Introduction.

The Stroop Interference effect is a psychological phenomenon in which people are more susceptible to making errors when naming the ink color of a word when the word itself is a color that is different from the ink. The Taboo Stroop effect relates to a similar phenomenon in which participants are more prone to delayed responses in naming the ink color of a word when presented with emotionally-charged, taboo words in comparison to neutral words.

In Mackay et al. (2004), 28 participants were presented with two different sets of stimuli (taboo and neutral words with differing emotional valence) and tested on two accounts of the taboo Stroop effect. They hypothesized that threat-linked stimuli, as in taboo words with high arousal properties, are denied entry into participants' awareness, which ultimately slows down their inhibitory processes and delays color-naming. Secondly, they hypothesized that taboo stimuli results in an attentional strategy in which participants attend to the meanings of such words, limiting the processing of font color and color names. To test both hypotheses, both variables appeared in five colors (blue, gray, brown, green, and red) and participants were tasked to name the font color of each word as quickly as possible. At the end of the experiment, they were also tasked with a "surprise memory" test, in which they recalled as many words from the preceding test as they could. Ultimately, their findings reflected a decrease in reaction times with trial number for taboo words, but not for neutral words, contradicting their first hypothesis, and a superior recollection of taboo words relative to neutral words, rejecting their second.

Contradictory to the previous experiment's findings, Hansen et al. (2019) found that, when participants were asked to name pictures while ignoring distractor words (which were neutral, taboo, or phonologically-related taboo), naming latency relative to the taboo stimuli was significantly slower than the neutral condition, and the same for the phonologically-related taboo

condition. With that being said, the purpose of our study was to replicate the first experiment in Mackay et al., without testing the inhibition-of-awareness hypothesis, to see how true these results are, as they appear to be counter-intuitive and not a consistent finding. For the Stroop effect, I hypothesized that incongruent stimuli (color words that are different from its ink color) would have greater RTs in comparison to congruent stimuli - aligning with the original experiment's results. For the taboo Stroop effect, I hypothesized that, although Mackay et al. did not find a strong, positive relationship, taboo stimuli would have greater RTs in comparison to the neutral stimuli.

Methods.

Participants. 36 participants were recruited in an undergraduate cognitive neuroscience course.

Materials. For the experiment, we used E-Prime on Mac computers running Windows in Bootcamp. There were a total of five colors (red, green, blue, purple, and maroon) for both the Stroop and taboo Stroop tasks. All stimulus words appeared in our five colors on the computer screen in 18-point, Consolas font against a white background. Our main independent variables were word-type (congruent vs incongruent, taboo vs neutral).

Procedure. Participants were first presented with consent forms regarding the psychological discomfort which may stem from exposure to socially "taboo" words. They were then provided with instructions on how to respond to the color of the ink regardless of the word, with each of our five colors corresponding to a number ranging from 1-5. For numbers 1-4, participants were instructed to use their four fingers on their left hand, and for number 5, they were told to use one finger on their right hand.

The experiment had a total of 3 blocks: practice Stroop, Stroop, and taboo Stroop. After the consent forms and instructions, five practice trials (2 congruent, 3 incongruent) were administered to familiarize participants with the Stroop effect. A 1000-msec fixation screen preceded each stimulus and a 1500-msec feedback screen followed with their reaction time and mean accuracy. To eliminate time pressure, there was an infinite duration set for the actual response, with the test only continuing after user input (this holds true for all of our blocks/trials). The Stroop task displayed a set of 25 colored trials (5 congruent, 20 incongruent) all in a randomized order (no repeat after reset). Again, each stimulus was preceded with a 1000-msec fixation screen; however, there was no feedback screen presented. The taboo Stroop experiment utilized a total of 20 words (10 taboo, 10 neutral) which all appeared five times (once per color), totaling to 100 words displayed (50 taboo, 50 neutral). Both the taboo and neutral words were similar phonetically and in their length. All stimuli were shown in a randomized order and preceded with a 1000-msec fixation screen, with no feedback screen being shown afterwards. We measured the RT and accuracy per stimulus.

Our method differed from the original experiments due to ours being more computational (i..e, hitting a numerical key on the computer's keyboard), while the others were verbalized or written responses. Additionally, our sample size (n = 36) was actually larger than that in Mackay et al. (n = 28); however, it was smaller than the original Stroop experiment (n = 70). Likewise, while we administered 25 trials for the Stroop task, Stroop used a total of 100 words in his first experiment, and while we used 100 trials for the taboo Stroop task, Mackay et al. provided 438. Despite these differences, however, we appear to have yielded similar results.

Stroop Results.

The mean accuracy for the Stroop effect experiment was 83.23%, ranging in participant accuracy from 4% to 100%. The incongruent stimuli had an 85.82 msec greater mean RT relative to the congruent stimuli (refer to Figure 1 below). There was a significant main effect of congruence, $F(1,27) = 15.53$, $p < 0.001$.

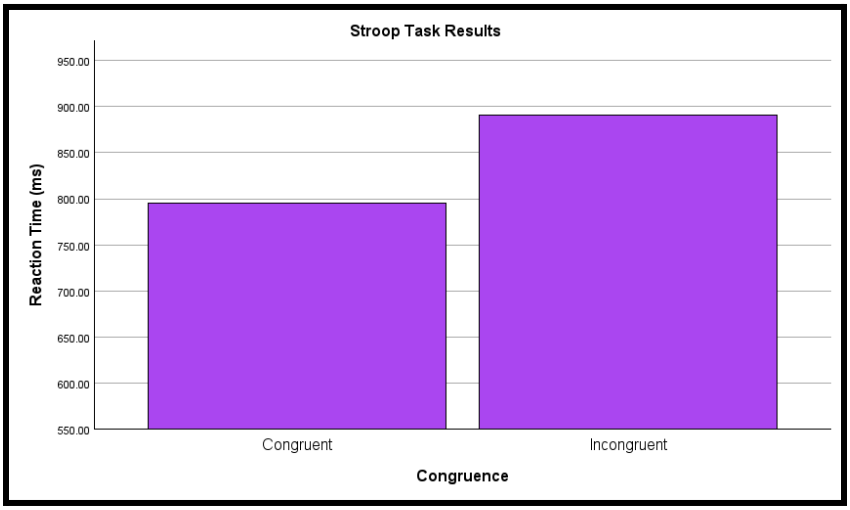

Figure 1. Mean response time for incongruent and congruent stimuli during the Stroop Task, measured in milliseconds. Congruent responses averaged to an 890.72 msec RT, while incongruent responses averaged to an 804.90 msec RT.

Taboo Stroop Results.

The mean accuracy for the Taboo Stroop effect was 93.06%, ranging in participant accuracy from 58% to 100%. The taboo stimuli only had a 12.25 msec greater mean RT relative to the neutral stimuli, not providing enough evidence for us to reject the null hypothesis (refer to figure 2 below). There was no significant effect of tabooness, $F(1,27) = 2.29$, $p = 0.140$.

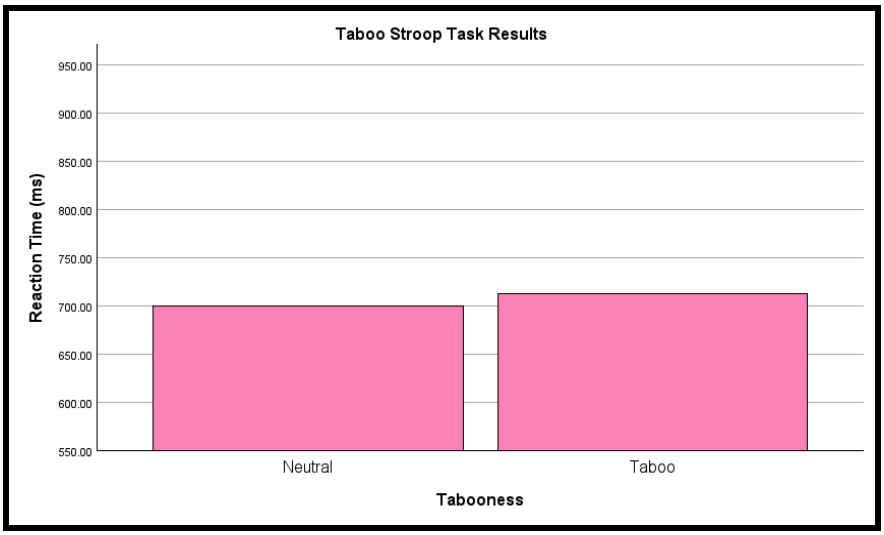

Figure 2. Mean response time for neutral and taboo stimuli during the Taboo Stroop Task, measured in milliseconds. Neutral responses averaged to a 700.37 msec RT, while taboo responses averaged to a 712.62 msec RT.

Correlation Analysis Results.

The Stroop interference variable ranged from -311.10 msec to 602.60 msec, with a mean value of 95.61 msec, while the Taboo interference variable ranged from -88.36 msec to 102.54 msec, with a mean value of 12.24 msec. The Stroop interference variable was taken by subtracting each participant's incongruent RT by their congruent RT and taking the mean of those values. Similarly, the taboo Stroop interference variable was measured by subtracting each participant's taboo RT by their neutral RT and taking the mean of those values. There was not a significant correlation between Stroop interference and Taboo interference ($r = 0.23$, $p = 0.176$).

Discussion.

After analyzing the results of both experiments, it is clear that although our Stroop effect was successful in regards to showing a strong relationship between incongruence and reaction times, our taboo Stroop effect was not. There is not enough substantial evidence for us to reject the null hypothesis that there is no correspondence between tabooness and reaction times,

supporting the original finding by Mackay et al. However, while we used general RTs grouped by our two stimuli in our analysis, the original experiment yielded RTs based on individual words via their trial number, depicting a decrease in RTs with trial number for taboo words specifically. Our study does not show such differentiation, hindering our replicability of the original results.

Although we should be cautious in drawing conclusions based solely on these two experiments, we can reasonably conclude, at this time, that tabooness is not as impactful on our inhibitory processes as incongruent stimuli is. This conclusion, thus, will need to be further investigated and replicated in order to confidently confirm the truthfulness of these results. With that being said, assuming that the findings of Mackay et al. are real, our results may suggest that the emotionalism which drives this theory of tabooness may be a temporary effect. Their hypothesis was motivated by the theory that "emotional reactions 'soak up processing resources', and clinical and emotional Stroop effects occur when limited-capacity attentional resources are allocated to threatening stimuli, thereby reducing resources available for processing and responding to other stimuli" (474). Our findings indicate that although this hoarding of processing resources in negatively-charged stimuli may hold true, after a certain point, the surprisal levels decrease and thus the effectiveness of this neurological blockage follows. This can be supported based on the fact that as more taboo stimuli was provided to participants in Mackay et al., RTs decreased as opposed to increased, meaning that participants may have gained desensitization as exposure to these stimuli progressed.

So why was there an opposite finding for Hansen et al.? Perhaps there is more of a cultural or generational explanation in contrast to an overall generalization of the population. Taking into account that Mackay et al. originated from the city of Los Angeles and our most

recent experiment was in Claremont, California, the results may have varied due to the experiment in Hansen et al. being based in Australia. There may be certain levels of exposure to typically “taboo” verbiage in which residents of Southern California produce or consume more than those in Australia. As I was experimenting with my select participants, I witnessed a slight giggle or arousal at the first few appearances of negative stimuli, yet an overall indifference towards both the neutral and taboo words. Is this due to our definition of what is “taboo” adapting? Or is there something fundamentally neurological which differs cross-culturally or cross-linguistically? If I were to replicate this study in the future, in order to enhance my understanding of the nature of the Stroop and taboo Stroop effects, I would diversify my participants based on region, culture, and/or religion to see how the results fluctuate with respect to these variables.

References

Mackay, D. G., Shafto, M., Taylor, J. K., Marian, D. E., Abrams, L., & Dyer, J. R. (2004). Relations between emotion, memory, and attention: Evidence from taboo Stroop, lexical decision, and immediate memory tasks. *Memory & Cognition*, *32*(3), 474–488. https://doi.org/10.3758/bf03195840

Hansen, S. J., McMahon, K. L., & de Zubicaray, G. I. (2019). The neurobiology of taboo language processing: fMRI evidence during spoken word production. *Social Cognitive and Affective Neuroscience*, *14*(3), 271–279. https://doi.org/10.1093/scan/nsz009

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology: General*, *121*(1), 15–23. https://doi.org/10.1037/0096-3445.121.1.15