4-20-2020

Examining the Roles of Font Size and Presentation Rate in Participants' Judgments of Learning and Memory Performance

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by

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An Honors Capstone

submitted in partial fulfillment of the requirements

for the Honors Diploma

to

The Honors College

of

The University of Alabama in Huntsville

April 20, 2020

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Abstract

The manipulation of font size and presentation rate of presented stimuli can affect how participants perceive the fluency of the stimuli, which can be observed using judgments of learning (JOLs) and recognition hit rates. The present study manipulated fluency by altering presentation rates (250, 1000, 3000ms) and the font size (small - 18 pt and large - 48 pt) in which words were presented. Each word presented during the criterion task was presented in either small or large font and at one of the three presentation rates. JOLs were expected to be higher for large font than small font words and the hit rates for small font words were expected to be greater than or equal to those of large font words. For presentation rate, I predicted that both JOLs and hit rates would increase as the presentation rate increased. Participants (N = 42) were instructed to provide a JOL for a future recognition task immediately after studying each word. After studying 72 words, a recognition task asked participants to report whether 96 words (72 studied words and 24 new words) were previously studied or not. The results showed significant effects, as well as interaction effects, for all factors. Small font words received higher JOLs than the predicted large font words. The highest JOLs for presentation rate were given to words presented at 1000 ms, followed by words presented at 3000 ms. Results for hit rates showed that large font words were recognized significantly more than small font words and that as the presentation rate increased, so did the hit rates. The results suggest that participants' beliefs influenced how they approached and encoded the presented words. Future research containing a longer presentation rate is suggested to further explore these findings.

Keywords: font size, presentation rate, judgments of learning, hit rates

Examining the Roles of Font Size and Presentation Rate in Participants' Judgments of Learning and Memory Performance

Fluency refers to the ease with which information is processed (Alter, 2013). A variety of factors have been identified that influence individuals' perceptions of fluency. Concerning the presentation of word stimuli, the factors that have been found to manipulate fluency include font size (Rhodes & Castel, 2008), presentation rate (Malmberg & Nelson, 2003), altered formatting of words (Mueller, Dunlosky, Tauber, & Rhodes, 2014), the frequency of words in everyday use (Malmberg and Nelson), and masking techniques (Yang, Huang, & Shanks, 2018). Researchers examine how fluency affects participants' perception by collecting judgments of learning (JOL), which are self-made predictions about the likelihood an individual will remember recently studied information. Lower JOLs indicate less chance of remembering and higher JOLs reflect a greater chance of remembering the material on a later memory test. In previous research, participants often give higher JOLs to large font items even though there is no observed difference in memory performance, leading Rhodes and Castel to deem this response the font size effect. By collecting participants' JOLs, researchers can gain insight into how stimuli are perceived, particularly whether they are perceived as fluent. Many counterarguments to fluency exist within current research and include participants' beliefs, disfluency of stimuli, and stimuli cues.

Beliefs

The cue-utilization view suggests that there are two frameworks that can be used as the basis for participants' JOLs. The experience-based frameworks state that participants make JOLs that are based on their feelings or prior experiences. Theory-based frameworks argue that

participants hold beliefs about how manipulated cues influence memory and thus they make JOLs based on these beliefs (Su, Li, Zheng, Hu, Fan, & Luo, 2018).

To explore the role of font size in participant's respective JOLs, Mueller, Dunlosky, Tauber, and Rhodes (2014) conducted studies using words presented in small and large font. They wanted to observe if differences in JOLs could be attributed to participants' beliefs about large font words, or if fluency remained the only deciding factor. Mueller et al. presented participants with words in both small and large font sizes, observed chosen study times for words in different font sizes, and occluded word presentation by presenting black rectangles to illustrate the size of each font size. They collected prestudy JOLs, which are thought to be based solely on beliefs given that participants provide them after seeing the size of the black rectangle but without seeing the to-be-remembered word, thereby removing any influence of fluency on participants' JOLs. They found that JOLs were greater for words presented in larger fonts than those presented in smaller fonts. Mueller et al. suggested that participants' beliefs about font size influenced their memory performance and led them to provide large font words with higher JOLs. From this perspective, participants hold the belief that large font words are more memorable than small font words and thus provide JOLs that align with their beliefs. While it is possible that these beliefs could have been formed prior to the experiment, Mueller and colleagues suggest that participants construct their beliefs within the experimental context when they are exposed to the specific demands required of them. Overall, Mueller and colleagues argue that participants' JOL ratings are primarily affected by their beliefs rather than their perceptions of fluency.

The font size of presented items has been shown to significantly influence participants' JOLs. Hu, Li, Zheng, Su, Liu, and Luo (2015) examined whether the font-size effect could be

influenced by participants' metamemory beliefs. Hu and colleagues applied a learner-observer paradigm where participants in the observer group examined the study phase of the learner group and made JOLs for the learners based on a given cue. By comparing the differences between the groups, Hu et al. would be able to determine if beliefs or other factors are the basis for the JOLs given by each group. Results from their experiment revealed that the mean JOLs in both the learner and observer groups were higher for large font words than small font words. The difference in JOLs between small and large font words was significantly larger in the observer group, which indicates that participants' beliefs about their memory played a role in the font-size effect in JOLs. Further exploring the role of beliefs, Hu and colleagues asked participants to provide belief-based recall predictions in a questionnaire prior to the exam, as well as provide their JOLs for large and small font words. Their results show that participants believe larger font words will evoke better memory performance and thus provided higher JOLs to large font words, confirming earlier findings that participants' beliefs contribute to their ratings and the font-size effect on participants' JOLs. In the learner-observer paradigm observers were not exposed to any indicators or examples of fluency yet still suggested, based on the beliefs they held, that words presented in large font would be more memorable than their small font counterparts. Overall, Hu et al.'s research confirms participants' beliefs that large font words are easier to remember than small font words as large font words received higher JOLs than small font words.

In their work, Blake and Castel (2018) sought to directly manipulate participants' beliefs about font size in order to observe how beliefs directly affect judgments. They did so by conducting experiments that provided material that either strengthened participants' pre-existing beliefs about font size or sought to directly challenge it. Blake and Castel provided participants with feedback prior to each experiment that was structured as scientific evidence that either

stated large font words were easier to remember, small font words were easier to remember, or that font size was irrelevant to memory. It was predicted that when participants were given feedback that confirmed their beliefs that large font words are easier to remember than small font words, participants would strengthen their beliefs and demonstrate a difference between their JOLs for large and small font words. Results from the confirmatory feedback trial revealed that higher JOLs were given to large font words even though no difference was found between the fonts on the recall test. To further test the role of beliefs, Blake and Castel presented participants with the opposing belief that small font words are more easily remembered than large font words, predicting that if JOLs are solely attributable to beliefs there would be a reversal in the JOLs provided. The results showed that JOLs remained higher for large font words and, again, there was no difference in the amount of words recalled from each font size. Therefore, participants still relied on their own beliefs even when they were introduced to "evidence" that supported the contrary. Blake and Castel continued their research by again introducing conflicting evidence but by manipulating its presentation to be between trials. The introduced belief induces a distinctive font-size effect where when told that small font words are easier to remember, participants' JOLs for large font words slightly decreased but their JOLs for small font words remained the same. This belief did impact recall for items as participants did end up recalling more small font items when they were instructed that they were more memorable. Blake and Castel's research reveals that while participants' beliefs concerning font size are important, they are not the sole influence on the font-size effect. Instead Blake and Castel argue that a combination of beliefs and other factors are responsible for participants' JOLs.

Yang, Huang, and Shanks (2018) sought to examine if perceptual fluency underlies the font-size effect by employing the use of a continuous identification (CID) task. In this task, both

a target word and a masked word are presented in fixed-duration cycles where the presentation time increases for the target word and decreases for the masked word. As the words cycle through the target word becomes clearer and easier to perceive and the fluency of the word is measured by participants' identification response time. Participants gave higher JOLs to the large font words and they also recognized them faster than they recognized the small font words, although their memory performance did not differ as a function of font size. These results reveal that perceptual fluency differs between the font sizes and that it does contribute to the font-size effect. Yang and colleagues continued their research to determine how fluency affects participants' JOLs – either by directly creating a feeling-of-knowing or indirectly through people's prior beliefs. They also sought to determine whether the analytic processing theory or the dual-basis theory contributed more to the judgments participants made about the stimuli. Analytic processing theory suggests that a participant's beliefs are more dominant than the role of fluency in JOLs, and the dual-basis theory argues that both fluency and beliefs contribute to JOLs. Yang and colleagues used the learner-observer research method to measure participants' beliefs about the font-size effect and the fluency of the stimuli. In both the learner role and the observer role, participants gave higher JOLs to large font words. Their identification response times were faster for large font words suggesting that font size affects JOLs through the perceptual fluency of the stimuli. Yang and colleagues' results support the dual-basis theory, suggesting that participants' beliefs and the fluency of the stimuli contribute to participants' JOLs.

Su et al.'s (2018) research sought to measure both processing experiences and participants' beliefs and examine how they influence JOLs. They employed the use of self-paced study times to examine processing fluency, global differentiated predictions (GPREDs) to

measure pre-existing beliefs, and ease-of-reading (EOR) measurements to record item-specific beliefs about fluency. Su and colleagues found that participants gave large font words higher JOLs and that recall performance was not affected by font size, consistent with the font-size effect. Participants also provided higher EOR ratings to the words presented in large font and the researchers found that self-paced study times were not influenced by font size. Further exploring fluency and beliefs, Su et al. had another group of participants provide their GPREDs the day before they took part in the study task. They found similar results to their first experiment in that participants gave higher JOLs to large font words and that memory performance was not influenced by font size, suggesting the presence of pre-existing beliefs. Su and colleagues also discovered that the stronger the participants believed that large font words would be better recalled, the more likely they would give higher JOLs to large font words. Even when study time was controlled for, participants continued to give higher JOLs, GPREDs, and EORs for large font words. Su et al.'s research showed that participants do hold beliefs about font size and fluency, mediating the font-size effect, as found by previous research.

Stimuli Cues

Manipulation of presentation rate influences participants' perception of fluency, which was studied by Malmberg and Nelson (2003). Using low frequency (LF) and high frequency (HF) words, they conducted experiments to test the elevated-attention hypothesis that predicts LF words will be studied longer than HF words, while also manipulating the time participants received to study the words. Prior research has indicated that LF are more likely to be recognized as previously studied words than their HF counterparts, leading researchers to name this the LF hit rate (HR) advantage. Using single-item yes-no recognition experiments, Malmberg and Nelson asked participants to study individually presented HF and LF words at the experimenter-

controlled presentation rates of 250 ms and 2500 ms. The results confirmed the assumption of the LF HR advantage in that it was disrupted when the attentional resources were limited due to the study time manipulation. Following up on their initial experiment, Malmberg and Nelson conducted a replica study with the only change being a wider range of manipulated study times. This experiment too confirmed the prediction of the elevated-attention hypothesis in that hit rates were greater for LF words than HF words and that they increased with study time. Thus, they argue that LF words are advantageously processed and stored compared to HF words. Concerning the presentation rate, Malmberg and Nelson discovered that both LF and HF words were more likely to be recognized when presented for a longer presentation rate.

Disfluency and Fluency

Another argument concerning how participants approach their JOL ratings was presented by Alter (2013) in which he argued that it is not fluency, but disfluency, that affects how people process presented information. To test the impact of fluent and disfluent stimuli, Alter presented participants with questions in which he manipulated the fluency of the text and found that those exposed to disfluently presented questions were more likely to score higher overall. The outcomes of Alter's research confirm previous findings that even though participants rate fluently processed stimuli more positively they spend less time studying it and are more likely to superficially process it. In contrast, disfluent stimuli present participants with a cognitive roadblock, requiring them to slow down and process the stimuli more deeply. Concerning the application to academic settings, disfluency should be interjected at carefully considered moments during lectures or tasks to encourage students to pay attention when their mental resources are strained or depleted. These planned bursts permit the recovery of cognitive resources and allow individuals to pay closer attention and deeply process information.

Disfluency also helps inoculate people to the impending elimination of the need to process information on their own accord as machines become more prominent in everyday life. Overall, Alter argues that the disfluency of information can be beneficial for processing.

Rhodes and Castel (2008) asked participants to study a list of items, where half of the items were presented in small font and half were presented in large font, and then asked them to take a recognition test. After studying each word, participants were asked to provide a JOL. Rhodes and Castel found that JOLs were reliably higher for items presented in large font than in small font, despite there being no differences in memory performance as a function of font size, which, as previously noted, they called the font size effect. The influence of font size on JOLs persisted over several experiments where there was an additional study-test trial, more diagnostic bases for judgment of stimuli were present, when participants were explicitly warned that font size was unrelated to future memory performance, and when judgments of forgetting (JOFs), where participants judged the probability that an item would not be remembered for a future memory test, were elicited. They found that participants were strongly influenced by font size even though their performance on the memory tests was unrelated to font size. Based on these results, the authors concluded that large font words were subjectively perceived as more fluent than small font words, leading participants to give higher JOLs for large font than for small font words.

To further examine this effect, Rhodes and Castel manipulated the ease with which participants could read items by presenting words in an altered format where some words were composed of both lowercase and uppercase letters. Only with this manipulation of fluency did they find a reduction of the influence of font size in that JOLs did not differ between font sizes. Overall, Rhodes and Castel suggest that individuals make their memory predictions based on

fluently processed perceptual information, which leads to metacognitive illusions when the information does not contribute to memory performance.

The perceptual fluency hypothesis predicts that easily perceived items will be remembered better even if actual memory performance does not reflect this. Besken and Mulligan (2013) sought to test this hypothesis by presenting stimuli that were either perceptually interfered or perceptually fluent. Perceptually fluent words were easy to read and did not have any extraneous variables that interfered with the word's presentation. Words that were presented as perceptually interfered with were presented very briefly, 100 ms, and then backward masked. They predicted that items that are perceptually interfered will reduce participants' JOLs while improving their recall of the items. It is possible that perceptual fluency provides individuals with the illusion that those items that are easily perceived are also easy to recall, even though prior research has discounted this belief. Previous research concerning the perceptual fluency hypothesis confirms that words presented in a perceptual interference trial are recalled and recognized more than those words presented as perceptually fluent. It is thought that these words produce better memory performance because it induces higher compensatory responses to process them among the interference stimuli. Besken and Mulligan presented participants with words that were either perceptually fluent or interfered. Results revealed participants believed they would remember more words from the perceptually fluent condition, but their recall test performance demonstrated that they recalled more words from the perceptual interference condition, consistent with the hypothesis. Further exploring these results, they ran another experiment where they collected item-by-item JOLs as opposed to list-wide JOLs collected in the first experiment. Again, they found that participants rated words presented as perceptually fluent to be better remembered than those words in the perceptual interference trial. There was

no difference in the participants' memory performance between the two conditions which suggests that item-by-item JOL requests eliminated the perceptual interference effect in recall. It could be that requiring item-by-item JOLs diverted participant attention away from the word. Overall, Besken and Mulligan's research supports the idea that perceptual interference can influence JOLs and under some circumstances lead to deeper encoding of presented stimuli.

Undorf and Erdfelder (2011) sought to determine which hypothesis or theory is responsible for participants' formation of JOLs. They too employed the use of a learner-observer paradigm, along with self-paced study time, to collect both participants' JOLs based on experience with the stimuli and their beliefs about the stimuli. Every participant in their study was exposed to all three conditions (learning task, observing-with-difficulty task, observing-without-difficulty task) with counterbalancing among participants. The key to their design was that the JOLs provided by a participant in the learning task were then used in the subsequent observing-with-difficulty and observing-without-difficulty tasks. Therefore, any difference in their JOLs and study times could reveal the role of encoding fluency in the formation of JOLs for the respective condition. Results allowed Undorf and Erdfelder to draw the conclusion that encoding fluency was a cue for participants' JOLs only in the learning-first group, suggesting that self-study time is an influential cue for JOLs. Previous research, along with Undorf and Erdfelder's work, suggests that self-paced study time gives participants the opportunity to experience encoding fluency. Participants who were exposed to the learning-first conditions were not able to reconstruct their specific JOLs on the other tasks. The researchers found supporting evidence for encoding fluency as a cue used by participants to form their JOLs. Overall, Undorf and Erdfelder's results suggest that the ease-of-processing theory is the most supportive of how JOLs are formed by participants within the context of an experiment.

Current Study

For the current study, I drew on the different presentation rates used by Malmberg and Nelson (2003), as well as the different font sizes used in the Rhodes and Castel (2008) and Mueller et al. (2014) articles to examine how these impact participants' JOLs and memory performance. Essentially by manipulating fluency in two ways, font size and presentation rate, I was able to see whether JOLs and recognition performance vary. If a difference in JOLs as a function of presentation rate is not observed, it would suggest that memory beliefs are responsible for the font-size effect rather than fluency. For JOLs based on font size, I predicted that participants would give higher ratings to those words presented in large font that those presented in small font. Presentation rate JOLs, I predicted, would be greatest for those words presented at 3000 ms, followed by words presented at 1000 ms. Words presented at 250 ms were predicted to have the lowest JOLs. Concerning hit rates related to font size, I predicted that small font word hit rates would be greater than or equal to the hit rates for large font words. I predicted hit rates for presentation rates would be greatest at 3000 ms, followed by 1000 ms, and 250 ms would have the lowest hit rates.

Method

Participants

A total of 44 undergraduate students at The University of Alabama in Huntsville participated in the current study for course credit. Two participants were excluded as a result of not completing all the tasks. Of the 42 whose data were analyzed, the ages ranged from 17 to 30 years old (M = 19.47 years old, SD = 2.58) and 57.14% of the participants were female. The race demographics were 73.47% Caucasians, 16.33% African Americans, 6.12% Asians, 2.04% American Indian/Alaskan Natives, and 2.04% specified their race as other. The ethnic

demographics revealed that 4.55% of participants were Hispanic. All were native English speakers or had at least spoken it for 10 years. This study was submitted to and approved by the UAH Institutional Review Board.

Design

The study followed a 2 (Font: small, large) x 3 (Presentation rate: 250 ms, 1000 ms, 3000 ms) repeated measures within-subjects design where each participant was exposed to both font sizes and all three presentation rates. The independent variables were the manipulations of font size, with the large font presented in 48 pt font and the small font presented in 18 pt font, and the manipulation of presentation rate at 250 ms, 1000 ms, and 3000 ms. The dependent variables were the participants' JOLs and their performance on the recognition task for the words presented during the criterion task.

Materials

The words presented during the study phase were all concrete objects for which a mental image could easily be formed. The presented words were derived from a list previously developed and were vetted to exclude words that were not concrete or were brand names. The words employed in the study were all nouns and ranged from four to eight letters, as seen in Table 1. The current experiment was created and presented using E-Prime to ensure that all variables were controlled for and accurately collected. Two Qualtrics files were created – one contained the consent form, the personal data sheet, the Memory Controllability Inventory (MCI; Lachman, Bandura, Weaver, & Elliott, 1995), and the Advanced Vocabulary Test (AVT; Ekstrom, French, Harman, & Dermen, 1976), while the other contained the post-task questionnaire (PTQ). The Pattern Comparison Task (PCT; Salthouse, 1996) was presented using paper and pencil. The current experiment was composed of one trial, preceded by a practice trial

identical to the criterion task format, where a fixation point was presented for 1000 ms, followed by a word presented in either small or large font and at one of the three presentation rates, and a JOL request followed each word presentation. The JOLs were collected on a 0 to 100 scale, where 0 represented no chance of recognition and 100 represented certain chance of recognition. Global and differentiated beliefs were collected pre-practice, post-practice/pre-study, post-study, and post-recognition test concerning overall performance (global), as well as specific performance for each font size and presentation rate (differentiated). These measures collected participants' potentially changing beliefs about their performance on the recognition task as they progressed through the criterion task. A distractor task was presented before the recognition test to minimize the number of items participants could hold in their short-term memory. A script was written and used to conduct the experimental sessions and included instructions and guidance for the experiment.

Procedure

The sessions took place in group settings of up to 6 participants in CTC Basement 010-2F. The participants were greeted and shown to their respective computers, and then asked for a form of government-issued identification. Those participants who were under the age of 18 were additionally asked for their consent form signed by a parent or guardian. Participants were instructed to read and electronically sign and date the consent form presented via Qualtrics. After which they were guided through the personal data sheet, MCI, AVT, and PCT. The mean score for the AVT was 16.30, out of 36 words, with a standard deviation of 4.09[1]. After completion of these external measures, the participants were instructed to open E-Prime and enter in their

[1]Due to campus closure as a result of the COVID-19 pandemic, the mean scores for the MCI and PCT were unable to be calculated.

assigned identification number and correct condition value. A verbal review of the instructions was completed with participants and then they were instructed to read through them again on their own and begin the criterion task when they were ready.

Before the practice trial, participants were prompted to provide answers to the global and differentiated belief questions. The global belief questions asked participants to rate how many words out of the 72 presented would they likely recognize on the upcoming recognition task. Differentiated belief questions sought to break down their ratings by font size and presentation rate. The first differentiated belief asked participants to rate how many of the 36 small font words they expected to recognize, and the second differentiated belief asked how many of the 36 large font words they expected to recognize. Differentiated beliefs three, four, and five concern the presentation rates and asked participants to rate how many of the 12 words they expected to recognize at 250 ms, 1000 ms, and 3000 ms, respectively. The mean scores for each of these collected beliefs can be found in Table 2. The practice trial included both font sizes and all three presentation rates to allow participants to become familiar with the font sizes and presentation rates before the study trial. Post-practice trial, participants were again asked to record their global and differentiated beliefs after experiencing the stimuli in the practice trials. The study trial with the 72 to-be-studied words followed these prompts. The presented words in the study trial were equally distributed among the font sizes and presentation rates – 36 words presented in small font, 36 words presented in large font, with 12 words presented for 250 ms, 12 words presented for 1000 ms, and 12 words presented for 3000 ms within each font size. None of the words presented in the practice trials were presented during the study trial. The presentation of each word followed the same sequence where a fixation point was presented for 1000 ms, followed by the word presented in either small or large font and for either 250 ms, 1000 ms, or 3000 ms,

which was then followed by a JOL request. After completion of the trial, participants were again prompted to provide their global and differentiated beliefs. Then they were instructed to count backwards by 4 from 459 for 30 sec to reduce the number of items they could hold within their short-term memory.

Before they began the recognition task, participants were again prompted to provide their global and differentiated beliefs concerning how many words they expected to accurately recognize. After completion of these prompts, participants then began the recognition task where, when prompted with a word, they were asked to respond old by selecting the "O" button if they think they recognize the word from the trial or new by selecting the "N" button if they think the word was not presented during the study trial. After the recognition task, participants then gave their final global and differentiated responses about the experiment where they were asked to judge their previous performance on the recognition task. After this task was completed, they were presented with the PTQ that collected their beliefs about the experiment and reported whether their beliefs and ideas changed throughout the experiment. Each participant was then debriefed and dismissed. The experiment took 1.5 hours to complete and each participant was compensated 3 points on SONA.

Statistics

The JOLs and hit rates of each participant were coded to provide an overall mean for each studied word and recognition task response. These were then combined and averaged in SAS for all participants, which provided a mean JOL and mean HR for each font size and presentation rate. The data were transferred to SPSS where two repeated measures analyses of variance (ANOVAs) were performed, with significance set at $p < .05$.

Results

JOLs

The data revealed that there was a main effect of font size for JOLs, $F(1, 41) = 22.86$, $MSE = 41.05$, $p < .000$, $\eta^2_p = .36$. As seen in Figure 1, small font words were given higher JOLs than words presented in large font. A main effect was also present for presentation rate, $F(2, 82) = 7.54$, $MSE = 24.9$, $p < .003$, $\eta^2_p = .26$, as seen in Figure 2. The highest JOL ratings were given to words presented at 1000 ms, followed by words presented at 3000 ms. Those words presented at 250 ms received the lowest JOL ratings overall. The data also revealed a significant interaction for font size and presentation rate on JOL responses as seen in Figure 3, $F(2, 82) = 25.48$, $MSE = 43.05$, $p < .000$, $\eta^2_p = .54$. Small font words presented at 3000 ms had higher JOL ratings compared to large font words presented at 3000 ms.

Recognition Hit Rates

The recognition data also revealed a main effect for font size, $F(1, 41) = 7.49$, $MSE = .012$, $p < .009$, $\eta^2_p = .15$. As seen in Figure 4, the mean hit rates were greater for words presented in the large font than those presented in the small font. A main effect was found for presentation rates, $F(2, 82) = 27.45$, $MSE = 0.17$, $p < .000$, $\eta^2_p = .51$. As the presentation rate increased so did participants' hit rates, as displayed in Figure 5. An interaction of font size and presentation rate for hit rates was also found, $F(2, 82) = 4.65$, $MSE = .009$, $p < .026$, $\eta^2_p = .17$. As displayed in Figure 6, both font sizes showed an increase in hit rates as the presentation rate increased.

Discussion

The data revealed significant results which did not support any of the proposed hypotheses. A main effect was found for font size and presentation rate, and interaction effects between the two factors. The results show that higher JOLs were given to words presented in

small font than those presented in large font, which is contrary to many previous research findings. Rhodes and Castel's (2008) research revealed that participants gave higher JOLs for those words presented in large font than small font and suggested that this difference results from the perceived difference of fluency for each font size. According to previous research, large font words are proposed to be more fluent, but our research findings do not support those outcomes. The font-size effect, as described by Rhodes and Castel, suggested that there would not be a difference in memory performance as a function of font size. Research collected by Yang and colleagues (2018) revealed that the perceptual fluency of stimuli differs between font sizes, contributing to the font-size effect. They too found that participants gave higher JOLs to large font words even though memory performance did not significantly differ. In the current research participants perceived small font words to be more fluent than large font words even though their performance on the memory test contradicts their judgments. The current research also conflicts with Undorf and Erdfelder's (2011) finding that the ease-of-processing fluency is supportive of participants' JOLs. If this was true, then in our study participants should have rated and remembered the large font and longer presentation rates higher and better than the small font words. This suggests that while fluency and the font-size effect can impact how stimuli are perceived, it is not the only factor to do so.

Differences in the JOLs and hit rates pertaining to font size have also been attributed to participants' beliefs, as seen in the previous research of Mueller et al. (2014). Participants' beliefs concerning font size can affect their performance in that they may believe that items presented in large font are more memorable than those presented in small font and then adjust their JOL ratings accordingly. Concerning the outcomes of the current experiment, it is likely that participants developed beliefs within the context of the experiment after being exposed to

the stimuli. Exposure to large font words induced a belief in participants that they would not be remembered as well as those words presented in the small font. Not only are the current findings of participants' JOLs contrary to the research presented by Mueller and colleagues, they also directly contradict the findings of Hu et al.'s (2015) research on memory beliefs. In their research, they too found that participants were more likely to give higher JOLs to large font words than small font words, suggesting that participants' beliefs were influential in the font-size effect on JOL ratings. Blake and Castel's (2018) previous research is also directly contrasted by the results of the current research. They also found that participants heavily relied on their beliefs to form their JOLs. Even when introduced with conflicting evidence, participants still looked to their own beliefs that were either previously formed or developed within the experiment to form JOLs for the large and small font words. Su et al.'s (2018) research provides evidence that participants' beliefs contribute to the font-size effect, supported by the results of the current research. They also found that the stronger someone's belief about a font size, the more likely a participant is to give words presented in that font size higher JOLs. In our current study participants believed that smaller font words are more memorable, evident by the fact that participants gave higher JOLs for small font words in each presentation rate than they did for the large font words. However, it is important to note that even though participants' beliefs about font size are important, other factors contribute to the font-size effect.

Alter's (2013) research implies that disfluency of stimuli is what contributes to an individual's likelihood of remembering recently studied material. The difficulty that comes with processing information that is perceptually interfered with in turn results in deeper processing of that stimuli. The results of our experiment show a significant effect of JOLs concerning presentation rate. Overall the highest JOLs were given to words presented at 1000 ms, followed

by words presented at 3000 ms. Words presented at 250 ms received the lowest JOL ratings by participants. These results suggest that participants found those words presented for 1000 ms to be the most fluently presented stimuli, whereas those words presented at 250 ms and 3000 ms were much more disfluent. However, when observing participants' hit rates in the current study, results reveal that words presented at 3000 ms had the highest hit rates, followed by 1000 ms, and then 250 ms. Even though participants rated the 3000 ms presentation rate as less memorable than the 1000 ms items, they processed this information more deeply, supporting Alter's idea about disfluency. Besken and Mulligan (2013) found that words that are perceptually interfered with are more likely to engage higher compensatory processes and lead to deeper encoding of the stimuli. Participants believe that they will be able to recognize more fluent words because the perceived fluency of stimuli encourages individuals to think that those items are also easier to recognize or recall. Our current research does support this outcome in that participants believed that small font words were more perceptually fluent and thus easier to learn and remember, but their memory test performance reveals that recognition was greater large font words. This suggests that those words participants thought would be hardest to remember ended up being the easiest to recall, indicating that some deeper encoding and processing occurred.

The results also show a significant effect for hit rates for both font size and presentation rate, which is consistent with Malmberg and Nelson's (2003) prior research. When participants are given more study time for stimuli, they are more likely to remember it on a later memory test. This occurs even when participants do not judge that they would be able to accurately recall or recognize the material. Participants in the current study gave higher JOLs to small font words but produced the greatest hit rates for words presented in large font. This reveals that even when they judged that they would not recall those words presented in large font, they were able to recognize

those words more so than those words presented in small font. A significant effect also shows that participants were also more likely to accurately recognize those words that had been presented at a longer rate for both font sizes. This finding is again consistent with Malmberg and Nelson's findings that longer presentation rates allow participants to better encode the presented word and remember it for a later memory test.

The results of the current experiment do not support the presented hypotheses as there are main effects for font size and presentation rate, as well as interaction effects between the two for both JOLs and hit rates. Small font words displayed the hypothesized pattern for JOLs because they increased as the presentation rate increased. However, large font words did not adhere to the predicted patterns as they showed a drop in participant JOLs at the 3000 ms presentation rate. This indicates a possible lack of expectation to recognize these words on the later recognition test. Hit rates for both font sizes increase as the presentation rate increases, which does follow the predicted pattern. This conveys that participants were able to more accurately recognize those words that were presented for a longer presentation rate in each font size, even if they judged that they would be unable to.

The present study yielded some interesting, if not unexpected, results. For future research, I suggest adding longer presentation rates seeing that there was a significant effect for the words presented at 3000 ms. A longer presentation rate, like 4000 ms, will allow for observation to see if these effects are present in longer presentation rates. If current predictions are maintained, a 4000 ms presentation rate should receive the highest JOLs and the highest hit rates compared to the presentation rates used in the current study. However, this is an empirical question that must be tested.

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Table 1

Examples of Stimuli

Word	Number of Digits	Font (1 - small, 2 - large)	Presentation Rate
star	4	1	3000 ms
cufflink	8	2	250ms
window	6	1	1000 ms
truck	5	1	250ms
penguin	7	2	3000 ms

Table 2

Global and Differentiated Beliefs

Measurement	Mean Score	Standard Deviation
Pre-Study Global	26.56	20.80
Pre-Study Differentiated 1	15.58	6.40
Pre-Study Differentiated 2	17.84	8.57
Pre-Study Differentiated 3	10.53	5.36
Pre-Study Differentiated 4	11.70	5.23
Pre-Study Differentiated 5	13.81	6.37
Post-Practice Global	32.70	16.92
Post-Practice Differentiated 1	14.42	7.16
Post-Practice Differentiated 2	19.05	7.77
Post-Practice Differentiated 3	9.58	5.69
Post-Practice Differentiated 4	12.56	4.99
Post-Practice Differentiated 5	15.05	5.66
Post-Study Global	32.40	17.72
Post-Study Differentiated 1	15.12	6.30
Post-Study Differentiated 2	18.84	6.56
Post-Study Differentiated 3	10.35	5.84
Post-Study Differentiated 4	12.12	5.25
Post-Study Differentiated 5	14.58	6.35
Post-Recognition Global	40.00	17.34
Post-Recognition Differentiated 1	15.98	8.20
Post-Recognition Differentiated 2	20.09	8.08
Post-Recognition Differentiated 3	11.51	5.28
Post-Recognition Differentiated 4	13.42	5.42
Post-Recognition Differentiated 5	15.12	5.92

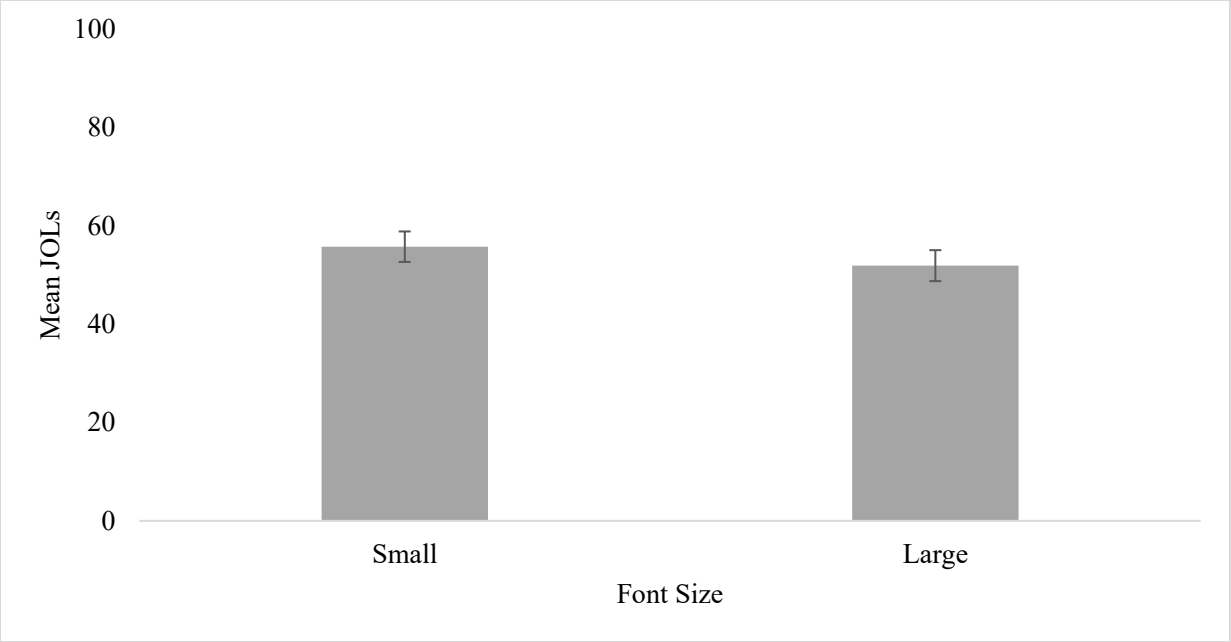

Figure 1. Small font words received the highest mean JOLs and large font words received the lowest mean JOLs.

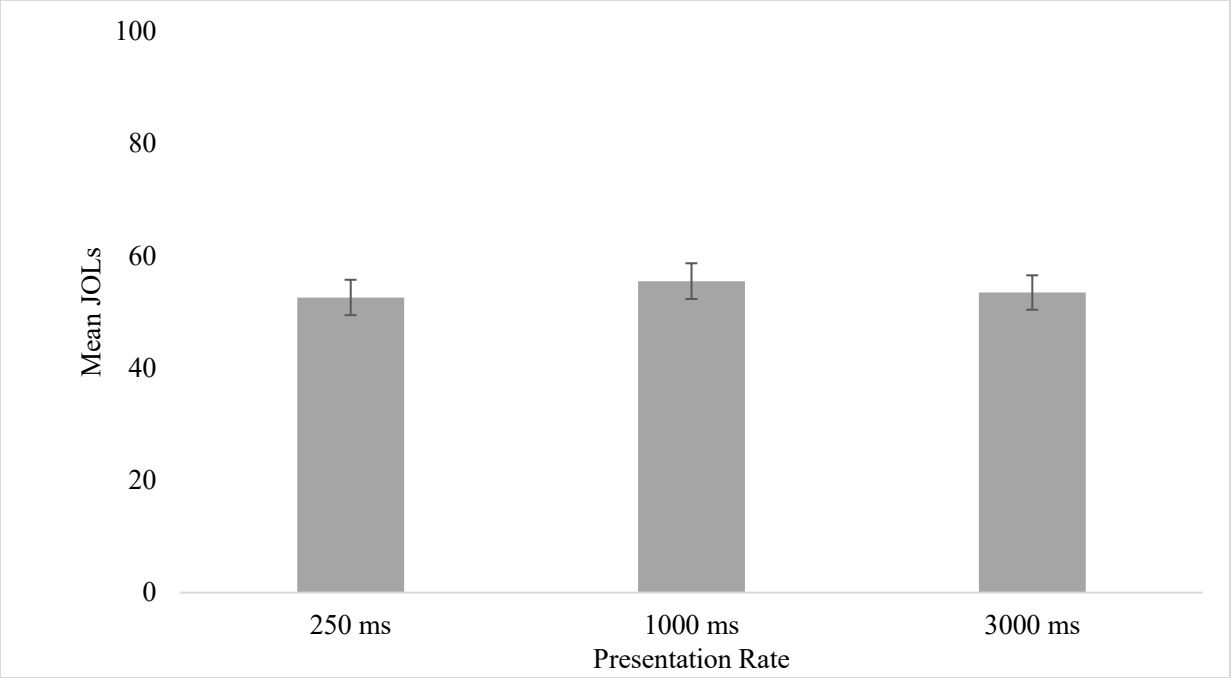

Figure 2. The words presented at 250 ms received the lowest mean JOLs, followed by words presented at 3000 ms, with words presented at 1000 ms receiving the highest mean JOLs.

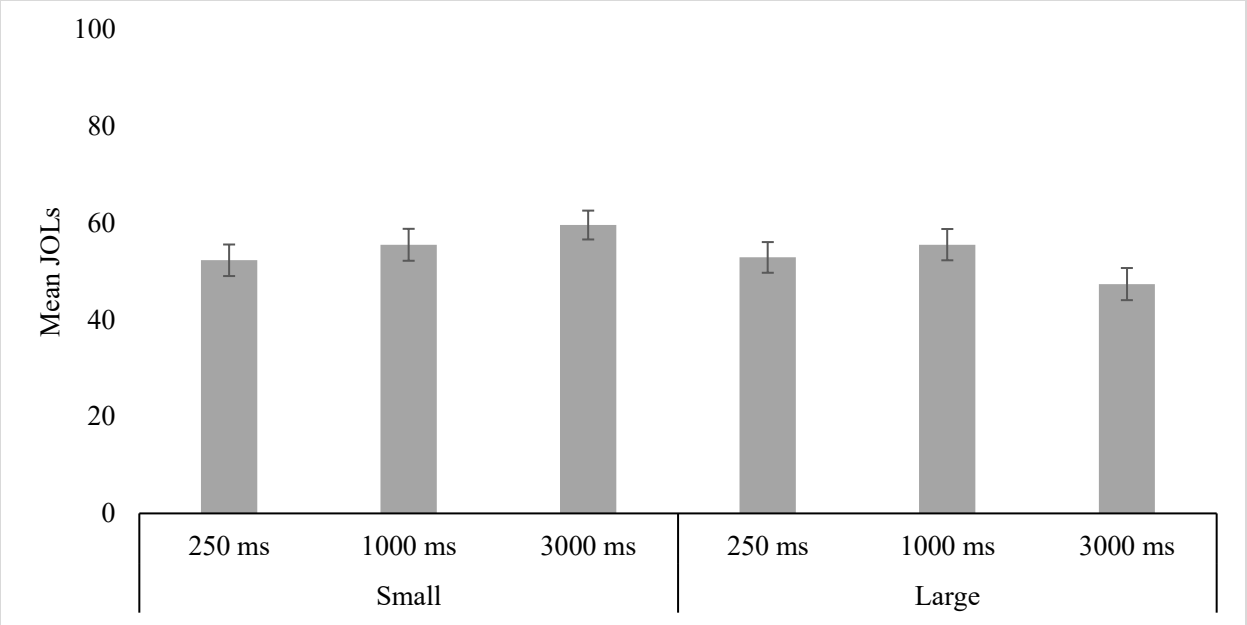

Figure 3. An interaction of font size and presentation rate shows that large font words presented at 3000 ms received the lowest mean JOLs.

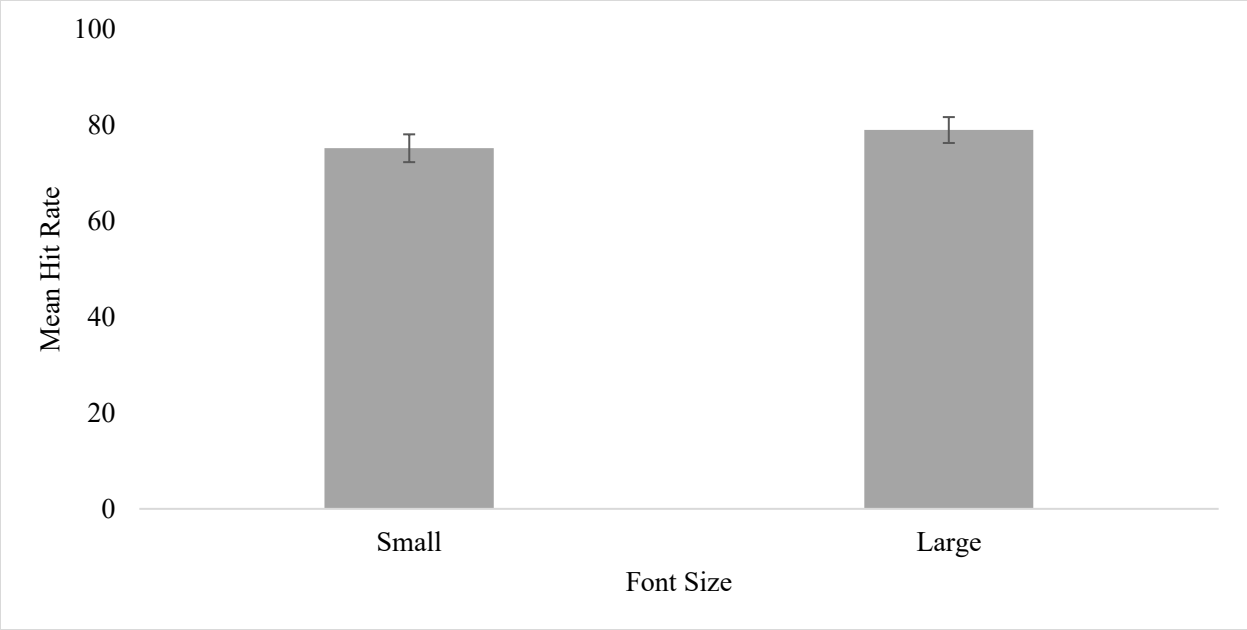

Figure 4. Large font words received the highest mean hit rates whereas small font words received the lowest mean hit rates.

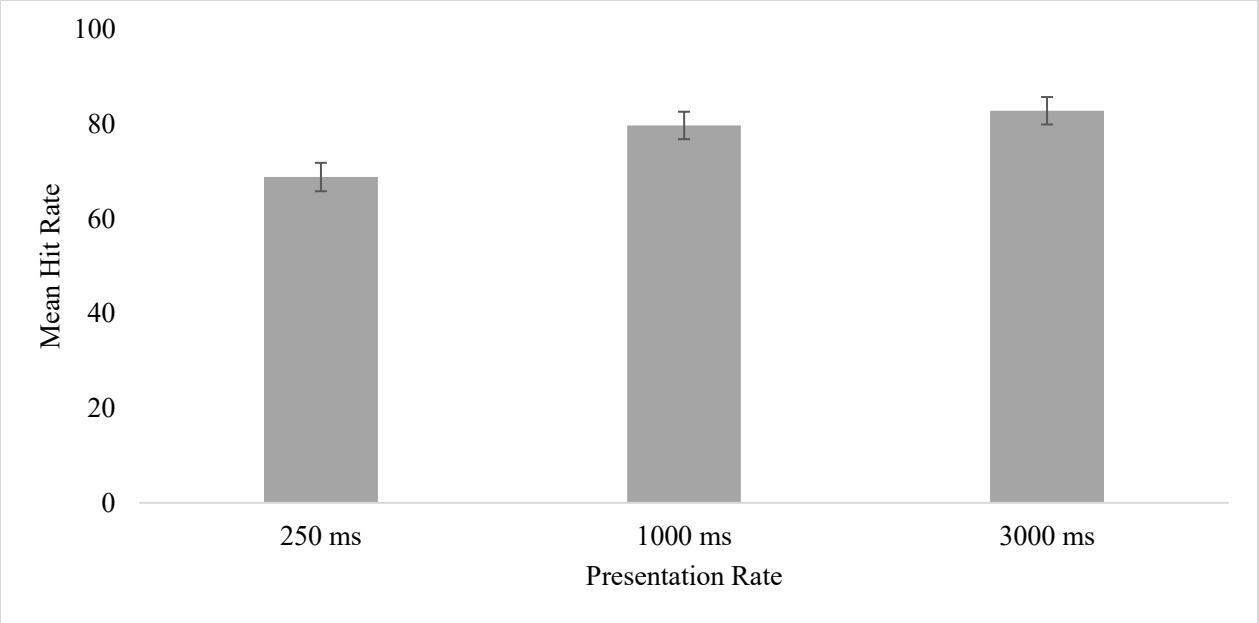

Figure 5. Words presented at 3000 ms had the highest mean hit rates, followed by words presented at 1000 ms, and words presented 250 ms having the lowest mean hit rates.

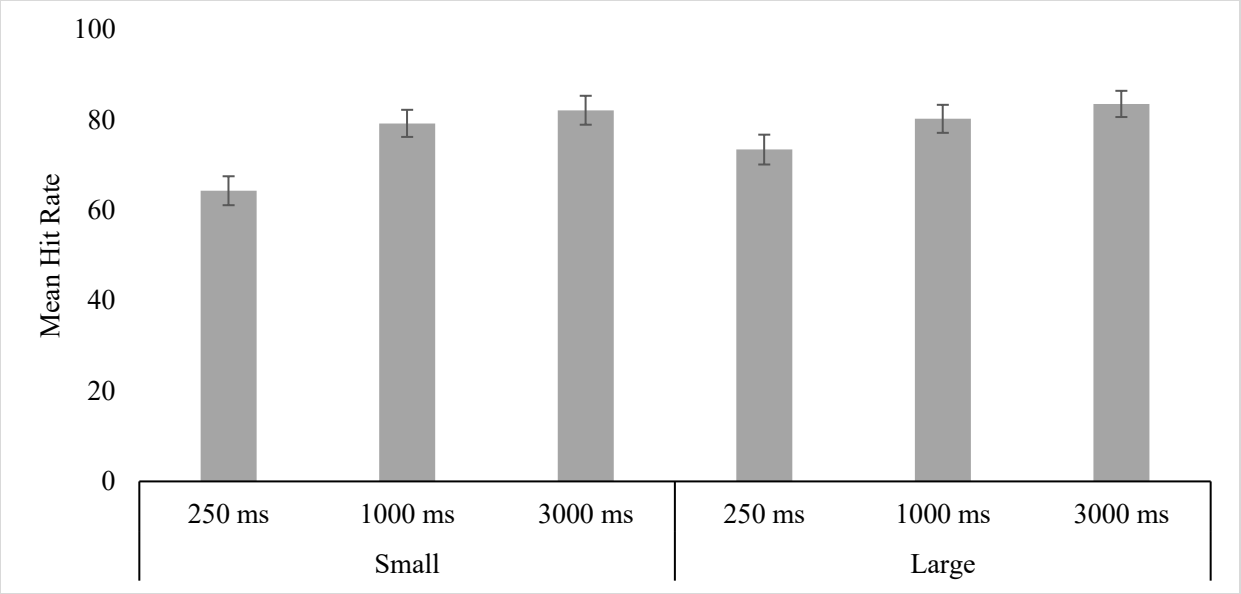

Figure 6. Both small and large fonts words saw an increase in mean hit rates as the presentation rate increased.

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Re: Katlyn Mullins - Honors Capstone Submission

Jodi Price <jlp0019@uah.edu> Tue, Apr 21, 2020 at 1:32 PM
To: Katlyn Mullins <kcm0014@uah.edu>
Cc: William Wilkerson <wilkerw@uah.edu>, David Cook <dac0010@uah.edu>, Jodi Price <jodi.price@uah.edu>

Katlyn,

Please find attached your approved and signed honors thesis. Excellent work! I'm very honored that you chose me to be your mentor for this project and am very proud of you and all the hard work you put into this project.

Best,

Jodi

On Mon, Apr 20, 2020 at 5:11 PM Katlyn Mullins <kcm0014@uah.edu> wrote:

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>
> Thank you!
>
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