Impact of using lowly-differentiated stimuli on the working memory research paper...

Impact of using lowly-differentiated Stimuli on the Working Memory

Abstract

Sternberg Paradigm has been used as a measure in short term memory studies since the model was developed in 1966. Several subsequent studies have, however, not being successful in duplicating the exact results achieved by Sternberg. The reason for this has been identified as the other researchers' use of faster stimulus presentation rates. The results from these subsequent studies indicate the impact of the presentation rate on the recall capability of the working memory. It is essential to highlight that all these studies used highly differentiated stimuli. This study will, however, analyze the impact of using lowly differentiated stimuli on the recall capability of the working memory.

This research used a sample of 72 students who were exposed to facial stimuli, and then probed on whether they could recall it.

The findings indicate that there is no interaction between the presence of a probe item in the list and the set size. This study has also established that the use of lowly differentiated stimuli has a significant impact on the closeness of the results to those obtained by Sternberg.

The researcher recommends further research on the impact of other variables on the RT of each participant.

Introduction

The Sternberg Paradigm is a parameter used in measuring short term memory; it is based on tests on this memory using information that has been rehearsed sparingly (Lambert, 1995; Liu & Smith, 2009). The paradigm

involves 2 main questions: whether the scanning is serial or parallel; and whether the scanning is exhaustive or self terminating (Johns & Mewhort, 2002). These questions are answered by giving participants a list of several numbers to memorize; the participants are then tested on whether they can remember which numbers were in the list. It is vital to note that this test is based on the reaction time of each participant when responding to the questions (Donkin & Nosofsky, 2012).

In this study, the lists used to test the participants short term memories comprised of mainly numbers and letters; however, other stimuli were also used. Similar to other tests involving the Sternberg Paradigm, the participants were probed using a target item to establish whether they could remember whether the item was in the list they had seen or was a new item (Garner, 1974; Glanzer & Shiffrin, 1984; Hintzman, 1988). The expected result in a Sternberg Paradigm study is that the response time will increase as the number of items on the list increase and as more probes are conducted (Goldstein & Steyver, 2001). This is based on findings from previous studies that showed that the more people have to remember within a short period, the more they forget (Busey & Arici, 2009). Previous studies have also established that the working memory's effectiveness reduces with time (Kahana, Zhou, Geller & Sekuler, 2007); as a result, response from the first probe will be given faster than those for subsequent probes. According to Sternberg (1966), these two results indicate that the short term memory is arranged sequentially; the psychologist identified this as evidence that this memory was serially exhaustive. The results from previous studies such as the one by Sternberg also indicate that the list of stimuli presented to a

participant is accessed wholly whether the item asked in the probe is in the list or not (Lambert, 1998).

Theoretically, the results from Sternberg Paradigm tests should be consistent with three theoretical accounts: parallel access, familiarity based and the limited capacity theory (Huang, Kahana & Sekuler, 2009). The parallel access model is based on the argument that information is simultaneously accessed from the working memory. The familiarity based approach argues that when a participant is probed, their positive response is based on whether the target item bears a close similarity to items in the list (Lamberts, 2000). The limited capacity approach states that humans have limited resources allocated for processing information. This theory, also, highlights that these resources are used during both sub-conscious and conscious search for information in the working memory.

Rationale for the Study

The researcher conducted this study to establish whether the three theoretical accounts and two expected results associated with studies involving the Sternberg Paradigm can be verified using primary research. This study will compare face recognition performance with the use of the Sternberg Paradigm. The variables will be the set size and the presence or absence of the probe. Some researchers argue that Sternberg result's aligned with the three theories because he used a slower stimulus presentation rate. This study will, however, seek to establish whether these same results can be achieved by using a hard to differentiate stimuli.

An example of the faces used in the study is in Figure 1 below:

Figure 1: An example of the study's stimuli

Research Hypothesis

The researcher believes that the response time will increase with the increase in the number of items in the list. It is also expected that the response time will increase with as more time lapses between receiving the stimuli and the probe. The researcher, however, expects that there will be no relationship between the existence of the target item in the list shown and the size of the list. It is also expected that the use of lowly differentiated stimuli does not significantly affect the expected results of the study.

Method

Participants

The study shall have a sample size of 72; this will include third year students that are taking Advanced Topics in Cognition laboratory classes. This is because participation in this study was a requirement for their course. It is essential to highlight that sex and age are not variables of interest in this study, and so will not be recorded.

Stimuli

The stimuli for this research will be sourced from Kayser (1985); these stimuli have been applied in other similar memory studies in the past (see e. g., Busey & Arici, 2009; Goldstone & Steyvers, 2001).

Apparatus

Participants in the study were studied in groups on computers that were using an application, which used two languages: Python and Pygame.

Procedure

The set size for this study ranged between 1 and 5. Each trial in this study started with the participants being shown a fixation cross for a period of 500ms. This was followed by a presentation of items in the list for a period of 1000ms; there was a 200ms break between each list item and the next. Once the presentation of all items in the list was complete, the participant was shown an asterisk for 2000ms. This signaled the end of the first part of the study, and the beginning of the test probe. The probe item was left on the screen up to when a response was given. Study participants were directed to identify whether the item on the screen was in the study list (an old item) by pressing ' F' or whether the item was not in the list (new item) by pressing ' J'. Feedback on the respondent's accuracy was then presented within 1000ms. After this the participants were required to take a break that was 1500ms long. After the break was over, a participant would press the spacebar to signal that they are ready for the next trial. There were 100 trials in this study.

Results

Data Screening

After the data screening, 12 participants were dropped from the research since their mean RTs were found to be larger than 3 SDs above the average RT for any cell (N= 5). Some of the participants were also dropped when p

was less than 0. 5 for any cell (N= 7). After the screening, the sample of the research reduced to 60 students.

Summary of Mean RTs

The high standard deviations of this study show that the RT data from each participant was not evenly distributed. This shows that there was a significant difference in the response rate of each participant. This may be as a result of other variables not studied in this research.

Anova Table

The similar values of F for each effect can be interpreted as an indicator of homogeneity of the variables under study. It is, however, essential to highlight that the accuracy of this test may have been affected by the responses not having a normal distribution. The significance of the probe effect, and its closeness to p= 0. 05 indicates that the likelihood of other studies obtaining similar studies is very likely. However, the likelihood of results of the other two effects being achieved in other studies is low.

Sphericity Test Table

As stated in the previous result, the F-test obtained in this study were subject to errors since the data did not have a normal distribution. The Sphericity test was, therefore, recommended to verify the homogeneity of the variables. Since the p value for Set Size was < 0. 05, the variances of individual hypotheses for this effect were considered as not equal. However, since for Probe*SetSize the p value was > 0. 05, the variances were considered equal for this effect.

Lag Function

Figure 2: Lag graph

This lag graph helps in proving that a probe into the working memory is sequential and is self-terminating. This can be noted from the fact that the last probe item has a lag of 1.

Figure 3: Accuracy graph for Set Size

Figure 4: Accuracy graph for std

Discussion

The results indicate that whereas there was no effect on the probe, there was a significant effect on the probe as a result of using lowly differentiated stimuli. It can, however, be deduced that there exists a relationship between the set size and probe. As a result, this study was not able to achieve the exact results with the Sternberg research; the absence of a probe effect was accepted as normal whereas the significant interaction between the two variables was noted. This significant interaction confirmed the first hypothesis that the response time will increase with increase in the number of items in the list. The lack of the probe effect confirms the third hypothesis that there is no relationship between the existence of the target item in the list shown and the size of the list; this null hypothesis was accepted. General observation of the data collected from the study confirms the second hypothesis that the response time will increase with as more time lapses between receiving the stimuli and the probe. Since this study did not match with the one by Sternberg, the null hypothesis that the use of lowly differentiated stimuli does not significantly affect the expected results of the study is therefore rejected.

Conclusion

This study was limited since it only considered two variables. The researcher proposes that subsequent studies should use more variables to analyze their impact on the independent variable- working memory. The impact of other variables not included in this research is evident in the difference of RTs between each participant for similar stimuli and probe.

References

Busey, T. A. &Arici, A. (2009). On the role of individual items in recognition memory and metacognition: Challenges for signal detection theory. Journal of Experimental Psychology: Learning, Memory & Cognition, 35, 1123-1136.

Donkin, C., & Nosofsky, R. M. (2012). The form of short-term memory scanning: an investigation based on response time

distributions. Psychonomic Bulletin & Review, 19, 363-394.

Garner, W. R. (1974). The processing of information and structure. Potomac, MD: Erlbaum.

Gillund, G., & Shiffrin, R. M. (1984). A retrieval model for both recognition and recall. Psychological Review, 91, 1–67.

Glanzer, M., & Adams, J. K. (1990). The mirror effect in recognition memory: Data and theory. Journal of Experimental Psychology: Learning, Memory, and Cognition, 16, 5–16.

Goldstone, R. L. & Steyvers, M. (2001). The sensitization and differentiation of dimensions during category learning. Journal of Experimental Psychology: General, 130, 116-139.

Heathcote, A., Popiel, S. J., & Mewhort, D. J. K. (1991). Analysis of response time distributions: An example using the Stroop task. Psychological Bulletin,

109, 340–347.

Hintzman, D. L. (1986). " Schema abstraction" in a multiple-trace memory model. Psychological Review, 93, 411– 428.

Hintzman, D. L. (1988). Judgments of frequency and recognition memory in a multiple-trace memory model. Psychological Review, 95, 528–551.

Hintzman, D. L., Caulton, D. A., & Curran, T. (1994). Retrieval constraints and the mirror effect. Journal of Experimental Psychology: Learning, Memory, and Cognition, 20, 275–289.

Hockley, W. E. (1984). Analysis of response time distributions in the study of cognitive processes. Journal of Experimental Psychology: Learning, Memory, and Cognition, 10, 598–615.

Hockley, W. E., & Corballis, M. C. (1982). Tests of serial scanning in item recognition. Canadian Journal of Psychology, 36, 189 –212.

Hooke, R., & Jeeves, T. A. (1961). Direct search solution of numerical and statistical problems. Journal of the ACM, 8, 212–229.

Huang, J., Kahana, M. J., & Sekuler, R. (2009). A task-irrelevant stimulus attribute affects perception and short-term memory. Memory & Cognition, 37, 1088–1102.

Johns, E. E., & Mewhort, D. J. K. (2002). What information underlies correct rejections in recognition from episodic memory? Memory & Cognition, 30, 46–59.

Kahana, M. J., & Loftus, G. (1999). Response time versus accuracy in human memory. In R. Sternberg (Ed.), The nature of cognition (pp. 323–384). Cambridge, MA: MIT Press.

Kahana, M. J., & Sekuler, R. (2002). Recognizing spatial patterns: A noisy

exemplar approach. Vision Research, 42, 2177–2192.

Kahana, M. J., Zhou, F., Geller, A., & Sekuler, R. (2007). Lure-similarity affects visual episodic recognition: Detailed tests of a noisy exemplar model. Memory & Cognition, 35, 1222–1232.

Lamberts, K. (1995). Categorization under time pressure. Journal of Experimental Psychology: General, 124, 161–180.

Lamberts, K. (1998). The time course of categorization. Journal of Experimental Psychology: Learning, Memory, and Cognition, 24, 695–711.

Lamberts, K. (2000). Information accumulation theory of categorization. Psychological Review, 107, 227–260.

Lamberts, K., Brockdorff, N., & Heit, E. (2003). Feature-sampling and random-walk models of individual-stimulus recognition. Journal of Experimental Psychology: General, 132, 351–378.

Little, D. R., Nosofsky, R. M., & Denton, S. E. (2011). Response-time tests of logical-rule models of categorization. Journal of Experimental Psychology: Learning, Memory, and Cognition, 37, 1–27.

Liu, C. C., & Smith, P. L. (2009). Comparing time-accuracy curves: Beyond goodness-of-fit measures. Psychonomic Bulletin & Review, 16, 190–203.

Kayser, A. (1985). Heads. New York: Abbeville Press.

Nosofsky, R. M., Little, D. R., Donkin, C. &Fific, M. (2011). Short-Term Memory Scanning Viewed as Exemplar-Based Categorization. Psychological Review, 118, 280-315.

Sternberg, S. (1966, August 5). High-speed scanning in human memory. Science, 153, 652–654.