# EMOTIONS AND DECISION MAKING:

# THE EFFECTS OF PSYCHOSOCIAL STRESS ON MORAL JUDGEMENT AND EXECUTIVE FUNCTIONING

By

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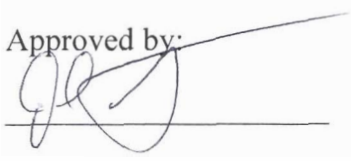

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## Abstract

Recent research suggesting the involvement of the activation of different cognitive and emotion driven areas of the brain when faced with a moral dilemma have led to the development of a Dual Systems Model in which these brain processes compete. The current study examined the effects of stress on these moral decisions. Thirty-nine participants were randomly assigned to either a control ($N$ = 19) or experimental ($N$ = 20) condition, the latter of which underwent a psychosocial stress induction using the Trier Social Stress Test procedure. Participant responses to a morality questionnaire were gathered both before and after this stress procedure, and compared by condition based on response type and response time. Changes in performance on a stroop task were also measured between conditions in order to provide insight on executive functioning abilities pre and post stressor. Results showed that stress may be related to increased response time on utilitarian decisions, and a decrease in the number of deontological responses, but overall these effects between groups were not significant. As a whole, the results do not indicate a significant effect of stress on changes in moral decision making or executive functioning.

**Effects of Psychosocial Stress on Moral Judgment and Executive Functioning**

At its core, morality represents the effort to guide one's conduct by conscientious reasoning (J. Rachels & S. Rachels, 2012). When determining a course of action in response to a moral dilemma, the lack of a universal distinction between "right" and "wrong" only adds to the complexity of this decisional process. In attempts to better understand the moral nature of a given choice, the philosophical viewpoints of deontology and utilitarianism are often employed to characterize its consequences (Broeders, Bos, Müller, & Ham, 2009). According to deontology, some actions (such as stealing) are never morally justified, regardless of the overall "good" of their consequences. Conversely, utilitarianism judges the ethical nature of an action based *solely* on the outcome of its consequences. An action is deemed "morally just" if it produces the greatest amount of overall utility in a given situation, leading to the classic consideration of utilitarianism as the more logic driven of the two viewpoints (Alexander & Moore, 2008). Although unable to speak towards the "rightness" or "wrongness" of a determination, recently a number of studies have been conducted with a focus on observing the physiological and psychological manifestations of moral processing. In particular, fMRI research has emerged as a popular tool in helping to uncover the neural correlates of moral decision making (Moll and Oliveira-Souza, 2007).

Through such research, it has been found that there is a strong relationship between the pre-frontal cortex (PFC) and moral decision making (Moll, Zahn, Oliveira-Souza, Krueger, & Grafman, 2005). Due to associations between the PFC and such regulations as emotion, attention, and planning, much focus has been placed on this area on determining the nature of the relationship between emotions and moral decision making (Casebeer, 2003; Greene, Sommerville, Nystrom, Darley, & Cohen, 2001). In one study, it was found that patients with

ventromedial prefrontal cortex damage (particularly associated with impaired social emotion) gave a utilitarian answer in response to personal moral scenarios significantly more often than a comparison group (Koenigs, Young, Adolphs, Tranel, Cushman, Hauser, & Damasio, 2007). Other studies employing brain scanning technology consistently have found evidence that brain regions associated with emotional and social cognition (such as the prefrontal cortex and posterior cingulate) are most active when participants are faced with a personal moral scenario, and regions relating to cognitive control and problem solving are more active when participants are dealt an impersonal moral scenario (Greene, Nystrom, Engell, Darley, & Cohen, 2004).

These findings have led to the development of the dual system model theory in which cognitive and emotional processes of the brain compete when facing a moral decision (Moll & Oliveira-Souza, 2007). For example, this theory has been used to describe participant reactions to classic "trolley" scenarios (Greene, 2007). In such a scenario, it is supposed that someone is walking along a train track when they witness a runaway trolley barreling towards a group of five helpless workers stuck on the track. Looking around, they notice that there is a switch that can be pulled to divert the trolley onto a different set of tracks where a single railway worker is caught. Is it okay to hit the switch so that the single worker will be struck and killed instead of the group of five? What if instead they are standing next to a large bystander and the only way to save the five trapped workers is push him in front of the trolley, killing him but saving the others? (Thomson, 1986). In general, most individuals confronted by these dilemmas agree that they would be unwilling to concede to pushing someone in front of the trolley to save those stuck on the track. The consequence of not committing this action results in a greater number of lives lost, characterizing such a response as less logical and less utilitarian. It is theorized that this aversion to the suggestion of personally pushing a man to his death (regardless of the "positive"

consequences) is influenced by the negative emotions associated with this personal act, accounting for the emotional component of the dual systems model (Greene, 2007). Additionally, increased brain activity in areas associated with cognitive control has been observed in participants when rejecting the notion of pushing the bystander onto the trolley tracks. Despite these increased activations, people typically provide an emotional response (Greene et al., 2004). As a result, it has further been suggested that the more emotional or personal a faced moral dilemma is, the greater the influence of emotion on the final decision (Young & Koenigs, 2007).

Based on these findings, the present investigation seeks to test the effects of stress on reactions to moral based scenarios. In general, the physiological effects of stress have been well documented. Additionally, more research has been conducted in recent years on the effects of stress on neural correlates (Starke & Brand 2012). Stress-induced releases of cortisol react with the central nervous system in such a way that it activates the prefrontal cortex, as well as the limbic system. These activations have been found to initiate the emotional responses that are associated with stressful situations (Youssef et al., 2012). One study found psychosocial stress in particular to be significantly associated with prefrontal cortex activation and inhibition (Kern et al., 2008).

In addition to the current investigation, two recently published studies also sought to determine whether induced psychosocial stress affected response to a morality based task (Starcke, Polzer, Wolf, & Brand, 2011; Youssef et al., 2012). While Starcke et al. did not find stress to significantly predict egoistic decision making between condition groups (Starcke et al., 2011), a similar study conducted by Youssef et al. (2012) observed that stress significantly predicted a lower rate of utilitarian responses on a morality questionnaire compared to a control

group. It was also found that females were less likely than males to react to morality scenarios with a utilitarian response. The present study seeks to clarify the findings of these studies by instead investigating the effects of stress on *change* in moral thinking, as well as whether or not the inclusion of an executive functioning task provides further insight on the cognitive ramifications of stress.

In accordance with the theory of the dual systems model, it is hypothesized that:

Hypothesis 1: Psychosocial stress significantly affects deontological and utilitarian responses. Those subjected to the TSST will more often respond to a moral scenario in a deontological fashion.

Hypothesis 2: Among those subjected to the TSST, a utilitarian response will take longer than a deontological response.

Hypothesis 3: Psychosocial stress significantly affects executive functioning (EF) as measured by a stroop task. Accuracy is more likely to deteriorate on a stroop if subjected to the TSST.

Hypothesis 4: Accuracy is more likely to deteriorate on a stroop if subjected to the TSST.

## Method

### *1. Participants*

All participants in this study were undergraduate students in the University of Arizona's INDV 101 psychology class, and recruited through the department's online experiment management system. A total of thirty-nine volunteers (10 male and 29 female) with a mean age of 19.3 (SD=1.58) participated in this Human Subjects Protection Program approved study.

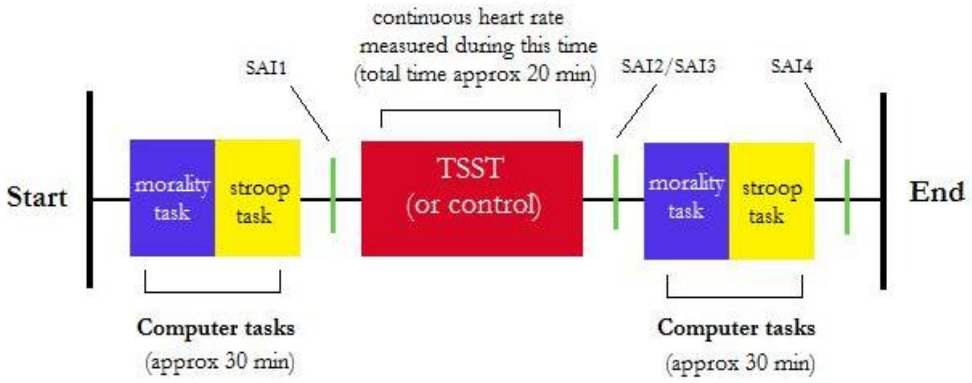
Upon arrival, participants were randomly assigned to either the experimental (n=20, female=12) or control (n=19, female=17) condition. All volunteers received course credit for participating.

*2. Study Design and Measurements*

*2. a. Experimental procedure*

After reporting to the lab, each participant was required to fill out an informed consent form, in addition to a Behavioral Anxiety Index (BAI) to account for pre-existing levels of anxiety, and a basic demographics survey. Figure 1 depicts the remaining tasks, and the order in which all participants completed them.

Figure 1. experimental procedure




*2 .b. Morality Tasks*

The moral decision making tasks consisted of two (list A and list B) questionnaires designed using Psychology Experiment Building Language (PEBL) software, which is an open source program used to design and run psychological experiments. These questionnaires each contained 16 hypothetical dilemmas. List A and list B each contained a random selection of four neutral scenarios, four impersonal scenarios, four personal-low conflict scenarios, and four

personal-high conflict scenarios, adapted from a previously published set of 50 (Koenigs et al., 2007). These moral scenarios were presented in a computer format with each screen outlining a dilemma and asking for a response of "Yes" (1) or "No" (0) before providing the next scenario. Participants indicated their response using the left and right control buttons, and their reaction from initial presentation of scenario to time of response was recorded in milliseconds. "Yes" and "No" responses were also categorized as either more characteristically deontological or utilitarian, based on the specific scenario. Each list was encountered only once, either pre or post stressor (see figure 1), and for balancing purposes participants randomly completed these tasks in either an AB (n= 18) or BA (n=21) order.

*2. b. 1. Neutral Scenarios*

Neutral scenarios are considered non-moral and non-emotional. An example is listed below.

You have decided to make a batch of brownies for yourself. You open your recipe book and find a recipe for brownies. The recipe calls for a cup of chopped walnuts. You don't like walnuts, but you do like macadamia nuts. As it happens, you have both kinds of nuts available to you. Would you substitute macadamia nuts for walnuts in order to avoid eating walnuts?

*2. b. 2. Impersonal Scenarios*

Impersonal scenarios are characterized by the deflection of an existing harm. An example is listed below.

You are at the wheel of a runaway trolley quickly approaching a fork in the tracks. On the tracks extending to the left is a group of five railway workmen. On the tracks extending to the right is a single railway workman. If you do nothing, the trolley will proceed to the left, causing the deaths of the five workmen. The only way to avoid the deaths of these workmen is to hit a switch on

your dashboard that will cause the trolley to proceed to the right, causing the death of the single workman. Would you hit the switch in order to avoid the deaths of the five workmen?

*2. b. 3. Personal-low/high conflict Scenarios*

Personal scenarios are characterized by recognition of the "you" source as the cause of a harm. The indications of low conflict or high conflict were determined by criteria laid out in a 2007 study by Koenigs et al. An example of each is listed below.

You are a doctor. You have five patients, each of whom is about to die due to a failing organ of some kind. You have another patient who is healthy. The only way that you can save the lives of the first five patients is to transplant five of this young man's organs (against his will) into the bodies of the other five patients. If you do this, the young man will die, but the other five patients will live. Would you perform this transplant in order to save five of your patients?

You, your husband, and your four children are crossing a mountain range on your return journey to your homeland. You have inadvertently set up camp on a local clan's sacred burial ground. The leader of the clan says that according to the local laws, you and your family must be put to death. However, he will let yourself, your husband, and your three other children live if you yourself will kill your oldest son. Would you kill your oldest son in order to save your husband and your other three children?

*2. c. Stroop Tasks*

Studies show that the prefrontal cortex is highly activated when taking part in a stroop task activity, which classically is used as a test for executive functioning (Adleman, Menon, Blasey, White, Warsofsky, Glover, & Reiss, 2002). As a result, Stroop tasks were also utilized in this study as a method of measuring executive functioning. Designed in conjunction with the

morality tasks using PEBL software, subjects were presented with a Stroop immediately upon completion of a morality questionnaire. Each Stroop consisted of a 16 trial long practice block followed by four experimental blocks(b) of 24 trials, between each of which was an instruction screen explaining the rule of the proceeding block. For example, the instructional screen for a block that required participants to respond in relation to the word component of a displayed stimulus would read: “Now you will be tested on how well you read words. Press the correct key [1-4] based on the name of the word in the center of the screen. Ignore the color that the word is printed in. Press any key to continue." Participants then indicated their response to each trial within the block using the 1, 2, 3, 4 number keys, which corresponded to a specific color (1=red, 2=green, 3=blue, 4=yellow). Overall, these blocks followed an ABBA pattern in that b1 and b4 required participants to respond towards the word of the displayed stimulus, and b2 and b3 required a response that indicated the color of the displayed stimulus. Response time in milliseconds and percentage correct were recorded for each block. If a subject responded incorrectly to a stimulus, a new trial would be generated for that block. As a result, trials per block ranged from 24-32.

*2. d. Stress Induction*

After completing the first round of the morality and stroop tasks, participants in the experimental condition were subjected to the Trier Social Stress Test (TSST) (Kirschbaum et al., 1993). The TSST procedure consists of a speech and arithmetic task designed with the specific intent of inducing psychosocial stress. Subjects were escorted into to a new room equipped with several large spotlights, microphone, and video cameras, and were informed that they will soon be giving a presentation to a panel of judges outlining why they are the best candidate for a job position. It was further explained that they will be video monitored throughout, as well as have

their verbal and non-verbal performance evaluated by these trained judges. The participants were then allowed to prepare with pen and paper for a five minute time period. When their time expires, two experimenters returned wearing lab coats to act as “judges”, and all preparative materials were taken from the participant. Subjects were then asked to begin their speech, and were required to present for a five minute time period. Failure to speak for the entire allotted time resulted in a cold reminder from a “judge” that time still remained. Immediately after the required time period was up, the participant was subjected to an unexpected arithmetic task. As quickly and as accurately as possible, they had to serially subtract 17 from 1873 for an additional five minute period. If any errors were made, the task had to be repeated from the starting value of 1873. Following this, the “judges” made their exit and the participant filled out two anxiety questionnaires before completing the morality2 and stroop2 tasks.

For the control condition, all TSST items (eg, spotlights) were hidden from view. Participants were first asked to write about a recent activity they took part in for a five minute period. Afterwards, the experimenter positioned themselves in such a way that they were not visible to the presenter as they then explained what they wrote about for five minutes. Following this, the participants were given a sheet of simple subtraction problems and asked to compute them aloud for an additional five minutes.

*2. d. a. Stress and Anxiety Measures*

Heart rate was continuously gathered during the TSST/control component of the experiment as a physiological indicator of stress levels. Using a handheld monitor by Vernier instruments, heart rate in BPM was recorded every five seconds for a 10 minute (600 second)

time period, with a starting time corresponding to the start of the speech task (true for both condition groups).

State Trait Anxiety (SAI) scales were also administered on four different occasions (see Figure 1) as a self-reported assessment of current anxiety. Questions with such traits as "I feel calm" and "I am worried" were rated by participants on a 4-point scale (e.g., from "Almost Never" to "Almost Always"), with higher scores indicating higher levels of anxiety. Test-retest reliability coefficients for this type of measure have ranged from .65 to .75 (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

*Data Analysis*

An independent *t*-test was used to compare between subject factors such as BAI, age, and difference between AB, BA morality groups, while a chi-square was used to determine sex differences between conditions. Univariate ANOVAs were conducted for comparisons between condition and sex on morality data (time in milliseconds and number of response type), heart rate data, SAI, and stroop data. A paired *t*-test was also utilized in the analysis of stroop and heart rate data change over time. In all, cases a two-tailed *t*-test was used and $p$ was set to 0.05.

## Results

*1. Demographics*

Although no exclusion factors were used, all participants were screened for existing anxiety levels using a Beck Anxiety Index (BAI) questionnaire (Fydrich, Dowdall, & Chambless, 1992). Age and BAI characteristics did not differ significantly between condition groups. However, the experimental group had a significantly greater percentage of male subjects as compared to the control group, $\chi^2$ (1, $N$ = 39) = 4.44, $p$ = .035.

Table 1: Demographic Characteristics of the Sample

| | *Control* | *Experimental* | *t* | *p* |
|---|---|---|---|---|
| Age | 19.47 ± 1.8 | 19.2 ± 1.36 | -.536 | .595 |
| BAI | 13.79 ± 9.92 | 11.0 ± 10.94 | -.833 | .410 |
| Sex | F:17, M:2 | F:12, M8 | | |

*2. Stress and Anxiety*

Heart rate measures were gathered continuously for 10 minutes during the TSST/control procedure of the experiment. The first five minutes worth of data correspond to when participants were completing the speech component of the experiment, while the last five minutes correspond to when participants were completing the math component of the experiment. Analysis of heart rate during the speech task revealed that no significant differences in variance existed between conditions or sexes (see figure 2). While levels of heart rate variance during the math component of this procedure did not significantly vary by sex, those in the experimental condition exhibited significantly higher levels of variance during this time, compared to participants in the control condition $F(1, 33) = 7.727$, $p = .009$.

For participants in both the experimental and control conditions, reported levels of state anxiety were significantly less from measurement 2 to 4, $p < .05$. However, the difference in mean anxiety rating from measurement 1 to 4 was found to be significantly higher, but only for those in the experimental group $t(19) = -6.46$, $p < .001$.

*3. Morality*

For balancing purposes, participants were presented the morality questionnaires in an AB ($N$ = 18) or BA ($N$ = 21) order. A series of $t$-test analyses were then conducted to determine if the order in which subjects were asked to complete morality list A and morality list B had any significant effect on response reaction time or response type. No significant differences were found between any of the morality measures, $p > 0.05$. After this was noted, morality data was then analyzed through several stages of comparison by condition and sex. As a whole, participants also had significantly faster response times to the moral scenarios presented post TSST/control: Deontological response time from morality 1 to morality 2: $t(37) = 3.036$, $p = .004$; utilitarian response time from morality 1 to morality 2: $t(34) = 4.51$, $p < .001$

While participants in the experimental condition did have longer reaction times when giving a utilitarian as opposed to deontological answer (see figure 8), this difference was not significant $t(17) = -1.886$, $p = .076$. In addition, it was observed (see figure 7) that those in the experimental condition were more likely to have a utilitarian response to a scenario in morality 2 as compared to those in the control condition $F(1, 35) = 1.487$, $p = .231$.

In terms of sex, overall, no significant differences between morality measures were found between the male and female groups (see table 3). That being said, even with such a large difference in sample size ($n_{male} = 9$; $n_{female} = 29$), the degree to which male participants more often responded in a utilitarian fashion from time 1 to time 2 compared to females was fairly high, $F(1, 37) = 3.519$, $p = .069$.

*4. Stroop*

Stroop task data was investigated by measuring the average reaction time and percent correct for each experimental block. It was observed that those in the experimental condition had a significantly slower reaction time in block 2 compared to block 1, $F(1, 35) = 7.049$, $p = .012$, but no other significant differences in between-block performance by condition were found, $p > 0.05$. Additionally, there were no significant differences in terms of change in average reaction time by block, or percentage correct from stroop 1 to stroop 2 between condition groups.

## Discussion

Overall, the results of this investigation suggest that while stress may influence some of the underlying logical and emotional components of moral decision making (as reflected by performance change on morality questionnaires), these effects are not strong enough to reject any of the null hypotheses at this time. Based on the characteristics of the dual systems model that suggest that the emotional components of a moral dilemma are negatively correlated with utilitarian responses, it was hypothesized that participants that were subjected to psychosocial stress would therefore be more likely to respond to moral scenarios with a deontological answer. Additionally if a utilitarian answer was instead given, such a response would take longer to make, compared to a deontological response (Greene et al., 2004). While my results do suggest that there is a trend regarding slower response times when giving a utilitarian answer if subjected to the TSST, this observation was not significant. In contrast to the hypothesis, there also was no recorded significant effect of stress on type of response given in the face of a presented moral dilemma. In fact, the observed results suggest that stress was positively associated with number of utilitarian responses, a trend that is in the opposite direction of the hypothesis.

These results share parallels between those observed in the studies by Starke et al. and Youssef et al. (Starcke et al., 2011; Youssef et al., 2012). Similar to Starke et al., as a whole, no significant relationships between stress and moral responses were found, providing evidence that stress may not affect moral decision making (Starke et al., 2011). However, results observed by Youssef et al. may help explain the surprising trend that utilitarian responses increased in participants in the experimental condition. Contradicting the prediction laid out by hypothesis 1, it is possible that this increase in utilitarian response rate is resultant of sex differences as opposed to condition. In the present study, there were significantly more males in the experimental condition as compared to the control condition. While overall sex did not appear to account for any other differences in moral decisions or stroop performance, males were found to respond to scenarios in morality 2 in a utilitarian manner more often than females, and such an effect was nearly significant. Youssef et al. also observed that males significantly had more utilitarian responses to moral dilemmas than females, bolstering the conclusion that these results were most likely resultant from the sex differences, and not the effects of stress (Youssef et al., 2012).

In the current study, it does appear however that overall the TSST had the desired effect of significantly increasing stress and anxiety levels in participants assigned to the experimental condition. Self-reported anxiety measures were significantly higher after time 1 for those subjected to the TSST. Moreover, heart rate variance during the math task was also found to be significantly higher for participants in the experimental condition. Despite these effects, it is very possible that the degree of these stress differences was not enough to facilitate a change in moral response or stroop performance. Table 2 shows that all participants indicated an increase in anxiety level both during and after the speech and math tasks, regardless of assigned condition.

Collectively, participants also had a significant increase in response times (regardless of type of response) in morality 2 as compared to the morality 1 task. All of these observations suggest that the TSST/control procedure affected participants in such a way to initiate these recorded changes. As all of the hypotheses are drawn from previous data that suggests stress alters the PFC and limbic systems of the brain, creating an imbalance between the emotional and cognitive processes of the dual systems model, proper inducement of a significant degree of stress is a critical component in the search to determine whether or not this theory is experimentally supported (Moll & Oliveira-Souza, 2007; Youssef et al., 2011). The addition of measurements such as cortisol levels (a hormone released when stressed) may have helped to provide additional insight on stress levels in order to determine how these differed between condition groups.

The lack of effects in the stroop task also may be related to stress. In general, stroop tasks are used as a measure of executive functioning. Because stress affects areas of the brain associated with stroop performance, it was predicted that subjection to the TSST would have a deteriorative effect on stroop performance (Adlemann et al., 2002). However, no such significant changes were noted. Based on other studies that indicate that the stressful effects associated with the TSST begin a rapid cessation following 35 minutes after the start of the initial stressor, it is more than likely that the time difference between the start of the TSST and start of the second morality task, in addition to the previous concerns over degree of stress induced, contributed to the lack of changes seen from stroop 1 to stroop 2 between conditions (Schoofs, Preub, & Wolf, 2008).

In summary, although not expected, it is not surprising that stress did not significantly affect moral decision making. As discussed in a recent study by Huebner, Dwyer, and Hauser, although emotion accompanies moral decisions, this does not mean that it is a requirement for

categorizing a decision as moral (Huebner, Dweyer, & Hauser, 2009). The constructs of morality are so complex even by philosophical standards, that it is important not to overextend the conclusions of neuropsychological and behavioral research to conclusions of moral decision making, especially since individuality plays such a large role (Young & Koenigs, 2007). The results of this study can only speak towards lab controlled conditions of morality.

Overall, several limitations must also be considered. While trends were observed in their predicted directions, perhaps a larger study sample would help increase these observed effects. Also, as previously discussed, an imbalance of sex between conditions may have affected observed results in regards to morality responses. In addition, a study design that better accounts for the reading time of scenarios (such as splitting the scenarios and their respective questions into different computer screens), gathering cortisol samples, and focusing primarily on personal moral scenarios compared to a mix that also included impersonal scenarios, may result in more complete and accurate data.

## References

Adleman, N., Menon, V., Blasey, C. M., White, C. D., Warsofsky, I. S., Glover, G. H., & Reiss, A. L. (2002). A Developmental fMRI Study of the Stroop Color-Word Task. *NeuroImage, 16*(1), 61-75.

Alexander, L., & Moore, M. (2008). Deontological Ethics. In *The Stanford Encyclopedia of Philosophy*. Retrieved from \url{http://plato.stanford.edu/archives/fall2008/entries/ethics-deontological/.

Broeders, R., van den Bos, K., Müller, P., & Ham, J. (2011). Should I save or should I not kill? How people solve moral dilemmas depends on which rule is most accessible. *Journal of Experimental Social Psychology*, *47*(5), 923-934.

Casebeer, W. D. (2003). Moral cognition and its neural constituents. *Nature Reviews Neuroscience*, *4*, 840-847.

Fydrich, T., Dowdall, D., & Chambless, D. L. (1992). Reliability and validity of the beck anxiety inventory. *Journal of Anxiety Disorders*, *6*(1), 55-61.

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.

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.

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*,

Huebner, B., Dwyer, S., & Hauser, M. (2009). The role of emotion in moral psychology. *Trends in Cognitive Sciences, 13*(1), 1-6.

Kern, S., Oakes, T. R., Stone, C. K., McAuliff, E. M., Kirschbaum, C., & Davidson, R. J. (2008). Glucose metabolic changes in the prefrontal cortex are associated with HPA axis response to a psychosocial stressor. *Psychoneuroendocrinology,33*(4), 517-529.

Kirschbaum, C., Pirke, K., & Hellhammer, D. (1993). The 'Trier Social Stress Test' – A Tool for Investigating Psychobiological Stress Responses in a Laboratory Setting. *Neuropsychobiology, 28*(1-2).

Koenig, M., Young, L., Adolphs, R., Tranel, D., Cushman, F., Hauser, M., & Damasio, A. (2007). Damage to the prefrontal cortex increases utilitarian moral judgments. *Nature, 446*(7138), 908-911.

Moll, J., & Oliveira-Souza, R. (2007). Moral judgments, emotions and the utilitarian brain. *Trends in Cognitive Sciences, 11*(8), 319-321.

Moll, J., Zahn, R., Oliveira-Souza, R., & Grafman, J. (2005). The neural basis of human moral cognition. *Nature Reviews Neuroscience, 6*, 799-809.

Rachels, J., & Rachels, S. (2012). *The Elements of Moral Philosophy* (7 ed.). New York: McGraw Hill.

Schoofs, D., Preub, D., & Wolf, O. (2008). Psychosocial stress induces working memory impairments in an n-back paradigm. *Psychoneuroendocrinology,33*(5), 643-653.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Starcke, K., & Brand, M. (2012). Decision making under stress: A selective review. *Neuroscience & Biobehavioral Reviews, 36*(4), 1228-1248.

Starcke, K., Polzer, C., Wolf, O., & Brand, M. (2011). Does stress alter everyday moral decision-making? Psychoneuroendocrinology, 36(2), 210-219 .

Thomson, J. J. (1986). *Rights, Restitution, & Risk: Essays in Moral Theory*. The President and Fellows of Harvard College.

Young, L., & Koenigs, M. (2007). Investigating emotion in moral cognition: a review of evidence from functional neuroimaging and neuropsychology. *British Medical Bulletin*, *84*(1), 69-79.

Youssef, F., Dookeeram, K., Basdeo, V., Francis, E., Doman, M., Mamed, D., ... Legall, G. (2011). Stress alters personal moral decision making. Psychoneuroendocrinology

**Tables and Figures**

*1. Stress and Anxiety*

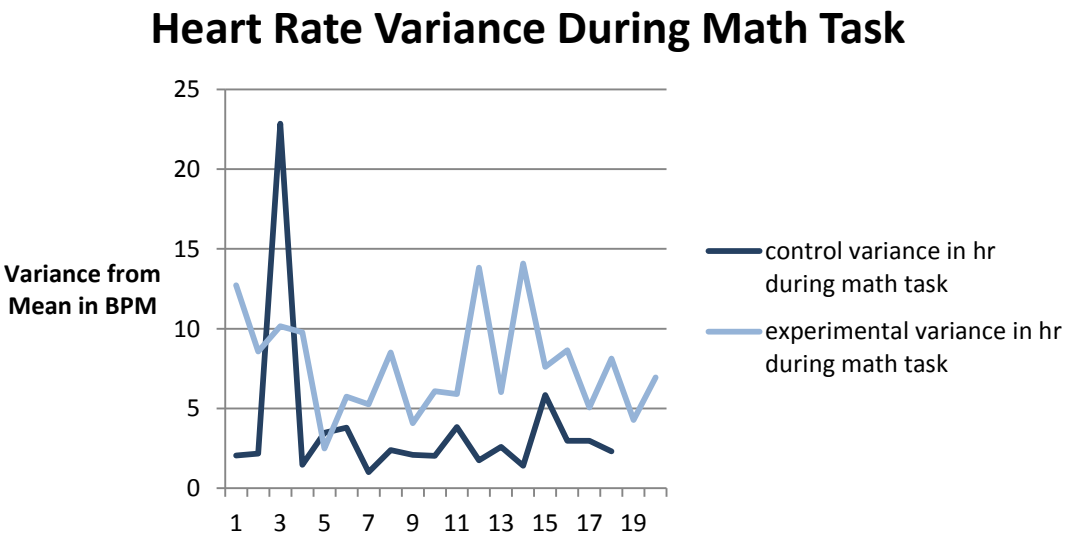



Figure 2.

In the experimental group, hr variance during the math condition was significantly greater than in the control group $F(1, 33) = 7.727$, $p = .009$

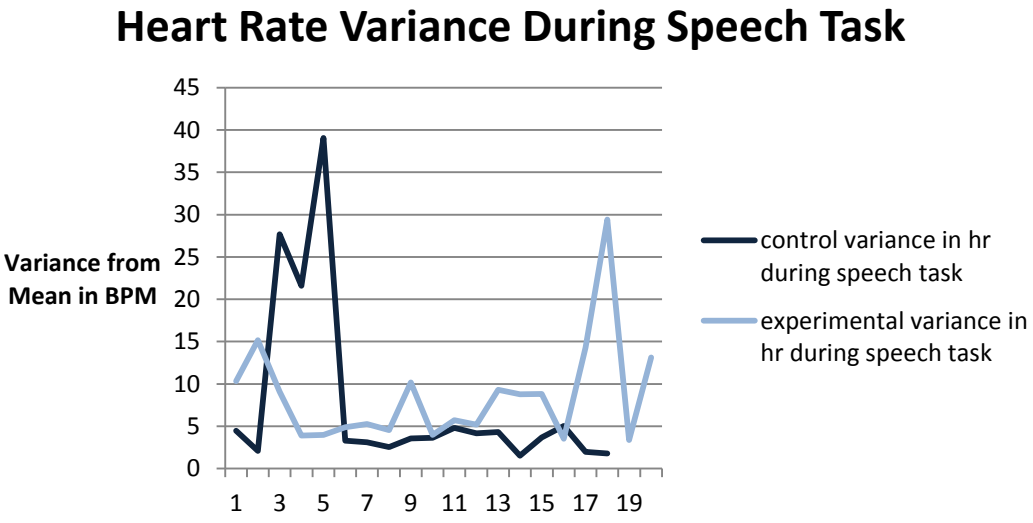



Figure 3.

Hr variance did not significantly differ between conditions $p > 0.05$

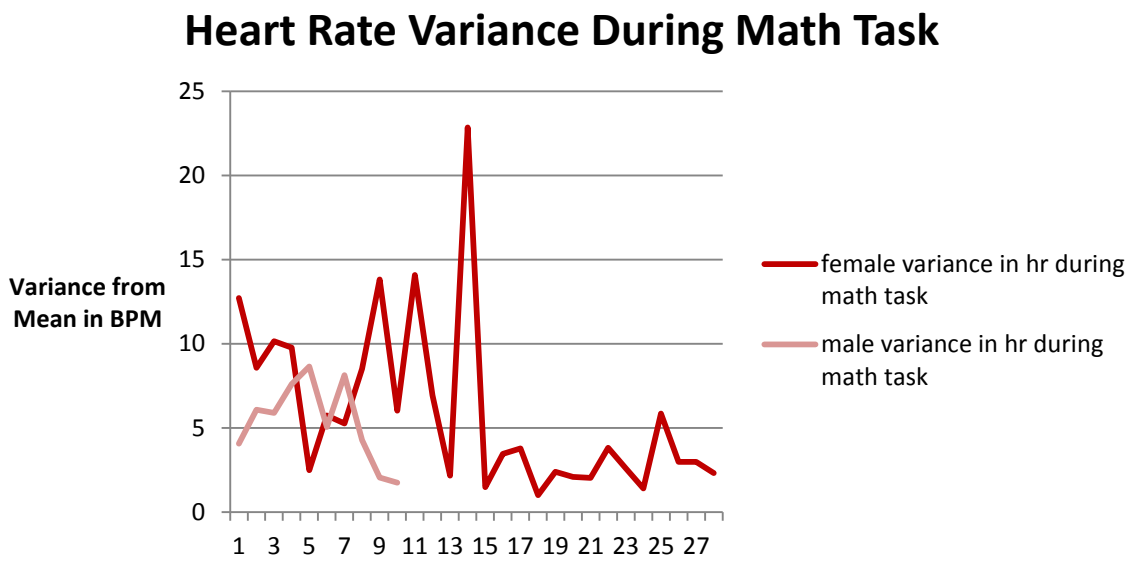



Figure 4.

No significant difference in hr variance was observed between sex groups during the math task period $p > .05$

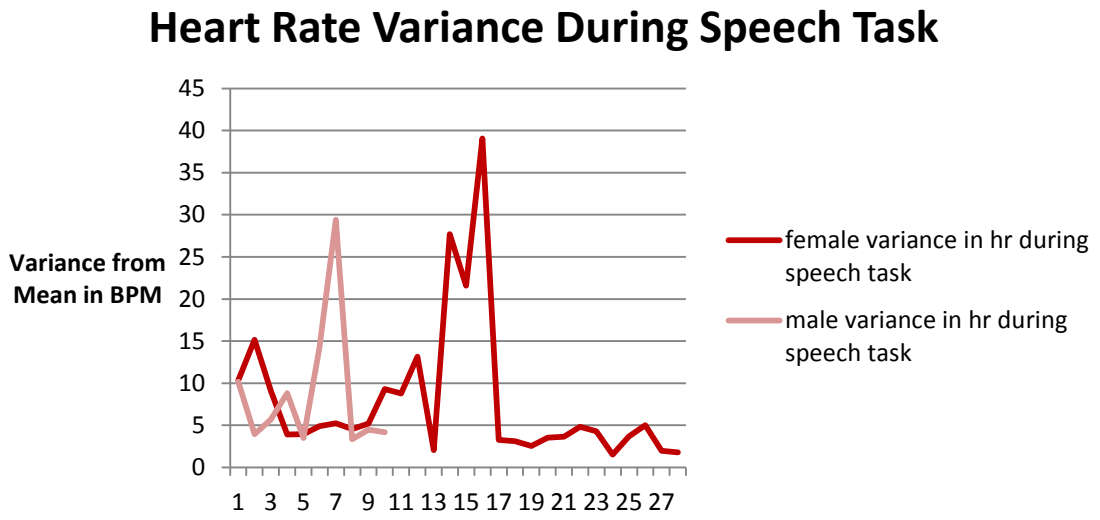



Figure 5.

No significant difference in hr variance was observed between sex groups during the speech task period $p > .05$

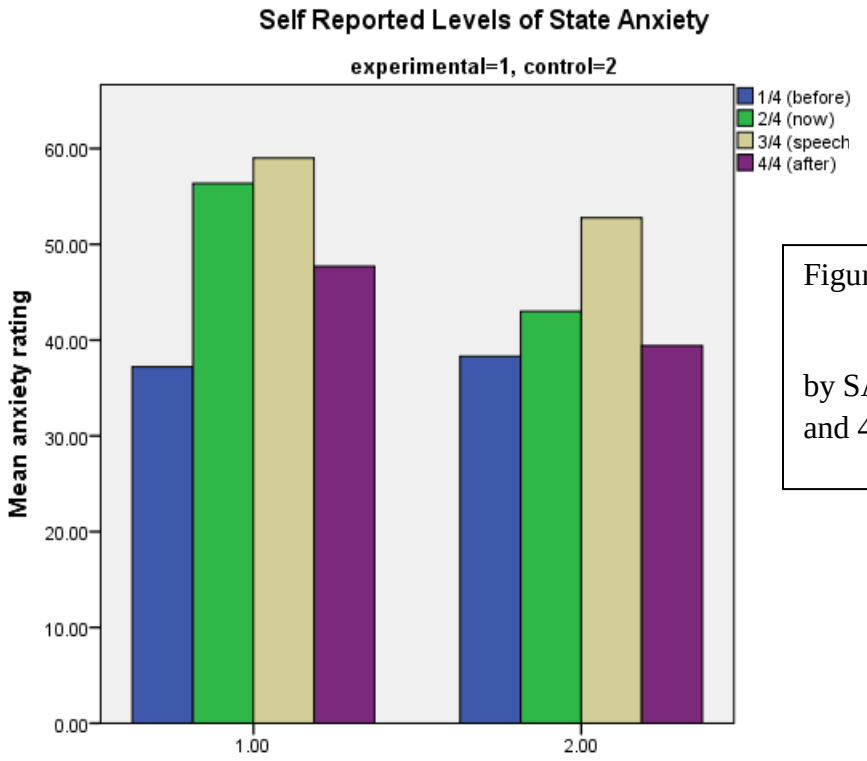



Figure 6a.

Mean anxiety rating by SAI from time 1, 2, 3, and 4 by condition group.

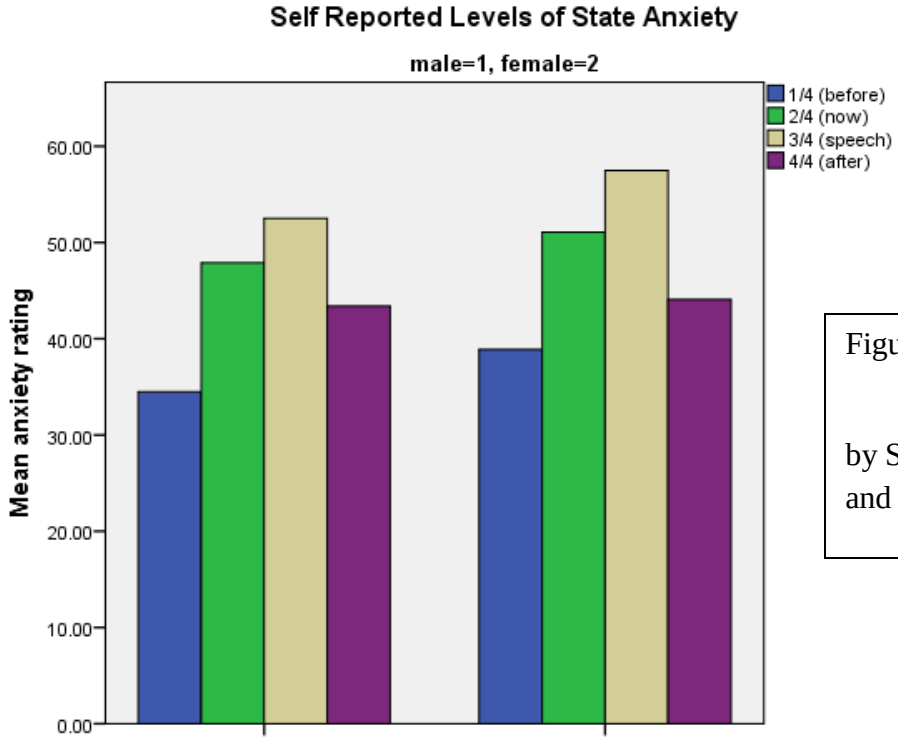



Figure 6b.

Mean anxiety rating by SAI from time 1, 2, 3, and 4 by sex group.

Figure 6a, Figure 6b

After the initial measure of anxiety at SAI 1, subsequent reported changes in anxiety level were significantly different between group conditions $F(1, 34) = 13.63$, $p = .001$. However, no significant differences in reported anxiety were found between sex groups $p > 0.05$.

Table 2: Descriptive statistics of SAI ratings between conditions (experimental=1, control=2)

| *SAI by completion time* | *Condition* | *Mean* | *S.D.* | *N* |
|---|---|---|---|---|
| 1 | 1 | 37.20 | 9.91 | 20 |
| (before stressor) | 2 | 38.29 | 7.98 | 17 |
| 3 | 1 | 59.00 | 10.47 | 20 |
| (during stressor) | 2 | 52.76 | 12.44 | 17 |
| 2 | 1 | 56.35 | 11.89 | 20 |
| (after stressor) | 2 | 43.00 | 10.86 | 17 |
| 4 | 1 | 47.7 | 10.26 | 20 |
| (after experiment) | 2 | 39.41 | 8.89 | 17 |

*2. Morality*

Table 3: Summary of time and response differences between morality tasks

| | | Total number of deontological responses in morality2 | | | | | Total deontological responses from morality1 to morality2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | N | Condition | | Mean | SD | N | Condition | |
| Condition | Experimental | 7.111 | 1.9369 | 18 | F | Sig | 6.947 | 2.013 | 19 | F | Sig |
| | Control | 7.895 | 1.9691 | 19 | 1.487 | 0.231 | 7.895 | 1.969 | 19 | 1.597 | 0.215 |
| | | Mean | SD | N | Sex | | Mean | SD | N | Sex | |
| Sex | Male | 6.56 | 0.527 | 9 | F | Sig | 6.56 | 0.527 | 9 | F | Sig |
| | Female | 7.69 | 2.238 | 29 | 2.233 | 0.144 | 7.69 | 2.022 | 29 | 3.519 | 0.069 |

| | | Average response time (ms) given a deontological answer in morality2, compared to morality1 | | | | | Average response time (ms) given a utilitarian answer in morality2, compared to morality1 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | N | Condition | | Mean | SD | N | Condition | |
| Condition | Experimental | 25850.894 | 13099.699 | 18 | F | Sig | 30406.043 | 12213.2 | 17 | F | Sig |
| | Control | 24581.966 | 10925.419 | 19 | 0.023 | 0.88 | 25002.144 | 13321.8 | 17 | 0.762 | 0.389 |
| | | Mean | SD | N | Sex | | Mean | SD | N | Sex | |
| Sex | Male | 25369.003 | 10043.141 | 9 | F | Sig | 32244.215 | 11159.8 | 9 | F | Sig |
| | Female | 25106.928 | 12355.72 | 29 | 0.016 | 0.899 | 37166.64 | 14868.2 | 26 | 1.435 | 0.24 |

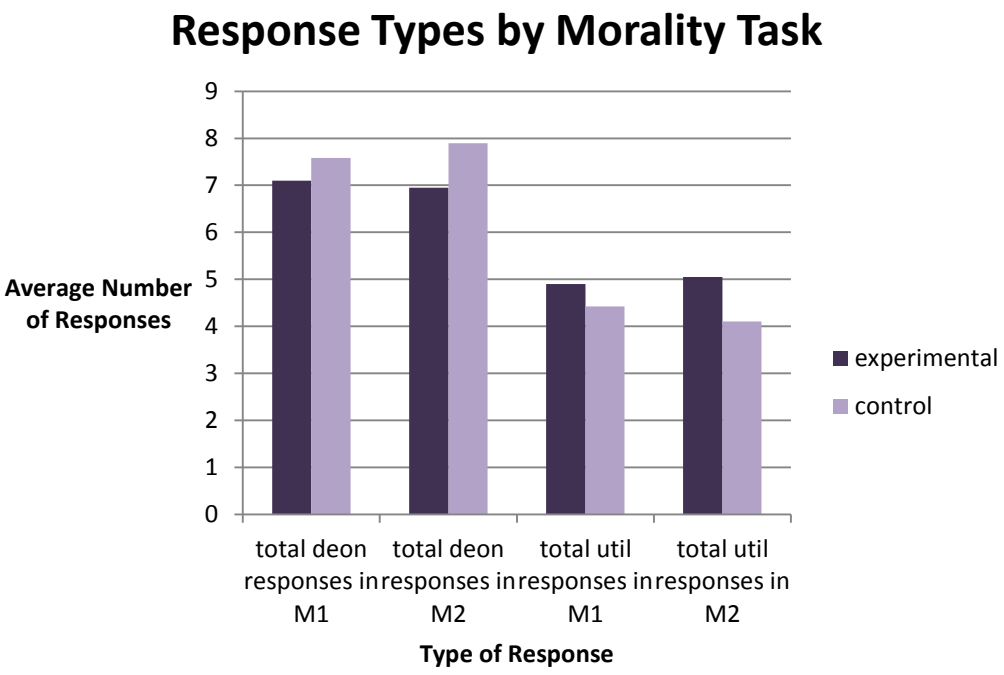



Figure 7.
Reponses by condition and morality

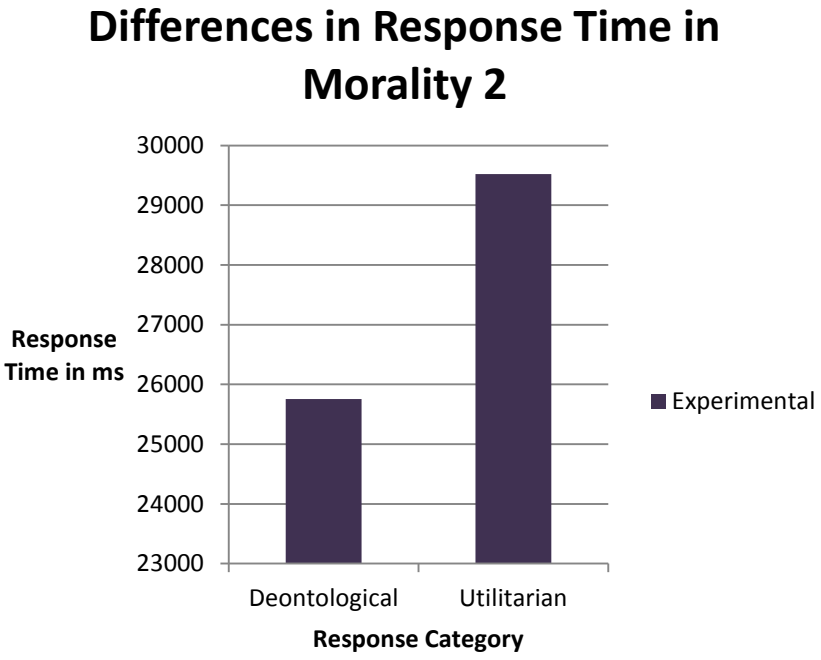



Figure 8.

Trend indicates that those in the experimental condition may be more likely to have a utilitarian response during the second morality task $F(1, 35) = 1.487$, $p = .231$.

*3. Stroop*

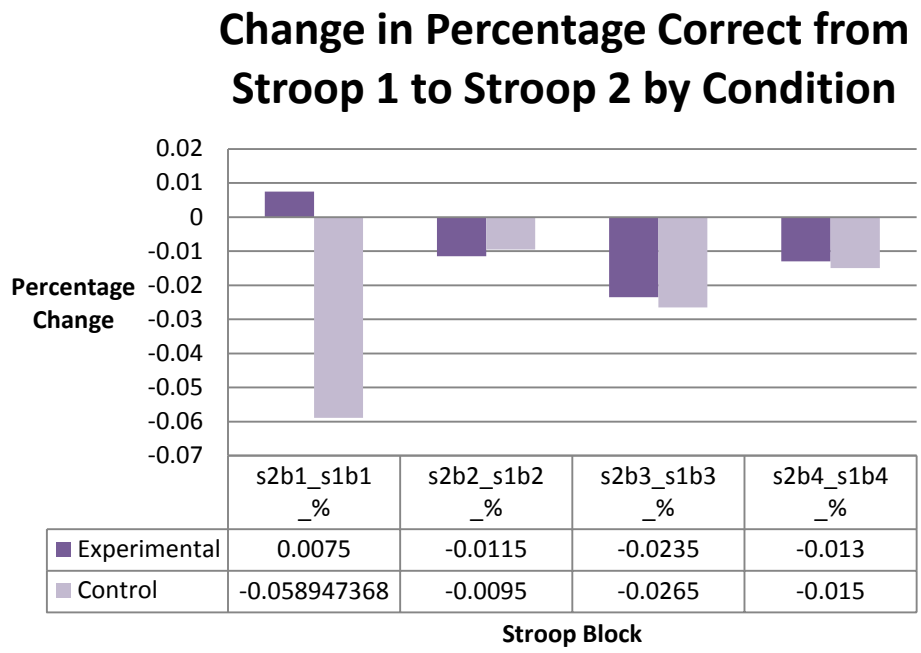



Figure 9.

Changes in overall percentage correct by experimental block from stroop 1 to stroop 2, based on condition

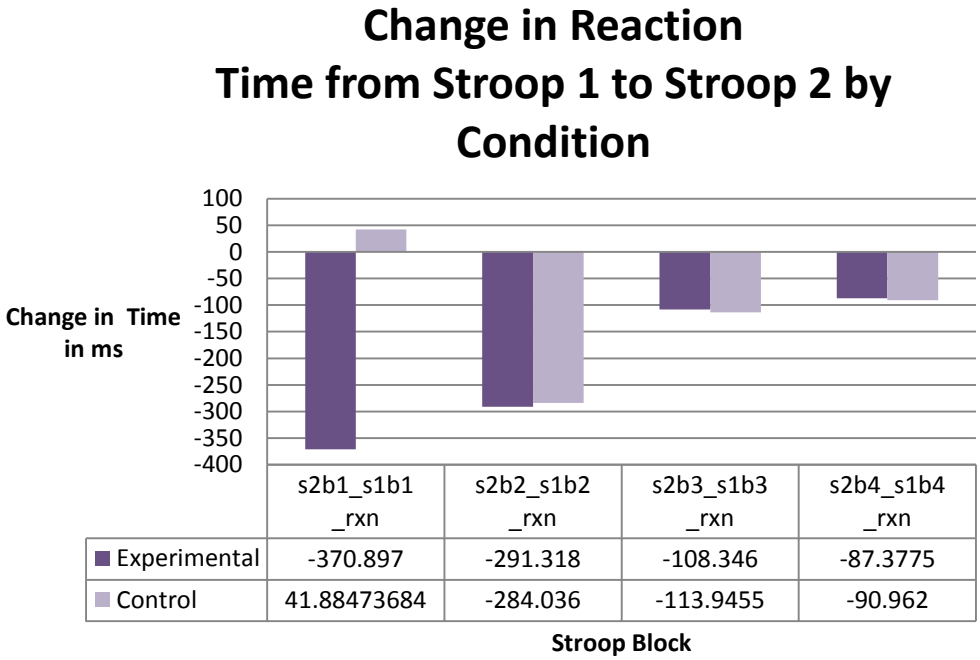



Figure 10.

Change in mean reaction time by experimental block from stroop 1 to stroop 2, based on condition