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Examining the Role of Scene Content, Cognitive Function, and Demographic Factors on Boundary Extension

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Abstract

Boundary Extension is a visual memory error that observer recall scene as wider-angle than was presented. The purpose of the current experiment was to examine scene content and relation of visuospatial memory with boundary extension in terms of cognitive functioning. Another aim of the study was to investigate the effect of factors effecting on boundary extension based on demographic information like gender, educational background and knowledge of foreign languages. WMS-R Visual Reproduction Sub-test and Benton Judgement of Line Orientation were used to measure visuospatial memory. Recognition task method used with five-point likert scale in the experiment. Results showed significant negative relationship between boundary extension and visuospatial memory. Moreover, language and educational background found having significantly negative relationship on boundary extension. Higher education and knowledge of foreign languages were found as factors reducing boundary extension. Subjects showed significantly more boundary extension at the scenes with focal objects. Emotional content of scenes and gender difference did not appear as factor on boundary extension. This study demonstrated that boundary extension is under influence of not only characteristics of the stimuli but also cognitive functioning of subjects.

Keywords: Boundary extension; visuospatial memory; scene perception; visual cognition; cognitive functioning.

1. Introduction

1.1. Problem statement

Our understanding of the world seems like a unitary experience.

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All sensory inputs and all processes become united into a mental representation. Indeed, the question of how this occurs, goes back to ancient Greek Philosophy. Cognition has been explained with different approaches until now. Besides, scientific approaches such as evolutionary biology that explains how cognitive functions have evolved and developed over thousands of years, behavioral genetics that explains how genes constitute the biological bases of our behavior, and etiology that studies the how environmental factors stimulate and shape behavior, this article focuses on the cognitive approach, striving to scrutinize certain aspects of visual processing and representation in the brain. Evidently, thousands of different stimuli enter our brains every second and initiate a heavy load of neural activity. It is amazing how these complex processes come together and form what seems to be a simple representation of the external world [1]. Among these representations, mental representation of visual data has been the focus of many studies. Visual processing in human brain is of great complexity. Numerous objects in the visual environment can be analyzed and recognized in seconds, by their orientations, size, color, shape, and distances. Moreover, visual representations of concepts assists the categorization of different stimuli [2]. But on the other hand, our mental representation of visual information is not immune to cognitive errors and biases [3]. Studies have revealed that perception of visual data varies depending on the objects and observers [4]. This phenomenon is called embodied cognition and has been the focus of several studies in the past decade [4]. The embodied cognition theory explains how the internal structure of an organism, such as certain aspects of its body or cognitive functioning, influences its perception of the external world. In other words, how an organism perceives the world partly depends on its cognitive constructs [4]. Beyond cognition, memory is another factor, heavily related with our perception of the world. Memory is one of the key concepts to explain why people act in certain ways. It helps us modify our behaviors and adapt to new situations based on prior experiences [5]. Earlier experiments on memory, Bartlett have reveal the reconstructive nature of human memory. As an instance, many studies have shown that participants can change their memories of an event, based on the information they receive afterwards [6,7]. A recent study has found that, people tend to falsely remember scenes or objects that have not been presented to them [8]. One important case of such visual error, where extra information is added to the originally perceived visual data, is known as Boundary Extension. This phenomenon was first found and described by Intraub and Richardson. Their study revealed that participants tend remember images wider than what had been presented to them. In other words, new information is generated and added to their memory of images. In the experiment, 37 participants draw pictures of the presented scenes and in 95% of the cases, drawings were wider than the original scenes [9]. Boundary extension is part of the unitary experience of cognitive functions. It may be influenced by the characteristics of the stimuli, the features of the subject and cognitive functioning. There are limited number of studies about the factors effecting boundary extension. The purpose of the current study was to investigate different factors effecting on boundary extension.

1.2. Aim of the study

Based on the findings of past studies on boundary extension, it was hypothesized that there will be no significant difference between the mean scores of wide angle, wide angle (WW) and close-up, close-up (CC) conditions on BE, and there will be a significant difference between the scores of wide angle, close-up (WC) and close-up, wide angle (CW) [10]. Participants expected to show similar boundary extension rate when same angle scenes were presented and recognize angle difference when wider angle scenes were presented. Similar to one of past study, present study also used foreground objects [11]. Therefore, another aim of the study was to examine the effects of foreground objects on boundary extension. Base on past research, was hypothesized that BE will be significantly higher for scenes with a foreground object, compared to those without one. The third aim of the study was to examine the effects of emotional content on BE. In this regard, it was hypothesized that the emotional content of the scene does not affect boundary extension [12]. Fourth hypothesis of the study was that greater boundary extension would be observed in patients with lower visuospatial test scores. Increased visuospatial memory function leads to less boundary extension. The last the aim of the current experiment was to investigate the effects of demographic factors of participants like gender, educational background, and knowledge of foreign languages on boundary extension. These factors may also play role in boundary extension phenomenon.

1.3. Definitions

1.3.1. Boundary Extension

Current work focuses on visual error and visual cognition. One of visual error is Boundary Extension that observer remember scenes further away than how scenes were presented [9]. Memory errors do not happen only by losing an information but also changing stored information in memory and adding new information to existed one. Boundary extension is kind of error that observer add new visual information to actually what it was. Boundary extension is related with memory, mental representations and scene content .

1.3.2. Memory

Memory is one of important thing for all living beings. Memory helps understanding of today and planning future in order to guide appropriate behavior [2]. In terms of storing information there are three type of memory stores; sensory store that having information for very short time period, short-term memory that longer than sensory store with very limited capacity and long-term memory that lasts even for ever with limitless capacity. Boundary extension is an error that takes place in long-term memory. In early research of Intraub and Richardson, after 25-30 minutes later participants were asked to recall scenes that presented [9].

1.3.3. Mental Representations

Mental representations are visual input that resembles of an object and its charged version of a non-existed mental subject [13]. Although this phenomenon is controversy and many philosophers stress about it, in cognitive sciences mental representations are mental images of existed objects in mind.

1.3.4. Scene Content

Current study stressed about scene content meaning that visual content of image, in terms of color, shape, objects, spatial orientation and spatial location of these objects, emotional states they stimulate. In the experiment emotional content and focal object to measure boundary extension.

1.4. Theoretical Framework

1.4.1. Boundary Extension

Boundary Extension is tendency of remembering scenes with a wider-angle then they have been seen [9]. Boundary Extension is not simply an error but also can be explained with the Anticipatory Nature of Representation meaning that humans and animals do not only get information with their sensorimotor neurons but also imagine their behaviors and plan for the future [14]. Boundary extension is indeed not a negative cognitive error. It is a consequence of how visual information is processed in our brain, so as to bring the input visual data together and create a coherent and continuous representation of the external world [15]. Moreover, Boundary Extension is an instinctual phenomenon and it occurs at every age [16]. First experiment done about boundary extension was based on participants' drawings [9]. 20 pictures were presented for 15s each to 37 participants and 30 minutes later participants were asked to draw pictures that were presented from their memory. Three results came up from the experiment; First, 95% of participants draw pictures as wider-angle than how they were presented. Second, cropped objects were presented as completed in drawings. Third, Background were presented as more extended [9]. Drawings may lead to experimental error so Intraub and Richardson used recognition task in their experiment. Rather than drawing presented pictures, participants were asked to rate pictures on boundary-placement scale [9]. Test images were either closer-up, wider-angle or same size as target versions. Recognition test became a more common methodology to test Boundary Extension because its easier to conduct for both researcher and the participants [17]. In another study Intraub and Bodamer explained the Boundary Extension to participants before conducting the experiment but results indicated that Boundary Extension occurred regardless of the given information, which suggests that the phenomenon is probably based on automatic mental processes [18]. Although it the intensity of the Boundary extension decreased but did not disappear. Moreover, even participants see and compare their drawings with the target scene, they generally cannot recognize their error [18,19].

1.4.1.1. Theories of Boundary Extension

1.4.1.2. Multisource Model of Scene Representations

Boundary Extension is a phenomenon that relates to scene perception. Traditional scene perception relies on different levels but source is one input [15,44]. Intraub takes an alternative view of scene perception and support that even if presented stimuli is one picture, input is based on multisource representations [21]. The point of this view is not visual input but spatial inputs of objects. All humans use spatial memory in their daily life and these experiences create spatial categories and effect understanding of the world. Multisource Model of Scene Representations focuses on egocentric framework of spatial cognition that observer recognize objects based on his/her place; “in front of me”, “behind me” [21]. Egocentric framework triggers visual processing and amodal perception of objects and generate scene perception [22]. Amodal perception means observer's visualization of unshown part of objects. For example, if you see a cat behind the door you do not need to see its tail to imagine it [23]. Another metaphors of amodal perception might be a puzzle. Observer has the some pieces of puzzle and puts them together for the completed picture. Amodal cognition does not occur in only visual perception, tactile can be another good example for amodal perception. Amodal perception is very important component of our understanding of the world. Nanay argues that there are four theories of amodal perception [23]. First, "Perception" is first process of amodal cognition. Information come to retina through perception. It is not possible to see something without perceiving it. Somebody can imagine a house without seeing it but obviously imagination is different thing than perception. Second theory is "Belief" which is not something related with perception but it's the main point of amodal perception. After part of an object perceived, observer guess the whole of it based on its visible parts. Third theory is "Access" suggests that observer does not see the whole object but have access to it. In other words, person does access to some part of presented object but if he moves his eyes or head he can see the whole. This view is not certain because we have amodal perception for the objects that we do not have access to see but we still complete them. Last theory is "Visualization" that is very simply closing the eyes and visualization of unshown things. This would be very hard for the observer who have not seen that object before. Therefore, it would not be possible to visualize things we did not perceive it before [23]. Amodal perception is an effortless and quick cognitive process. In the experiment of Intraub and Richardson cropped and broken objects were presented [9]. All participants draw pictures as unbroken and continuous. That means general knowledge about the world helped them to fill unshown parts and fix abnormalities in the pictures. Moreover, participants guessed the sky above when outdoor pictures were presented without the sky [9]. In short, based on the multisource model, when visual input is gone, memory generates the information based on amodal perception and when it tries to recall presented scenes people tend to remember amodally generated memory which called is Boundary Extension [21].

1.4.1.3. Scene Content Hypothesis

Scene Content Hypothesis focuses on expectations that are formed as scene content based on perceptual schemas [11]. When participants see part of an object, perceptual schemas from past experiences create expectations about the presented object. One of the experiments done by Matthew and Mackintosh shows that emotionally arousal content takes observer's attention and perceptual schemas become active, as a result boundary extension occurs [24]. They theorized that highly anxious people tend to extend boundaries of scenes more than low-anxious people. State-Trait Anxiety Inventory used to categorize participants into two groups. Subjects rated target pictures from 1 to 5 in terms of emotional sensation of the pictures. Then participants performed a recognition test [25]. Results showed that highly arousal pictures lead to less boundary extension in negative pictures.

1.4.1.4. Perceptual Schema

When partial scene or part of an object is presented, perceptual expectations related to spatial view create wider expectations and this leads to boundary extension [9]. Understanding of presented information is dependent on perceptual schemas. These schemas are located in the long-term memory. When new input is presented, new information is fitted into the old schemas and if presented scene disappears, perceptual schemas create new expectations about the presented scene. Chapman, Ropar, Mitchell, and Ackroyd found that closer-up pictures lead to more boundary extension because observer can predict more surrounding world with closer-up pictures [26]. When presented picture is wider-angle, there would be less information to be predicted. Moreover, when participants do not pay attention to scenes boundary extension decreases [15]. This is because the person cannot fit the new information with old perceptual schemas. When observer sees the scene, perceptual schemas become activated and this leads to greater boundary extension [27].

1.4.1.5. Attentional Selection

In their study, Matthew and Mackintosh used emotional content to trigger observers' perception [24]. Another thing that authors suggested was that attention plays role in boundary extension. They argued that anxious participants paid more attention to threatening objects on pictures and ignored the background. Paying attention to the focal object results in weaker encoding of the background which increases boundary extension. However, another study argued that increased attention leads to less boundary extension [27]. Attentional selection theory is to some extent contradictory and there are not many studies that support this view.

1.4.1.6. Memory Schema

Memory schema theory focuses on the viewing distance in the images. When images have a viewing distance less than the prototypical one, scenes will be remembered with wider-angles [12]. Close-up pictures that include less background will be remembered with wider-angle which means more boundary extension. This theory supports that the closer the viewing distance in the image, the more boundary extension will be exhibited. Intraub and his colleagues conducted an experiment in terms of two different conditions [12]. First, they tested subjects immediately after scenes were presented. In the second condition, subjects were tested 48 hours after the presentation. Results showed that in the first condition boundary extension occurred only when pictures presented a close viewing distance. There was no boundary extension or boundary restriction on wider-angle pictures. For second condition, similarly boundary extension occurred in closer distance, but boundary restriction observed on wider-angle scenes. Memory schema was supported with this experiment [12]. Another experiment results did not support memory schema [12]. In this experiment viewing distance was eliminated. Boundary extension occurred in this condition too, suggesting that viewing distance does not play a role in boundary extension. Normalization is more likely to be at play in this case. Several studies by Intraub and his colleagues have revealed that memory schema theory is not consistent. Normalization is observed more consistently [12].

1.4.1.7. Extension-Normalization Model

Boundary extension may occur as a result of observer's expectations of a standard object [12]. Extension-Normalization Model focuses on prototypes of objects. Observer sees same object over and over again and normalize it. Several researches have shown that normalizing is more likely to happen than object completion because not only cropped objects but also uncropped objects presented as whole [12]. Extension-Normalization Model related to schemas suggest that two processes are involved; presented scenes activate perceptual schemas, and then these schemas extend boundaries of scenes with things that are expected to be there [25].

1.4.1.8. Source Monitoring

Source monitoring is the attribution of a memory to a perception like visual experience or to an internal imagination [28]. How people interpret their thoughts influences their perception of external world. Based on this theory Boundary Extension is related to a cognitive error in source monitoring [29]. Boundary extension can be explained as faulty reality monitoring because of misattribution. When the observer has uncertainty about internal or external sources Boundary Extension occurs [30]. In other words, boundary extension appears due to mixing the source with internal memories [31].

1.4.2. Factors Effecting on Boundary Extension

There are various scene dependent factors that effect Boundary Extension. In Boundary Extension experiments usually there is an object in front of the background [25]. However, studies suggest that the shape of the objects do not effect BE [32]. Boundary Extension occurs according to duration of presented stimulus [33]. When stimulus is presented for a longer period of time boundary extension diminishes. Inconsistent pictures lead to less boundary extension as well. Another study suggested that motion and direction of motion affects boundary extension intensity [3]. There was less boundary extension in implied-motion condition compared to the static-scan condition. Quality and resolution of pictures also effects visual memory. Participants exhibit more boundary extension when tested with low resolution pictures [34]. Also atypically colored objects like blue bananas lead to greater BE than typical colored objects because the difficulty in encoding atypically object prevents paying attention to the background [35]. Observer-dependent factors also play role on Boundary Extension. Vantage point of view is also another factor affecting BE. Central vantage point leads to greater boundary extension than 45° angle [36]. A past study showed that expert knowledge plays role on boundary extension. In the experiment, a road scene is presented and results show that expert drivers exhibited greater BE than beginner drivers [22]. Yet there is another controversial factor which is the content of scene. Candel and his colleagues argued that participants tend to extend pictures rather than restricting them for both neutral and emotionally arousal pictures [37]. Two experiment were conducted to test BE. Free recall drawing is used in first experiment. During the experiment, participants attended to neutral or emotionally arousal conditions and pictures presented for 15 seconds, then participants were asked to draw presented pictures. After that, participants rated pictures that they draw in terms of feelings they felt. In second experiment, pictures were presented for 5 seconds each and recognition test was used to rate whether test pictures were either closer-up, same or wider-angle. Results from both experiments showed that for both neutral and emotionally arousal pictures BE occurred [37]. Mathews and Mackintosh observed that emotionally arousing pictures effect BE. In their study, its been found that positively arousal pictures lead to greater BE than negatively arousal pictures [24]. Another study showed that BE only occurs with positively valenced pictures [38]. No BE was observed in negatively valenced pictures.

2. Structure

2.1. Model of the study

Correlational study model was used to investigate relationship between factors. Every participant attended to the experiment individually. All research was conducted in accordance under the approval of Near East University

Scientific Research Ethics Committee for human participants. All participants provided written informed consent. Before experiment started, participants performed on two cognitive functional tests. Firstly, Weschler Visual Reproduction Sub-test Revised conducted to test visual perception and memory [39]. 4 cards presented to participants for 15 seconds and participants drew the picture was presented. After the experiment finished (40 minutes later) participants drew same picture as much as they memorized to score delayed memory. Secondly, Benton Judgement of Line Orientation created by Benton, Vatney, and Hamsher in 1987 was conducted [40]. Participants were expected to remember direction and spatial location of presented lines in order to test visual-spatial memory. Participants were seated approximately 60cm far from screen with a dark background. Room was dimly-lit. Subjects are asked to run Microsoft Power Point to start the experiment. There were 4 trial and 40 experimental pictures in the experiment. Subjects performed on 4 trial pictures in order to understand the process of the experiment. There as no marking on practice part. Participants practiced on pressing space button to see next presented picture. When trial section has ended, proper experiment has begun. *Presentation Phase*. Participants were asked to pay attention and memorize every picture they seen. There were 20 pictures included different content in memorization phase. Each picture has been shown for 250ms in random order. Once presentation phase has been finished participant pressed space button to see test phase. *Test Phase*. There was no timing in test phase and pictures presented in same order presented before. Half of the presented pictures were in closer-up version and the other half were more wide-angle version (WC, CW). Also half of these pictures were same versions as presented phase and he other half were different (WW, CC). Participants asked to press space button and rate each picture verbally by using five-point Likert scale from (-2) to (2). Values were "much closer-up" (-2), "slightly closer-up" (-1), "the same" (0), "slightly wide-angle" (1), "much more wide-angle" (2). In other words, negative values meaning boundary extension and positive values indicates boundary restriction. Researcher filled the observation sheet. At the end of experiment debriefing form was given to participants.

2.2. Population and the sample

The population of the study was adult people. Convenient sampling technique was used to include participants. 50 participants (25 females, 25 males) between the ages 18 and 52 (M= 31.06, SD= 9.01, Range= 34.00) were tested in laboratory. All participants reported having normal or corrected-to-normal vision and normal color vision, no history of attention deficit disorder or psychotic disorder, no history of epilepsy. 42% of participants reported talking one language, 46% of participants reported talking two foreign languages and 12% of participants reported talking three languages. 80% participants reported being right-handed.

2.3. Instruments

2.3.1. Socio-demographic form

In order to investigate sample background, socio-demographic form was given to each participant and they are asked to fill individually. Socio-demographic form included questions like educational background, sex, marital status, health condition, and knowledge of foreign languages.

2.3.2. Apparatus

Scenes presented with Nvidia 6e force GTS40M i5 Laptop. Pictures are shown on 15.6'' LCD screen with 1366x768 resolution and 32 Bit color. Presentation was controlled with Windows 7, 8GB memory RAM.

2.3.3. Stimuli

Series of 22 (2 trial, 20 experimental) colored everyday images used for the experiment that collected from online sources. picture preferences were depending on previous experiments, for example, large background with an object [25]. Images had both indoor and outdoor scenes and either there was one foreground object on the center of photographs or not. 12 images were psychologically arousal that included face expressions that positive, negative and neutral arousal photographs, for example, a man crying, a baby laughing, and somebody playing golf. Pictures are shown in JPEG format. Close-up and wide-angle versions of images are created by using method of Intraub and Dickinson by zooming and cropping pictures on Adobe Photoshop [15]. Both versions of images had width of 750 pixels and height of 450 pixels. Thus, pictures size of images stayed same but %20 closer-up images are created. Each images presented with Microsoft Powerpoint at the center of screen with black background for 250ms. During test phase (recognition), pictures are presented same order as presentation phase (memorization). In test phase, pictures were in either same version or much closer-up or wide-angle version.

2.3.4. Weschler Visual Reproduction Sub-test Revised (WMS-R)

WMS-R Visual Reproduction Sub-test used to test visual perception and memory in order to investigate cognitive skills of participants [39]. Visuospatial memory is tested in this test with drawing methodology. In WMS-R test for immediate recall (G1), 5 different shapes were shown to participants for 10 seconds each and they were asked to copy shown shapes on paper. For delayed recall (G2), after 40 minutes participants were asked to draw shapes they did before as much as they remember. Highest scored participants can get from the test is 41. Test-retest reliability study of WMS-R done in Turkey [41].

2.3.5. Benton Judgement of Line Orientation Test (BJLOT)

Benton Judgement of Line Orientation created by Benton, Vatney, and Hamsher in 1987 was used. Test measures participant's spatial skills and visuospatial ability by matching lines with different angles. In this test, 11 line is presented to participants with different directions and participants asked to show which two lines are presented in 11 subjects. Before starting to test 5 trial test is conducted and there is 30 total questions in the test. Highest score participants might get from the test is 30. Benton Judgement of Line Orientation standardization study in Turkey was done by Karakaş and Dinçer [42].

2.4. Tables

Average of BE ratings are calculated and negative values indicate extension. Therefore a paired-sample t-test was conducted to see whether there is BE for identical and different scenes to test whether they are significant less than zero or not and if there is asymmetry between values of each conditions. Results show that, no significant difference is found in both identical scenes Close-up, Close-up and Wide-angle, Wide-angle (CC, WW). In other words people did not recall significantly different for CC and WW conditions, t(49)= 19.03, p= ,41.

Table 1: Comparison of BE Test Scores for Identical Scenes (Close-up, Close-up and Wide-angle, Wide-angle)

Scenes	N	x̄	SD	df	t	p
CC	50	-3.02	1.75			
				49	-8.83	.41
WW	50	-2.80	2.39			

Participants recognized angle differences when Close-up, Wide-angle and Wide-angle, Close-up (CW, WC) pictures were presented, t(49)=19.03, p< .001. Subjects rated more closer-up in WC condition (M= -6.98, SD= .58) than CW condition (M= 1.88, SD= 3.21). This finding supports that pictures used in experiment were appropriate to test BE.

Table 2: Comparison of BE Test Scores for Different Angle Scenes (Wide-angle, Close-up and Close-up, Wide-angle)

Scenes	N	x̄	SD	df	t	p
WC	50	-6.98	.58			
				49	19.03	.00
CW	50	1.88	3.21			

One of the hypothesis of the experiment was to test that there would be more BE when the presented picture has a foreground object. Average ratings were compared with paired samples t-test. There was a significant difference between scenes with a foreground object (M= -1.98, SD= 1.50) and scenes without a foreground object (M= -2.80, SD= 1.67); t(49)= 4.29, p< .001. BE was significantly greater for scenes with foreground object compared to those without one.

Table 3: Comparison of BE Test Scores Between Scenes With Foreground Object and Scenes Without Foreground Object

Scenes	N	x̄	SD	df	t	p
Fpositive	50	-1.98	1.50			
				49	4.29	.00
Fnegative	50	-2.80	1.67			

An independent samples t-test was used for analysis of gender difference. No significant gender differences were found; t(48)= -,32, p= .75.

Table 4: T-test Results Comparing Males and Females on Boundary Extension

Gender	N	x̄	SD	df	t	p
Female	25	-10.52	6.75			
				48	-.32	.74
Male	25	-9.96	5.45			

A one-way ANOVA test was employed to analyze knowledge of language and educational background's effect on BE. Language knowledge had a significant effect on BE; t(2, 47)= 21.55, p< .001.Post hoc analyses using the Scheffé post hoc criterion for significance indicated that participants who does not speak foreign language showed significantly higher BE scores than the participants who talks two foreign languages (p=.00) and three and more languages (p=.00). Participants who talk two foreign languages showed greater BE scores compare to participants who talk three and more languages (p=.00). Participants who talk two foreign languages showed greater BE scores compare to participants who talk three and more languages (p=.00).

Table 5: ANOVA Results Comparing BE Scores of Participants According to Number of Knowledge of Foreign Languages

Source of Variance	Sum of Squares	df	Mean Square	F	p
Between groups	856.40	2	432.55	21.55	.00
Within groups	943.72	47	20.08		
Total	1809.12	49			

Educational background effects BE significantly; t(3, 46)= 10.29, p< .001.Post hoc analyses using the Scheffé post hoc criterion for significance showed that people with high school degree showed greater BE than participants with bachelor degree (p=.01), participants with master degree (p=.00), and participants with doctorate (p=.01). Results show that educational background significantly affects boundary extension.

Table 6: ANOVA Results Comparing Educational Background on Boundary Extension

Source of Variance	Sum of Squares	df	Mean Square	F	p
Between groups	726.75	3	242.25	10.29	.00
Within groups	1082.37	46	23.53		
Total	1809.12	49			

Cognitive functioning was another variable of research. Pearson's r data analysis revealed a high negative correlation between Benton test results and boundary extension (r= .87, p=.00). Participants who got higher scores in BJLOT exhibited less BE. Similarly, Pearson's r data analysis revealed negative correlation between both WMS-G1 (immediate recall scores) and WMS-G2 (delayed recall scores) test scores with boundary extension (r= .75, p= .00; r= .76, p=.00). Both immediate and delayed memory test found significantly correlated to boundary extension

Table 7: Pearson's Correlation of BJLOT and WMS-R Test Scores and Boundary Extension

Boundary Extension	Benton	WMS-G1	WMS-G2	
Boundary Extension		.87	75	.76
Benton			.86	.84
WMS-G1				.93
WMS-G2				

In order to look at difference of emotionally arousal content repeated-measures ANOVA was conducted. Emotional content has no effect on BE, Will's Lambda= .879, $F(2,48)= 3.60$, $p= .03$.

3. Discussion

The current study revealed different factors effecting on boundary extension. Effect of educational background and knowledge of language were some of new variables. Moreover, cognitive functioning was another factor that plays role on boundary extension. Spatial memory and visuospatial abilities lead people process visual input better and reduce boundary extension error. Although new study has new variables, one main limitation of the current study related with visuomemory performance and Boundary extension is the correlational nature of the study. Though the findings of this study clearly indicate a negative correlation between the two, it does not necessarily imply a causal relationship. It might be the case that these variables covary due to a third cofounding variable which might account for their negative correlation. As instance, those participants who got better scores in the memory test might have had better motivation to do test and hence also exhibited less boundary extension since they paid more attention to images. Another limitation of the study was its relatively low sample size, which reduces the external validity of the findings and makes hard to draw generalizations based on these findings. It is suggested to future studies to use larger sample sizes to improve current finding. Results of past studies on boundary extension it hypothesized that there will be no significant difference between the mean scores of wide angle, wide angle and Close-up, close-up (WW and CC) conditions on BE (Hale, Brown, Mcdunn, & Siddiqui, 2014), and there will be a significant difference between the scores of wide angle, close-up (WC) and close-up, wide angle (CW). Result of current study supported the hypothesis. People recognized when wider-angle picture was shown. Although, boundary extension rates were not significantly different for identical scenes (CC, WW). Based on the findings of past studies, it was hypothesized by the current study that participants will have higher boundary extension scores for images with a foreground object, compared to images without it. Results of the study confirmed the hypothesis and supported past studies. Another factor related with boundary extension that has been examined in previous studies is the emotional content of the images. Past studies have examined how the arousal content of the images affects the amount of boundary extension exhibited by participants. In accord with past findings, this study hypothesized that there will be significant difference in boundary extension scores between images with neutral, negative, and positive content. The hypothesis was confirmed by the findings of the study and indicated no significant relationship between emotional content and boundary extension. The current study have also examined the effects of visual memory functioning on boundary extension. Although this relationship has not been investigated by past studies, theoretical explanations of boundary extension clearly indicated a link between visual memory processes and boundary extension. After all, boundary extension is a type of visuomemory bias and hence might be related with the general visual memory performance. As such, the current study examined this relationship and hypothesized a significant negative correlation between visuomemory scores on Benton and Weschler tests and Boundary extension scores. Results of the study supported the hypothesis and indicated that participants with better visuomemory performance exhibited less boundary extension. Moreover, two demographic variables, knowledge of different languages and educational background, were also examined in relation with boundary extension. A general finding of memory studies is that both bilingualism and better educational background improve memory performance, and hence were hypothesized to be negatively correlated with boundary extension. The hypothesis was supported by the findings of the study, which indicated lower boundary extension for bilingual participants, as well as participants with better educational background.

4. Conclusion and Recommendation

The main aim of the current study was to study Boundary Extension and examine some of the important factors related with it. Boundary extension refers to the phenomenon that people tend to remember images in a wider-angle compared to what they have seen. In other words, some extended parts are mentally created and added to the memories of the seen images, that had not been there. The aforementioned phenomenon had been the focus of many studies in cognitive psychology as it sheds light on how visual processing takes place in our brain and what kinds of cognitive biases and error might happen during these mental processes. Over the years, several important factors have been identified to affect boundary extension. One of these factors is the foreground object. Several past studies have examined the effect of the foreground object on the extent of Boundary Extention and have shown that Boundary Extension is greater for images with a foreground object, compared to images without. One of the past findings suggested that boundary extension is greater with focal point [43]. Moreover, larger object has significant effect on boundary extension [43]. Their findings showed that changing target object from 200cm distance did not effect on boundary extension. Although, in 500cm distance condition focal object was significantly effective on boundary extension to occur. Another research used foreground object [11]. They used simple, medium and complex pictures meaning that other objects were also presented at the background. Results showed that foreground object is effective on boundary extension. Also complexity was another interesting finding of the research that complex pictures with one foreground object lead greater boundary extension. Its been argued that observers recall pictures as wider-angle for both neutral and emotional pictures [37]. They used both recall task and drawing task methodology and results showed that for both conditions boundary extension occurs. Another study done by Mathews and Mackintosh looked at participants' psychological states too [24]. They argues that when anxious people see threatening scene they more likely to extend edges of scenes than less anxious people. Also another result of their study was that positive pictures lead greater boundary extension than negative pictures. One of the current study showed that boundary extension does not occur with negatively arousal pictures, only positively arousal pictures lead observer see wider-angle of presented pictures [38]. One of the main theories that explains boundary extension is the multisource model of scene representation [15]. Based on this theory amodal visual perception accounts for boundary extension. Amodal perception refers to mentally visualizing the unshown parts of scenes or objects. The theory states that human brain tends to see objects or scenes as complete, and hence when a scene or object is partially presented, the rest will be mentally visualized. In other words, unseen parts of a perceived scene or object are visually imagined based on the past knowledge of that scene or object. Intraub and Richardson have argued that perceptual schemas that are formed by past visual information, form certain expectations about the unseen parts of currently presented objects, that are then turned into mental visualizations [9]. This theory explains that boundary extension is greater for images with closer-angle since a larger proportion of the scene will assumed unseen and will be predicted by perceptual schemas. These expectation-based visual predictions can consequently influence the encoding of the actual visual information and result in a systematic visual error (i.e. boundary extension). The latter part is further scrutinized in the source monitoring theory which states that uncertainty about the internal and external sources of visual information results in boundary extension [28].

Based on this theory, expectation-based visualizations about the unseen parts of a scene or object, that are generated by perceptual schemas, provide an internal source of visual information, besides the actual external visual data, and boundary extension occurs due to the brains failure in clearly monitoring and differentiating these internal and external sources of visual data. As such, internally generated visual data can be incorporated into the actual external information and result in perceptual bias and false memory fragments. Another noteworthy theory that can explain the boundary extension phenomenon is the Extension-Normalization theory [12]. Based on this theory, long-term memory forms certain schematic prototypical visualizations about the scenes and objects that it encodes, and tends to normalize later encounters of those objects so as to fit them into the prototypical visualizations that it already has. In other words, when an object is repeatedly seen, the brain forms a normal visual prototype of that object which specifies how this object must look like. Moreover, the brain tends to fit input visual data into previously formed prototypical categorizes, and as such when an incomplete or deformed object or seen is perceived, it is visually normalized and completed so as to fit its prototypical category. In this sense, boundary extension occurs when an incomplete scene is normalized and completed based on the previously stored prototypical visualizations of that scene. Findings of the current study in regard with foreground focal object can be explained by the Attentional model of boundary extension [24]. Based on this model, the focal object reduces the attentional resources allocated to background scene and hence a less accurate encoding occurs which calls for more expectation-based imaginary visualizations that are guided by previously formed perceptual schemas. In this manner, weaker encoding of external background information increases the room for greater internally generated background information that are later on incorporated into the actual visual data and result in greater boundary extension and systematic memory bias. A similar argument can be used to explain the findings of the current study about the negative correlation between visuomemory performance and boundary extension. In this regard, it can be reasoned that a better general visuomemory functioning results in a more accurate and comprehensive encoding of images and leaves less room for expectation-based visualization which results in lower boundary extension. On the other hand, participants with weaker visuomemory functioning tend to have weaker memories of the actual presented scene and are more likely to complete the presented but not accurately encoded scene, with prototypical visualizations. As such, the effects of bilingualism and educational background on boundary extension can be explained as well. Indeed, numerous studies have revealed that bilingual participants and participants with higher educational backgrounds, get higher scores in different types of memory tests. In this regard, better memory functioning of bilingual participants and participants with better educational backgrounds, can account for their lower scores in boundary extension. Apart from confirming the general findings of past Boundary Extension studies, the contribution of the current study to the field was examining the relationship between visuomemory performance and Boundary Extension. The negative correlation found between memory functioning and intensity of Boundary Extension suggests that inaccurate encoding can be a contributory factor to Boundary Extension which is consistent with both perceptual schema and source monitoring theories. This finding indicates that better visuomotor functioning significantly reduces Boundary Extension, as a visual processing error, which consequently implies that Boundary Extension could be the outcome of an innate visual processing mechanism through which precieved visual data is schematically corrected and completed. This mechanism can in fact play a crucial role in our visual pattern recognition capabilities, where incomplete or deformed objects are involved. As such, deformed or incomplete objects are imaginarily normalized to their prototypical forms which can highly facilitate the recognition process. This on the other hand, leaves us with the hint that evolutionary forces might have been involved in the formation of this neural mechanism, since rapid pattern recognition for complex object based on uncertain, inaccurate, or incomplete visual data, has been of great survival importance to homosapiens over time. In this regard, studying and examining boundary extension from an evolutionary point of view might also shed light on the nature and mechanism of the phenomenon. Future research may focus on cognitive fuctions more other cognitive functions may play role also on boundary extension. The more we learn about human visual memory error the more we will be able to understand how do people understand and the process the world.

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