researchers to study the areas of the brain at work during moral dilemma tasks. And indeed,~~R~~r~~esearch shows that different brain areas associated are ~~with emotion are more~~ active during contemplation of the footbridge dilemma versus the trolley dilemma.

Inspired by Greene, Sommerville, Nystrom, Darley and Cohen (2001), this video demonstrates how to design moral dilemma tasks and integrate them into experiments using using functional magnetic resonance imaging (fMRI) ~~fMRI~~ technology.

Principles

To assess brain activity during task performance, an ~~threshold omnibus~~ analysis of variance (ANOVA) is performed on the functional images created by the fMRI. ~~-~~The authors reported several~~Recent~~ functioning imaging~~e~~ studies ~~associate~~ linking the following brain areas with emotion: medial frontal gyrus; posterior cingulate gyrus; and angular gyrus~~, bilateral~~. Conversely, the following brain areas ~~are~~ were linked to ~~stimulated during~~ cognitive, non-emotional processing: middle frontal gyrus~~, right ;~~ and parietal lobe, ~~bilateral.~~ ~~-~~Using this information, brain images derived during the experimental procedure can be analyzed to evaluate the participant's relative use of reason versus emotion in the psychological processes involved with conditions of moral judgment.

Procedure

1. ~~Recruit 10 participants.~~Conduct a power analysis and recruit a sufficient number of participants.

Commented [JS1]: This is not well-defined in the procedure itself. As written, the analysis is very vague and should include critical details related to brain image acquisition and post-processing.

JVB: I can add more details (e.g., cutting from the article). But I honestly don't think any self-respecting fMRI research would want to use these details if they try to replicate the study - most of the specific steps are now outdated (including the software package they used to analyze the data). I think it's much better to outline the key details that should remain the same in a replication and focus on those rather than the details that should probably be changed.

Commented [JS2]: Why is the OFC left out?

JVB: Because they found activity in the medial frontal gyrus. https://static.squarespace.com/static/54763f79e4b0c4e55ffb000c/t/5477ccc3e4b01fb132f9bcc3/1417137347517/an-fmri-investigation-of-emotional-engagement-in-moral-judgment.pdf

Commented [JS3]: The importance of hemisphere is not clear. You bring up bilateral and right in some of the areas, but not all. Please clarify with additional statements or references for why some regions appear to be merged. The analyses steps make no mention examining left and right vs. bilateral.

JVB: The authors report laterality with certain findings, but I don't think their are strong theoretical reasons for expecting laterality so I'd rather avoid talking about laterality in terms of a replication.

2. Create 30 moral dilemmas divided equally into categories of (1) personal moral dilemmas, (2) impersonal moral dilemmas, and (3) non-moral dilemmas.

   2.1. A *personal moral dilemma* involves the participant imagining to perform an action that directly harms one person ~~toward~~ in the service of some goal.

      2.1.1. Examples include the footbridge dilemma, harvesting the organs of a person to save several other people, and throwing someone off a lifeboat to save others on the boat.

   2.2. An *impersonal moral dilemma* involves the participant imagining to perform an action that indirectly harms one person ~~toward~~ n the service of some goal.

      2.2.1. Examples include the trolley dilemma, cheating on taxes, and stealing a boat in order to save people from a storm.

   2.3. A *non-moral dilemma* involves the participant imagining to perform an action that is not typically viewed in moral terms at all.

      2.3.1. Examples include deciding to buy a name-brand versus an off-brand medicine and whether to travel by plane or train given certain time constraints.

3. Present every~~Each of the 10~~ participant~~s is presented~~ with each of the 30 dilemmas while undergoing brain scanning using fMRI.

4. The intertrial interval (ITI) lasts for a minimum of 14 s (seven images) in each trial. Baseline activity is defined as the mean signal across the last four images of the ITI. Task-related activity is measured using a "floating window" of eight images surrounding (four before, one during, and three after) the point of response. (This window includes three post-response images in order to allow for the 4- to 6-s delay in hemodynamic response to neural activation).

5. Functional images can be acquired in 22 axial slices parallel to the AC-PC line (echoplanar pulse sequence; TR, 2000 ms; TE, 25 ms; flip angle, 90°; FOV, 192 mm; 3.0-mm isotropic voxels; 1-mm interslice spacing) using a 3.0-T Siemens Allegra head-dedicated scanner.

Stimuli (dilemmas) will be presented on a visual display projected into the scanner. Each dilemma is presented as text through a series of three screens, the first two describing a scenario and the last posing a question about the appropriateness of an action one might perform in that scenario (e.g., turning the trolley).

~~3. Instruct participants to respond to each dilemma by indicating that the action proposed is "appropriate" or "inappropriate."~~

Commented [J4]: Most of the dilemmas can be found here: https://static.squarespace.com/static/54763f79e4b0c4e55ffb000c/t/5477ce88e4b0780d55b9aac7/1417137800861/cognitive-load-selectively-interferes-with-utilitarian-moral-judgment-supplementary-materials.pdf

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Commented [JS5]: Several details for the experimental design are missing. Are the dilemmas presented randomly, in a block design? ITI?

JVB: How much detail do you want? fMRI is obviously very complete. Here is a description of the methods. Stimuli (dilemmas) were presented on a visual display projected into the scanner. Each dilemma was presented as text through a series of three screens, the first two describing a scenario and the last posing a question about the appropriateness of an action one might perform in that scenario (e.g., turning the trolley). Participants were allowed to read at their own pace, pressing a button to advance from the first to the second screen and from the second to the third screen. After reading the third screen participants responded by pressing one of two buttons ("appropriate" or "inappropriate"). Participants were given a maximum of 46 s to read all three screens and respond. The intertrial interval (ITI) lasted for a minimum of 14 s (seven images) in each trial, allowing the hemodynamic response to return to baseline after each trial. Baseline activity was defined as the mean signal across the last four images of the ITI. Task-related activity was measured using a "floating window" of eight images surrounding (four before, one during, and three after) the point of response. (This window includes three post-response images in order to allow for the 4- to 6-s delay in hemodynamic response to neural activation.) This "floating window" technique combined the benefits of an eventrelated design with the flexibility required to image a complex and temporally extended psychological process that inevitably proceeds at its own pace. In Experiment 1, functional ...

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Commented [JS6]: This is out of order and should be connected to Step 6. ...

4.6. Present the dilemmas over two screens on a laptop computer – the first half of the dilemma is read and then when Tthe participant clicks next the second half of the dilemma is read.

7. Participants then click next again to see a question that asks ifs the action in the dilemma was appropriate or not.

5. Give participants 46 seconds maximum to get through all three screens.

8.

6. Dependent measure: Measure participants' moral judgments by their rating of whether or not the action described in the dilemma was appropriate or inappropriate (binary choice).

9.

10. Analyze fMRI scans for each participant during each task. Before statistical analysis, images for all participants should be coregistered using a 12-parameter automatic algorithm and smoothed with an 8-mm full width at half maximum 3D Gaussian filter.

11. Analyze fMRI scans for each participant during each task. The images contained in each response window should be analyzed with the use of a voxelwise mixed-effects ANOVA with participant as a random effect, and dilemma-type, block, and response-relative image as fixed effects. Statistical maps of voxelwise F-ratios should be thresholded for statistical significance (P = 0.0005) and cluster size (8 contiguous voxels). The planned comparisons for significant differences between conditions should be thresholded for statistical significance (P = 0.05, and cluster size (8 voxels).

7.12. Measure the percentage change, relative to the baseline, in brain activity for each of the crucial brain areas at play.

Representative Result

The brain data supports the idea that emotion is more involved in personal moral dilemmas than impersonal dilemmas and non-moral dilemmas (**Figure 1**). Brain areas associated previously linked with emotion (*e.g.*, the medial frontal gyrus) were significantly more active when participants made judgments about personal dilemmas (*e.g.*, the footbridge dilemma) than when they made judgments about impersonal dilemmas (*e.g.*, the trolley dilemma). For impersonal dilemmas, brain areas associated previously linked with reasoning were significantly more active than when making personal dilemmas. Taken together, these data suggestThe authors concluded that moral judgments about personal dilemmas rely heavily on emotional processes, while moral judgments about impersonal dilemmas rely more heavily on reasoning processes.

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Commented [JS7]: This is rather simplistic. Include specific details about registration, smoothing, voxel sizes for regional comparisons.

JVB: Added. Is this better now?

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Commented [JS8]: This is rather simplistic. Include specific details about registration, smoothing, voxel sizes for regional comparisons.

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Commented [JS9]: There's a typo for Parietal lobe. (L) is ...

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Summary

In the debate over the effects of reason versus emotion in moral judgment, this experiment provides evidence of powerful psychological processes involved: ~~-~~moral judgments about personal dilemmas rely heavily on emotional processes, while moral judgments about impersonal dilemmas rely more heavily on reasoning processes. Indeed, judgments concerning impersonal dilemmas are more like judgments concerning non-moral dilemmas than personal dilemmas. Techniques involved in this experiment are basic, and the results derived should be used as a ~~jumping off point~~basis for more sophisticated research. ~~In their experiments, Greene *et. al.* delve deeper into the psychology of judgments be measuring the reaction time taken by participants to decide whether action is appropriate or inappropriate.~~

Applications

These results shed light on an ancient debate about our sense of morality. ~~--~~Do people rely more on emotion or reasoning? This research suggests that the answer is both: emotion drives our moral judgments especially during personal dilemmas, whereas impersonal situations typically involve more reasoning. This finding has at least three major implications. First, given that political divides are often driven by differences in moral views (*e.g.*, American conservatives who view same-sex marriage as wrong versus liberals who view it as permissible), this research highlights that these differences are often driven by emotions that may not be responsive to reasoned argumentation presented by the other political party~~. In order to achieve less polarization and subsequently less turmoil in bipartisan governments, it may be that politicians need to specifically focus on nudging people's deeply held feelings~~ (Weston, 2008).

Second, these results provide an interesting explanation for the immoral behavior of certain abnormal populations such as psychopaths, who appear to be perfectly intelligent yet perform immoral acts such as murder. The results of this study suggests that these abnormal populations may have their reasoning intact, but may have no emotional response telling their brain that what they are doing is "wrong" when they are committing personal immoral actions (Bartels & Pizarro, 2011). If this is true, these populations may require therapy that focuses on training them to be more in touch with their feelings or fostering specific emotions toward certain immoral actions.

~~Lastly, these results provide a framework for the developmental origins of our sense of morality. Historically, psychologists assumed that children learn morality through specific stages in which their reasoning ability developed in sequence. However, the results of this study suggest that our sense of morality is in large part learned through the development of our emotion which may develop much earlier than our ability to reason. This idea can change the strategy that parents and educators utilize to inculcate the accepted moral views of a culture.~~

Legend

Figure 1. Differences in brain activity in response to making judgments about personal, impersonal, or non-moral dilemmas. The left pane shows brain areas associated with emotion. Personal moral dilemmas evoked significantly greater activation in emotion areas of the brain

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Commented [JS10]: It's strange to tell us this and then leave us hanging. While it would be nice to know what they found regarding reaction times, the statement is tangential to this summary and should be deleted.

JVB: Deleted.

Commented [JS11]: The applications would be more compelling with references to actual studies, where possible. For instance, brain scans of psychopaths have been examined. Is there evidence of decreased activation in some of the same regions that respond with an increase?

JVB: I've added some references. But I'm not sure I understand your question. Are you asking if psychos have completed the moral dilemmas task in the scanner and found the opposite results?

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Commented [JS12]: This is not the clearest example of how to apply this scientific technique to another situation. A more obvious question would be about the neurological correlates of political beliefs. Can we manipulate emotional drive and tip more towards reason? The last sentence of the paragraph does not make sense to me.

JVB: I added a citation and deleted the last sentence to stick closer to the data. The book by Weston delves into these issues in greater depth that I can explain here.

Commented [J13]: https://www.amazon.com/Political-Brain-Emotion-Deciding-Nation/dp/1586485733

Commented [J14]: http://www.ncbi.nlm.nih.gov/pubmed/21757191

Commented [JS15]: While I like the developmental approach, it's not made clear enough how these results suggest the statements made. Please expand so that there's not such a huge jump that's unjustified.

JVB: I agree. I deleted it.

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Commented [JS16]: The legend should mention that it's % change from baseline.

compared to the other dilemma types. The right pane shows brain areas associated with reasoning processes. Impersonal and non-moral dilemmas evoked greater activation of these reasoning areas of the brain than did personal dilemmas. The Y-axis shows percentage change in MRI signal relative to baseline.

References

Bartels, D. M., & Pizarro, D. A. (2011). The mismeasure of morals: Antisocial personality traits predict utilitarian responses to moral dilemmas. *Cognition*, *121*, 154-161.

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.

Weston, D. (2007). The political brain: The role of emotion in deciding the fate of nations. Perseus Books.

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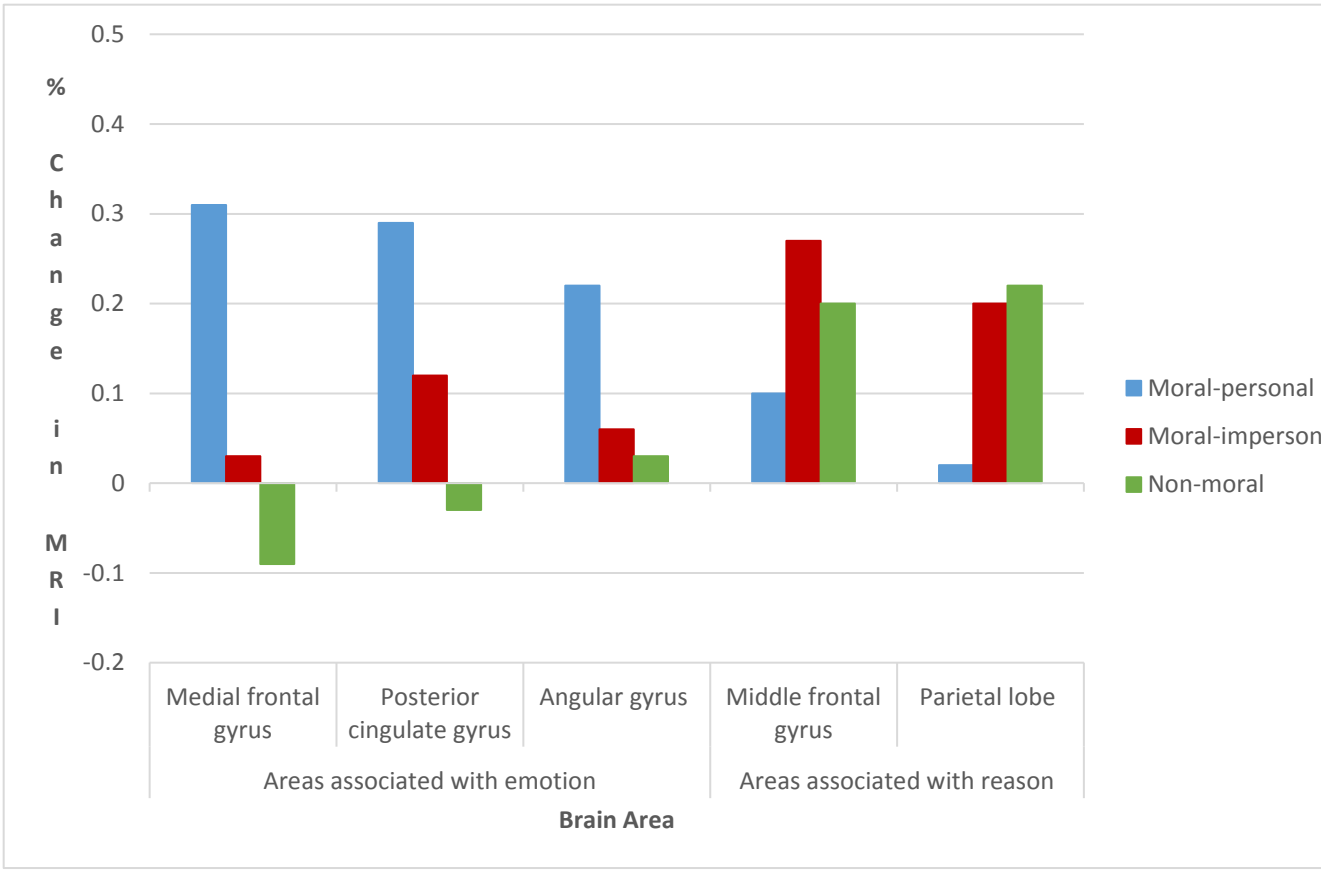
		Moral-personal	Moral-impersonal	Non-moral
Areas associated v	Medial frontal gyrus	0.31	0.03	-0.09
	Posterior cingulate gyrus	0.29	0.12	-0.03
	Angular gyrus	0.22	0.06	0.03
Areas associated v	Middle frontal gyrus	0.1	0.27	0.2
	Parietal lobe	0.02	0.2	0.22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% Change in MRI
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Posterior cingulate gyrus
Angular gyrus
Middle frontal gyrus
Parietal lobe
Areas associated with emotion
Areas associated with reason
Brain Area
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Moral-imperson
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