The Journal of Undergraduate Research

Volume 9 *Journal of Undergraduate Research, Volume 9: 2011*

Article 3

2011

Anxiety and Visual Discriminations in Undergraduates

Katherine Bowers
South Dakota State University

Anxiety and Visual Discriminations in Undergraduates

Author: Katherine Bowers
Faculty Advisor: Debra Spear
Department: Psychology

ABSTRACT

Mathematics tests were used to create anxiety in undergraduates. Heart rates were recorded as a measure of anxiety. Following each mathematics test, participants completed a different visual discrimination tasks, Stroop Colored Word Tests, Where's Waldo Puzzles, and IQ Matching Tests. Reaction times and accuracy were measured for each task. The hypothesis was that those with more difficult mathematics tests would have longer reaction times and be less accurate. The results of the study suggest that mathematics anxiety did not have a significant effect on reaction times for any task, and was only significant for the accuracy of the IQ matching tests.

Keywords: visual discriminations, anxiety, stroop, IQ, where's Waldo, mathematics

ANXIETY AND VISUAL DISCRIMINATION IN UNDERGRADUATES

Visual discrimination is the ability to recognize and identify visual shapes, objects, and patterns in various forms. Many visual discrimination tasks are considered of average difficulty level under normal conditions. However, with the introduction of anxiety, visual discriminations become more difficult (Knights, 1965). Anxiety is the increase of heart rate due to a difficult, stressful situation. Anxiety is considered to consistently alter the result of visual discrimination tasks (Bai et al., 2009).

Research has shown that mathematics is thought to consistently induce anxiety (Bai et al., 2009). Geist (2010) found that mathematics anxiety is also very predictable when paired with strict time constraints. Alansari (2004) conducted Stroop colored-word tests on individuals who scored high on anxiety tests. They found that those with high levels of anxiety scored lower on Stroop tests than those with normal levels of anxiety. Head and Engley (1991), as well as Avram et al., (2010), found that anxiety increased reaction time (RT) for high and low level difficulty tasks. Britton et al., (2009) found that participant reaction times (RTs) increased when participants were under stress and had an increased heart rate. Bradley et al., (2010) researched the relationship between heart rate and anxiety. They found that heart rate increased with anxiety and that participants with lower heart rates (control group) were more accurate on a variety of tasks, including visual discrimination tasks. Hopko et al., (2002) found that self-reporting the increase of heart rate was accurate when using mathematics to induce anxiety.

In the current study, anxiety is induced by having the participants complete timed mathematics tests. The experimental group will only view each problem for 2,000 milliseconds then be presented with the multiple-choice answers. Answering incorrectly will result in the problem being repeated. The control group will have 10,000 milliseconds to view each problem and will then be presented with the multiple-choice answers. Answering incorrectly will not result in the problem being repeated for the control group (Appendix B). The hypothesis of the current study is that those who complete mathematics tests with strict time limits (experimental group) will be less accurate and have longer reaction times than those in the control group. Accuracy and reaction time will be measured across three different stimulus types, Stroop colored word tests, IQ matching tests, and Where's Waldo tests. The independent variables for this study are anxiety and type of visual discrimination tasks. This study is a 2 (Group Type [Control, Experimental]) x 3 (Visual Discrimination Task [Stroop, Where's Waldo, IQ]) Mixed Factorial design. Counter-balancing was used to ensure that the results were not due to the order of the visual discrimination tasks. Both groups will receive mathematics tests, however the control group will have more time to complete the task than those in the experimental group, those in the control group will also not have to repeat problems that are answered incorrectly. Accuracy and reaction time will be measured and compared for both groups to see if the independent variables had an effect.

METHOD

Participants

The Institutional Review Board (IRB) approved this experiment (IRB approval number 1103006-EXP). The recruitment for participants took place in five history classes and one psychology class. The participants were 18-24 years old and were current students of South Dakota State University. The experimenters visited the classes and asked for volunteers. Twenty-four participants completed the study and consented for their data to be included in the final analysis, 14 men and 10 women. The data from one man and one woman were thrown out due to errors with the stimulus presentation software. Students who met the following criteria were not allowed to participate: students with a current diagnosis of any form of psychiatric or behavioral disorder, students who at the time of testing were under the influence of alcohol, illegal substances, any form of antidepressant or anti-anxiety medication, antihistamines or any form or cold medication, students with a history of epilepsy or seizures, students taking medication for any form of Attention Deficit Disorder, students under 18 years of age and students who were colorblind. One professor offered compensation for participation in the form of extra credit. An alternate form of extra credit, worth the same amount of points, was offered for those that chose not to participate in the study. The possible benefits for participation included the opportunity to participate in and learn more about a psychological study. Possible risks of participation included minor anxiety or frustration. All participants were provided with the contact information for both experimenters, the project supervisor, the IRB, and the SDSU Counseling Center.

Materials

Heart rate recording sheets were used for participants to keep track of their heart rates, an experimenter made these. SuperLab (Versions 4.0 and 4.5) was the software used to conduct the study. Three types of visual discrimination stimuli were used. The Stroop colored word stimuli were experimenter made, the Where's Waldo puzzles were from *Where's Waldo? The Great Picture Hunt* (Handford, 2009) and *Where's Waldo? The Fantastic Journey* (Handford, 2006). The IQ matching questions were from *IQ Tests to Keep You Sharp* (Philip & Kenneth, 2002). The Stroop colored word stimuli were the following words: black, blue, green, brown, white, orange, yellow, purple, and pink. All of the words were in a color not matching the word (Appendix A). The Where's Waldo pictures were complex pictures of various scenes in which Waldo or Odlaw was hiding. The IQ matching questions were multiple-choice questions, and the participants were presented with the question and the answers on the same screen (Appendix A). All mathematics problems were addition and multiplication. The problems and answers were made in a drawing program by the experimenters. The red "WRONG" screen was also experimenter made (Appendix B).

Procedures

All sessions took place on campus and the experimenter completed the study with up to four participants in each session. The researcher read the consent form to the participants and asked that if anyone did not meet the requirements they should leave, and they would still be awarded extra credit. Participants were then instructed how to take a measure of their pulse using the carotid artery.

Before participants arrived they were placed in groups to determine which group they would be in (control or experimental) and which order they would complete the tasks (Version 1: Stroop, Waldo, IQ; Version 2: Waldo, IQ, Stroop; or Version 3: IQ, Waldo, Stroop). Each trial consisted of completing a mathematics test, a heart rate recording, and a visual discrimination task. All components were presented for each of the three visual discrimination tasks. For the math tests, the experimental group had 2 seconds to select a multiple-choice answer, and answering incorrectly resulted in a red screen being presented with the words "WRONG!!! Try Again," and the problem repeated. The control group had 10 seconds to select a multiple-choice answer and answering incorrectly did not result in the problem being repeated. There were twelve addition and multiplication mathematics problems (Appendix B).

For the Stroop task, the word "black" was displayed on the computer screen; the color of the word was purple. Participants were instructed to press the key that corresponded to the first letter of the color. For this example, the correct response was "P" because the word was colored purple. Participants only had 5 seconds to make a response. There were fifteen different stimuli in the Stroop colored word section. The Where's Waldo task started with a picture of Waldo and Odlaw. For each picture shown, participants were to press W if the picture contained Waldo, or O if the picture contained Odlaw. They had 10 seconds for each stimulus. There were twenty different stimuli in the Where's Waldo section. For the IQ section, participants were shown a series of symbols and asked to find which one did not fit in with the rest, and press the key A, B, C, D, or E, that corresponded to the correct answer. Participants were informed that for each problem, they were to determine either which shape

did not fit, or which shape should come next in a series. They had 10 seconds to complete each stimulus. There were ten IQ questions. The experimenter debriefed the participants and told them what the experiment was measuring and the hypothesis. All participants were given the contact information of both experimenters, the project supervisor, the IRB and the SDSU counseling center.

Results

The control group was more accurate on all math tests than the experimental group. The average accuracy on the three math tests for the control and experimental groups is compared in Table 1. The most accurate group is the control group for math test 1. A mixed ANOVA shows there is a significant difference in accuracy on the different math tests, $F(2,40)=12.318$, $p=.0003$. The control group is more accurate than the experimental group. There is a significant difference in accuracy of the control and experimental groups, $F(1,20)=15.086$, $p=.01$. There is not a significant interaction between the accuracy on the math tests and group type, $F(2,40)=.591$, $p=.673$.

The average change in heart rate (HR) for the control and experimental groups are compared for HR 2, HR 3, and HR 4 in Figure 1. A mixed ANOVA shows there is not a significant difference in the HR change for the four HR recordings, $F(2,40)=.894$, $p=.417$. There is not a significant difference in HR change for the control and experimental groups, $F(1,20)=2.151$, $p=.158$. There is a significant interaction between HR change for group type and the four HR recordings, $F(2,40)=3.746$, $p=.03$. A post-hoc within *t*-test was conducted to see if there is a significant change in HR toward the end of the study. There is not a significant difference between the baseline HR and HR 3 and baseline HR and HR 4, $t(21)=1.48$, $p=.155$, two-tailed.

Accuracy on the visual discrimination tasks is shown in Figure 2. Participants are most accurate on the Stroop task. There is a significant difference in accuracy on the three visual discrimination tasks, $F(2,40)=193.94$, $p=2.87E-21$. Neither the control nor the experimental group is more accurate for all three tasks. There is not a significant difference in the accuracy of the control and experimental groups, $F(1,20)=1.749$, $p=.201$. There is not a significant interaction between the control and experimental groups and accuracy on the different tasks, $F(2,40)=1.589$, $p=.217$. The IQ task had the greatest difference in accuracy for the control and experimental groups. A post-hoc between *t*–test was conducted to compare the accuracy on the IQ task for the control and experimental groups. There is a significant difference between the accuracy on the IQ task and the control and experimental groups, $t(20)=1.93$, $p=.03$, one-tailed.

The average reaction times (ms) for the different visual discrimination tasks are compared in Figure 3. Participants are fastest on the Stroop task. There is a significant difference in the reaction times on the different tasks, $F(2,40)=133.142$, $p=2.52E-18$. Participants in experimental group are faster than the control group on all three tasks. There is not a significant difference in the reaction times on the control and experimental groups, $F(1,20)=.476$, $p=.498$. There is not a significant interaction in the reaction times of group type and the reaction times on the different tasks, $F(2,40)=.017$, $p=.984$.

Discussion

The hypothesis of the current study was that with the presence of anxiety, accuracy on visual discrimination tasks would decrease and reaction time (RT) would increase. Anxiety was induced by using timed mathematics tests and measured by self-report heart rate. Heart rate was only a measure of anxiety, not a variable. The mathematics tests were more difficult for the experimental group than the control group. There was not a significant difference in accuracy on the three math tests. However, the third math test had the lowest accuracy for both the control and experimental groups. This may be due to the third math test containing more multiplication problems than the other two tests. A Latin square design was used to rule out the order effect in the mathematics tests.

The increase in heart rate was not significant when comparing the average HR change of the control and experimental groups. However, there was an interaction between the control and experimental groups and the different HR changes. For the experimental group, HR 4 produced the greatest change from the baseline, which was taken after the final math test. This slight increase in HR was most likely due to the participants in the experimental group getting frustrated and tired due to task completion.

There was not a significant difference in the accuracy of the control and experimental groups on the Stroop colored word test or the Where's Waldo tests. However, the control group was significantly more accurate on the IQ task. According to Richards and French (1992), anxiety reduces the accuracy on visual discrimination tasks. The IQ questions were the most difficult out of the tasks. This is due to the questions being more complex and difficult to answer correctly in the given time compared to the other tasks. This suggests that perhaps the actual IQ questions, not the math tests, raised the anxiety of the participants. The Stroop colored word questions were the least difficult of the tasks. This is evident in the very high accuracy on this task and minimal difference in accuracy for the control and experimental groups. According to this same concept, that difficult tasks produced more anxiety than math, the Stroop task produced the least anxiety during the actual task because it was the easiest task. According to Alansari (2004), those with increased anxiety were less accurate on Stroop colored word tasks than those who were not anxious. If the Stroop task was more difficult (more anxiety provoking), the differences in accuracy between the control and experimental group would most likely be greater. This is also true for the Where's Waldo task. If the actual task was more difficult, it might have produced more anxiety during the task than was produced during the math tests, which would have reduced accuracy for the experimental group. If all the visual discrimination tasks were as difficult as the IQ task, significance might have been found for accuracy on the different visual discrimination tasks.

There was not a significant difference in the RTs for the control and experimental groups with regard to the different tasks. Increased HR has been correlated with increased reaction times (Head & Engley 2002). Britton et al., (2009) also found that as HR increased, RT increased. However, the difference in HR for the control and experimental groups, in the current study, did not achieve statistical significance. This suggests that the anxiety was not sufficient in altering the average reaction times of the control and experimental group on any of the tasks.

In the current study, this lack of difference in both reaction time and accuracy between the groups is most likely due to low anxiety. The participants also may not have been

anxious for the duration of task completion. In sessions where multiple participants were completing the experiment, some participants had to wait after completing the math tests for all other participants to finish the math test. This may have resulted in a decrease in anxiety. The decrease in anxiety may not have been evident in the results because anxiety may have decreased faster than actual HR decreased.

Possible confounding variables are the warm temperature of the experimental room, task timing, and instruction errors. Temperature of the room would affect the results because if the room was very warm at the time of the study, the participants would be distracted and may not pay attention to the actual tasks. Temperature may also have caused participants to hurry through the tasks in an attempt to complete the study as soon as possible.

The timing of the tasks also may contribute to the lack of significance in the results. If participants selected an answer at the end of the time limit, they would often accidentally select an answer at the start of the next question, resulting in very fast RT. However, this was not examined in the current study. Instruction errors may have also affected the results. There were errors in the script that were not discovered until participant sessions had already begun. These errors were minor and included incorrect instructions, such as "Press P" when the correct key was "X." These errors could have contributed to the insignificance of the results because if participants received incorrect instructions, they were more likely to not pay attention to the rest of the study. Inaccurate instructions would result in the participants devaluing the study and not paying attention to the actual tasks.

The current study did not use the same recruitment measures as those of Bradley et al., (2010) who required participation as part of a class. Requiring participation would increase participant motivation. In addition, Geist (2010) used money as compensation for participants. This would also increase motivation. Because the current study did not require participation and did not offer money as compensation, this most likely caused participants to have lack of motivation about completing the experiment resulting in overall low anxiety.

ACKNOWLEDGEMENTS

Special thanks to Dr. Debra Spear, for guidance, leadership, helping this project become a reality and editing this article. Thanks to Kasandra Johnson, my research partner, for not only being a researcher, but also for being a friend. Thanks to Professor Christopher Hummel and Dr. Andrew Woster, for allowing me and Kasandra to recruit participants in their classes. Thanks to the Psychology department for giving me this opportunity.

REFERENCES

Alansari, B. (2004). The relationship between anxiety and cognitive style measured on the Stroop test. *Social Behavior & Personality*, 32(3), 283-293.

Avram, U., Baltes, F. R., Miclea, M., & Miu, A. C. (2010). Frontal EEG activation asymmetry reflects cognitive biases in anxiety: Evidence from an emotional face Stroop task. *Applied Psychophysiology & Biofeedback*, 35(4). 285-292. doi: 10.1007/s10484-010-9138-6

Bai, H., Wang, L., Wei, P., & Frey, M. (2009). Measuring mathematics anxiety: Psychometric analysis of a bidimensional affective scale. *Journal of Instructional Psychology*, 36(3). 185-193.

Bradley, R. T., McCraty, R., Atkinson, M., Tomasino, D., Daugherty, A., & Arguelies, L. (2010). Emotional self-regulation, psychophysiological coherence, and test anxiety: Results from an experiment using electrophysiologial measures. *Applied Psychophysiology & Biofeedback*, 35(4). 261-283. doi: 10.1007/s10484-010-9134-x

Britton, J. C., Gold, A. L., Deckersbach, T., & Rauch, S. L. (2009). Functional MRI study of specific animal phobia using an event-related emotional counting Stroop paradigm. *Depression & Anxiety*, 26(9). 796-805. doi: 10.1002/da.20569

Geist, E. (2010). The anti-curriculum: combating math anxiety in the classroom. *Journal of Instructional Psychology*, 37(1). 24-31. Retrieved from http://web.ebscohost.com.excelsior.sdstate.edu

Handford, M. (2006). *Where's Waldo? The Great Picture Hunt*. Somerville, Massachusetts: Candlewick.

Handford, M. (2002). *Where's Waldo? The Fantastic Journey*. Somerville, Massachusetts: Candlewick.

Head, L. Q., & Engley, E. (1991). The effects of trait anxiety on state anxiety and perception test difficulty for undergraduates administered high and low difficulty tests. *Journal of Instructional Psychology*, 18(1). 65-71. Retrieved from http://web.ebscohost.com.excelsior.sdstate.edu

Hopko, D. R., McNeil, D. W., Gleason, P. J., & Rabalais, A. E. (2002). The emotional Stroop paradigm: Performance as a function of stimulus properties and self-reported mathematics anxiety. *Cognitive Therapy & Research*, 26(2). 157-166. Retrieved from http://web.ebscohost.com.excelsior.sdstate.edu

Knights, R. M. (1965). Test anxiety and visual discrimination of social scenes. *Child Development*, 36(4). 1083-1092. Retrieved from http://web.ebscohost.com.excelsior.sdstate.edu

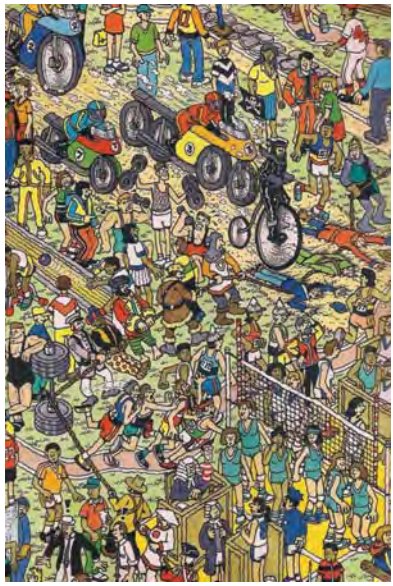
Philip, J. C & Kenneth, A. R. (2002). *IQ Tests To Keep You Sharp*. New York, New York: Sterling.

Richards, A., French, C. C. (1992). Effects of mood manipulation and anxiety on performance of an emotional Stroop task. *British Journal of Psychology*, 83(4). 479-491.

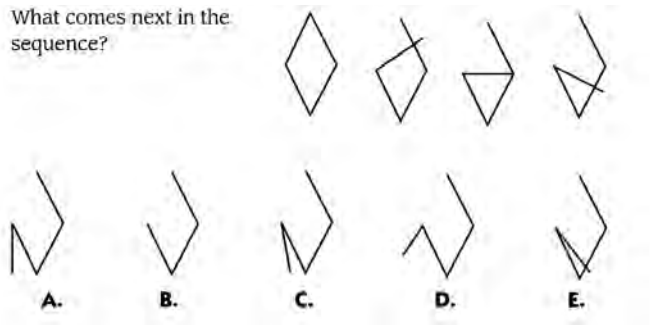
SuperLab (Versions 4.0 and 4.5) [Computer Software]. Pedro, CA: Cedrus Corportation.

APPENDIX A

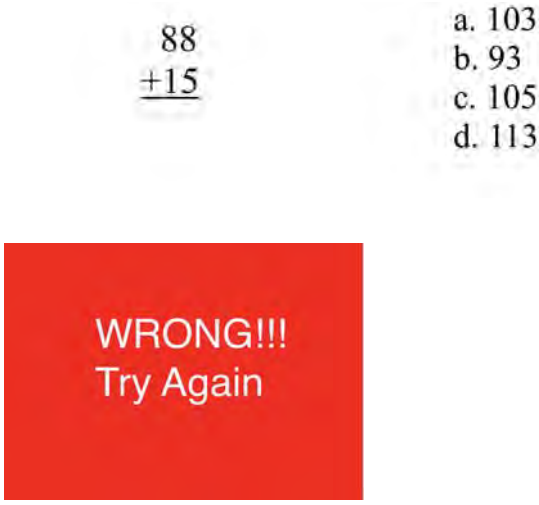
Black



(Hanford, 2006)



(Phillip and Kenneth, 2002)



APPENDIX B

Table 1. Means and Standard Deviations of Math Tests 1, 2, 3 and Total

	Test 1	Test 2	Test 3	Total
Control	*M*=96.97	*M*=91.67	*M*=82.58	*M*=90.40
	SD=4.20	*SD*=10.54	*SD*=14.17	*SD*=7.59
Experimental	*M*=81.82	*M*=71.21	*M*=65.91	*M*=72.98
	SD=13.34	*SD*=16.82	*SD*=16.86	*SD*=12.80

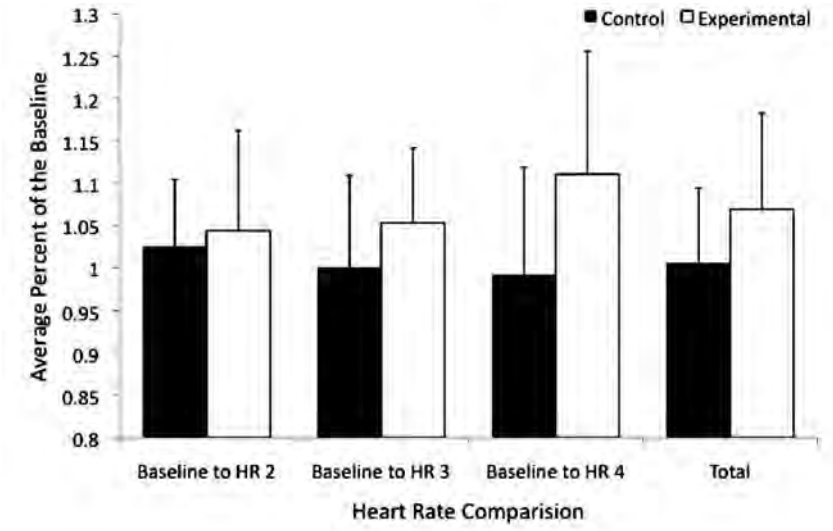


Figure 1. The average change in heart rate from the baseline for the control and experimental groups. Error bars denote standard deviations.

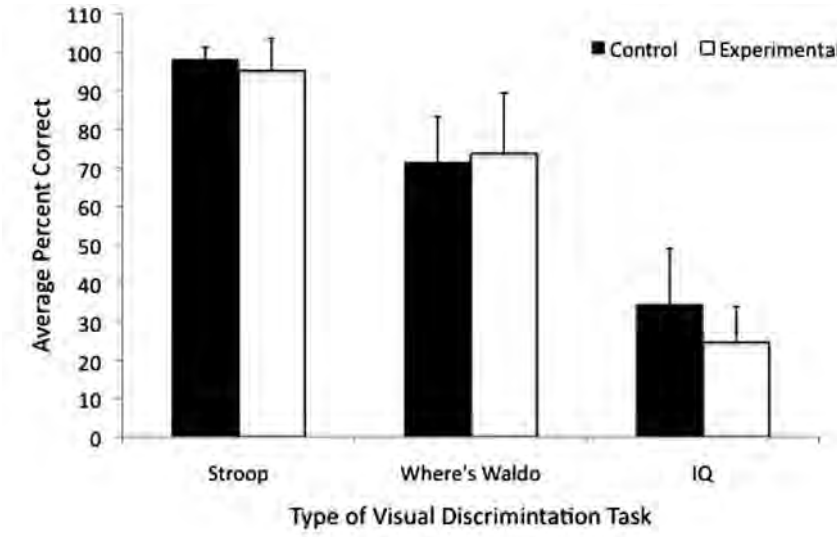


Figure 2. The average percent correct for the different visual discrimination tasks are illustrated for the control and experimental groups. Error bars denote standard deviations.

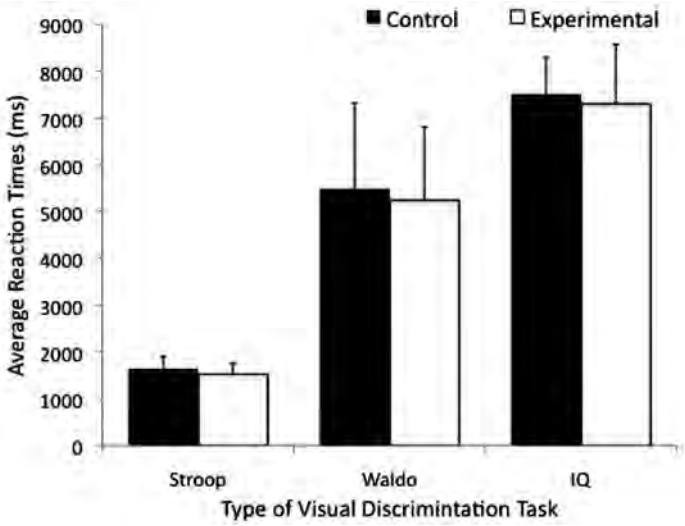


Figure 3. The average reaction times (ms) for the different visual discrimination tasks are illustrated for the control and experimental groups. Error bars denote standard deviations.