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Effects of Exposure Duration and Brightness on Visual Memory Performance

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ABSTRACT

The purpose of these present experiments is to find out whether the exposure duration and brightness have any effect on visual memory performance. Both exposure duration (0.5 sec, 1.0 sec, 1.5 sec, 2.0 sec and 2.5 sec) and brightness (30lumen, 60lumen, 90lumen, 120lumen and 150lumen) are varied in five ways. Both of the two experiments were conducted with the help of thirty random participants who were selected following simple random sampling technique. One-factor repeated measures design was used to analyze the data. Collected data were analyzed by one-way repeated measures ANOVA with a view to investigating the effects of exposure duration and brightness on visual memory performance. Post-hoc pair wise comparisons (LSD's Method) were carried out for visual memory performance with reference to exposure duration and brightness. The ANOVA results represented that there was an effect of exposure duration and brightness on visual memory performance. Moreover, the post-hoc tests indicated that visual memory performance improved with the increase in both exposure duration and brightness.

Keywords: Exposure duration, LSD's Method, Brightness, ANOVA, and Visual memory performance.

INTRODUCTION:

Memory is a very fascinating and undeniable topic in our everyday life. We go through an enormous amount of information in our daily life, but not all of them are equally important for us to keep in mind or memorize. If we couldn't recall the who's, what's, where's, and when's of our everyday lives, we'd never be able to manage. We can store current ideas in the present with our short-term (or working) memory, while we can store past events and learn meanings in our long-term (episodic or semantic) memory. Memory is the record of experience presented in the brain and it is also the process in which the information is encoded, stored, and retrieved. Encoding allows information that is from the outside world to reach our senses in the forms of chemical and physical stimuli. In this first stage, we must change the information so that we may put the memory into the encoding process. Again, storage is the second memory process in which it entails that we maintain information over periods of time. Finally, the third process is the retrieval of information that we have stored where we must locate it and return it to our consciousness. Some retrieval attempts may be effortless due to the type of information. From an information processing perspective, there are three main stages in the formation and retrieval of memory; (a) Encoding or registration: receiving, processing and combining of received information. (b) Storage: creation of a permanent record of the encoded information. (c) Retrieval, recall or recollection: calling back the stored information in response to some cue for use in a process or activity

The cellular basis of memory involves activity dependent plasticity in the synaptic connections. An important model in the study of the cellular basis of memory is the phenomenon of long-term potentiation (LTP), a long-lasting growth in synaptic response strength after stimulation (Bliss *et al.,* 2007). In human being, the prefrontal cortex is highly actuate during the encoding, retrieval, maintenance, and manipulation of memories. It was observed to see some positive relationships between working memory and exposure duration and between working memory and brightness. This means that working memory is benefited when exposure duration is increased and when something is represented with standard level of brightness. Distinct areas within the prefrontal cortex assist various executive functions in cognition, including selection, rehearsal, and monitoring of information being retrieved from long-term memory. In performing these functions, the prefrontal cortex interlude with a broad network of posterior cortical areas that encode, maintain, and retrieve appointed forms of perceptual information (Postle, 2006). Research using functional brain imaging have proved that the hippocampus and parahippocampal region are actuate during the encoding and retrieval of memories in humans, and these studies have also marked a broad network of areas in the cerebral cortex that work together to help declarative memory, our ability for learning and consciously remembering everyday facts and events (Squire *et al.,* 2004). Brain imaging becomes easier and effective when exposure duration is increased and when a standard value of brightness is used. Information from recent expertise initially is gathered in iconic memory and forms of short-term memory that can help short storage and early recall of substantial detail. Working memory rely on the prefrontal cortex as well as a large network of other cerebral cortical region. Findings on experimental animals have shown that prefrontal neurons preserve relevant information during working memory and can flexibly assemble various types of sensory information and abstract thoughts and rules on which verdict are made (Miller, 2000; Sabuz *et al.,* 2023).

Serial position effect plays a vital role regarding those experiments on brightness and exposure duration. This effect is a person's tendency to perceive the first and last items in a series good, and the middle items worst. Hermann Ebbinghaus generate the item, refers to the studies that recall propriety alter as a function of an item's location within a study list. When respondents were requested to recall a list of items in any format (free recall), people oversee to begin perceive with the end of the list, perceiving those items best (the recency effect). Among prior list items, the first several items are perceived more often than the medium items (the primacy effect). One suggested reason for the primacy effect is that the primary items submitted are most practically gathered in long-term memory because of the large number of processing devoted to them (The first list item can be repeated by itself; the second must be repeated along with the first, the third along with the first and second, and so on.). The primacy effect is less when items are given rapidly and is enhanced when given gradually (factors that reduce and enhance processing of each item and thus permanent storage). Longer submission lists have been found to minimize the primacy effect. One theorized cause for the recency effect is that these items are still arrived in working memory when recall is solicited. Items that favor from neither (the middle items) are recalled most weakly. An additional explanation for the recency effect is connected to temporal context: if tested instantly after repetition, the present temporal context can serve as a retrieval cue, which would count more recent items to have a higher likelihood of recall than items that were studied in a several temporal context (earlier in the list). The recency effect is diminished when an interfering task is given where medial tasks include working memory, as the distractor activity, if exceeding 15 to 30 seconds in duration, can cancel out the recency effect. Additionally, if recall occur instantly after test, the recency effect is compatible regardless of the extent of the studied list, or presentation rate.

Rationale of the study

There are many studies on exposure duration but none of those are related to visual memory performance which is the core of this experiment. So, this is considered as a new experiment and also helpful for the students and the teachers in order to select the way of teaching method. Teachers can be benefited by choosing some particular way to teach those students who are facing difficulties in learning. They can find out the effect of exposure duration and brightness on students' weakness in relation to visual memory performance and they can also solve their problems. Through this experiment, students can come to learn how long they need to concentrate on their study.

Research Problem

The problem of these present experiments was to investigate whether there was any effect of exposure duration and brightness on visual memory performance.

Hypotheses

Experiment 1

It was hypothesized that visual memory performance would be better with the increase in exposure duration.

Experiment 2

It was hypothesized that visual memory performance would be better with the increase in brightness.

Variables

Experiment 1

Dependent Variable

Visual memory performance (Measured by the number of correct recall)

Independent Variable

Exposure duration (0.5 sec, 1.0 sec, 1.5 sec, 2.0 sec and 2.5 sec).

Experiment 2

Dependent Variable

Visual memory performance (Measured by the number of correct recall)

Independent Variable

Brightness (30lumen, 60lumen, 90lumen, 120lumen and 150lumen).

MATERIALS AND METHODS:

Experiment 1

Participants

Thirty undergraduate students from University of Dhaka in Bangladesh were selected as participants in order to conduct the experiment whose age ranges were from 20 to 25 years. All participants were physically and mentally healthy and they had corrected-to-normal vision.

Apparatus and stimuli

Stimuli consisting of 10 non-syllable words were presented on a 17 inch CRT (Cathode Ray Tube) Samsung Monitor (Model: 793DFW, Made in China, Voltage: 100-240~) with a pixel resolution of 1024×768. The program for generating stimuli was prepared with the help of Microsoft Office-2007. Paper and pencil were used when participants recalled those stimuli.

Table 1: Stimuli presented to the participants.

Stimuli	
JIK	XTM
HVG	VYX
FIB	AYW
LQP	QOV
UTZ	ICR

Design

A one-factor with repeated measurement design was used because the same participants were treated under one condition (exposure duration) which was varied in five ways (0.5 sec, 1.0 sec, 1.5 sec, 2.0 sec and 2.5 sec). The dependent variable was number of correct recall.

Table 2: Design of the present experiment.

Participants	Correct Recall For Exposure Duration				
	0.5 sec	1.0 sec	1.5 sec	2 sec	2.5 sec
1					
.					
.					
.					
30					
Total					

Procedure

The thirty participants were treated under one factor such as exposure duration where the exposure duration was varied in five ways (0.5 sec, 1.0 sec, 1.5 sec, 2.0 sec and 2.5 sec) with a view to measuring visual memory performance. At first, the participants were welcomed to the experimentation venue. They sat in a comfortable chair and positioned in front of the computer monitor at a viewing distance of 40 cm. The PowerPoint slide consisted of ten non-syllable words was then displayed to each participant by using Microsoft Office 2007. In this part of experiment, brightness was fixed where it was 150lumen for each word of each level (0.5 sec, 1.0 sec, 1.5 sec, 2.0 sec and 2.5 sec) of exposure duration. In the first level of the experiment, the exposure duration was set as 0.5 second for each of those 10 non-syllable words meaning that one word disappeared after 0.5 seconds and then the next word appeared. After completing the slideshow, the participant was given paper and pencil to write down as many words he could remember from those ten words of the slideshow. Then the exposure duration was set to 1.0 second and again the slide-show was viewed. For the rest levels of exposure duration (1.0 sec, 1.5 sec, 2.0 sec and 2.5 sec), this procedure was followed. After each slideshow, the participant had to recall as many words he could remember from those ten words of the slideshow.

Experiment 2

Method

Participants

The thirty undergraduate students considered as participants were selected from University of Dhaka in Bangladesh in order to conduct the experiment. Their age ranges were from 20 to 25 years and they were physically and mentally healthy and they also had corrected-to-normal vision.

Apparatus and stimuli

Stimuli including 10 non-syllable words were presented on a 17 inch CRT (Cathode Ray Tube) Samsung Monitor (Model: 793DFW, Made in China, Voltage: 100-240~) with a pixel resolution of the 1024×768 in order to view. The program for generating stimuli was made by the help of Microsoft Office-2007. Necessary paper and pencil were used when participants recalled those stimuli.

Table 3: Stimuli presented to the participants.

Stimuli	
RXP	DMO
TZK	GEJ
KQL	YLD
WOS	MPS
CEA	IAK

Design

A one-factor with repeated measurement design was used because the same participants were treated under one condition (brightness) which was varied in five ways (30lumen, 60lumen, 90lumen, 120 lumen and 150 lumen). The dependent variable was number of correct recall.

Table 4: Design of the present experiment.

Participants	**Correct Recall For Brightness**				
	30 lumen	60 lumen	90 lumen	120 lumen	150 lumen
1					
.					
.					
.					
30					
Total					

Procedure

The thirty participants were treated under one factor such as exposure duration where the brightness was varied in five ways (30lumen, 60lumen, 90lumen, 120lumen and 150lumen) with a view to measuring visual memory performance. Participants were requested to sit in a comfortable chair and positioned in front of the computer monitor at a viewing distance of 40 cm. The PowerPoint slide consisted of ten non-syllable words was viewed to each participants by using Microsoft Office 2007. In this part of experiment, exposure duration was constant and that was 2.0 seconds for each words of each level (30lumen, 60lumen, 90lumen, 120lumen and 150lumen) of brightness. In the first level of the experiment, the brightness was set as 30lumen for each of those 10 non-syllable words. This means, all of the words on the slide have a brightness value of 30lumen which was so less value for brightness. After completing the slideshow, the participant was given paper and pencil to write down as many words he can remember from those ten words of the slideshow. Then the exposure duration was set to 1.0 second and again the slideshow started. For the rest levels of exposure duration (60lumen, 90lumen, 120lumen and 150lumen), this procedure was followed. After each slideshow, the participant had to recall as many words he can remember from those ten words of the slideshow.

RESULTS AND DISCUSSION:

For the purpose of investigating the effect of exposure duration on visual performance, one-factor with repeated measurement design was taken in the first experiment where one-way repeated measures ANOVA were selected to analyze the obtained data.

Table 5: Analysis of variance of Correct Recall with five levels of exposure duration (*P<.01).

Source of variation	Sum of Squares	*df*	Mean square	*F*
Rows (A) (participants)	142.16	29	4.90	
Columns (B) (exposure durations)	670.43	4	167.61	F_B=155.19*
Interaction (A×B)	125.57	116	1.08	
Total	938.16	149		

As shown in the **Table 5**, the effect of exposure duration on visual memory performance was found to be significant ($F_{4,\ 116}$ = 155.19, p < .01). On the other hand, the exposure duration was found to be different at least one of possible pairs of five exposure duration. However it can't be determined which pair is significant? To answer this question, post-hoc pair-wise comparisons of the exposure durations on visual memory performance were carried out.

Table 6: The mean differences in visual memory performance at possible pairs of exposure durations.

Exposure Duration (sec)	0.5	1.0	1.5	2.0	2.5
0.5	---	-1.70*	-2.97*	-4.43*	-6.10*
1.0		---	-1.27*	-2.73*	-4.40*
1.5			---	-1.47*	-3.13*
2.0				---	-1.67*
2.5					---

As displayed in the **Table 6**, the post-hoc pair-wise comparison (LSD's method) revealed that visual memory performance improved with the increase in exposure duration. Further, for investigating the effect of brightness on visual performance, one-factor with repeated measurement design was carried out in the second experiment in which one-way repeated measures ANOVA were used to analyze the data.

Table 7: Analysis of variance of Correct Recall with five levels of brightness (*P<.01).

Source of variation	Sum of Squares	*df*	Mean square	*F*
Rows (A) (participants)	75.47	29	2.60	
Columns (B) (brightness)	677.17	4	169.30	F_B=121.8*
Interaction (A×B)	161.03	116	1.39	
Total	913.67	149		

The effect of brightness on visual memory performance was found to be significant ($F_{4,\ 116}$ = 121.80, p<.01) in the **Table 7**. Again, the brightness was found to be different at least one of possible pairs of five brightness. However it is not possible to determine which pair is significant? To answer this question, post-hoc pair-wise comparisons of the brightness on visual memory performance were administered.

Table 8: The mean differences in visual memory performance at possible pairs of brightness.

Brightness (lumen)	30	60	90	120	150
30	---	-1.60*	-3.47*	-4.43*	-6.07*
60		---	-1.87*	-2.83*	-4.47*
90			---	-0.97*	-2.60*
120				---	-1.63*
150					---

The post-hoc pair-wise comparison (LSD's method) revealed that visual memory performance improved with the increase in brightness in **Table 8**. Both of the two experiments in this study can be discussed in the following way:

The aim of the first experiment was to examine the effects of exposure durations on visual memory performance of individuals. The null hypothesis was that there was no significant effect of exposure duration on visual memory performance and the alternate hypothesis was that there existed a positive impact of exposure duration on visual memory performance. The finding of this experiment was that there is a positive relationship between exposure duration and visual memory performance. This indicated that visual memory performance is more when exposure duration is increased. The hypothesis has been accepted by the result of ANOVA indicated that the effect of exposure durations on the visual memory performance was found to be significant and visual memory performance improved with the increase in exposure durations. On the other hand, the second experiment investigated the effects of brightness on visual memory performance. The null hypothesis was that there is no significant effect of brightness on visual memory performance and the alternate hypothesis was that there exists a positive impact of brightness on visual memory performance. The finding of the present experiment revealed that there was a positive relationship between brightness and visual memory performance indicating that visual memory performance is very good when brightness is increased. The hypothesis has been accepted by the result of ANOVA indicated that the effect of brightness on the visual memory performance was found to be significant and visual memory performance improved with the increase in brightness.

CONCLUSION:

The first and second experiment investigated to find out whether or not the exposure duration and brightness had any effect on visual memory performance of the individuals respectively. In the first experiment, exposure duration was varied in 5 ways; and in the second experiment, brightness was varied in five ways also. After obtaining the findings from the first experiment, it might be said that visual memory performance varies with manipulation of exposure durations and these performances may be improved with the increase in exposure durations. Thus, the present study in this experiment added a knew knowledge to the body of existing literature showing that visual memory performance is considered as a function of exposure durations and both of them are independent processes. Again, from the results of the second experiment, it could be speculated that visual memory performance changes with manipulation of brightness and these performances might be improved with the increase in brightness. Therefore, the present study included another knowledge to the body of existing literature revealing that visual memory performance is regarded as a function of brightness and both of them are independent processes also.

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CONFLICTS OF INTEREST:

The authors declare that there is no conflict of interest.

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