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Using the Stroop Effect to Examine the Effect of Words to Which Humans are Sensitive on Cognitive Conflict

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Using the Stroop Effect to Examine the Effect of Words to Which Humans are Sensitive on Cognitive Conflict

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ABSTRACT

The purpose of experiment one was to test the effects of drink consumed (glucose, artificial sweetener, or water) and stimuli (food or non-food) on cognitive conflict. Glucose has been known to better cognitive functioning, and preoccupation with food worsens cognitive functioning on a food-related task. We hypothesized that participants who received glucose and non-food stimuli will perform best on the cognitive tests, and participants who received aspartame and food-stimuli will perform worst on the cognitive tests. Participants were each given an 8 oz. drink to consume, shown six minutes of stimuli, performed an "X-word" Stroop test, shown six more minutes of stimuli, and finally, performed a "Food-word" Stroop test. There was a significant effect of stimulus shown on reaction time. The purpose of experiment two was to test the effects of stimuli, emotionally positive or negative, on cognitive conflict. The lateral prefrontal cortex shows a crossover between emotion and cognition, predicting behavioral performance. We hypothesized that participants who are shown positive emotion-evoking pictures will have a larger Stroop effect on a "Positive-word" Stroop and participants who are shown negative emotion-evoking pictures will have a larger Stroop effect on a "Negative-word" Stroop. Participants were shown four minutes of assigned stimuli, given a basic "X-word" Stroop test, shown four more minutes of stimuli, given either a "Positive-word" or "Negative-word" Stroop test, shown four more minutes of stimuli, and given the final Stroop test they had not yet taken. No significant results regarding a difference between positive and negative stimuli were found.

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Experiment One

In order to study cognitive performance, preoccupation, and selective attention, Stroop tests are commonly used. The Stroop Test, more commonly known for its effects, or the Stroop effect, is the measure of cognitive interference through the reaction time of a task. The most common Stroop test uses the name of a color printed in a color not denoted by the name. In this test, the participant is required to go through a list of words and name the color of the ink in which the word is printed. The Stroop effect (reaction time) is greater when the color of the ink does not match the name of the color than when the color of the ink matches the name of the color.

Glucose is a carbohydrate, and is an extremely important sugar in human metabolism. Glucose is a simple sugar because it is one of the smallest carbohydrates having the characteristics to carry out its function. Glucose functions as a primary energy source for plants and animals. In humans, glucose is found in the bloodstream, and when measured, is known as blood sugar.

Glucose levels in the body are strikingly related to functions in the brain, including cognitive functioning, reaction times, and selective attention. Food cues are also often used in these glucose related studies. Food cues include the sight or smell of food, or people eating or talking about food. Food cues have been known to increase feelings of hunger, change emotions, or change the way people complete activities (Muele, Skirde, Freund, Vogele, & Kuber, 2012). A previous study showed that when participants were presented with either high-calorie foods or neutral pictures, to observe the effects of craving on memory function and craving exhausting resources, the participants shown higher calorie foods showed slower reaction times and more omission errors (Muele et al., 2012).

A study was also conducted to test how food stimuli activate parts of the human brain. Wang, Volcow, Telang, Jayne, Ma, and Rao (2004) tested 12 normal body-weight participants who were food deprived before the study, and showed these participants appetizing food pictures. The food representation significantly increased metabolism in the whole brain, including the activation of the right orbitofrontal cortex, the region of the brain involved in motivation to procure food, experienced as “desire for food” and “hunger” (Wang, Volkow, Telang, Jayne, Ma, & Rao, 2004). The purpose of this study is to test glucose levels and food cues in relation to cognitive functioning.

Glucose Use

The effect of glucose on brain functions is important in many real-world problems, and therefore, is important to test. Previous research has studied dieting and eating disorders in relation to preoccupation and reaction times. Francis, Stewart, and Hounsell (1997) showed that restrained eaters, those who avoid certain foods or entire food categories, were found to have more preoccupation with high calorie foods and greater reaction times on a Stroop test using high calorie food words. This study suggests that dieters who restrict their eating to certain food groups suffer a negative impact on testing and performing on reaction time tasks.

Glucose levels have also become relevant on college campuses. Because there has been a dramatic rise in consuming glucose containing energy drinks, Howard and Marczinski (2010) conducted a study in which college students were given a survey on mental fatigue and assigned to either an energy drink, placebo drink, or no drink. The energy drinks decreased mental fatigue and increased cognitive functioning on a computer based cued go/no go test.

Artificial Sweeteners

Artificial sweeteners are used in foods to provide a sweet taste, yet do not use any glucose or form of sugar. Most people choose artificial sweeteners over natural sweeteners to lose weight. In a study by Christian et al. (2004), male Sprague-Dawley rats receiving aspartame in their drinking water (250 mg/kg/day) took longer to find the reward in a T-maze after they had been drinking this water for 3-4 months. After 90 days of treatment, the rats showed a significant increase in time to reach the reward. This effect was only seen after 90 days of aspartame treatment. This supports short-term studies finding no effects.

Winder and Borrill (1997) showed that after giving participants either a drink sweetened with 50 grams of glucose powder or a drink with 4 grams of an aspartame-based placebo powder, both balanced for taste and acidity with a lemon drink concentrate, the drink alone appeared to have no significant effect on short or long-term memory for names with faces and shopping list items. Spiers et al. (1998) conducted an investigation study after adverse experiences were reported from consuming aspartame. Type of drink (aspartame, sucrose, or placebo) was examined. The dose of aspartame given to participants was nearly 20 times the 90^{th} percentile average daily intake of aspartame but did not result in adverse behavioral, neuropsychological, or neurophysiologic effects. No effect of type of drink was found. Also, in a postmarking surveillance study done by Butchko and Stargel (2001), aspartame caused a significant increase in the frequency of headaches but not in the intensity or duration of headaches.

Nonetheless, symptoms allegedly associated with aspartame tended to be mild and were common in the general population. Also, when participants who were convinced that aspartame had caused their headaches were evaluated in a randomized, double-blind, placebo-controlled study, aspartame was no more likely than a placebo to elicit headaches.

Although significant differences in these short-term studies were not found, aspartame is negatively related to hunger, and hunger has an effect on cognitive performance. In a study done by Alaimo, Olsen, and Frongillo (2001), regression analyses were done to test for associations between food insufficiency and cognitive, academic, and psychosocial performance. After adjusting for confounding variables, it was found that food-insufficient students had significantly lower mathematics scores and were more likely to have seen a psychologist, get suspended from school, and report lower scores on exams. According to a study done on poor school performance by Karande and Kulkarni (2005), malnutrition is associated with poor cognition, independent of psychosocial adversity. They also found that vitamin deficiency adversely affects long-term cognitive development. Yang (2010) showed that artificial sweeteners such as aspartame, when given to normal weight adult males, increased subjective appetite ratings, and increased subjective hunger ratings compared to glucose or water. Aspartame was also associated with a heightened motivation to eat and with more items selected on a food preference list. There is a motivation to eat sweet tasting food, and if humans are not satiated, they will want to eat more of the sweet tasting food. In a study in which half of the participants were given a glucose containing drink, and half of the participants were given an artificial sweetener containing drink, glucose decreased appetite following its consumption, and the artificial sweetener increased the motivation to eat and decreased feelings of fullness, therefore decreasing satiety (Benton, 2005). Benton (2005) suggests that these different effect of glucose and artificial sweeteners may be due to the fact that artificial sweeteners do not activate the food reward pathways in the same fashion as natural sweeteners, and lack of caloric contribution usually eliminates the post-ingestive component of the food reward branches, which depends on metabolic products of the food.

Cognitive Performance

Cognitive performance is exceedingly dependent on the levels of glucose in the body. Meikle, Leigh, and Stollery (2004) found that increasing blood glucose levels by methods such as consuming glucose-containing drinks leads to enhanced cognitive performance and glucose consumption largely contributes to performance on memory based tasks. With respect to this, low glucose levels result in less work done by the part of the brain focused on higher-level thinking. By using a logical reasoning test and a Stroop test, researchers found that low glucose levels resulted in rigid thinking and higher glucose levels resulted in higher-level thinking (Donohoe & Benton, 1999).

Self- Control and Preoccupation

Another measure frequently studied to determine the effect of glucose levels is self-control and preoccupation. Self-control requires the effort to manage thoughts, response tendencies, and the ability to pull oneself away from preoccupations. Previous studies have shown that fluctuations in glucose affect self-control tasks, in other words, individuals with lower glucose levels show deficiencies in self-control tasks (Gailliot, et al., 2007). This study confirmed that self-control tasks require glucose and showed that after being shown a video that served as a manipulation of self-control exertion, glucose levels were taken, and the levels were lower than before the task. After performing a second subsequent task, poorer self-control was shown.

Francis et al. (1997) showed restricting food intake, lowering glucose levels, and therefore lowering self-control, is associated with a preoccupation with food and eating. Restrained, dieting eaters were more preoccupied with high calorie and low calorie food words when performing a food cued Stroop test.

Selective Attention

Finally, the effects of glucose on selective attention have been studied. In a study designed by Brody, Keller, Degan, Cox, and Schachinger (2004), patients experienced hypoglycemia, having very low glucose levels, and normoglycemia, having normal glucose levels, using a hypoglycemic clamp procedure. After performing a Stroop test, the results showed that an interference effect, or the inability to correctly complete the Stroop test in a normal reaction time range, was present during hypoglycemia, and a selective attention to the food stimuli was present during hypoglycemia. Also with regards to selective attention, substance abusers, food abusers included, show this selective attention for substance-related stimuli. Fadardi and Bazzaz (2011) tested dieters as opposed to non-dieters selective attention. The participants were shown 24 high calorie and 24 low calorie food pictures for 32 ms before being shown the appearance of a congruent or incongruent color world, in which the participants were to show the correct color word as quickly as possible. Researchers found that dieters showed the highest reaction times to incongruent color words following higher calorie food pictures.

Food Stroop Test

A food cued Stroop test has been used to study selective attention of dieters, restricted eaters, and food substance abusers. Stroop Tests using food cue words have been formulated to imitate the classic Stroop Test. A previous studied showed that when given a food cued Stroop test, including food words, or color control words, the Stroop interference effect is present during low glucose levels, therefore it was harder to name the correct color of the food words with low glucose levels in the body (Brody et al., 2004). In a study using patients undergoing treatment for anorexia, participants were given a normal color word Stroop test and a food word Stroop test. The results showed that anorexic and bulimic patients had significantly greater reaction times on the food word Stroop test than the normal color word Stroop test (Ben-Tovim, Walker, Fok, & Yap, 1988). Francis et al. (1997) showed that Stroop interference for high-calorie food words and low-calorie food words were greater with restrained eaters than non-restrained eaters, and the amount of calories did not have a significant effect when using the food words.

Effects of Glucose Levels/ Food Cues on Stroop Test Performance

Previous research has shown how low glucose levels have a negative effect on cognitive performance and high glucose levels have a positive effect on cognitive performance (Meikle et al., 2004). Previous research also shows how a food stimulus has a positive effect on greater reaction times to food-cued tests (Fadardi & Bazzaz, 2011). However, research has yet to show if changing glucose levels before viewing stimuli will have similar effects to the previous studies. This current will attempt to explain glucose and food stimuli's effects on cognitive functioning using a food word Stroop test. There has been success from past studies using glucose drinks with levels ranging from as little as 1.8-g/100 mL of glucose to as high as 25-g/100 mL of glucose. A glucose containing energy drink having 1.8-g/100 mL of glucose given to a participant showed increased cognitive performance on a cued go/no go test (Howard & Marczinski, 2010). A similar study showed that a glucose containing drink having 25-g/100 mL of glucose given to a participant largely facilitated performance on memory tasks and memory enhancement (Meikle, Leigh, & Stollery, 2004). Yang (2010) showed that knowingly ingesting an artificial sweetener increased overall consumption of a meal, and hunger of the participant, suggesting overall compensation for the expected caloric reduction. Diet Lemonade does not have a major taste difference from Non-Diet Lemonade, masking the artificial sweetener. Aspartame is also used in many studies to detect the effects of artificial sweeteners, having had the greatest effect on hunger, food reward, and energy intake differences when compared to glucose containing substances (Benton, 2005; Yang, 2010). This study has the following hypotheses: Participants who are given a glucose drink and shown non-food stimuli will have the least amount of preoccupation with food words and will perform the best on the Stroop test, or have the shortest reaction time. Participants who are not given the glucose drink and shown non-food stimuli should have a slight decrease in performance on the Stroop test. Participants who are given the glucose drink and shown food stimuli should have more preoccupation than the two preceding groups because of the food stimuli. Participants who are given the non-glucose drink and shown food stimuli should have a higher preoccupation with the food words and worse performance on the Stroop test than the preceding groups. Because of the overwhelming research on aspartame causing hunger, participants given the artificial sweetener and shown the food-stimuli should have the greatest preoccupation with the food words and have the greatest decrease in performance on the Stroop test. Women will have a greater preoccupation with the food words, and will have greater reaction times on the Food-Stroop test.

Method

Participants

Eighty-one students from undergraduate psychology courses at Georgia Southern University participated in this study, in order to complete their undergraduate course requirements or for extra credit. The participants were recruited from an online subject pool. Data was collected from White and Black males and females. Of these participants, 52% were men, 48% were women, 53% were White, and 47% were Black. The mean age was 19.73 (*SD*= 2.82). The mean weight of the participants was 163.05 lb. (*SD*= 35.51).

Materials

Three different drinks were used: a glucose drink (Minute Maid Lemonade, containing 11.25 g/100 mL of sugar), an artificially sweetened drink (Minute Maid Light Lemonade, containing 0 g/ 100 mL of sugar), and water.

Two different forms of stimuli were used in the form of PowerPoint pictures, non-food pictures and food pictures.

Two different forms of the Stroop test were used, an “X-word” condition, and a “Food-word” condition. The “X-word” condition consisted of a series of X’s placed in a row given in a certain color. A sample item includes “XXX” listed in blue ink, or “XXXXX” listed in purple ink. This test was used mainly as a control to see how quickly a participant could get through an ink-naming task in comparison to the food-word task.

The “Food-word” condition consisted of a series of food words given in a different color than the word itself. A sample item includes “Cheese” listed in red, or “Chocolate” listed in purple. The participant’s task is to name the color of the word. Five short questions served as a manipulation check and to determine if the participants were influenced by the drink and stimuli shown. The questions were as follows: “What was the first thought that came to your mind during the slideshow?” “What was the first thought that came to you mind after the slideshow?” “What are you planning to do after the study?” “How did you feel before viewing the stimuli?” “How did you feel after viewing the stimuli?” A demographics survey containing age, ethnicity, gender, and weight was used. The weight of the participants was needed in order to account for differences in the effects of glucose of a large vs. small participant, and to assess the proportion of glucose/body weight, which may have an effect on the results. Two questions were also asked concerning when the last time they ate that day, and what they ate at that time. See Appendix A for all materials in experiment one.

Procedure

This experiment involved a 3 (Drink: Glucose vs. Artificial Sweetener vs. Water) x 2 (Stimuli: Food Slideshow Stimuli vs. Non-food Slideshow Stimuli) between-subjects design. Participants were randomly assigned to one of six experimental conditions. Participants completed the study individually and at different times in a laboratory setting. Once a participant came into the testing session, participants read and signed an informed consent form. Once the participant signed the informed consent form, the experimenter randomly assigned him or her to one of the three drink conditions and gave the participant the drink to consume. After the drink was consumed, the participant was randomly assigned to one of two stimuli. The stimulus pictures were shown in a Power point for 6 min. The participant was then given a Stroop test to complete. The participant was then shown the rest of the stimulus pictures for 6 min. The other Stroop test was then completed. Half of the participants were given the basic X-word Stroop test first, and food-word Stroop test second, and vice versa. The manipulation check questions and demographics measure were then given. When the participant completed all measures, her or she was debriefed. The participant was then thanked and dismissed from the study. For the last thirteen participants, a simple word search was given after consuming the drink to allow more time for the drink to get into the participant's system. This was done in order for the drink to have more of an effect than it had in previous participants.

Results

Preliminary Analyses

Reaction Times of the "X-word" condition ranged from 13.26 to 33.42 (M = 21.47, SD = 4.02). Reaction Times of the "Food-word" condition ranged from 18.00 to 52.05 (M = 26.71, SD = 4.71).

Participants' responses to the two Stroop tests were averaged and compared, with greater reaction times indicating a larger Stroop effect. A Pearson correlation coefficient was computed to assess the relationship between the reaction times of the "X-word" condition and reaction times of the "Food-word" condition. There was a positive correlation between the two variables $r(80) = .44$, $p < .05$.

A paired samples t-test was conducted to determine if there was a significant difference between participants' reaction times on the "X-word" condition and reaction times on the "Food-word" condition. Participants' had less of a Stroop effect on the "X-word" condition than the "Food-word" condition, $t(80) = -10.12$, $p < .05$, Cohen's $d = -1.20$.

Hypothesis Testing

To test our hypotheses that the drink consumed and stimuli shown would affect the "Food-word" reaction times, a series of 3(drink) x 2(stimulus) ANCOVA tests were conducted controlling for "X-word" Stroop reaction times on "Food-word" Stroop reaction times. We hypothesized that consuming aspartame should result in the highest reaction times on the "Food-word" condition, followed by water, and glucose. Contrary to the hypothesis, the effect of drink consumed on reaction time did not reach statistical significance, $F(2, 75) = .16$, $p > .05$, $\eta^2 = .00$. We also hypothesized participants shown food-stimuli should have greater reaction times on the "Food-word" condition than participants shown non-food stimuli. In support of this hypothesis, the effect of stimulus shown on reaction time did reach statistical significance, $F(1, 75) = 6.70$, $p < .05$, $\eta^2 = .08$. We also hypothesized that the drink consumed and stimuli shown combined should affect reaction times differently. Contrary to this hypothesis, the drink consumed combined with stimuli shown did not have a significant interaction effect on reaction times, $F(2,75) = .05$, $p > .05$, $\eta^2 = .00$. The last thirteen participants that received the word search were not analyzed separately, as the mean of this group was not significantly different to the mean of the group as a whole.

Discussion

The purpose of this research was to test whether glucose levels and food stimuli caused changes in cognitive conflict between reading and color naming. This research also examined whether artificial sweeteners would affect Stroop performance in the same manner as ingesting glucose or not ingesting glucose. The data collected did not support the hypotheses that drink consumed would affect cognitive performance on a "Food-word" test, or that drink consumed combined with stimuli shown would affect cognitive performance on a "Food-word" test. The data did support the hypothesis that stimuli shown would affect cognitive performance on a "Food-word" test. The reaction time means regarding the stimuli seen are consistent with the hypothesis that those who saw food stimuli should have a greater preoccupation with the food words than those who saw the non-food stimuli, and thus a greater reaction time on the "Food-word" test.

This experiment had low power, due to a small sample size in each sub-group. Of the six experimental groups the participants could have been randomly assigned to, none of the groups had more than twenty participants. Only nine participants were assigned to receive glucose and be shown food stimuli. This may have accounted for the inability to find statistical significance between the means of the drink consumed and the drink consumed combined with the stimuli shown. However, there was not enough time to accurately assess if running more participants would have caused an effect. The findings at the current moment did not prove to be strong enough to test this possible limitation. The methodology could have also contributed to the inability of the drink consumed and drink consumed combined with stimuli shown to have an effect. Although previous literature has shown success with as little as 1.8-g/100 mL of glucose (Howard & Marczinski, 2010), a greater dose may have been needed to have an effect with the Stroop tests. There was no way, given the circumstances of this study at an undergraduate university, to test the participants' level of glucose in their blood at the time of their test, and was essentially blind to how much glucose or lack of glucose was in a participant's body at any given moment of the study.

The significant findings concerning stimuli shown before taking a cognitive test suggest practical implications for the future. Cognitive performance should not be expected to be high if one is hungry. Any slight preoccupation with food could reduce cognitive performance. If pre-exposed to food, one should not be expected to perform highly on a cognitive exam, especially if this exam is concerning food or contains food words within the test.

Because of the small sample size, it was not possible to see if the drink consumed needs to be changed to a different glucose drink or a different artificially sweetened drink. It was also not possible to detect the amount of glucose in the participants at the time the study took place. The manipulation check did show the strength of the stimulus variable. Participants stated that they were hungrier after viewing the food stimuli, and often wanted to go eat directly after the study. Participants who viewed the non-food stimuli stated they felt no change after viewing the stimuli. Because of the significance found in the stimuli, a future study will be done to expand on this. The Stroop effect will be used to examine the effects of emotion-evoking words on cognitive conflict.

Experiment Two

Because of the significance of the stimuli in the previous experiment, this part of the experiment will be expanded to include an emotional aspect of the stimuli shown. In a study done by Cartwright-Finch and Lavie (2007), it was found that simply instructing participants to focus on a certain task is not sufficient to prevent distracter interference. In the previous experiment, focusing on a Food-Stroop test was not sufficient enough to distract from the Food Stimuli. This will be expanded to include emotional stimuli, not simply food. Upon giving participants an emotional word Stroop test, containing words related to anxiety, the interference effect was greater in participants with high trait anxiety (Eysenck et al., 2007). From a broader perspective, in a study conducted with 14 participants, a whole brain image was taken after viewing a comedy film, neutral film, or horror film. After looking at the brain images, it was found that the lateral PFC region showed a crossover interaction between emotion and cognition, predicting behavioral performance (Gray, Braver, & Raichle, 2001). Niedenthal et al. (2005) showed the effects of preoccupied individuals detecting facial expressions by finding that distressed, insecurely attached individuals perceived the offset of negative expressions as occurring later than did the secure individuals. Finally, in a study conducted by Williams, Mathews, and MacLeod (1996), snake-avoidant participants and snake-control participants were given a Stroop-test with snake words to test the interference. As predicted, snake-avoidant participants showed greatest color-naming interference on words related to snakes.

The study being conducted will be expanded to include a variety of pictures evoking negative emotion and a variety of pictures evoking positive emotion. Previous research has shown that emotion has an effect on cognitive abilities. However, research has yet to show if being shown positive emotional evoking pictures and negative emotional evoking pictures will have similar effects to the studies presented on a cognitive test concerning the emotion of the stimuli shown. This study has the following hypotheses: Participants who are shown positive emotion-evoking pictures will be more preoccupied with positive emotion words, and will have a larger Stroop effect on a positive-word Stroop. Participants who are shown negative emotion-evoking pictures will become preoccupied with negative emotion words, and will have a larger Stroop effect on a negative-word Stroop.

Method

Participants

Thirty-seven students from undergraduate psychology courses at Georgia Southern University participated in this study, in order to complete their undergraduate course requirements or for extra credit. The participants were recruited from an online subject pool. Of these participants, 27% were men, 73% were women, 46% were White, and 46% were Black. The mean age was 19.81 (*SD*= 2.46).

Materials

Two different forms of stimuli were used in the form of PowerPoint pictures, positive emotion-evoking pictures or negative emotion-evoking pictures. These pictures were chosen based on online research of photographs (comforting, positive, and uplifting vs. frightening, negative, and upsetting) as well as research done with 10 close acquaintances. These 10 acquaintances were asked to name 10 to 20 things that made them extremely happy, comforted, or uplifted and 10 to 20 things that made them extremely upset, frightened, or disturbed. If three to four people had overlapping answers, those answers chosen to be placed in the PowerPoint presentation.

Three different forms of the Stroop test were used, an “X-word” condition, a “Positive-word” condition, and a “Negative-word” condition. The same “X-word” condition used in experiment one was used in experiment two. The two other conditions consisted of a series of emotion words, either all positive or all negative, given in different colors. A sample item includes “Comfort” listed in red, or “Snake” listed in purple. The participant’s task is to name the color of the word. Five short questions served as a manipulation check and to determine if the participants were influenced by the drink and stimuli shown. The questions were as follows: “What was the first thought that came to your mind during the slideshow?” “What was the first thought that came to you mind after the slideshow?” “What are you planning to do after the study?” “How did you feel before viewing the stimuli?” “How did you feel after viewing the stimuli?” A demographics survey containing age, ethnicity, and gender was used. See Appendix B for all materials in experiment two.

Procedure

This experiment involved a between subjects design. Participants were randomly assigned to one of the two experimental conditions. The same procedures were followed as in experiment one with the following exceptions: no drinks were consumed, the stimulus slideshow was shown in three different periods of 4 minutes each, and an extra Stroop condition was added.

Results

Preliminary Analyses

Reaction Times of the "X-word" condition ranged from 12.95 to 40.86 (M = 22.62, SD = 5.79). Reaction Times of the "Positive-word" condition ranged from 14.18 to 40.85 (M = 25.12, SD = 6.39). Reaction Times of the "Negative-word" condition ranged from 14.88 to 46.87 (M=25.79, SD= 6.35).

A repeated-measures ANOVA was conducted to determine if there was a significant difference between participants' reaction times on the "X-word" condition and reaction times on the "Positive-word" / "Negative-word" conditions. Participants had lower reaction times on the "X-word" condition than the "Positive-word" and "Negative-word" conditions, F (2, 70) = 11.49, $p < .05$, $\eta^2 = .247$.

Hypothesis Testing

To test our hypotheses, a repeated-measures ANOVA was conducted. We hypothesized that those participants who saw positive stimuli should have a greater Stroop effect on the "Positive-word" condition, and those participants who saw negative stimuli should have a greater Stroop effect on the "Negative-word" condition. Contrary to hypothesis, the effect of stimuli on the reaction times of the "Positive-word" and "Negative-word" conditions did not reach statistical significance F (2, 70) = .126, $p > .05$, $\eta^2 = .004$.

Discussion

The purpose of this research was to test whether positive and negative emotion-evoking pictures would have an effect on cognitive conflict concerning the emotion of the stimuli shown. The data collected did not support the hypotheses that positive stimuli would cause a greater Stroop effect on the "Positive-word" test, and negative stimuli would cause a greater Stroop effect on the "Negative-word" test.

It was difficult to assess whether the stimuli had a large enough effect on the participants to cause a change in their cognitive functioning. The demographics reports showed that the participants knew the pictures were of positive/negative things. Many of the participants reported feeling “happy”, or “disturbed”. It is impossible to know, however, if the participants knew the picture was a “happy” picture, or if the picture genuinely evoked a feeling of “happiness” from the participants. Also, with the negative stimuli, real snakes, real spiders, etc. were not used to avoid psychologically affecting a participant. This could have had an impact on lessening the stimuli’s effects. There were no data to report how the participant felt before performing the Stroop tasks. In the study conducted by Williams, Mathews, and MacLeod (1996), it was known that the participants were either snake-avoidant or snake-controlled, and thus adequate testing could be done. The stimuli may also have needed to be shown for a longer period of time, more likely to ensure that the proper emotion was felt before performing the Stroop tasks.

Upon deciding the stimulus pictures/words, advice was only gained from 10 close acquaintances. More people could have been spoken with in order to form a more general consensus on what a person believes constitutes a positive or negative emotional evoking picture. Finally, more or different words could have been needed in the Stroop conditions to portray a “Positive-word” or “Negative-word” test.

Based on the results of this study, a Stroop test indicates that the emotionally laden words did increase the cognitive conflict between the tendency to read and the task of naming the ink color. Because there was not a significant difference between the “Positive-word” condition and “Negative-word” condition, a more verbal cognitive test may need to be used to assess how a participant is feeling in the moment.

For future research, a new test may need to be devised to assess cognitive functioning upon reaching a desired emotion. The manipulation check did show the stimulus was having some sort of desired effect. The stimuli could be changed and practiced on various controls to achieve a desired emotional state before testing participants. Also, as stated previously, a written test may not be an accurate way to assess cognition with relation to emotion. Some type of verbal test may need to be used in order to assess for voice inflection, or facial expression upon hearing an emotion word similar to the emotion they should be feeling after the stimuli is shown.

Conclusion

More participants and more advanced equipment/researchers were needed in experiment one in order to understand the other directions in which the research needs to go. The results of this experiment, however, were promising enough to expand the research to include the Stroop effect on emotionally laden words.

Emotion plays a large factor in every-day lives. If an emotion is going to affect cognitive functioning, specifically the ability to function when encountered with a specific emotion during a task, research needs to done in order to test this theory and apply practical solutions to solve this issue. If variations are performed of experiment two, helpful suggestions could be made to the study of emotion and cognition.

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Appendix A

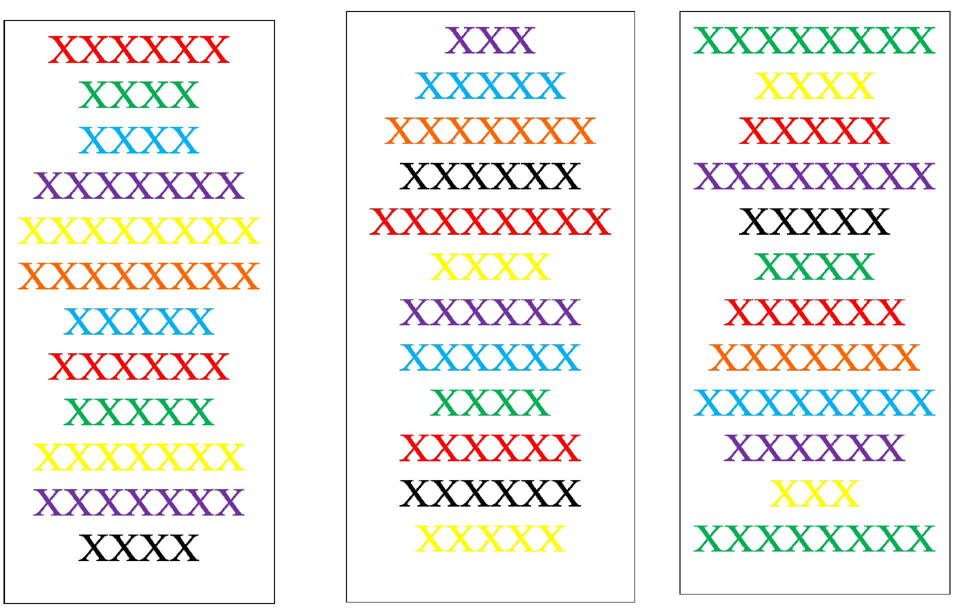
Sample Stimuli

Non-food Stimuli

Food Stimuli

Stroop Tests

“X-Word” Stroop Test



"Food-word" Stroop Test

Tomato	Egg	Cucumber
Corn	Onion	Milk
Milk	Coconut	Bacon
Avocado	Carrot	Zucchini
Broccoli	Cantaloupe	Bacon
Strawberry	Rice	Okra
Apple	Potato	Wasabi
Coffee	Peanut	Popcorn
Peach	Steak	Clementine
Spinach	Celery	Coffee
Popcorn	Radish	Egg
Plum	Grits	Strawberry

Appendix B

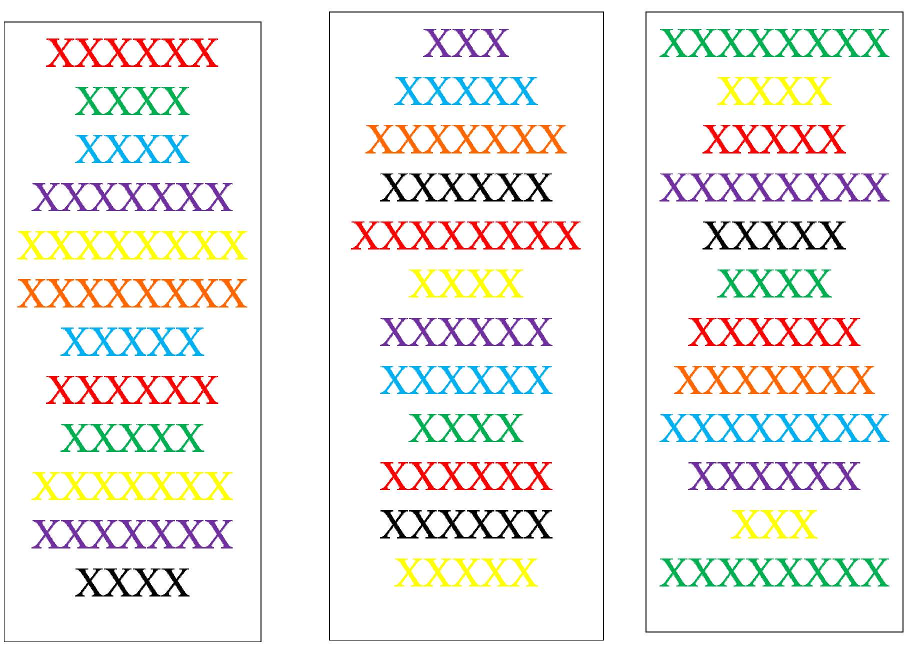
Sample Stimuli

Positive Stimuli

Negative Stimuli

Stroop Tests

"X-Word" Stroop Test



"Positive-word" Stroop

Warm	Sunset	Family
Hugs	Smile	Music
Cocoa	Comfort	Birthday
Puppies	Relax	Mom
Bonfire	Love	Ice cream
Kisses	Rainbows	Pajamas
Cozy	Bubbly	Rosy
Blanket	Beach	Hearts
Flower	Breezy	Trust
Happy	Heart	Candy
Cake	Couch	Coffee
Smores	Excited	Sunshine

"Negative-word" Stroop

Spiders	Haunted	Shark
Death	Zombie	Disease
Crying	Fire	Mold
Homeless	Skull	Broke
Tear	Wreck	Bat
Snake	Tornado	Exams
Fail	Clown	Fear
Sad	Monster	Roach
Embarrass	Drown	Devil
Rat	Burn	Python
Ghost	Caged	Scared
Grave	Prison	Dark