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Title: Effects of Exposure Duration and Brightness on Visual Memory Performance

Abstract

The purpose of the study experiment 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 (30 lumen, 60 lumen, 90 lumen, 120 lumen and 150 lumen) varied in five ways. Two experiments were conducted with the help of thirty random participants who were selected in simple random sampling technique. One factors repeated measurement design was used to analyze the data. 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 6 a significant effect of exposure duration and brightness on visual memory performance. Moreover, the post-hoc tests indicated visual memory performance improved with the increase in both exposure duration and brightness. The implication of this study has been discussed.

Key words: Exposure Duration, Brightness and Visual Memory Performance

Introduction

Memory, a very fascinating and undeniable topic in our everyday life. We go through an enormous amount of information in our daily life. 6 But not all of them are equally important for us to keep in mind or memorize. Memory makes us. 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. 7 We mull over ideas in the present with our short-term (or working) memory, while we store past events and learned meanings in our long-term (episodic or semantic) memory. Memory is the record of experience represented in the brain. 8 Memory is the process in which 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. 3 In this first stage we must change the information so that we may put the memory into the encoding process. Storage is the second memory stage or process. This entails that we maintain information over periods of time. Finally the third process is the retrieval of information that we have stored. We must locate it and return it to our consciousness. Some retrieval attempts may be effortless due to the type of information. From 4 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: 3 creation of a permanent record of the encoded information. (c) Retrieval, recall or recollection: 4 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 synaptic connections. 2 An important model in the study of the cellular basis of memory is the phenomenon of long-term potentiation (LTP), a long-lasting increase in the strength of a synaptic response following stimulation (Bliss, T., Collingrindge, G, and Morris, R., 2007). In humans, the prefrontal cortex is highly activated during the encoding, retrieval, maintenance, and manipulation of memories. We found some positive relationships between working memory and exposure duration and between working memory and brightness. Means working memory is benefited when exposure duration is increased and when something is represented with standard level of brightness. 2 Distinct areas within the prefrontal cortex support different executive functions in cognition, including selection, rehearsal, and monitoring of information being retrieved from long term memory. In performing these functions, the prefrontal cortex interacts with a large network of posterior cortical areas that encode, maintain, and retrieve specific types of perceptual information (Postle, 2006). Studies using functional brain imaging have confirmed that the hippocampus and parahippocampal region are activated during the encoding and retrieval of memories in humans, and these studies have also identified a large network of areas in the cerebral cortex that work together to support declarative memory, our ability for learning and consciously remembering everyday facts and events (Squire LR, Stark CE, Clark RE., 2004). Brain imaging becomes easier and effective when exposure duration is increased and when we use a standard value of brightness. [2] Information from new experiences initially is stored in iconic memory and forms of short term memory that can support brief storage and immediate recall of substantial detail. Working memory depends on the prefrontal cortex as well as a large network of other cerebral cortical areas. Studies on experimental animals have shown that prefrontal neurons maintain relevant information during working memory and can flexibly combine different kinds of sensory information and abstract concepts and rules on which decisions are made (Miller, 2000).

Serial position effect plays a vital role regarding those experiments on brightness and exposure duration. Serial position [1] effect is the tendency of a person to recall the first and last items in a series best, and the middle items worst. The term was coined by Hermann Ebbinghaus through studies he performed on himself, refers to the finding that recall accuracy varies as a function of an item's position within a study list. When asked to recall a list of items in any order (free recall), people tend to begin recall with the end of the list, recalling those items best (the recency effect). Among earlier list items, the first few items are recalled more frequently than the middle items (the primacy effect). One suggested reason for the primacy effect is that the initial items presented are most effectively stored in long-term memory because of the greater amount of processing devoted to them. (The first list item can be rehearsed by itself; the second must be rehearsed along with the first, the third along with the first and second, and so on.) The primacy effect is reduced when items are presented quickly and is enhanced when presented slowly (factors that reduce and enhance processing of each item and thus permanent storage). Longer presentation lists have been found to reduce the primacy effect.

One theorized reason for the recency effect is that these items are still present in working memory when recall is solicited. Items that benefit from neither (the middle items) are recalled most poorly. An additional explanation for the recency effect is related to temporal context: if tested immediately after rehearsal, the current temporal context can serve as a retrieval cue, which would predict more recent items to have a higher likelihood of recall than items that were studied in a different temporal context (earlier in the list). The recency effect is reduced when an interfering task is given. Intervening tasks involve working memory, as the distractor activity, if exceeding 15 to 30 seconds in duration, can cancel out the recency effect. Additionally, if recall comes immediately after test, the recency effect is consistent regardless of the length of the studied list, or presentation rate.

Rationale of the study

There are lots of 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. This experiment is helpful for the students and the teachers 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 and solve them. Students can come to learn how long they need to concentrate on their study through this experiment.

Research Problem

The problem of this present experiment 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 of exposure duration.

Experiment 2

It was hypothesized that visual memory performance would be better with the increase of 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 (30 lumen, 60 lumen, 90 lumen, 120 lumen and 150 lumen).

Experiment 1

Method

Participants

Thirty undergraduate students from University of Dhaka were selected to conduct the experiment. The ages of the participants were between 20 to 25 years. All had normal or corrected-to-normal vision. They were fully physically and mentally healthy.

Apparatus and stimuli

Stimuli were presented to view 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 written by the help of Microsoft Office-2007. Stimuli display consisting 10 nonsyllable words. Paper and pencil were used when participants recalled those stimuli.

Table 1

Stimuli presented to the participants

Stimuli
JIK
HVG
FIB

LQP

UTZ

XTM

VYX

AYW

QOV

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

.

.

.

Total

Procedure

The same 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. [9] Participants sat in a comfortable chair and positioned in front of the computer monitor at a viewing distance of 40 cm. The Power Point slide consists of ten non-syllable words was then shown to each participants by using Microsoft Office 2007. In this part of experiment, brightness was fixed and that was 150 lumen 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. Which means one word disappeared after 0.5 seconds and then came the next word. 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 (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 can remember from those ten words of the slideshow.

Results

For the purpose of investigating the effect of exposure duration on visual performance, in this experiment study, the one factors repeated measurement design was used. In order to examine the effect of exposure duration on visual memory performance, one way repeated measures ANOVA were used to analyze the data.

Table 3

Analysis of variance of Correct Recall with five levels of exposure duration

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	FB=155.19*
Interaction (A×B)	125.57	116	1.08	

Total

938.16

149

*P<.01

As shown in the Table 3, 5 the effect of exposure duration on visual memory performance was found to be significant ($F_{4, 116} = 155.19$, $p<.01$).

The exposure duration 1 was found to be different at least one of possible pairs of five exposure duration. However we cannot determine which pair is significant? To answer this question, we further carried out post-hoc pair-wise comparisons of the exposure durations on visual memory performance.

Table 4

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 shown in the table 4, the post-hoc pair-wise comparison (LSD's method) revealed that visual memory performance improved with the increase in exposure duration.

Discussion

The present experiment examined to examine the effects of exposure durations on visual memory performance. The null hypothesis was there is no significant impact of exposure duration on visual memory performance and the alternate hypothesis was there exists a positive impact of exposure duration on visual memory performance. The one-factor with repeated measurement design was used to conduct the experiment. The findings of the present experiment were there exists a positive relationship between exposure duration and visual memory performance. Which means visual memory performance is benefited 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.

In conclusion, visual memory performance varies with manipulation of exposure durations and these performances improve with increase in exposure durations. Thus, the present study added knew knowledge to the body of existing literature showing that visual memory performance as a function of exposure durations and both of them are independent processes.

Experiment 2

Method

Participants

Thirty undergraduate students from University of Dhaka were selected to conduct the experiment. The ages of the participants were between 20 to 25 years. All had normal or corrected-to-normal vision. They were fully physically and mentally healthy.

Apparatus and stimuli

Stimuli were presented to view 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 written by the help of Microsoft Office-2007. Stimuli display consisting 10 nonsyllable words. Paper and pencil were used when participants recalled those stimuli.

Table 5

Stimuli presented to the participants

Stimuli
RXP
TZK
KQL
WOS
CEA
DMO
GEJ
YLD
MPS
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 (30 lumen, 60 lumen, 90 lumen, 120 lumen and 150 lumen). The dependent variable was number of correct recall.

Table 6

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 same participants were treated under one factor such as exposure duration where the brightness was varied in five ways (30 lumen, 60 lumen, 90 lumen, 120 lumen and 150 lumen) with a view to measuring visual memory performance.

At first, the participants were welcomed to the experimentation venue. 9 Participants sat in a comfortable chair and positioned in front of the computer monitor at a viewing distance of 40 cm. The Power Point slide consists of ten non-syllable words was then shown to each participants by using Microsoft Office 2007.In this part of experiment, exposure duration was fixed and that was 2.0 seconds for each words of each level (30 lumen, 60 lumen, 90 lumen, 120 lumen and 150 lumen) of brightness. In the first level of the experiment the brightness was set as 30 lumen for each of those 10 non-syllable words. This means, all [1] of the words on the slide have a brightness value of 30 lumen 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 (60 lumen, 90 lumen, 120 lumen and 150 lumen), 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

For the purpose of investigating the effect of brightness on visual performance, in this experiment study, the one factors repeated measurement design was used. In order to examine the effect of brightness on visual memory performance, one way repeated measures ANOVA were used to analyze the data.

Table 7

Analysis of variance of Correct Recall with five levels of brightness

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

FB=121.80*

Interaction (A×B)

161.03

116

1.39

Total

913.67

149

*P<.01

As shown in the Table 7, the effect of brightness on visual memory performance 1 was found to be significant ($F_{4, 116}$ = 121.80, p<.01).

The brightness was found to be different at least one of possible pairs of five brightness. However we cannot determine which pair is significant? To answer this question, we further carried out post-hoc pair-wise comparisons of the brightness on visual memory performance.

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

As shown in the table 8, the post-hoc pair-wise comparison (LSD's method) revealed that visual memory performance improved with the increase in brightness.

Discussion

The present experiment examined [6] to examine the effects of brightness on visual memory performance. The null hypothesis was there is no significant impact of brightness on visual memory performance and the alternate hypothesis was there exists a positive impact of brightness on visual memory performance. The one-factor with repeated measurement design was used to conduct the experiment. [6] The findings of the present experiment was there exists a positive relationship between brightness and visual memory performance. Which means visual memory performance is benefited 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 [1] was found to be significant and visual memory performance improved with the increase in brightness.

In conclusion, visual memory performance varies with manipulation of brightness and these performances improve with increase in brightness. Thus, the present study added knew knowledge to the body of existing literature showing that visual memory performance [1] as a function of brightness and both of them are independent processes.

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