THE ROLE OF CONTEXT IN BOUNDARY EXTENSION

AYŞE EZGİ MAMUS

BOĞAZİÇİ UNIVERSITY

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THE ROLE OF CONTEXT IN BOUNDARY EXTENSION

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Ayşe Ezgi Mamus

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The Role of Context in Boundary Extension

The thesis of Ayşe Ezgi Mamus

has been approved by:

Assoc. Prof. Ayşecan Boduroğlu
(Thesis Advisor)

Prof. Ali İ. Tekcan

Dr. Alper Açık
(External Member)

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DECLARATION OF ORIGINALITY

I, Ayşe Ezgi Mamus, certify that

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- this thesis contains no material that has been submitted or accepted for a degree or diploma in any other educational institution;
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ABSTRACT

The Role of Context on Boundary Extension

Boundary extension (BE) is a memory error in which observers tend to remember more of a scene than they are actually viewed, which reflects a good prediction of the natural continuation of a scene (Intraub & Richardson, 1989). According to the multisource model of scene perception, scene schema and contextual knowledge are main contributors to support these predictions (Intraub, 2012). In two separate experiments we investigated the necessity of context and scene schema in BE. In Experiment 1, observers viewed scenes that either contained semantically consistent or inconsistent objects as well as objects on white backgrounds. In Experiment 2, observers viewed abstract shapes on blank backgrounds. We also measured individual differences in visual and spatial imagery ability. In all types of scenes and the no background condition there was a BE effect; but critically, semantic inconsistency in scenes reduced the magnitude of BE. When abstract shapes were used instead of meaningful objects, no BE effect was seen. The results also showed that imagery abilities influenced BE ratings only when scenes had no element to trigger prediction. Our findings are consistent with the multisource model. We suggest that although scene schema is necessary to elicit BE, contextual consistency is not required but only increases the magnitude of BE.

ÖZET

Bağlamın Görsel Sahnelerin Sınırlarının Genişletilmesindeki Rolü

Görsel sahnelerin sınırlarının genişletilmesi, kişilerin kendilerine gösterilen sahnelerin içerdiği bilgiden fazlasını hatırlamasına yol açan bir bellek hatasıdır. Ancak bu hatanın sahnenin dışında görünmeyen kısımların nasıl devam edeceğini tahmin etmede faydalı bir işlevi vardır (Intraub & Richardson, 1989). Çok-kaynaklı (*Multisource*) modele göre, sahne şeması ve bağlamsal bilgi bu tahminin oluşmasına destek olan iki temel unsurdur (Intraub, 2012). Bu tezde, iki ayrı deney ile bağlamın ve sahne şemasının görsel sahnelerin sınırlarının genişletilmesindeki gerekliliğini inceledik. Birinci deneyde katılımcılar beyaz bir arka planda duran nesnelere ek olarak, bağlamsal olarak uyumlu veya uyumsuz nesneler içeren sahneleri incelediler. İkinci deneyde ise katılımcılar boş arka plan üzerine konumlandırılmış soyut şekilleri incelediler. Ayrıca kişilerin görsel ve uzamsal imgelem becerilerindeki farklılıkları ölçüldü. Her tür sahne ve beyaz arka plan koşulunda sınırların genişletilmesi etkisi görüldü. Ancak sahnelerdeki bağlamsal uyumsuzluğun bu etkinin miktarını düşürdüğü bulundu. Anlamlı nesneler yerine soyut şekiller kullanıldığında ise etki görülmedi. Ayrıca, sadece resimler tahmin yürütmeyi tetikleyebilecek bir unsur içermediği koşulda bireylerin imgelem becerilerindeki farklılıklar sınırların genişletilmesi etkisinin miktarını öngörmektedir. Bu çalışmanın bulguları Çok-kaynaklı model ile uyumludur. Görsel sahnelerin sınırlarının genişletilmesi etkisini gözlemleyebilmek için sahne şemasının varlığı gerekli olsa da, bağlamsal uyum gerekli değildir. Bağlamsal uyum yalnızca etki miktarını artırmaktadır.

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To My Family

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CHAPTER 1

THEORETICAL BACKGROUND

Boundary extension (BE) is a memory error in which observers tend to remember more of a scene than they are shown, particularly areas which fall outside the physical boundaries of a view (Intraub & Richardson, 1989). While BE is typically described as an error, it is believed to have heuristic value. BE reflects a mostly accurate prediction of the natural continuation of a scene and viewing durations as short as 42ms have been shown to induce BE (Intraub & Dickinson, 2008; Intraub & Richardson, 1989). Intraub (2012), in her multisource model of scene perception, has specifically argued that BE may support scene perception by simulating an internal scene representation (Intraub, 2012; Intraub & Dickinson, 2008). Given the frequent interruptions of the visual input by blinks and saccades, BE may be functional in facilitating and speeding up the integration process of successive sensory input, leading to a more continuous perceptual experience of the visual surroundings. While earlier findings from scene memory tasks have demonstrated that BE was limited to scene memory and did not occur when objects were presented on blank backgrounds (Gottesman & Intraub, 2002; Intraub, Gottesman, & Bills, 1998), more recent research showed that BE was similarly elicited for abstract stimuli on blank backgrounds, a manipulation that eliminated context and schematic information from images (McDunn, Siddiqui, & Brown, 2014). Given these discrepant findings, in this study, we further investigated the necessity of object and context related conceptual information on BE.

Intraub and Richardson (1989) initially introduced the BE phenomenon based on data gathered from experiments using both the picture drawing and picture recognition tasks. When viewers were asked to draw previously studied scenes, they drew parts of the scenes that were not seen in the original stimulus. For instance, they completed the cropped objects in the studied picture and drew them in a complete fashion. In a separate experiment, participants studied both close-up and wide-angle scenes. After a 2 day delay, they were asked to rate whether the test scene was identical, closer or farther apart from the studied scenes. Participants rated both close-up and wide-angle test scenes as being more closer-up than before, but close-up scenes were rated as more closer than wide angle scenes, leading to larger BE errors. Subsequent research by Intraub and colleagues has repeatedly shown that the BE error is only associated with images involving scenes or elements that can be construed as scenes (Gottesman & Intraub, 2002; Intraub et al., 1998). For instance, Intraub et al. (1998) presented photographs of objects in coherent scene contexts, line drawings of those natural scenes or line drawings of single objects on blank white backgrounds. Participants were instructed to remember the objects and their sizes. The results revealed that participants in scene conditions (either natural or line drawings) showed the BE error but this error did not occur in the blank background condition. When participants were instructed to imagine a coherent context for the blank backgrounds, BE occurred as if the objects were presented in natural scenes. Thus, presence of a real or imagined natural context stimulated probable scene layout which was invisible at the time of viewing. Gottesman and Intraub (2002) also showed that photographs of objects on blank backgrounds elicited BE whereas line drawings of the same objects did not. They suggested that real photographs as opposed to line drawings are more likely to induce a partial image of a continuous scene. In her unpublished thesis, Gottesman (1998) created non-organized scenes by cutting a scene into six pieces and jumbling them up, and she found BE even for these jumbled scenes. However, even though Gottesman (1998) argued that these scenes were jumbled, breaking a continuous background (such as rocks on the beach) into six pieces and shuffling them around did not eliminate scene schema as much as had planned. Based on all these findings, Intraub and colleagues concluded that observer's interpretation of a background as a continuous surface rather than background details per se might be critical in eliciting BE.

The multisource model of scene perception was proposed to account for these set of findings on BE (Intraub & Dickinson, 2008). According to this model, various sources of top-down and bottom-up information are integrated to internally simulate the world that humans cannot see as a whole within a single view. Together with visual sensory input, expectations and restrictions arising from context knowledge and our prior experience construct an internal spatial framework (Intraub, 2012). The model states that BE occurs because observers erroneously rely on the representation they have internally stimulated instead of the sensory experience during scene memory tasks. Therefore, the BE error could be considered as a source monitoring error (Gagnier & Intraub, 2012; Intraub, Daniels, Horowitz, & Wolfe, 2008). For instance, Intraub et al. (2008) showed that BE error for scene memories was higher when observers attended to an unrelated visual search task in addition to picture viewing. They inferred that decreased attention during picture viewing increased the difficulty of differentiating the internal amodal representation and experienced visual input. Moreover, Gagnier and Intraub (2012) found that line drawings of scenes elicited much more BE error than colored photographs of the same scenes. They concluded that reduced quality of visual input might increase the source monitoring error for the line drawings because the sensory experience becomes more similar to the imperfect internal representation.

Despite both the empirical evidence and the models that indicate that BE is driven by contextual processing of scenes (Gottesman, 1998; Gottesman & Intraub, 2002; Intraub et al., 1998), a recent study by McDunn et al. (2014) demonstrated that BE occurred even in abstract scenes consisting of irregular polygons in which semantic context and scene schema were eliminated. While McDunn et al. concluded that high-level information might not be necessary to elicit BE, they also mentioned that placing the objects on random-dot backgrounds might have created "some sense of a spatial context" (p.374). Furthermore, it is also possible that the long study durations (15s) in this particular study may have helped participants to create an imaginary context around these abstract polygonal shapes. Intraub et al. (1998) had demonstrated earlier that BE occurred when viewers were asked to imagine a context of an outlined object for 15s. The data present in McDunn et al. (2014) does not allow us to determine whether the participants spontaneously engaged in this imagining-context strategy to perform the task. Thus, the current evidence does not allow us to determine whether some kind of contextual information is necessary for BE.

In order to directly test the impact on contextual information on BE, we specifically focused on how object and context consistency impact scene processing. Both empirical studies and computational models have illustrated that scenes are processed rapidly and in a holistic fashion, and identification of scene gist is known to contribute to object identification (for a review see Bar, 2004). Since the early work by Potter (1975), it has been known that target objects could be detected in scenes viewed as short as 125ms. More recently, Oliva and colleagues demonstrated that scenes can be accurately categorized in even shorter durations, around 40ms (Greene & Oliva, 2009). Critically, contextual consistency has been shown to facilitate object perception (e.g. Biederman, Mezzanotte, & Rabinowitz, 1982; Davenport, 2007; Davenport & Potter, 2004; Palmer, 1975). Inconsistency between the target and the context retarded processing of scenes and decreased accuracy in scene categorization even when these scenes were flashed for as short as 26ms (Joubert, Rousselet, Fize & Fabre-Thorpe, 2007). The advantage of using contextually consistent and inconsistent scenes is that in both cases the background context is continuous; however, the perception of the latter group of scenes are not likely to be facilitated by any existing scene schemas (e.g. Biederman et al., 1982, Davenport & Potter, 2004; Palmer, 1975; Potter, 1976). Thus, we expected that BE would be less in the contextually inconsistent scenes. We also included another condition which consisted of a target object on a white background. Blank background should have reduced contributions from scene schemas; thus we expected the least BE in this condition, if at all.

A secondary goal of the present study was to determine how individual differences in visual and spatial imagery were related to BE. Image quality and attentional processes have been shown to affect BE (Gagnier & Intraub, 2012; Intraub et al., 2008). Recently, Munger and Multhaup (2016) investigated whether observers' elaboration of sensory details in images increased BE error via a boost in source memory error. They hypothesized that visual and spatial imagery might be positively correlated with magnitude of BE because observers high in imagery might have richer internal representations of scenes, and therefore, make more source memory error. In six experiments, they asked participants to imagine additional smells, sounds, and visual details while viewing scenes. Additionally, participants were given different self-report imagery questionnaires. However, Munger and Multhaup (2016) found that elaboration of any additional sensory details did not predict the magnitude of BE and visual imagery was not correlated with BE magnitude. In one of the six experiments (Exp.3a), they showed that individuals higher in spatial imagery had greater BE error, but this was shown only for one type of trials (CC trials) out of four trial types. Although there was no strong experimental evidence, imagery differences were theoretically argued as an influential factor in simulating internal representations of scenes, and therefore, for BE. Hence, in both experiments we measured visual and spatial imagery by applying a mental rotation task and collecting participants' self-reports.

CHAPTER 2

EXPERIMENT 1

2.1 Method

2.1.1 Participants

A total of 120 undergraduate students at Bogazici University participated in the experiment in exchange for extra credit in their psychology courses. There were 80 participants (*M* = 20.11 years (18-24), *SD* = 1.21, 78% female) in the scene condition and 40 participants (*M* = 20.33 years (18-25), *SD* = 1.76, 75% female) in the no background condition. They all had normal or corrected-to-normal vision and provided written informed consent.

2.1.2 Materials

2.1.2.1 Picture Rating Task

The picture rating task consisted of two between subject conditions. One group of participants were asked to rate studied scenes and a separate group of participants were asked to rate single objects presented on blank backgrounds (no background condition). In the scene condition, there were both consistent and inconsistent scenes presented in a mixed order (see Figure 1). In all conditions, participants were asked to study the presented stimuli for a future memory test and immediately following the study phase, they completed the test phase in which they had to rate whether a test picture was in the same perspective, closer up or further away than the studied one. Before the study phase, participants were instructed to try to remember the pictures in as much detail as possible. In the scene condition, participants were specifically instructed to pay attention equally to the objects, the background, and the layout in the pictures. In the no background condition, participants were asked to remember the object in as much detail as possible.

In the study phase, we presented each picture for 15s. Images in the test phase were presented in the same order as in the study phase. Studied pictures were either close-up or wide-angle images. In the test phase, half of the images were shown identical to their studied versions and the remaining half were presented from the alternative perspective of the study versions (i.e. close-up pictures were presented in wide-angle or vice versa). Therefore, there were four trial types in the test phase: close-up study and test (CC), wide-angle study and test (WW), close-up study and wide-angle test (CW), and wide-angle study and close-up test (WC).

In the test phase, participants were instructed to rate each test picture on a 5-point scale. Specifically they were asked to indicate the position of the camera as being ‘‘much closer-up’’ (-2), ‘‘slightly closer-up’’ (-1), ‘‘same’’ (0), ‘‘slightly more wide-angle’’ (1), or ‘‘much more wide-angle’’ (2). Then, they also reported their confidence in their rating on 4 point scale, with 0 indicating no memory of the picture, (1) ‘‘not sure’’, (2) ‘‘pretty sure’’, and (3) ‘‘sure’. Before the test phase, participants completed two practice trials with both close-up and wide angle versions of the pictures in succession. In the scene condition, the first practice trial included a consistent picture which was shown as closer-up at test, and the second practice trial included an inconsistent picture which was shown at a wider angle at test. In the no background condition, participants also had two practice trials; in the first one, the test object was presented as closer-up and in the second one it was presented at a wider angle. After completing the practice trials, participants were given further explanations if there was any indication that they misunderstood the instructions.

2.1.2.2 Pictures

We prepared two sets of 40 (i.e. total 80) colored natural images using Adobe® Photoshop® CS6. Each image had a central foreground object pasted onto a background scene that was either semantically consistent or inconsistent with the object. We collected these objects and the backgrounds separately from available data sets (Davenport & Potter, 2004), and other online services (e.g. Google images). Objects consisted of individuals, animals, or inanimate man-made things, and scenes included both indoor and outdoor environments.

To create consistent images, we pasted foreground objects onto semantically consistent background scenes. We created 3 options for each one of 40 semantic categories (e.g. forest, underwater etc.). These scenes were assessed in a pilot study in our previous work (Mamus, Boduroglu, & Gutchess, 2015). Using a scale from 1 to 7, 73 naive participants rated pictures in terms of semantic consistency and image quality. We selected 40 images from different categories that were rated above 4 in terms of both semantic consistency and image quality to be used in the study. To create 40 inconsistent images, we exchanged the foreground objects between two semantically consistent images. The position and the size of each object remained the same in both the semantically consistent and inconsistent versions of images. All final images were in JPEG format, and had a width of 750 pixels and height of 450 pixels. The stimuli were presented on a gray screen.

Close-up and wide-angle versions of each image were created based on the method used by Intraub and Dickinson (2008). Close-up versions were prepared by enlarging the wide-angle images by 20% and then by cropping the new image to its original wide-angle size. Thus, the sizes of the images remained the same across both versions, but wide-angle views had more background and smaller objects (see Figure 1 for examples).

For the scene condition, we randomly separated all 80 consistent and inconsistent images into two 40 image sets such that semantic consistency and close-up/wide-angle versions of the images were equally distributed. A foreground object or a background scenery never occurred more than once in each set. For the no background condition, we used 40 images having different objects, and the scenes of these images were replaced with white blank backgrounds. In addition, the no background condition included close-up and wide-angle objects as well (See Figure 1).

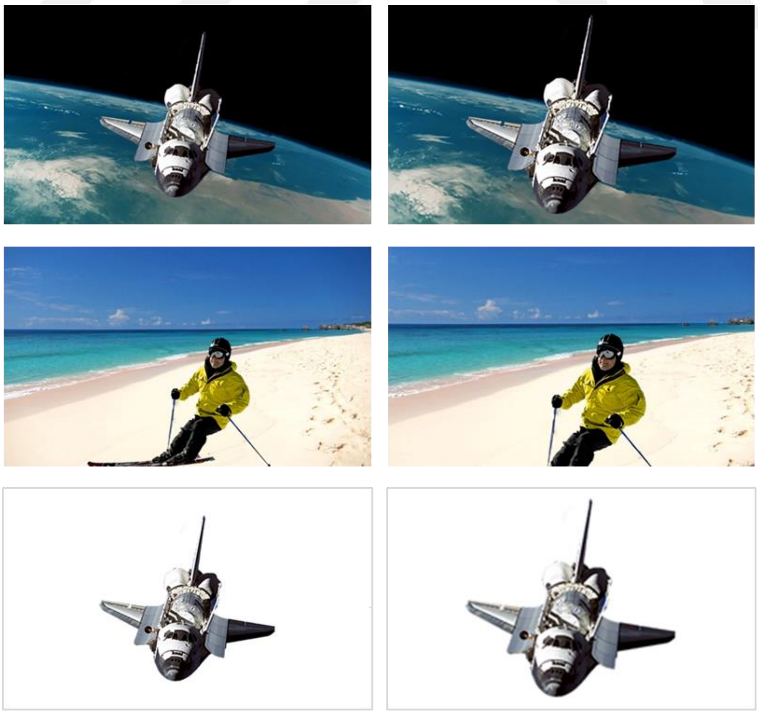

Figure 1. Example images in Experiment 1. Wide angle (left) and close-up views (right). Top, consistent scene; middle, inconsistent scene; bottom, no background condition

2.1.2.3 PEBL Matrix Rotation Task (MRT)

The PEBL Matrix Rotation Task is a computerized version of matrix rotation task in UTC-PAB Test developed by Perez, Masline, Ramsey and Urban (1987). This task measures spatial rotation ability and short term perceptual memory (Mueller & Piper, 2014). In this task participants saw a series of 6 by 6 cell matrices. Each matrix had 6 illuminated cells. Participants had to determine if the second matrix was a 90° (either left or right) rotated version of the first matrix. Participants had to press the left shift key if two matrices were the same, otherwise they had to press the right shift key on the keyboard. They received two practice trials together with the instructions. Accuracy and response time (RT) were measured over 20 test trials.

2.1.2.4 Object-Spatial Imagery and Verbal Questionnaire (OSIVQ)

Participants were asked to complete the OSIVQ (Blazhenkova & Kozhevnikov, 2009). This questionnaire consists of 45 items and three subscales (Appendix A). Participants were asked to rate each item on a 5-point Likert scale from 1 (totally disagree) to 5 (totally agree). They indicated their preferences for colorful, pictorial, and high-resolution images for the object imagery scale, for schematic images, spatial relations amongst objects, and spatial transformations for the spatial imagery scale, and verbal explanations and writing abilities for the verbal imagery scale. We calculated reliability scores based on our data coming from both experiments (n = 206). Cronbach's alphas were .84, .80, and .83 for object imagery, spatial imagery, and verbal thinking, respectively.

2.1.2.5 Picture Questionnaire

We also asked each participant to rate the pictures they studied via an online survey. In the scene condition, participants rated each image in terms of semantic consistency (1: highly inconsistent; 7: highly consistent) and distinctiveness (i.e. capturing attention) (1: highly indistinctive; 7: highly distinctive). In the no background condition, they were only asked to indicate how distinctive each object was.

2.1.3 Procedure

Participants individually sat in a dimly lighted room approximately 57 cm away from a 17 inch CRT monitor (60-hz refresh rate) which was set to a resolution of 1280x1024 pixels. Each participant was randomly assigned to the scene or the no background condition. Participants in the scene condition was randomly assigned to one of two sets. The procedure was the same for both the scene and no background conditions except the nature of the pictures presented. The experiment started with the picture rating task, and immediately after, it continued with the MRT, the OSIVQ, the picture questionnaire and demographic questionnaires. The total duration of the experiment was about 50 minutes.

2.2 Results

For each participant, we calculated the average BE ratings separately for all trial types. For the scene group, there were two critical variables: consistency (2-levels) and viewing condition (4-levels), resulting in 8 trial types. For the no background group, only viewing condition was manipulated resulting in 4 different trial types. We determined whether there were any individuals with extreme responses by calculating the Cook's distance for all trial types. In the scene condition, 7 participants' average ratings were at extreme in at least 2 out of 8 trial types. In the no background condition, 2 participants' average ratings were at extreme in at least 2 out of 4 trial types. After the exclusion of participants with extreme ratings, we were left with 73 participants in the scene condition and 38 participants in the no background condition. Furthermore, we examined participants' confidence in their response to detect cases referring to no memory of the picture. Across all trial types, only on 2 % of the trials participants reported that they did not remember the picture. This pattern was similar across both the scene and the no background conditions. After the exclusion of these trials the pattern of the results did not change. Therefore, all trials were included in the analyses.

2.2.1 Boundary Extension

To determine whether our set of stimuli elicited BE, we first looked at the identical viewing conditions (WW & CC). For identical scenes, ratings below zero indicate extension. Therefore, we conducted one-sample t-tests (criteria = 0) and found that for both the WW (M = -.16, SD = .36) and the CC (M = -.43, SD = .38) conditions, people remembered the scenes as more extended, $t(72) = -3.88$, $p < .001$, $d = .44$;, $t(72)$ = -9,57, $p < .001$, $d = 1.13$, for WW and CC, respectively. In addition, participants were able to notice correctly when the view of the pictures were changed at test; they rated the scenes closer in the WC condition (M = -1.04, SD = .46), $t(72) = -19.49$, $p < .001$, $d = 2.26$, and wider in the CW condition (M = .46, SD = .42), $t(72) = 9.18$, $p < .001$, $d = 1.10$. Thus, participants followed the instructions of the task and correctly used the scale.

To determine whether contextual inconsistency between a foreground object and its background scene may have affected the occurrence and/or the magnitude of BE, we conducted a 2 (consistency: consistent, inconsistent) X 4 (viewing condition: WW, CC, WC, CW) repeated measures ANOVA. The results revealed that there was a main effect of consistency, $F(1,72) = 4.30$, $MSE = .118$, $p = .04$, $n_p^2 = .06$. Semantically consistent scenes ($M = -.32$, $SD = .27$) elicited more boundary extension than semantically inconsistent scenes ($M = -.26$, $SD = .29$), $d = .25$. There was also a main effect of viewing condition, $F(3, 216) = 210.72$, $MSE = .266$, $p < .001$, $n_p^2 = .75$. Pairwise comparisons adjusted with Bonferroni revealed that the CC condition elicited more BE than the WW condition, $p < .001$ (see Figure 2). In addition, these main effects were qualified by a significant interaction effect between consistency and viewing condition, $F(3, 216) = 6.41$, $p < .001$, $n_p^2 = .08$. This interaction[1] was due to the fact that consistent scenes elicited much greater BE error compared to inconsistent scenes, but this difference emerged only from the different viewing conditions, in which the view of the pictures were changed. There was no significant difference between consistent and inconsistent scenes in the identical WW and CC conditions, *p*s > .05; but consistent scenes were rated much closer-up than inconsistent scenes in the different viewing conditions, $t(72) = -3.01$, $p = .004$, $t(72) = -3.27$, $p = .002$, for WC and CW conditions, respectively.

[1] We repeated the ANOVA with scores transferred from (-2 to +2) to (1 to 5) range in order to avoid any computational bias due to high contrast between the sign of the values in the CW and the other conditions. The results remained similar.

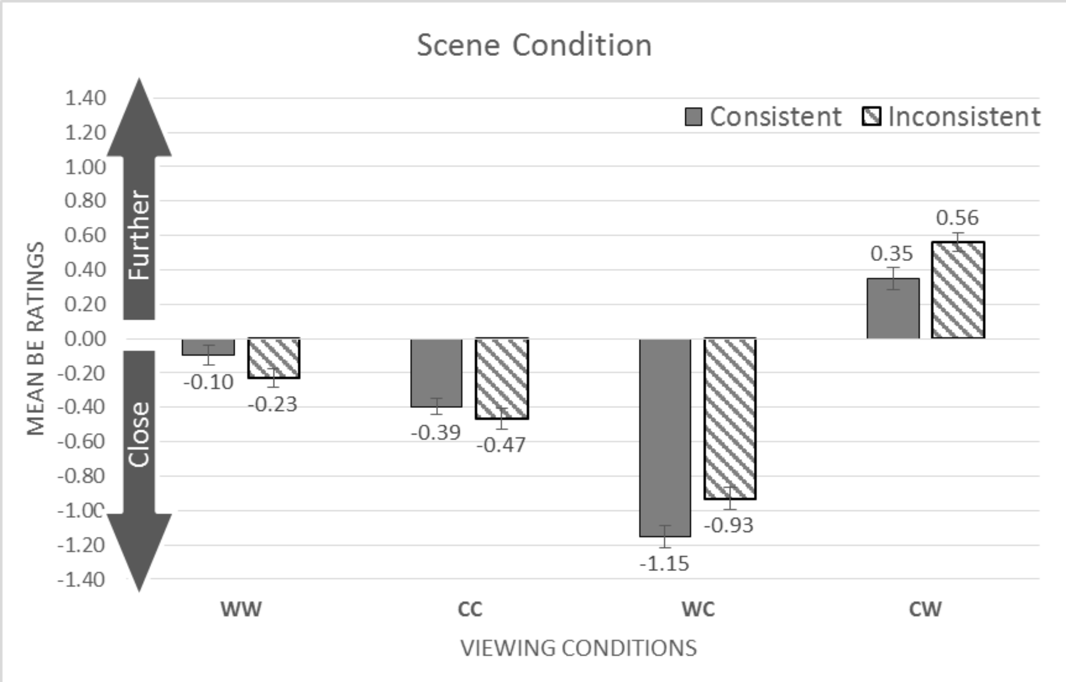

Figure 2. The effect of consistency on mean BE ratings for different viewing conditions. Error bars indicate standard error of mean

Since it was previously argued that people in the WC condition were disproportionately more biased to rate a picture as closer than a CW picture further (e.g. Dickinson & Intraub, 2008; Gottesman & Intraub, 2002), we wanted to test whether there was such an asymmetry in our data. In the WC condition, when the scene was already closer, correct recognition of the change would require negative ratings. So, negative ratings receding away from zero could be taken to indicate boundary extension. On the other hand, in the CW condition, since the second scene is already extended, correct performance would require a positive rating. Therefore in this condition, positive ratings approaching zero could be taken as indicating a tendency for boundary extension. To test this idea, we followed the approach taken by Gottesman and Intraub (2002) who compared the absolute values of the ratings for the WC and CW conditions. To test whether the magnitude of ratings in these conditions were asymmetrical in our data, we transformed the ratings in the WC condition to a positive range by multiplying by (-1). A paired-subject t-test revealed that the responses in the WC and CW conditions were significantly different and thus asymmetrical, $t(72) = 8.54$, $p < .001$, $d = 1.32$. This overall pattern suggests that in addition to the identical viewing condition, in the different viewing conditions, there was a tendency towards BE; this tendency was stronger in the WC condition.

To determine whether BE was also elicited for the no background condition, we conducted one-sample t-tests (criteria = 0). Interestingly, as can be seen in Figure 3, the results revealed that the BE was significant in the CC condition ($M = -.46$, $SD = .48$), $t(37) = -5.84$, $p < .001$, $d = .96$; but not in the WW condition ($M = -.03$, $SD = .45$), $t(37) = -.43$, $p = .66$. As in the scene condition, participants' ratings reflected that they correctly noticed that the view of the pictures were changed at test (for the WC condition $M = -.71$, $SD = .79$, $t(37) = -5.53$, $p < .001$, $d = .90$; and the CW condition $M = .46$, $SD = .53$, $t(37) = 5.35$, $p < .001$, $d = .87$).

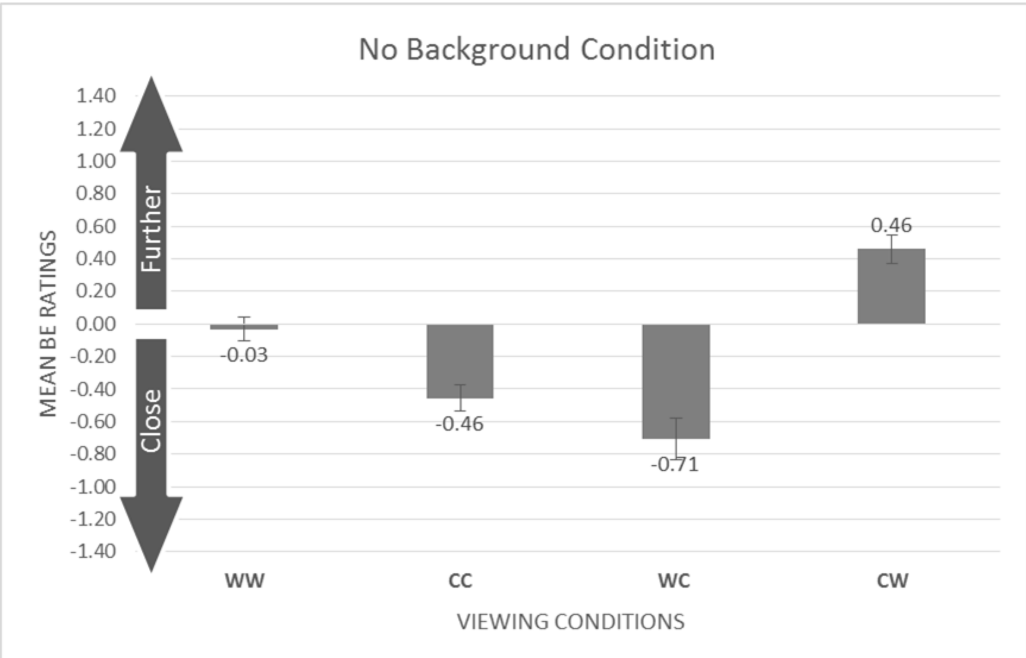

Figure 3. Mean BE ratings in the no background condition. Error bars indicate standard error of mean

Previous work had repeatedly shown that participants were highly confident in their ratings even though those ratings reflected the BE error (e.g. Gottesman & Intraub, 2002; McDunn et al., 2014). We wanted to determine whether the confidence and picture rating data were also dissociated in our sample. In both the scene (M = 2.28, SD = .38) and the no background condition (M = 2.32, SD = .25), confidence ratings were above midpoint (range: 1-3), and there was no difference between the groups (p = .4), replicating earlier findings (Gottesman & Intraub, 2002; McDunn et al., 2014). We also examined whether the difference in BE ratings between consistent and inconsistent scenes reflected on participants' confidence. A within t-test showed that participants were more confident in their response for consistent scenes (M = 2.32, SD = .38) compared to inconsistent scenes (M = 2.25, SD = .40), $t(72) = 3.04$, $p = .003$, $d = .18$. Thus, the results indicated that although participants' task performance was better (as suggested by less BE error), their confidence decreased in the inconsistent scenes.

2.2.2 Individual Differences in Imagery

Participants completed the matrix rotation task (MRT) and the Object-Spatial Imagery and Verbal Questionnaire (OSIVQ). We examined whether imagery abilities as measured by the behavioral task and the self-report measures explained the magnitude of the BE error. For each participant, we calculated the scores for each one of the three subscales of the OSIVQ by averaging their responses for those subset items. To determine whether there was a correlation between imagery scores and BE ratings, we conducted Pearson correlations separately with the 8 trial types in the scene condition and the 4 trial types in the no background condition. None of the BE ratings correlated with neither object nor spatial imagery (all rs < +/-.15, all ps >

.10). We also looked at extreme groups in the scene condition by focusing on the ratings of the top and bottom quartiles in object and spatial imagery. However, we did not find any difference in the BE ratings for any of the 8 trial types, $t(36) < 1.5$, $p > .13$, $t(33) < 1.4$, $p > .18$ for object and spatial imagery, respectively. The same approach was taken for the no background condition; we again did not found any imagery differences in the BE ratings for none of the 4 trial types, $t(18) < .85$, $p > .40$, $t(18) < 1.1$, $p > .30$ for all comparisons with object and spatial imagery, respectively.

We also calculated participants' percent accuracy and response time in the MRT; but none of the BE ratings in the 8 trial types of the scene condition and in the 4 trial types of the no background condition correlated with MRT measures (all *p*s > .10). Overall, for both conditions, no relation was found between self-report or measured imagery skills and BE ratings.

2.2.3 Perceived Distinctiveness and Image Saliency on BE Ratings

We wanted to determine whether consistent and inconsistent scenes differed in how much they captured one's attention and whether this contributed to the BE difference across scenes. We took a two-fold approach. First, we asked each participant to rate pictures on image distinctiveness. Participants rated inconsistent scenes ($M = 5.6$, $SD = .45$) as more distinctive than consistent scenes ($M = 2.9$, $SD = .55$, $p < .001$). To determine whether there was any difference in BE ratings related to perceived distinctiveness of scenes, we separately examined all viewing trials (identical or different) for both consistent and inconsistent scenes. There was no correlation between perceived distinctiveness scores and BE ratings in any of the 8 trial types, all *r*s < +/- .40, all *p*s > .23.

Second, we computed saliency maps for all consistent and inconsistent scenes based on measures in the Graph-Based Visual Saliency (GBVS) algorithm (Harel, Koch, & Perona, 2006). To understand whether inconsistency between object and background created any boost in saliency scores, we calculated the object/background saliency ratio for both consistent and inconsistent scenes by dividing object saliency value by the remaining peripheral area saliency value. We checked whether saliency map scores differed between consistent and inconsistent scenes. There were no difference between consistent and inconsistent scenes in terms of object saliency, $t(78) = -.35$, $p = .73$ and object/background ratio, $t(78) = -.10$, $p = .92$., rendering it unlikely that image characteristics lead to BE extension.

2.3 Discussion

In line with our predictions, we found that boundary extension existed in both identical and different viewing conditions, and critically, semantically consistent scenes elicited much greater BE error than semantically inconsistent scenes. However, we also found that the difference in the size of BE between consistent and inconsistent scenes came from the judgments in the different viewing conditions. In the different viewing conditions consistent pictures were more likely to be rated as extending outwards than not. This was revealed by a more negative judgment in the WC condition and a positive yet closer to zero judgment in the CW condition for consistent than inconsistent pictures. We also found that the BE was present for close-up scenes but not for wide angle scenes in the no background condition. We replicated earlier findings demonstrating that close-up scenes elicited greater BE error than wide angle scenes did (e.g. Intraub and Dickinson; 2008); we extend these findings to the no background condition. Critically, we were able to demonstrate that the neither the perceived distinctiveness nor the differences in saliency maps of our images contributed to BE ratings.

Importantly, our results suggest that BE does not depend on the consistency between foreground object and the background context. When there is a meaningful scene, independent of whether it is contextually consistent or not, people extend scenes. Considering these findings, we do not rule out the prediction account of the multisource model, which indicates that contextual knowledge helps individuals to create internal representations based on learned categories (Intraub, 2012). We merely state that contextual consistency is not necessary for prediction but that when scenes are consistent this allows more prediction and consequently leads to greater extension.

Although the BE observed in the no background condition may seem contradictory to the hypothesis of the multisource model, BE error had been shown to be present in earlier studies presenting objects on blank backgrounds as well. Similar to our findings, both Gottesman & Intraub (2002) and McDunn et al (2014) did not find BE in the WW condition for their stimuli on the blank background, but they found BE in the CC condition. As Gottesman and Intraub (2002) argued, even a pretense of continuity may be sufficient to elicit extension. Therefore, real pictures of objects might lead blank backgrounds to be interpreted as part of continuous scene even though they lack enriching details. Besides, it has also been shown that just the imagination of a coherent scene around single objects may be sufficient to trigger BE errors (Intraub et al., 1998).

Even though there has been empirical demonstrations that imagery based instructions have resulted in BE in no background conditions (Intraub et al., 1998), the individual differences evidence linking imagery abilities and BE magnitude has been equivocal at best (e.g. Munger & Multhaup, 2016). In this experiment, we also examined whether individuals high in imagery skills had greater BE error. However, we found that individual differences in object and spatial imagery skills had no influence on BE ratings, elicited by natural scenes and real objects on the blank background. There was no relationship between BE ratings with self-report measures of visual or spatial imagery or with a performance based measure of spatial imagery (i.e. spatial rotation). Similar to the current results, Munger and Multhaup (2016) did not find any consistent relationship between the BE magnitude and visual imagery. The reported that spatial imagery scores were correlated with BE error, they could show this finding only for CC trials and only in one of the six experiments (Exp.3a). However, they used only a self-report measure to assess participants' imagery skills, which might reflect biased judgments. Considering that even a real object on a blank background can trigger observers' imagination similar to natural scenes do, we can argue that imagery abilities are not essential for images which allowed observers to easily predict their continuation. Thus, stimuli characteristics may be critical while investigating the relationship between BE and imagery skills.

Finally, we also showed that no major perceptual or stimuli characteristic contributed to the difference in BE ratings across consistency manipulations. We used a bottom-up approach where we looked at potential differences in saliency maps across consistent and inconsistent scenes and showed that there were no differences across these scenes that could contribute to differences in BE ratings. Although participants reported inconsistent pictures more distinctive compared to consistent pictures, no effect of perceived distinctiveness was found. Thus, we ensured that the results did not reflect the effect of a potential confound in stimulus characteristics.

CHAPTER 3

EXPERIMENT 2

In Experiment 1, we found that contextual inconsistency in scenes decreased the magnitude of BE error, and people extended scenes even when pictures did not fit a scene schema. We also found BE in the no background condition. This may have been due to the ease of imagining a real object on a continuous background. Thus, the no background condition in Experiment 1 may not have been sufficient to eliminate contributions from scene schemas fully. To solve this, in Experiment 2 we generated meaningless shapes based on the real objects in the first experiment. Thus, we had stimuli that were semantically meaningless, but at the same time, similar in size and shape with the stimuli in Experiment 1.

3.1 Method

3.1.1 Participants

A total of 86 Turkish undergraduate students (*M* = 20.13 years (18-24), *SD* = 1.2, 75% female) at Bogazici University participated in the experiment in exchange for extra credit in their psychology courses. They all had normal or corrected-to-normal vision and provided written informed consent.

3.1.2 Materials

3.1.2.1 Picture Rating Task

It was the same with the task in the Experiment 1, except the nature of the images. There were two between subject conditions which were the gray background and the white background conditions. Both conditions contained semantically meaningless shapes with the only difference being the color of the background. We presented images each for 15s in the study phase. Images in the recognition test were presented in the same order as in the study phase. Like in Experiment 1, there were four trial types in the recognition test: CC, WW, CW, and WC.

3.1.2.2 Pictures

The stimuli consisted of semantically meaningless patterns that were created from slightly distorted contours of the same target objects in the first experiment (see Figure 4 for examples). These patterns were filled by black-and-white texture and were displayed centrally on a blank white or gray background. A total of 40 images were prepared with their close-up and wide angle versions in a similar manner with the first experiment. All images were prepared using Adobe® Photoshop® CS6. They were in JPEG format, and had a width of 750 pixels and height of 450 pixels.

The matrix rotation task and the OSIVQ were administered similarly as in Experiment 1. In the picture questionnaire, participants answered two questions regarding the images presented in the memory task. First, we asked the participants to rate the images on a 7-point Likert scale in terms of distinctiveness (1: highly indistinctive; 7: highly distinctive). Second, we asked them to report whether the shapes in the images evoked any real objects while viewing the images, and if so they were asked to name them.

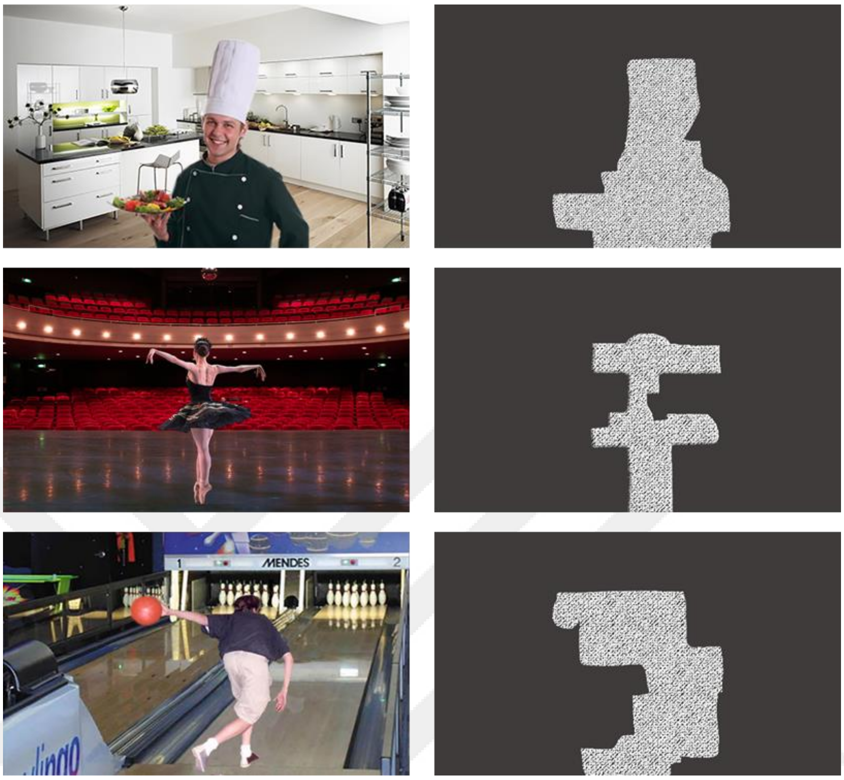

Figure 4. Example images from Experiment 1 (left) and their distorted counterparts used in Experiment 2 (right)

3.1.3 Procedure

The procedure were the same as in the first experiment, except the nature of the pictures presented. Participants individually sat in a dimly lighted room approximately 57 cm away from a 17 inch CRT monitor (60-hz refresh rate) which was set to a resolution of 1280x1024 pixels. Each participant was randomly assigned to the gray background or the white background condition[2]. The procedure was the same for both conditions. The experiment started with the picture rating task, and

[2] We compared the results whether the color of blank background (white or gray) would affect BE ratings. There was no difference between the two colors; thus we combined the data for the analyses.

immediately after, it continued with the MRT, the OSIVQ, the picture questionnaire and demographic questionnaires. The total duration of the experiment was about 50 minutes.

3.2 Results

Data was analyzed similarly to Experiment 1. For each participant, we calculated the average BE ratings separately for all trial types. There was only viewing condition variable, and therefore 4 different trial types. We determined whether there were any individuals with extreme responses by calculating the Cook's distance for all trial types. One participant's average ratings were at extreme in at least 2 out of 4 trial types; after the exclusion of this participant, we were left with a total of 85 participants. Furthermore, we examined participants' confidence in their response to detect cases referring to no memory of the picture. Across all trial types, on 19 % of the trials participants reported that they did not remember the picture. After the exclusion of these trials the pattern of the results did not change. Therefore, all trials were included in the analyses.

3.2.1 Boundary Extension

To determine whether our non-sense stimuli elicited BE, we first conducted one-sample t-tests (criteria = 0) for the identical viewing conditions in which pictures were presented in the same view (WW & CC). For identical scenes, ratings below zero would indicate extension whereas ratings above zero would indicate restriction. As expected, there was no BE in the identical viewing conditions, (M = .19, SD = .37), $t(84) = 4.74$, $p < .001$, d = .51, and (M = -.09, SD = .45), $t(84)$ = -1,82, p = .07, d = .20; for WW and CC conditions respectively. In addition, participants were able to correctly identify when the view of the pictures were changed at test; they rated the scenes closer in the WC condition (*M* = -.47, *SD* = .51), *t*(84) = -8.44, *p* < .001, *d* = .92, and wider in the CW condition (*M* = .43, *SD* = .46), *t*(84) = 8.60, *p* < .001, *d* = .93 (see Figure 5). Thus, as in Experiment 1, participants followed the instructions of the task and correctly used the scale.

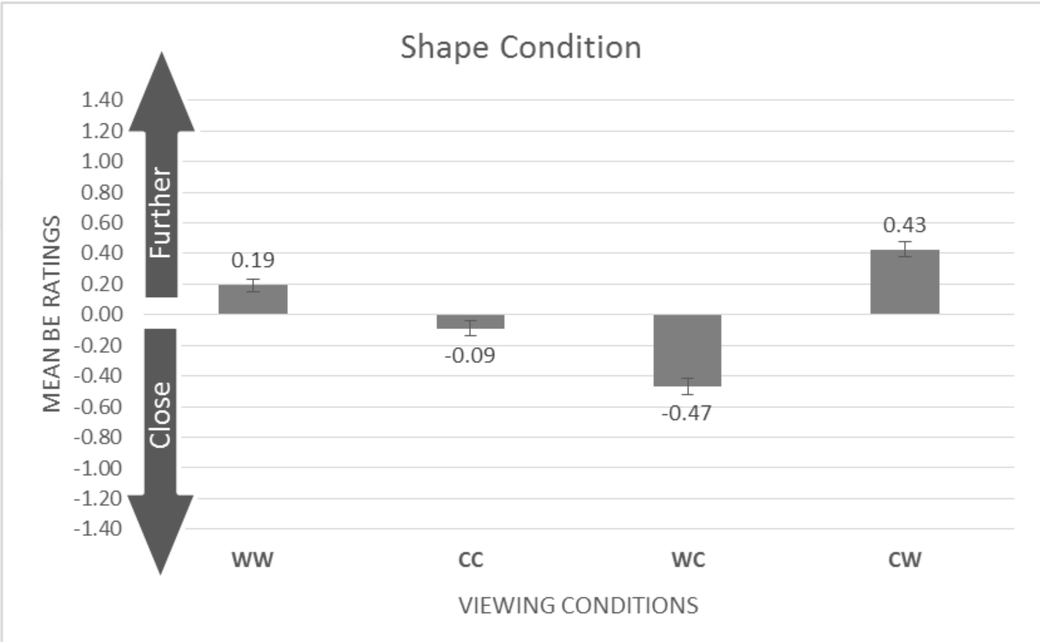

Figure 5. Mean BE ratings in the shape condition. Error bars indicate standard error of mean

As we discussed in greater detail in Experiment 1, there may be some asymmetry in BE magnitude across the CW and WC conditions (Dickinson & Intraub, 2008; Gottesman & Intraub, 2002). In the WC condition, negative ratings receding away from zero could be taken to indicate boundary extension. On the other hand, in the CW condition, positive ratings approaching zero could be taken as indicating a tendency for boundary extension. As in Experiment 1, to test whether any asymmetry existed between different viewing conditions, we transformed the ratings in the WC condition to a positive range by multiplying by (-1). A paired-subject t-test revealed that the responses in the WC and CW conditions were not different, thus symmetrical, $t(84) = .54$, $p = .59$.

Previous work had repeatedly shown that participants were highly confident in their ratings even though those ratings reflected the BE error (e.g. Gottesman & Intraub, 2002; McDunn et al., 2014). Interestingly, in Experiment 1 we also found that participants' confidence decreased when their task performance was better (as suggested by less BE error). Thus, we compared the groups across the experiments to determine how participants' confidence ratings would change when there was no BE error. To test whether the participants' confidence in the shape condition differed from confidence in the scene and no background conditions, we conducted a one-way ANOVA. The results showed that participants in the shape condition ($M = 1.94$, $SD = .41$) were less confident in their responses than participants in the scene ($M = 2.28$, $SD = .38$) and no background conditions ($M = 2.32$, $SD = .25$), $F(2,193) = 19.73$, $MSE = .135$, $p < .001$, $n_p^2 = .17$. Thus, regarding the confidence pattern, we replicated our finding in Experiment 1.

3.2.2 Individual Differences in Imagery

As in Experiment 1, we measured participants' imagery skills by applying the matrix rotation task (MRT) and the Object-Spatial Imagery and Verbal Questionnaire (OSIVQ). For each participant, we calculated the scores for each one of the three subscales of the OSIVQ by averaging their responses for those subset items. To determine whether BE ratings differed regarding imagery scores, we conducted Pearson correlations separately with the 4 trial types. However, none of the BE ratings correlated with neither object nor spatial imagery across all conditions (all *r*s < +/-.18, all *p*s > .11). We also calculated participants' percent accuracy and response time in the MRT. The results showed that percent accuracy was negatively correlated with BE ratings in the identical viewing conditions, $r(85) = -.324$, $p = .003$, and in the different WC condition, $r(85) = -.326$, $p = .002$, but not in the CW condition $p = .2$. Thus, participants with higher spatial imagery were more likely to extend scenes than those with lower spatial imagery (reflected in negative values).

3.3 Discussion

In line with our predictions, semantically meaningless stimuli on blank background did not elicit BE in the identical viewing conditions. Thus, we demonstrated that when the foreground object did not make it possible to imagine a continuous context, boundary extension was unlikely. Interestingly, we also found that although self-reported object and spatial imagery did not correlate with BE ratings, participants who showed better spatial rotation ability were more likely to extend pictures.

Although our results supported the multisource model, these were in conflict with McDunn et al. (2014)'s findings which showed BE even in abstract images consisting of irregular polygons. They inferred that high-level information might not be necessary to elicit BE when any simple element in images could support imagination of context. Specific to their study, McDunn et al. also suggested that placing the objects on random-dot backgrounds might have helped observers by creating "some sense of a spatial context" (p.374). However, the data present in McDunn et al. (2014) does not allow us to determine whether their participants were able to engage in any imagining-context strategy to perform the task. In our data, although there was no BE elicited by our semantically meaningless stimuli, we found that participants who had better spatial skills were more likely to extend pictures. This may be due to the fact that when observers cannot find any sign in pictures to assume continuity, better imagery skills are effective in helping people imagine those pictures in a context-like manner. Likewise, it could be possible that individuals in McDunn et al. (2014) might have good ability in spatial imagery, or even simple dotted backgrounds could easily prompt their imagination. Thus, measuring observers' imagery skills might be crucial especially when study stimuli do not have semantic meaning.

CHAPTER 4

CONCLUSION

We are the first to test the role and the necessity of context information on boundary extension phenomenon by violating scene consistency and focusing on scene schema. In Experiment 1 we examined how semantic consistency between object and background would influence BE. Along with consistent scenes, we used inconsistent scenes that have been known to decrease accuracy in scene categorization and object perception (Biederman et al., 1982; Davenport, 2007; Davenport & Potter, 2004; Joubert et al., 2007). In Experiment 2 we aimed to eliminate scene schema completely from images as a step further from violating scene consistency, and thus we created images including distorted contours of the same target objects in Experiment 1.

The results showed that although scene schema is necessary to elicit BE, contextual consistency is not required but increases the BE magnitude. Our findings are consistent with the multisource model. According to this model, scene schema and contextual knowledge are defined as two of the main contributors to BE; these factors play a critical role in helping individuals create internal representations (Intraub, 2012). We supported this model by demonstrating that when scene schema and semantic meaning were eliminated from the images as in Experiment 2, BE did not occur. However, contrary to the multisource model, we critically showed that scenes with semantic inconsistency and no background scenes also elicited BE, but the magnitude of the BE error for these two types of scenes was less.

Interestingly, we also found BE for real objects on blank backgrounds. While this finding seems to contradict predictions drawn from the multisource model, earlier studies had also showed that real objects on blank backgrounds could elicit BE (e.g. Gottesman & Intraub, 2002). It has been argued even a pretense of continuity may be sufficient to elicit extension even though scenes lacked enriching elements such as background details (Gottesman & Intraub, 2002). Thus, Intraub and colleagues concluded that any interpretation of a background as a continuous surface is necessary in eliciting BE. We support this argument by suggesting that imagination skills may become essential only when there is no scene element to induce interpretation of background as a continuous surface. Indeed, we found that when individuals were presented with natural scenes and real objects, their imagery skills did not explain their BE ratings. However, when images consisted of semantically meaningless shapes, individuals with higher spatial imagery had a tendency to rate scenes more extended compared to ones with low spatial imagery. This difference may be due to the fact that pictures with sufficient details like natural scenes allow viewers to easily predict a context. Thus, individuals' imagery abilities are not needed for that kind of pictures. Yet, it is reasonable to expect the influence of imagery skills only when images do not have any elements to promote imagination. For instance, it may be more likely for individuals with better imagery skills to imagine continuity for irregular octagon on a white surface. Indeed, McDunn et al. (2014) showed that BE was elicited by images contained of abstract polygons. They argued that elements in their images such as random-dot backgrounds might have triggered participants' imagery. However, they had no measure for imagery. Thus, it was not truly clear whether their participants were able to use in any imagining-context strategy or whether dotted backgrounds promoted the participants' imagery.

Importantly, we looked at potential differences in perceived distinctiveness and saliency maps across our natural scenes. To our knowledge, we are the first to take such an approach among the BE studies. We showed that no major perceptual or stimuli characteristic contributed to the difference in BE ratings across consistency manipulations. Thus, we assured that the results did not depend on any potential confound effect in stimulus characteristics.

The results indicated that the consistent pictures were more likely to be rated as extended than inconsistent pictures in the different viewing conditions but not in the identical viewing conditions. Thus, we also showed that BE in the identical and the different viewing conditions might differ from each other in relation to scene consistency. Previous studies investigated the different viewing trials either in terms of asymmetry between the magnitude of BE in WC and CW trials, or as a task control (Dickinson & Intraub, 2008; Gottesman & Intraub, 2002; Intraub et al., 1998). Furthermore, our results suggest that it is also worthwhile to investigate how exactly different viewing trials are deviating from identical trials in order to better understand observers' internal schemas.

Observers' spatial imagery skills did not predict their ratings when they viewed natural scenes and real objects on blank backgrounds although both types of pictures elicited BE error. However, when observers viewed semantically meaningless shapes, those with higher spatial imagery were more likely to rate pictures as more extended even though the overall participants' ratings did not reflect BE error. However, we could only show this tendency in the correlational analyses. Therefore, we cannot suggest a causal relationship between spatial imagery and BE. In addition, we found this correlation of BE ratings only with measured spatial performance but not with self-report measures. This difference might arise from the fact that individuals' self-reports might be erroneous compared to their real performance. Indeed, Munger and Multhaup (2016) presented conflicted findings on the effect of imagery with the self-report imagery questionnaire. They found that BE ratings were not influenced by visual imagery, and only in one of the six experiments (Exp.3a) they could show the relation of BE with spatial imagery. As far as we know, this is the only study to assess individuals' spatial rotation skill. Future work should clarify the effect of imagery in BE magnitude by measuring imagery performance.

In summary, with two experiments we demonstrated that scene schema is necessary for BE existence but contextual consistency is influential only on the magnitude of BE. We also suggest that spatial imagery skill may foster greater BE but only when picture elements do not persuade observers to imagine a continuous context. Further exploration of individual differences in imagery skills and differences of trial types is needed to illuminate how BE support scene processing.

APPENDIX

OBJECT-SPATIAL IMAGERY AND VERBAL QUESTIONNAIRE

1. I was very good in 3D geometry as a student.
2. I have difficulty expressing myself in writing.
3. If I were asked to choose between engineering professions and visual arts, I would prefer engineering.
4. My verbal abilities would make a career in language arts relatively easy for me.
5. Architecture interests me more than painting.
6. My images are very colorful and bright.
7. I prefer schematic diagrams and sketches when reading a textbook instead of colorful and pictorial illustrations.
8. I tell jokes and stories better than most people
9. Essay writing is difficult for me and I do not enjoy doing it at all
10. My images are more like schematic representations of things and events rather than like detailed pictures.
11. When reading fiction, I usually form a clear and detailed mental picture of a scene or room that has been described.
12. If I were asked to choose among engineering professions, or visual arts, I would choose visual arts.
13. I have a photographic memory.
14. I can easily imagine and mentally rotate three-dimensional geometric figures.
15. I enjoy pictures with bright colors and unusual shapes like the ones in modern art.
16. My verbal skills are excellent.
17. When thinking about an abstract concept (or building), I imagine an abstract schematic building in my mind or its blueprint rather than a specific concrete building.
18. When entering a familiar store to get a specific item, I can easily picture the exact location of the target item, the shelf it stands on, how it is arranged and the surrounding articles.
19. Putting together furniture kits (e.g. a TV stand or a chair) is much easier for me when I have detailed verbal instructions than when I only have a diagram or picture.
20. My images are very vivid and photographic.
21. When explaining something, I would rather give verbal explanations than make drawings or sketches.
22. If someone were to give me two-digit numbers to add (e.g. 43 and 32) I would simply do the adding without visualizing the numbers.
23. My mental images of different objects very much resemble the size, shape and color of actual objects that I have seen.
24. I usually do not try to visualize or sketch diagrams when reading a textbook.

25. I normally do not experience many spontaneous vivid images; I use my mental imagery mostly when attempting to solve some problems like the ones in mathematics.
26. When I imagine the face of a friend, I have a perfectly clear and bright image.
27. I have excellent abilities in technical graphics.
28. When remembering a scene, I use verbal descriptions rather than mental pictures.
29. I can easily remember a great deal of visual details that someone else might never notice. For example, I would just automatically take some things in, like what color is a shirt someone wears or what color are his/her shoes.
30. I can easily sketch a blueprint for a building I am familiar with.
31. In school, I had no problems with geometry.
32. I am good in playing spatial games involving constructing from blocks and paper (e.g. Lego, Tetris, and Origami).
33. Sometimes my images are so vivid and persistent that it is difficult to ignore them.
34. I can close my eyes and easily picture a scene that I have experienced.
35. I have better than average fluency in using words.
36. I would rather have a verbal description of an object or person than a picture
37. I am always aware of sentence structure.
38. My images are more schematic than colorful and pictorial.
39. I enjoy being able to rephrase my thoughts in many ways for variety's sake in both writing speaking.
40. I remember everything visually. I can recount what people wore to a dinner and I can talk about the way they sat and the way they looked probably in more detail than I could discuss what they said.
41. I sometimes have a problem expressing exactly what I want to say.
42. I find it difficult to imagine how a three-dimensional geometric figure would exactly look like when rotated.
43. My visual images are in my head all the time. They are just right there.
44. My graphic abilities would make a career in architecture relatively easy for me.
45. When I hear a radio announcer or a DJ I've never actually seen, I usually find myself picturing what he or she might look like.

REFERENCES

Bar, M. (2004). Visual objects in context. *Nature Reviews Neuroscience, 5*, 617-629.

Biederman, I., Mezzanotte, R. J., & Rabinowitz, J. C. (1982). Scene perception: Detecting and judging objects undergoing relational violations. *Cognitive Psychology, 14*, 143-177.

Blazhenkova, O., & Kozhevnikov, M. (2009). The new object-spatial-verbal cognitive style model: Theory and measurement. *Applied Cognitive Psychology*, *23*(5), 638-663.

Davenport, J. L. (2007). Consistency effects between objects in scenes. *Memory & Cognition*, *35*(3), 393-401.

Davenport, J. L., & Potter, M. C. (2004). Scene consistency in object and background perception. *Psychological Science, 15*, 559-564.

Dickinson, C. A., & Intraub, H. (2008). Transsaccadic representation of layout: What is the time course of boundary extension? *Journal of Experimental Psychology: Human Perception and Performance*, *34*, 543–555.

Gagnier, K. M., & Intraub, H. (2012). When less is more: Line drawings lead to greater boundary extension than do color photographs. *Visual cognition, 20*(7), 815-824.

Gottesman, C. V. (1998). *The role of the perceptual schema in the representation of visual scenes* (Unpublished doctoral dissertation). University of Delaware, Newark, USA.

Gottesman, C. V., & Intraub, H. (2002). Surface construal and the mental representation of scenes. *Journal of Experimental Psychology. Human Perception and Performance, 28*, 589–599.

Greene, M. R., & Oliva, A. (2009). The briefest of glances: The time course of natural scene understanding. *Psychological Science*, *20*(4), 464-472.

Harel, J., Koch, C., & Perona, P. (2006). Graph-based visual saliency. *Advances in Neural Information Processing Systems*, 545-552.

Intraub, H. (2012). Rethinking visual scene perception. *Wiley Interdisciplinary Reviews: Cognitive Science, 3,* 117–127.

Intraub, H., Daniels, K. K., Horowitz, T. S., & Wolfe, J. M. (2008). Looking at scenes while searching for numbers: Dividing attention multiplies space. *Perception & Psychophysics, 70*, 1337–1349.

Intraub, H., & Dickinson, C. (2008). False memory 1/20th of a second later: What the early onset of boundary extension reveals about perception. *Psychological Science, 19*, 1007–1014.

Intraub, H., Gottesman, C. V., & Bills, A. J. (1998). Effects of perceiving and imagining scenes on memory for pictures. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24*, 186–201.

Intraub, H., & Richardson, M. (1989). Wide-angle memories of close-up scenes. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15,* 179–187.

Joubert, O. R., Rousselet, G. A., Fize, D., & Fabre-Thorpe, M. (2007). Processing scene context: Fast categorization and object interference. *Vision Research, 47*, 3286-3297.

Mamus, A. E., Boduroglu, A., & Gutchess, A. (2015, November). *Cross-Cultural Differences in Conceptual Scene Processing*. Poster session presented at the Psychonomic Society Annual Meeting, Chicago, IL.

McDunn, B. A., Siddiqui, A. P., & Brown, J. M. (2014). Seeking the boundary of boundary extension. *Psychonomic Bulletin & Review*, *21*(2), 370-375.

Mueller, S. T., & Piper, B. J. (2014). The Psychology Experiment Building Language (PEBL) and PEBL Test Battery. *Journal of Neuroscience Methods, 222*, 250–259.

Munger, M. P., & Multhaup, K. S. (2016). No imagination effect on boundary extension. *Memory & Cognition*, *44*(1), 73-88.

Palmer, S. E. (1975). The effects of contextual scenes on the identification of objects. *Memory & Cognition*, *3,* 519-526.

Perez, W. A., Masline, P. J., Ramsey, E. G. & Urban, K. E. (1987). Unified Tri-services cognitive performance assessment battery: Review and methodology, DTIC Document ADA181697.

Potter, M. C. (1975). Meaning in visual search. *Science*, *187*, 965–966.

Potter, M. C. (1976). Short-term conceptual memory for pictures. *Journal of Experimental Psychology: Human Learning and Memory*, *2*, 509–522.