IS SPATIAL UNCERTAINTY NECESSARY FOR THE CONTEXT SPECIFIC PROPORTION CONGRUENCY EFFECT?

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ABSTRACT

IS SPATIAL UNCERTAINTY NECESSARY FOR THE CONTEXT
SPECIFIC PROPORTION CONGRUENCY EFFECT?

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Cognitive control is generally measured with the Stroop effect which is signified by slow responses in the incongruent (the word and color mismatch) items. The magnitude of the Stroop effect is modulated by experimental manipulations, for instance it is reduced by presenting items in mostly incongruent contexts as compared to mostly congruent contexts. The difference between the Stroop effects observed in these contexts is called the *context specific proportion congruency* (CSPC) effect. A large number of CSPC studies used the rather unconventional prime-probe version of the Stroop task. By its very nature, this version creates spatial uncertainty for the color dimension, since the word dimension is presented at the center of the screen, while the color dimension is presented at the bottom or top half of the screen. We speculated that this uncertainty might have contributed to the CSPC effect. For this reason, the current study aimed to examine the role of uncertainty on the CSPC effect. With two systematic manipulations, it was aimed to eliminate the uncertainty of the color dimension in one condition, and both the color and word dimension in the other. It was hypothesized that both manipulations would lead to the elimination of the CSPC effect. According to results, although the CSPC effect was not observed in the first condition, it was still observed in the second. These results partially support the hypothesis that uncertainty played a significant role in the CSPC effect. Findings were discussed under the scope of spatial attention and evidence accumulation perspectives.

Keywords: cognitive control, attention, Stroop task, context specific proportion congruency, spatial uncertainty

ÖZ

UZAMSAL BELİRSİZLİK BAĞLAM DÜZEYİ UYUMLULUK ORANI ETKİSİ İÇİN GEREKLİ MİDİR?

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Bilişsel kontrol, genellikle uyumsuz uyarıcılardaki (renk ve kelime eşleşmediğinde) yavaş tepkiler sebebiyle ortaya çıkan Stroop etkisi ile ölçülür. Stroop etkisinin büyüklüğü çeşitli deneysel yöntemlerle ile değiştirilebilir. Örneğin, uyarıcıları bir bağlamda çoğunlukla uyumlu sunarak Stroop etkisi artırabilirken; uyarıcıları başka bir bağlamda çoğunlukla uyumsuz sunarak Stroop etkisi azaltılabilir. Bu iki bağlam arasındaki Stroop etkisi farkına *bağlam düzeyi uyumluluk oranı* (BDUO) etkisi denir. BDUO etkisini konu alan pek çok çalışma, klasik Stroop görevi yerine *uzamsal olarak ayrık* (UOA) hazırlayıcı (prime-probe) Stroop görevini kullanmıştır. Bu alışılmadık Stroop görevinin doğası gereği, kelime boyutu ekranın tam ortasında sunulurken, renk boyutu ekranın alt veya üst yarısında sunulmakta ve bu da renk boyutunda uzamsal belirsizlik ortaya çıkarmaktadır. Bu uzamsal belirsizliğin BDUO etkisine katkı sağlıyor olabileceği düşünülmüştür. Dolayısıyla, bu çalışma uzamsal belirsizliğin BDUO etkisi üzerindeki rolünü incelemeyi amaçlamıştır. İki adet sistematik değişimleme ile bir koşulda, renk üzerindeki belirsizliğin, diğer koşulda ise hem kelime hem de renk üzerindeki belirsizliğin ortadan kaldırılması hedeflenmiştir. Hipotezlere göre bu değişimlemelerin, BDUO etkisini ortadan kaldırması beklenmiştir. Sonuçlar, BDUO etkisinin ilk koşulda ortadan kalkarken, ikinci koşulda hala var olduğunu göstermiştir. Bu sonuç, kısmi olarak, uzamsal belirsizliğin BDUO etkisinde önemli bir rol oynadığını belirten hipotezi desteklemektedir. Bulgular, uzamsal dikkat ve kanıt toplama perspektifleri açısından değerlendirilmiştir.

Anahtar Kelimeler: bilişsel kontrol, dikkat, Stroop görevi, bağlam düzeyi uyumluluk oranı, uzamsal belirsizlik

To My Family

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LWPC	List Wide Proportion Congruency
ISPC	Item Specific Proportion Congruency
CSPC	Context Specific Proportion Congruency

CHAPTER 1

INTRODUCTION

1.1. General Introduction

In everyday life, people frequently need to limit their attention to a specific topic. While doing this, they also need to suppress other irrelevant stimuli in their surroundings. This process can be defined as *cognitive control.* More specifically, cognitive control is the capacity to limit attention to goal-directed behavior (Amer, Campbell, & Hasher, 2016). Cognitive control is especially required when we need to suppress routine behavior in order to execute less routine behavior (Matsumoto & Tanaka, 2004). In the cognitive psychology literature, cognitive control is mostly studied with selective attention tasks, such as the Stroop and the Flanker tasks (MacLeod, 1991). In this thesis, the main focus will be on the Stroop task.

The Stroop task (Stroop, 1935) has been one of the most popular tools in the cognitive control and selective attention literature (MacLeod, 2005). In a standard Stroop task, a color and a color-word are presented to the participants, and participants are required to name the color while ignoring the color-word (MacLeod, 1991). Generally, three types of stimuli are used in the Stroop task: congruent, incongruent, and neutral. Stimuli which have matching color and color-word are called *congruent* stimuli (i.e., the word blue is written in blue ink). On the contrary, when the color and the color-word mismatch, the stimuli are named as *incongruent* stimuli (i.e. the word blue is written in red ink). Lastly, when the color-unrelated words, nonwords, letter strings, and non-letter strings are used instead of color-words (i.e., %%%% in blue ink) the stimuli are named as *neutral* stimuli (MacLeod, 2005). The critical point in the Stroop task is that when an incongruent stimulus is presented, there is a conflict between the word and the color. Therefore, participants need to suppress the word reading processes in order to correctly name the color. This suppression process slows down the response times for incongruent stimuli, and also leads more errors. However, since the color-word and the color itself are the same, there is no such conflict for the congruent stimuli, and thus, either word reading or color naming results in fast and correct responding. The response time difference between the congruent and the incongruent stimuli is named the *Stroop Effect*. To clarify, in order to respond correctly to an incongruent stimulus, participants must direct their attention to the colors rather than the words. However, to do this, they need to suppress an automatic word reading response, which, in turn, slows down responding. By comparison, for the congruent items, this process is faster because there is no need for word suppression (Botvinick, Braver, Barch, Carter, & Cohen, 2001).

The Stroop effect can be attenuated or accentuated by certain manipulations, and these manipulations help clarify the underlying mechanisms of cognitive control. Changing the proportion of the congruent items within a list is one of the most common manipulations. When most of the items in a list are congruent, the Stroop effect is larger, whereas, when most of the items in a list are incongruent, the Stroop effect is smaller (Logan & Zbrodoff, 1979; Logan, Zbrodoff, & Williamson, 1984). The difference between these two Stroop effect is called *the proportion congruency* effect (Bugg & Crump, 2012). The proportion congruency effect is seen as an indication of the strategic control processes over the Stroop task, and it has been studied widely in the recent years.

In the literature, the proportion congruency effect has been studied with three different manipulations: list wide proportion congruency (LWPC), item-specific proportion congruency (ISPC), and context specific proportion congruency (CSPC). The LWPC is presumed to indicate a goal-directed and global form of control. However, ISPC and CSPC are considered to reflect a more dynamic, rapid and online form of cognitive control (Bugg & Crump, 2012).

Proportion congruency effects at all levels have been subject to theoretical debate regarding the cognitive processes underlying these effects. Regarding the CSPC effect, in specific, however, there is also a debate regarding the replicability of the observed effect. Specifically, while some of the researchers showed that context – especially location– could be used as sign of proportion congruency in the Stroop task (Crump, Gong, & Milliken, 2006; Crump & Milliken, 2009, Crump, Vaquero, & Milliken, 2008), other researchers could not exactly replicate these results (Atalay et al., in preparation; Crump, Brosowsky, & Milliken, 2016, Experiment 2; Hutcheon & Spieler, 2016). In order to resolve this discrepancy in the CSPC literature, the current study aims to examine the CSPC effect with a set of systematic experimental manipulations. In the following sections, each level of proportion congruency will be mentioned in detail and the current research idea will be presented at the end.

1.2. List Wide Proportion Congruency

Chronologically, the first proportion congruency manipulation in cognitive control literature is the LWPC manipulation. There are two kinds of lists in the LWPC designs: the mostly congruent and the mostly incongruent. In the mostly congruent lists, the proportion of the congruent items varies between 67-80% according to specific experimental manipulations. In the mostly incongruent lists, the proportion of the incongruent items, again, varies between the 67-80% in the same way (Bugg & Crump, 2012).

One of the initial examples in LWPC belongs to Logan, Zbrodoff, and Williamson (1984). In this study, the proportion of the congruent items in the mostly congruent list was 80% and proportion of the incongruent items was 20%, and vice versa for the mostly incongruent list. According to the reaction time analysis of this study, the Stroop effect was smaller for the mostly incongruent list (7 ms) than for the mostly congruent list (96 ms), signaling a significant interaction between item type and proportion congruency (Logan, Zbrodoff, & Williamson, 1984, see also Logan & Zbrodoff, 1979).

Moreover, Tzelgov, Henik, and Berger (1992) stated that the Stroop effect was influenced by the expectations of the participants. They manipulated expectations by changing the proportions of the neutral versus congruent and incongruent items. According to the results of this study, the Stroop effect was larger when there were more color-words than neutral words.

Another important study related to the LWPC effect was conducted by Lindsay and Jacoby (1994). In the third experiment of this study, the proportion of congruent items in the mostly congruent list was 83% and proportion of the incongruent items was 17%, and these proportions were reversed for the mostly incongruent list. For the mostly congruent list, both word reading and color naming could result in correct responding, and the Stroop effect was larger in this list. On the other hand, in the mostly incongruent list, participants had to ignore the color-words and name the color to respond correctly for 83% of the time. Consequently, participants performed better in the incongruent items, and the Stroop effect was smaller for the mostly incongruent list (Lindsay & Jacoby, 1994).

Besides, researchers demonstrated that the LWPC effect could be transferred to an unbiased set of items (Bugg, 2014; Bugg & Chanani, 2011; Gonthier, Braver, & Bugg, 2016). For instance, in the well-established study of Bugg (2014), a set of items which had 50% proportion congruency was embedded into both the mostly congruent (75% congruent) and the mostly incongruent (25% congruent) lists. This resulted in lists having 67% (mostly congruent) and 33% (mostly incongruent) proportion congruency (see Table 1). Items were presented in a random order within lists.

Table 1.

Sample Stimulus Set for the LWPC Transfer Study

	Color								
	Word	Red	Blue	White	Purple	Pink	Green	Black	Yellow
Biased 75%	Red	36	4	4	4				
	Blue	4	36	4	4				
	White	4	4	36	4				
	Purple	4	4	4	36				
Unbiased Transfer 50%	Pink					12	4	4	4
	Green					4	12	4	4
	Black					4	4	12	4
	Yellow					4	4	4	12
Biased 25%	Red	12	12	12	12				
	Blue	12	12	12	12				
	White	12	12	12	12				
	Purple	12	12	12	12				
Unbiased Transfer 50%	Pink					12	4	4	4
	Green					4	12	4	4
	Black					4	4	12	4
	Yellow					4	4	4	12

Results indicated that the LWPC effect was also present in the unbiased items when simple associative learning was not possible. Specifically, the Stroop effect was larger in the unbiased items which were presented within the mostly congruent list as compared to the Stroop effect in the unbiased items that were presented within the mostly incongruent list. This indicates that participants adopted a more conservative control strategy when they encountered high level of conflict in the mostly incongruent lists. However, they adopted a lax control strategy when they encountered low level of conflict in the mostly congruent lists. Therefore, unbiased items which were embedded within the lists were also affected from these global control strategies. This result was accepted as a key piece of evidence for the list level (or top-down) control processes (Bugg, 2014). In summary, it can be argued that participants adopt a strategy according to global level of proportion congruency (i.e., conflict level) and they apply this strategy to the all items in the list regardless of the item level proportion congruency.

Contrary to the studies described above claiming that the LWPC effect is a result of list wide control strategies, some other studies (i.e. Blais & Bunge, 2010; Bugg, Jacoby, & Toth, 2008) claimed that the LWPC effect could be the end product of item-specific control strategies, since the LWPC manipulation in biased items were fully confounded with item-specific biases. Even though the LWPC effect which was observed in unbiased sets partially refutes this claim (i.e., Bugg, 2014), debates about the LWPC effect is still ongoing. Furthermore, a group of researchers claimed that this effect was the result of learning mechanisms. For instance, Schmidt (2017), purported that the LWPC effect was related to temporal learning rather than global control. According to this view, participants initiate slightly faster responses to the mostly congruent lists since most of the items in these lists are congruent. In contrast, in the mostly incongruent lists, most of the items are incongruent, and hence, they are associated with slow responses. Consequently, according to the temporal learning account, this discrepancy between the rhythm of these two lists produces the LWPC effect.

To summarize, these studies demonstrated the existence of a global control strategy in the Stroop task, suggesting that cognitive control could be modulated by list-wide proportion congruency manipulations. However, there is also evidence supporting the notion that the LWPC effect is explained by item-specific control or temporal learning mechanisms rather than the global control mechanism. In conclusion, this debate is still controversial and more diagnostic studies are needed to reveal the underlying mechanisms of the LWPC effect.

1.3. Item Specific Proportion Congruency

To the author's knowledge, the ISPC manipulation was used by Jacoby and his colleagues for the process dissociation procedure for the first time (Jacoby, McElree, & Trainham, 1999). However, the classic study that presented the ISPC effect belongs to Jacoby, Lindsay, and Hessels (2003). As the name implies, in this study, proportion congruency was manipulated at an item level. There were six colors in their study and these colors were divided into two sets: the mostly congruent and the mostly incongruent. In the mostly congruent set, Stroop items were congruent 80% of the time and incongruent for the 20% of the time and the proportions were reversed for the mostly incongruent set. Crucially, these sets were presented together in a random order. In this way, overall LWPC was kept at 50%, and hence, preventing a possible LWPC confound. Results demonstrated that the Stroop effect was smaller in the mostly incongruent set than the mostly congruent set, and the difference between these two Stroop effects was named the *ISPC Effect.*

The study by Jacoby, Lindsay, and Hessels (2003) is very important for the cognitive control literature in terms of its theoretical contributions. This study revealed that cognitive control could operate at the item level and this type of control was triggered by the stimulus onset in a fast and online manner. As aforementioned, there are two processes which contribute to responding in a Stoop task: word reading and color naming. Previous studies showed that word reading was a more effective strategy in the mostly congruent lists while color naming was a more effective strategy in the mostly incongruent lists. However, Jacoby et al. (2003), presented these lists together in a random order to participants. Therefore, global control strategies could not be used, which led participants to use item-specific control strategies instead. In detail, mostly incongruent items required more effort in order to suppress word reading, and therefore, they were associated with strict attentional filters. However, the mostly congruent items required less effort and hence they were associated with lax attentional filters. Crucially, the design of Jacoby et al. (2003) revealed that participants could shift these strict and lax attentional filters rapidly between the mostly congruent and the mostly incongruent sets automatically.

However, there is an alternative explanation for the ISPC effect, and it was proposed by Schmidt and Besner (2008). According to this alternative account, the ISPC effect is completely related to stimulus-response contingency learning. In order to support this claim, Schmidt and Besner (2008) inspected the stimulus set of Jacoby et al. (2003) and re-analyzed their results. After this inspection, they concluded that the design of Jacoby et al. (2003) was fully confounded with stimulus-response contingency learning. Specifically, Schmidt and Besner (2008) claimed that, item-specific proportion congruency manipulation in Jacoby et al. (2003) produced different contingency levels between words and correct responses. For instance, in a mostly congruent set, the word dimension of the congruent items, is highly contingent with the correct responses. Therefore, participants are able to use this information to predict the correct response. For the incongruent items in the mostly congruent set, however, there is not highly contingent response. Similarly, in a mostly incongruent set, the word dimension of the incongruent items is highly contingent with the correct responses, enabling the participants to use this information to predict correct responses. Overlooking this confound, in Jacoby et al. (2003), the congruent items from the mostly congruent set (high contingency items) were compared with the incongruent items from the same set (low contingency items), similarly the incongruent items from the mostly incongruent (high contingency items) set were compared with the congruent items from the same set (low contingency items).

Schmidt and Besner (2008) argued that, in order to prevent this confound, the high contingency items had to be compared with high contingency items, and low contingency items with low-contingency items. Therefore, the contingency account predicted no interaction between item type (i.e., congruent vs. incongruent) and contingency (i.e., high vs. low contingency), since the Stroop effect and contingency effect were end products of independent processes. In other words, the magnitude of the Stroop effect had to be the same for both high contingency and low contingency trials. However, the item-specific control account should predict a significant interaction, since incongruent items would be affected from attentional processes more than the congruent items. When Schmidt and Besner (2008) reanalyzed the data of Jacoby et al. (2003) in the proposed way, they found no interaction between contingency and item type, suggesting that the ISPC effect was the result of contingency learning rather than the interaction between proportion congruency and item type. Particularly, the contingency view suggests that the observed ISPC effect in Jacoby et al. (2003) was the result of simple stimulus-response learning and high contingency items were faster regardless of their proportion congruency level (Schmidt, & Besner, 2008).

The debate on the ISPC effect did not end there. Bugg, Jacoby, and Chanani (2010) showed that the ISPC effect could not be entirely explained by contingency learning processes. In their study, a picture-word version of the

Stroop task was used with an overlapping set design; controlling for contingency learning. Specifically, an animal name was written both on a picture from the mostly incongruent and the mostly congruent set. Therefore, the contingencies between the words and pictures were controlled especially for the incongruent items, which were diagnostic for control processes. Besides, four different pictures were used for each animal and, in order to reduce the reliance on information coming from the word dimension and direct attention to the picture dimension, the animal-words were written in a relatively smaller font (see Melara & Algom, 2003 for further information). Even after preventing contingency learning by described manipulations, a control based ISPC effect was observed in this study. These results demonstrated that the ISPC effect was not entirely due to contingency learning, and that control processes also played a role. This claim is supported by the evidence that the ISPC effect was driven by the reaction time change observed for the incongruent items, which require control processes. However, in the last experiment of this study, there was also evidence in support of the contingency account. In this experiment words were made more contingent with correct responses. Therefore, the word, rather than the picture, could now be used to predict the response. As a result, a contingency based ISPC effect was observed and this effect stemmed from faster reaction times on congruent trials rather than the incongruent trials, which was in line with the predictions of the contingency learning account. Overall, these results suggested that contingency learning and item-specific control processes were used according to the demands of certain circumstances that directed participants to one of these mechanisms (Bugg et al., 2010).

Moreover, the results described above were conceptually replicated with a color-word Stroop task by Bugg and Hutchison (2013). Particularly, this study demonstrated once again that both contingency learning and item-specific control could be used depending on the circumstances. Critically, both two-item and four-item sets were utilized in this study. In order to create a two-item set, which made the words more predictive of correct responses, two colors and corresponding color-words were used for the mostly congruent set, and different two colors and corresponding color-words were used for the mostly incongruent set. These sets were not permitted to overlap, as in Jacoby et al. (2003). On the other hand, to create a four-item set, which made the colors more predictive of correct responses, four colors and corresponding color-words were used to create the mostly congruent set and four different colors and corresponding color-words were used to create the mostly incongruent set. As predicted, results revealed that while contingency learning was used for the two-item sets, item-specific control was used for the four-item sets (Bugg & Hutchison, 2013). That is to say, since contingency learning is a simpler mechanism, it was easily used when it was available. However, contingency learning is not compatible with the larger stimulus sets, which reduce the contingency between the word and correct response, and therefore item-specific control mechanisms were used when contingencies were not advantageous.

In brief, these studies demonstrated that there were attentional filters associated with specific stimulus types, and they triggered particular item-specific control mechanisms. However, these explanations did not entirely rule out the role of contingency learning. Both mechanisms were used when the situation called for (Bugg & Crump, 2012).

1.4. Context Specific Proportion Congruency

Context-dependent cognitive control strategies –under the scope of proportion congruency literature– were first demonstrated with a flanker task by Corballis and Gratton (2003). The flanker task is another selective attention task widely used in the attention and cognitive control literature. In a standard flanker task (Eriksen & Eriksen, 1974), a target letter (or arrow) and distractor (noise/flanker) letters (or arrows) are used to create stimulus. Participants are required to respond the target letter located at the center of the stimulus array. As in the Stroop task, generally two types of basic stimuli are common in the flanker task: compatible (i.e., HHHHH or <<<<<) and incompatible (i.e., SSHSS or >><>>). Participants respond slower to the incompatible stimulus than the compatible stimulus, since they need more time to suppress the distracting letters. The response time difference between the compatible and incompatible stimulus is called the flanker effect and it is accepted as a measure of a cognitive control, similar to the Stroop effect (Bugg, 2015; Gratton & Corballis, 2003).

Going back to the main point, in Gratton and Corballis (2003), left and right visual fields were used as context, and the percentages of the compatible and incompatible stimulus arrays differed for these two fields. By this way, compatibility for expectancies for left and right visual field was manipulated. For example, for the left visual field, stimulus arrays were compatible 75% of the time (i.e., mostly congruent), whereas for the right visual field they were incompatible 75% of the time (i.e., mostly incongruent). These sets were presented in a mixed order keeping the overall LWPC level at 50%, which made participants unable to engage in global control strategies. According to the results, participants could adopt local control strategies for different visual fields which was designated by the interaction between item type (i.e., compatible vs. incompatible), expectancy (i.e., mostly congruent vs. mostly incongruent), and field. More specifically, the flanker effect for the mostly congruent field was larger than the Flanker effect for the mostly incongruent field. This result is seen as an evidence for local, dynamic, and context-dependent control procedures as opposed to the central or global control strategies.

1.4.1. The CSPC Effect in the Stroop Task

Crump, et al. (2006) replicated the finding of Gratton and Corballis (2003) by using the prime-probe Stroop task. In this version of the Stroop task, the word and the color dimensions were separated both spatially and temporally. The word dimension was presented at the center of the screen for 100 ms and then it disappeared. Afterwards, the color dimension appeared as a color patch at either top or bottom half of the screen. In addition, different from Gratton and Corballis (2003), in the first experiment of this study, both the shape of the color patch and its location were used as an integrated context. For instance, at the upper half of the screen there was always a square and at the lower part of the screen there was always a circle. The mostly congruent (congruent 75% of the time) and the mostly incongruent (incongruent 75% of the time) sets were assigned to one of these integrated contexts. In other words, the mostly congruent set was assigned to the upper half/square context and the mostly incongruent set was assigned to the lower half/circle context, and this assignment was counterbalanced. Similar to the previous study (Gratton and Corballis, 2003), the overall LWPC level was 50% and therefore, global control strategies were not applicable. Thus, the Stroop effect in the mostly incongruent context was found to be smaller than that of the mostly congruent, as signified by the significant interaction between item type and proportion congruency. This interaction between the proportion congruency and item type was named the *CSPC effect*. As stated, in this experiment, the shape and the location were integrated, and redundant. However, in their second and third experiments, the location and the shape were separated in order to determine whether they would differ in terms of producing the CSPC effect. To that end, proportion congruency was signaled by only the location in Experiment 2A and it was signaled by only the shape in Experiment 2B. According to the results, the shape itself as a context did not produce a CSPC effect while the location itself was able to produce a significant CSPC effect (Crump, et al., 2006). This demonstrated that the observed CSPC effect was caused by the location-based control strategies rather than the shape-based strategies. In order to examine the shape and the location-based CSPC effect further, Crump et al. (2008) conducted another study in which, participants were informed about the CSPC manipulation prior to experiment and both location and shape signaled proportion congruency in separate experiments (Experiment 1a and 1b respectively). Similar to Crump et al. (2006), the CSPC effect was observed only when the context was the location. However, when participants were instructed to count one of the shapes during the experiment, in other words, they were required to process the shape cue deeper, the CSPC effect was observed in the shape condition, too (Crump, et al., 2008, Experiment 2). To summarize, while location was a salient enough context which produced the CSPC effect by itself, shape was not salient enough, and in turn, could not produce the CSPC effect without additional engagement.

1.4.2. Contingency Learning Account

Under the scope of the contingency learning and the control debate (Bugg et al., 2010; Schmidt & Besner, 2008), Crump and Milliken (2009) conducted a study by adding proportion congruency unbiased items to the classic CSPC design. As in the LWPC transfer studies (i.e., Bugg, 2014), an unbiased set which had 50% congruency was included in both the mostly congruent and the mostly incongruent contexts. By this manipulation, the CSPC effect should generalize to the unbiased set if the previously observed CSPC effects were indeed a result of strategic cognitive control processes. On the contrary, if the CSPC effect was due to stimulus-response learning mechanisms, the contingency learning account should predict that the CSPC effect would not generalize to the unbiased items. Specifically, if contingency learning is essential for the CSPC effect, the information coming from the word + context + correct response (color) would be associated together and these specific stimulus-response associations would be used to predict correct responses. Since these associations are stimulus-specific, they would not be generalized into the unbiased items according to the contingency account (Crump & Milliken, 2009). In support of the control account, Crump and Milliken (2009) revealed that the CSPC effect was transferred to the unbiased items as signaled by a smaller Stroop effect in the mostly incongruent context (62 ms) as compared to the mostly congruent context (85 ms), in the last block of their experiment. This result supports the control account, which presumes that specific attentional filters are associated with specific contexts and that the CSPC effect is the result of the rapid shifts of attentional filters between these different contexts.

However, there are also studies supporting the contingency account for the CSPC effect (Schmidt & Lemercier, 2014; Schmidt, Lemercier, & De Houver, 2018). According to the contingency account, even though the contingencies between the word and the correct response (color) in the CSPC studies did not directly help to predict correct responses (see Table 2), word + context + correct response contingencies may have helped to predict the correct response. This kind of learning is called *compound-cue contingency learning* (Schmidt et al., 2018). In order to independently asses the contributions of control and contingency learning processes to the CSPC effect, Schmidt et al. (2018) adapted a classic stimulus set which was used in the CSPC experiments. In this adapted version of the stimulus set, there were four different kinds of stimuli: high contingency-mostly incongruent items, low contingency-mostly incongruent items, low contingency-mostly congruent items, and congruent items. Besides, font type was used as a context (see Bugg et al. 2008 for a font-based proportion congruency effect). Results demonstrated that there was a proportion congruency and item type interaction, hence, a CSPC effect. However, the critical manipulation of this study revealed that the high contingency-mostly incongruent items were responded faster (752 ms) than the low contingency-mostly incongruent items (802 ms), indicating that the CSPC effect was driven by contingency learning (Schmidt et al., 2018).

To sum up, while there are studies supporting the control account for the CSPC effect, there is also a growing body of evidence in support of the contingency learning account. Therefore, the debate about the control and the contingency-based CSPC effects is continuing.

1.4.3. The CSPC Effect in the Flanker Task

Apart from the debate mentioned above, CSPC and CSPC-like effects were observed several times with the flanker and flanker-like tasks in various designs, generally in support of the cognitive control account. In these studies, locations within the same visual fields, colors, foreperiods, and near locations were used as contextual cues for proportion congruency. Besides, there is also evidence from the different paradigms, such as masked priming and attention capture, which support the flanker studies. In the next paragraphs, these studies will be briefly mentioned.

Wendt, Kluwe, and Vietze (2008) observed a context-based flanker effect for locations within the same visual fields in addition to locations in different visual fields. In addition, it was observed that colors as a context also produced a significant CSPC effect in both the classic letter (Vietze & Wendt, 2009) and the numerical version of the flanker task (Lehle & Hübner, 2008, Experiment 2). Apart from the locations and colors, temporal cues were also used as a context. For instance, Wendt and Kiesel (2011) utilized foreperiods as a contextual cue for proportion congruency by manipulating the duration of the fixation screen. Specifically, the fixation cross was presented for either 200 ms or 1200 ms, and the mostly congruent and incongruent sets were assigned randomly to one of these durations. Results demonstrated that the foreperiod manipulation also acted as a context and help to modulation of cognitive control.

In addition to the above manipulations, different variants of the flanker task were also used in different CSPC studies. For instance, a face viewpoint version of the flanker task using left and right visual fields as a contextual cue successfully produced a significant CSPC effect (King, Korb, & Egner, 2012). Furthermore, Weidler and Bugg (2015) observed that the location based CSPC effect could be transferred to the near locations by using the arrow version of the flanker task. This study indicated that context dependent cognitive control was a flexible mechanism which associated with the categorical (i.e., top vs. bottom) locations rather than absolute coordinates of the stimulus (see also Weidler, Dey, & Bugg, 2018).

In addition to the studies described above, there is also further evidence from the attention capture and masked priming literature. For instance, Crump, Milliken, Leobe-McGowan, Leobe-McGowan, and Gao (2018) demonstrated that attention capture could also be modulated via context dependent control mechanisms by using location as a contextual cue. Also, it was demonstrated that color as a contextual cue produced a CSPC like effect in a masked priming paradigm (Heineman, Kunde, & Kiesel, 2011).

In brief, the common theme emerging from the studies discussed is that context dependent control strategies are observed easily in the flanker and flanker-like tasks regardless of the changes in the paradigms or designs. However, this is not the case in the Stroop task. The CSPC effect is not resistant to changes in the Stroop task and it almost only emerges with the prime-probe version (Atalay et al., in preparation; Crump et al., 2008).

1.4.4. Discrepancies in the Literature Regarding the CSPC Effect

The above evidence from the flanker and flanker-like paradigms seems to be consistently supporting the context dependent control view (but see Schmidt et al., 2018). However, the CSPC effects in the Stroop tasks are not as reliably and consistently observed as the ones in the flanker task. More importantly almost of all studies demonstrating a CSPC effect with the Stroop task, used the prime-probe version of the Stroop task (Crump et al., 2006; Crump et al., 2008; Crump & Milliken, 2009; Crump et al., 2016) as opposed to the flanker studies (but see King et al., 2012). The studies which used a Stroop version other than the prime-probe version did not replicate the CSPC effect. As a matter of fact, Atalay et al. (in preparation) used a spatially integrated version of the Stroop task with similar stimulus sets and design with Crump et al. (2006, 2008) and Crump and Milliken (2009, Experiment 2) with a stimulus onset asynchrony (SOA) manipulation. Unexpectedly, they did not observe a CSPC effect in the biased items[1]. After this interesting result, Atalay et al. conducted a very close replication of Crump et al.'s (2006) Experiment 2A by using the prime-probe Stroop task and they observed a CSPC effect. This result may indicate that the CSPC effect in the Stroop task could be dependent on using the prime-probe version of the Stroop task. Partially supporting this idea, it was stated in the footnote of Crump et al. (2008) that integrated version of the Stroop task did not produce the CSPC effect in a pilot study.

There are possible explanations for these discrepancies in the CSPC studies. The most likely explanation is that the CSPC effect may not simply be

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[1] However, they observed a significant CSPC effect in the unbiased transfer items. This finding was also present in Crump et al., 2016, Experiment 4 with the flanker task.

as robust as the ISPC and the LWPC effects. Previous studies demonstrated that the CSPC effect could disappear with even minor changes in the experimental procedures (Atalay et al., in preparation), supporting our claim. Therefore, a close inspection of the experimental procedures used in the CSPC studies was deemed necessary. In Crump et al.'s (2006) design, at first, a fixation cross appears at the center of the screen for 1000 ms followed by a 250 ms blank screen. Then, a color-word appears at the center of the screen for 100 ms, followed by a color patch either at the top half or the bottom half of the screen, which remains until a response is given. Studies that did not use this exact procedure did not find a significant CSPC effect. Additionally, even some researchers used the exact procedure with Crump et al. (2006; 2009), they still did not observe the CSPC effect (Hutcheon & Spieler, 2016; Crump et al., 2016, Experiment 2). Therefore, there is a possibility that some other random or systematic factors which were related to the procedure might have contributed to the observed the CSPC effect. More specifically, in the studies which demonstrated a significant CSPC effect with the Stroop task, the word was presented at the center 100 ms earlier than the color patch, which may change the underlying process related to the Stroop effect. Importantly, when the word presented at the center of the screen, participants possibly lost time directing their gaze to above or below the fixation point as the color patch appeared at top or bottom half of the screen. In other words, when the word and the color were presented at the same place on the screen, there is no need for extra fine motor movement to direct the gaze from the word toward color patch. However, if the word and the color patch are separated both temporally and spatially as in Crump et al. (2006), participants will need more time to direct their gaze toward the color patch. A close inspection of the reaction times from Experiments 2A and 2B (Crump, et al., 2006) supports this claim. In Experiment 2A, the location was used as a cue for proportion congruency and the word and the color dimensions were presented at different locations. However, in Experiment 2B, shape was used as the cue of for proportion congruency and both the word and the color dimension were presented at the same place. Overall reaction times in Experiment 2B were faster than that of Experiment 2A. The mean reaction time was 486 ms on congruent items in Experiment 2B whereas it was 507 ms in Experiment 2A. The pattern was also the similar for the incongruent items: in Experiment 2B, mean reaction time of incongruent items was 562 ms while it was 579 ms in Experiment 2A. Noticeably, the CSPC effect was not observed in Experiment 2B (Crump et al., 2006). A possible reason of these faster reaction times in Experiment 2B might be fact that the colored shapes were presented at the same location as the prime word, at the center of the screen. Therefore, the participants did not lose time to look up or down as in the Experiment 2A. In addition, in the location based CSPC experiments using this prime-probe version of the Stroop task, participants always knew the location of the prime word: the center. However, they did not know or could guess where the color patch would be presented: above or below the fixation point. Therefore, there was an uncertainty about the location of the color patches; which the Crump et al. (2006) also mentioned as a possible factor in the observed effect. In MacLeod (1991), it was stated that location-based uncertainty of the relevant dimension (color in the current case) may also boost the Stroop effect as compared to the location-based uncertainty of the irrelevant dimension (word). In line with this argument, Tectonic Theory (Melara & Algom, 2003) claimed that uncertainty and surprisingness on a dimension, helped participant use information coming from that dimension. Therefore, uncertainty on the color dimension in the prime-probe Stroop task, which was used in CSPC studies, could possibly help participants to use context information, and may help the production of the CSPC effect that is limited to only this special version of the Stroop task.

CHAPTER 2

THE CURRENT STUDY

2.1. Introduction

In the light of the previous studies and possible discrepancies regarding the designs, the current study was designed to examine the role of the spatial uncertainty of the color and the word dimension on the CSPC effect. In order to disentangle the effects of these uncertainties, a classic prime-probe CSPC experiment was conducted. A between-subjects manipulation with two levels was utilized in order to eliminate the uncertainty from the color and/or the word dimension, step by step, in a systematic manner. This manipulation was implemented by either changing the location of the word or both changing the location of the word and the fixation cross. This between-subjects condition was called the *fixation condition* since the only difference between these levels was the location of fixation (see Figure 1 and 2).

In the first level of the fixation condition, namely *centered fixation*, fixation cross was presented at the center of the screen while the prime word and the color patch were presented at the same place: top or bottom half of the screen. By this manipulation, uncertainty of the color was eliminated but the location of the word now became uncertain. In this way, only the location of the word dimension was uncertain and once the word appeared participants knew where the color patch would be presented. This procedure also might have helped reduce the lost time while directing one's gaze from the fixation point to top or bottom of half of the screen for the color dimension. Therefore, we did not expect to find a significant CSPC effect in this condition, since we eliminated the uncertainty of the color dimension, which probably gave rise to the CSPC effect in the previous studies (see Figure 1 in section 2.2.3.).

The second level of the fixation condition, namely *up-down fixation*, was designed to eliminate the uncertainty of both the color and the word dimensions. For this purpose, the fixation was presented at the bottom or top half of the screen, at exactly the same place with the word and the color patch. After the presentation of the fixation cross, the prime word appeared in the same place again, followed by the color patch (see Figure 2 in section 2.2.3.). Therefore, with this procedure, the uncertainty of both the word and the color patch was expected to be eliminated and the time it took to look up or down for the color patch or the word would not be an issue. As a result, we did not expect to observe a significant CSPC effect since we eliminated the uncertainty of both dimensions. Nevertheless, the possibility to observe a CSPC effect with the up-down fixation condition due to presenting the fixation cross at the top or bottom half of the screen providing the participants with extra time (1000 ms fixation + 250 ms blank screen) to develop CSPC strategies. However, this was not the case in the first condition since the fixation cross was presented at the center of the screen. Also, the procedure in the up-down fixation condition might have made the location more salient and therefore may have indirectly contributed to the CSPC effect even though we did not expect to observe a CSPC effect.

Furthermore, three-way interaction between the item type, proportion congruency and fixation condition may indicate that the location of the fixation cross (centered vs. up-down) contributed to the CSPC effect. This would indicate that the magnitude of CSPC effect might differ in the centered vs. the up-down fixation conditions, since the location of the word is uncertain in the first condition whereas neither location of the word nor the location of color are uncertain in the second condition. Also, as stated, the up-down fixation condition may have indirectly contributed to the CSPC effect.

2.2. Method

This study was preregistered to Open Science Framework prior to creation of data. Research questions, hypotheses, study design, sample size rationale and all materials including participant list, E-Prime and R scripts, raw data, and analyses are available on this link: https://osf.io/hytup

2.2.1. Participants

In order to reach .80 power for a medium effect (f = .25) in the current experimental design, 128 participants are needed (G*Power 3.1, Faul, Erdfelder, & Buncher, 2014) as specified in the Cohen (1988). The reported effect sizes are not reliable in the CSPC literature since some of the studies did not replicate the CSPC effect by using previous large effect sizes (Hutcheon & Spieler, 2016). For this reason, a more conservative approach was adopted in this study and a medium effect was chosen in order to increase the sample size. Critically, the sample size is higher than almost all sample sizes used in the CSPC literature using the prime-probe Stroop task (Crump et al., 2006: 16 participants; Crump et al., 2008: 35; Crump et al., 2016, Experiment 1: 95; Crump & Milliken, 2009: 30; Hutcheon & Spieler, 2016: 32). Data of participants who did not follow the experimental procedures, who had missing or scratch trials more than 10% in the whole experiment, who had missing or scratch trials more than 25% in any condition, and whose native language was not Turkish were removed from the analysis and additional data were collected to replace them.

In total 143 (including replaced ones) participants were invited to the study in return for course credit. All participants were university students, had normal or corrected to normal visual acuity, and normal color vision. Nine participants were removed from the analyses since they had more than 10% missing (scratch) trials in total, four of them were removed since they did not follow instructions (they attended another proportion congruency study just before the current one despite the warning), one of them was removed since her native language was not Turkish, and vocal data of one participant was not recorded because of a technical problem. All analyses were conducted with the remaining 128 participants (100 females, M_{age} = 21.04 years, *SD* = 1.36, age range: 18–25 years, age information of one participant was not recorded and not included in the mean).

2.2.2. Stimuli and Design

The experimental procedure was approved by the ethic committee of the Middle East Technical University (see Appendix A). The prime-probe version of the Stroop task was used and a very similar procedure with Crump et al.'s (2006) Experiment 2A was followed. Four colors and corresponding color-words in Turkish were used in this study: red (kırmızı, RGB: 245 0 0), blue (mavi, RGB: 0 102 255), yellow (sarı, RGB: 255 255 0), and green (yeşil, RGB: 0 128 0). The words were written in white ink against black background in 36-point Arial font in a fixed point at the bottom or top half of the screen. The colors were always presented in a rectangle color patch (~2.9 x ~8.7 cm) in black background either at the top (~7.7 cm above from fixation point) or the bottom (~ 7.7 cm below from fixation point) half of the screen. The colors and the words were never presented at the center of the screen.

A 2 (proportion congruency: mostly congruent vs. mostly incongruent) x 2 (item type: congruent vs. incongruent) x 2 (fixation condition: centered vs. up-down) mixed design was used. Proportion congruency and item type were within-subjects variables and the fixation condition was a between-subjects variable. In addition, the levels of the between-subjects condition were planned to be analyzed separately in order to investigate the CSPC effect (item type x proportion congruency interaction) in each level.

2.2.3. Procedure

Experiments were conducted in a silent room. Each participant was tested individually for about 30 minutes. The experimenter was present in the room. All participants signed the inform consent before the experimental procedure started. Experiments were conducted automatically on a computer running E-Prime 2.0 software (Schneider & Zuccoloto, 2007). Participants were seated about 60 cm away from the computer screen. Once the inform consent was signed, participants' demographic information (age, gender, visual acuity, color blindness, reading disability, and native language) were recorded on E-Prime. Thereafter, they were instructed to name the color out-loud as fast and as accurate as possible, while ignoring the word (see Appendix C and D). After the instructions, all participants completed 10 practice trials. In the centered fixation condition, the fixation cross was presented at the center of the screen while the word prime and the color patch was presented at the top or bottom half of the screen in the same location. The sequence of the process is presented in Figure 1. First, a fixation screen was presented for 1000 ms followed by a 250 ms blank screen. Later, a word prime was presented for 1000 ms followed by a color patch that remained until a response was made or the 3000 ms deadline was reached. Note that the duration of the word prime was extended to 1000 ms in order to make sure that the word dimension was processed. Specifically, the fixation cross and the word were presented in different locations in the current condition and hence 100 ms was not enough to direct one's gaze from the center of the screen toward the word located at top or bottom half of the screen in addition to processing the word. After the color patch, if the participants responded, another blank screen was presented for 1000 ms. If the participants did not give a response, feedback was given for 1000 ms.

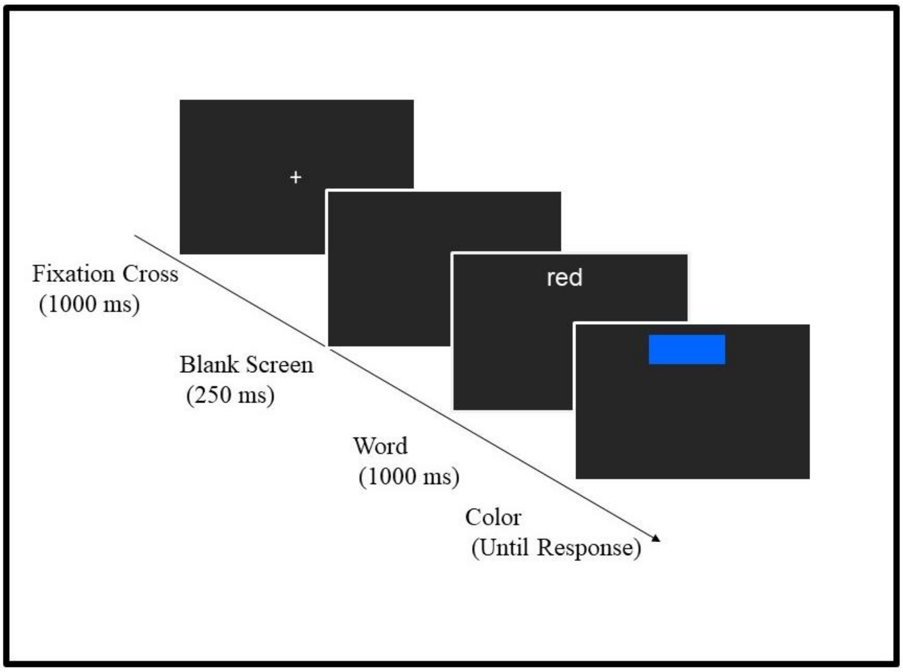

Figure 1. Process of the centered fixation condition

Half of the participants were assigned to the centered fixation condition and the other half was assigned to the up-down fixation condition randomly. For each level of the between-subjects condition, items were assigned to either the mostly congruent (75% congruent) or the mostly incongruent (75% incongruent) set, each participant receiving both the mostly congruent and the mostly incongruent sets. Each set was assigned to either top or bottom half of the screen and this assignment was counterbalanced across participants. Almost half of the participants received a version (MC-Top condition) where the mostly congruent condition was assigned to the top half of the screen and the mostly incongruent condition was assigned to the bottom half of the screen. Remaining participants received a version (MI-Top) where the mostly congruent condition was assigned to the bottom half of the screen and the mostly incongruent condition was assigned to the top half of the screen.

After the practice trials ended, the experimental session started. Four blocks of 96 trials (total 384) were presented. Forty-eight of these 96 trials were presented in the mostly congruent-top location (36 congruent, 12 incongruent). The rest of the items in a block were assigned to the mostly incongruent-bottom location (36 incongruent, 12 congruent, see Table 2). Besides, this stimulus set was identical to Crump et al. 2006 and Crump et al. 2008, in that, the word dimension did not strongly predict the correct response in this stimulus set (see Schmidt & Lemercier, 2018). All items in a block were presented in a different random order for each participant.

Table 2.

Sample Stimulus Set for the Centered and the Up-Down Fixation Condition for a Block

		Color			
	Word	Red	Blue	Yellow	Green
Mostly Congruent-Top	Red	**9**	1	1	1
	Blue	1	**9**	1	1
	Yellow	1	1	**9**	1
	Green	1	1	1	**9**
Mostly Incongruent-Bottom	Red	**3**	3	3	3
	Blue	3	**3**	3	3
	Yellow	3	3	**3**	3
	Green	3	3	3	**3**

Note: Congruent items are written in bold.

Reaction times were detected via a microphone connected to the Serial Response Box and all responses were recorded with a second microphone. After the experimental session ended, a trained undergraduate intern listened to all responses one by one and coded each trial as scratch, correct or incorrect. Trials including high levels of external noise and sounds other than responses (which might trigger the microphone such as coughing, sneezing etc.), trials without a response or straight response, and trials which had multiple responses were coded as scratch trials. Besides, after the first coding procedure ended, the author also listened and checked all the trials coded by the coders, and if necessary, corrections were made.

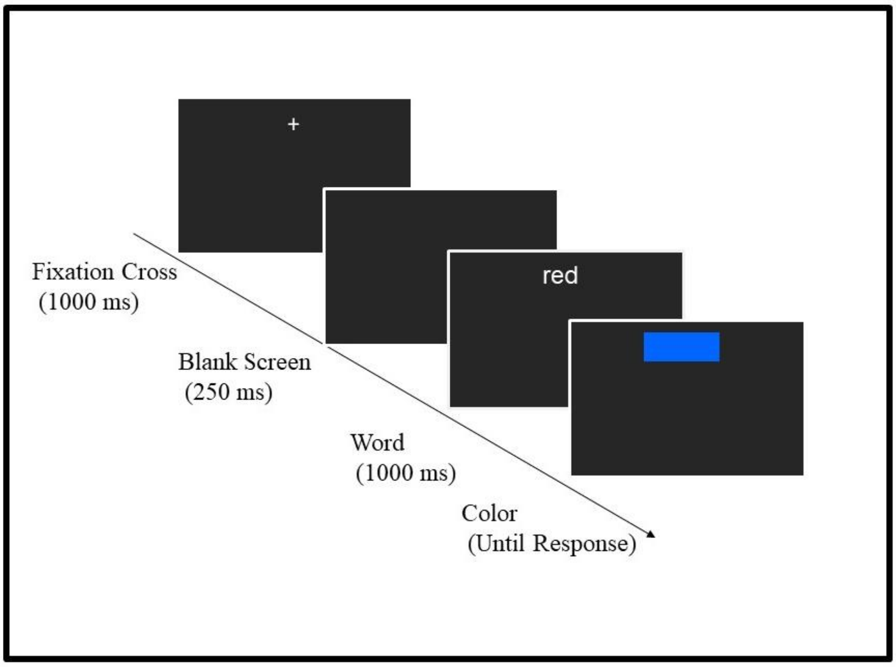

Figure 2. Process of the up-down fixation condition

In the up-down fixation condition, the fixation cross, the word prime and the color patch were presented in the same location: either top or bottom. The sequence of the process is presented in the Figure 2. In detail, in this condition, the fixation cross was presented for 1000 ms at the same place as the word prime and the color patch (see Figure 2). The procedure for the rest of this condition was exactly the same as the first condition.

2.3. Results

Before the reaction time analysis, practice trials, error trials, scratch trials, trials following scratch or error trials, trials without a response, trials having reaction times smaller than the 200 ms were removed from the data. Besides, correct reaction times were submitted to a recursive outlier elimination procedure for each condition and each participant, and these procedures were implemented with an R script (Van Selst & Jolicoeur, 1994, see Appendix E). These procedures resulted in the removal of 6.95% of the trials and reaction time analyses were conducted with the remaining data. Mean reaction times are presented in Table 3. In addition, the data of the replaced participants were also submitted to the outlier elimination procedure. This procedure resulted in removal of far more trials, especially for the replaced participants because of scratch rates, further supporting that these participants' data were indeed problematic, and our data exclusion criteria's were justified.

For the error data, only scratch trials (2.57%) were removed, and mean percentage of errors were analyzed for each condition and each participant. Mean percentage of errors are presented in Table 4.

Alpha level was set .05 and partial eta squared (η_p^2) was reported for the effect size for all of the analyses. In addition, before the main analysis, a four-way mixed ANOVA was conducted in order to check whether the counterbalancing condition had an effect on the observed results. The interaction between item type, proportion congruency, fixation condition, and the counterbalancing condition (MC-Top vs. MI-Top) was not significant, indicating that the counterbalancing condition did not have an effect on the CSPC effect and its interaction with the fixation condition.

Table 3.

Mean Reaction Times as Milliseconds for the Centered and the Up-Down Fixation Condition

	Centered Fixation		Up-Down Fixation	
	Mostly Congruent	Mostly Incongruent	Mostly Congruent	Mostly Incongruent
Congruent	573 (11)	574 (11)	574 (11)	579 (12)
Incongruent	612 (11)	616 (11)	617 (11)	613 (11)
Stroop Effect	39	42	43	34
CSPC Effect	-4		9	

Note: Standard Errors are given in the parenthesis

Table 4.

Mean Percentage of Errors for the Centered and the Up-Down Fixation Condition

	Centered Fixation		Up-Down Fixation	
	Mostly Congruent	Mostly Incongruent	Mostly Congruent	Mostly Incongruent
Congruent	0.16 (0.07)	0.10 (0.06)	0.11 (0.04)	0.07 (0.05)
Incongruent	0.33 (0.13)	0.26 (0.06)	0.17 (0.09)	0.18 (0.06)
Stroop Effect	0.17	0.16	0.06	0.11
CSPC Effect	0.01		-0.05	

Note: Standard Errors are given in the parenthesis

2.3.1. Reaction Times

Remaining reaction time data after the exclusions and data trimming procedure were submitted to a 2 x 2 x 2 mixed design ANOVA. Fixation condition (centered vs. up-down) was between-subjects variable while item type (congruent vs. incongruent) and proportion congruency (mostly congruent vs. mostly incongruent) were within-subjects variables. Main effect of item type was significant, $F(1, 126) = 251.97$, $MSE = 790.67$, $p < .001$, $\eta_p^2 = .67$, indicating that reaction times were faster for congruent items ($M = 575$) than incongruent items ($M = 614$). Main effect of proportion congruency was not significant, $F(1, 126) = 1.12$, $MSE = 287.84$, $p = .29$, $\eta_p^2 = .01$. Reaction times in the mostly congruent condition ($M = 594$) and reaction times in the mostly incongruent condition ($M = 596$) was similar. The last main effect, fixation condition, was not significant, $F(1, 126) = 0.02$, $MSE = 30{,}173.77$, $p = .88$, $\eta_p^2 = .00$, indicating reaction times in the centered fixation condition ($M = 594$) and the up-down fixation condition ($M = 596$) did not differ significantly (see Figures 3 and 4).

As expected, the interaction between the item type and the proportion congruency, in other words the CSPC effect, was not significant, $F(1, 126) = 1.05$, $MSE = 220.83$, $p = .31$, $\eta_p^2 = .01$. This demonstrates that the Stroop effect for the mostly congruent ($M = 41$) set was not significantly different from the mostly incongruent set ($M = 38$). In addition, the interaction between item type and fixation condition, $F(1, 126) = .15$, $MSE = 790.67$, $p = .70$, $\eta_p^2 = .00$, and the interaction between proportion congruency and fixation condition, $F(1, 126) = .024$, $MSE = 287.84$, $p = .62$, $\eta_p^2 = .00$, were not significant either.

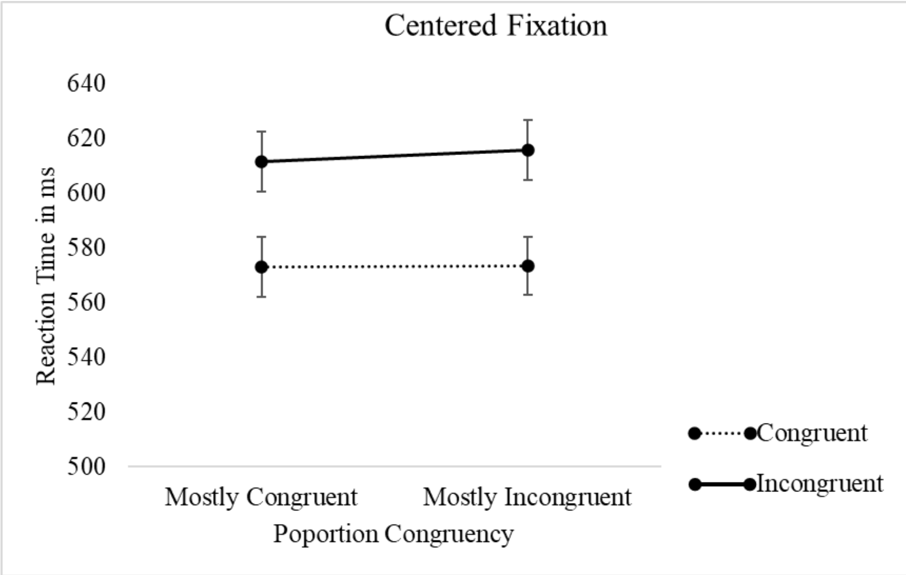

Figure 3. Mean reaction times as a function of proportion congruency and item type in the centered fixation condition. Bars represent standard errors.

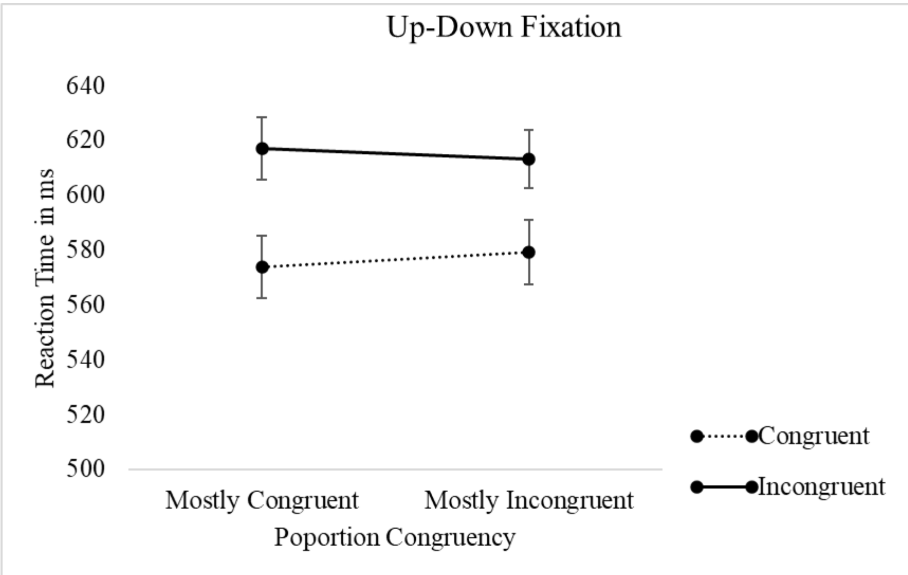

Figure 4. Mean reaction times as a function of proportion congruency and item type in the up-down fixation condition. Bars represent standard errors.

Importantly, the three-way interaction between item type, proportion congruency, and fixation condition was significant, $F(1, 126) = 6.12$, $MSE = 220.83$, $p = .01$, $\eta_p^2 = .05$. In order to understand where this effect stemmed from, the levels of between-subjects condition were analyzed separately for both reaction time and percentage of error data. For the centered fixation condition, the interaction between item type and proportion congruency, in other words the CSPC effect, was not significant, $F(1, 63) = 1.75$, $MSE =132.59$, $p = .19$, $\eta_p^2 = .03$. However, this interaction, namely the CSPC effect, was significant in the up-down fixation condition, $F(1, 63) = 4.37$, $MSE = 309.06$, $p = .04$, $\eta_p^2 = .06$ (see Figure 3 and 4).

2.3.2. Percentage of Errors

Overall, error rates were quite low (0.17 %). For this reason, the results may not be as informative as the reaction time analyses. Percentage of errors were submitted to a 2 x 2 x 2 mixed design ANOVA. Only the main effect of item type was significant, $F(1, 126) = 4.53$, $MSE = .45$, $p = .04$, $\eta_p^2 = .03$, which means that error rates were lower for the congruent items ($M = 0.11$ %) than the incongruent items ($M = 0.24$ %). Main effect of proportion congruency, $F(1, 126) = 1.05$, $MSE = .19$, $p = .31$, $\eta_p^2 = .01$, main effect of fixation condition, $F(1, 126) = 1.79$, $MSE = .46$, $p = .18$, $\eta_p^2 = .01$, interaction between item type and proportion congruency, $F(1, 126) = .06$, $MSE = .25$, $p = .80$, $\eta_p^2 = .00$, the interaction between item type and fixation condition, $F(1, 126) = .51$, $MSE = .45$, $p = .48$, $\eta_p^2 = .00$, the interaction between proportion congruency and fixation condition, $F(1, 126) = .39$, $MSE = .19$, $p = .53$, $\eta_p^2 = .00$, and the three way interaction between item type, proportion congruency and fixation condition, $F(1, 126) = 0.17$, $MSE = .25$, $p = .68$, $\eta_p^2 = .00$, were not significant.

Although the three-way interaction was not significant in the error data, separate analyses for the levels of between-subjects variable were conducted so that they would be comparable to the reaction time analyses. Item type and proportion congruency interaction, namely the CSPC effect, was not significant for both the centered fixation condition, $F(1, 63) = .01$, $MSE = .34$, $p = .92$, $\eta_p^2 = .00$, and the up-down fixation condition, $F(1, 63) = .35$, $MSE = 0.16$, $p = .55$, $\eta_p^2 = .01$ (see Figures 5 and 6).

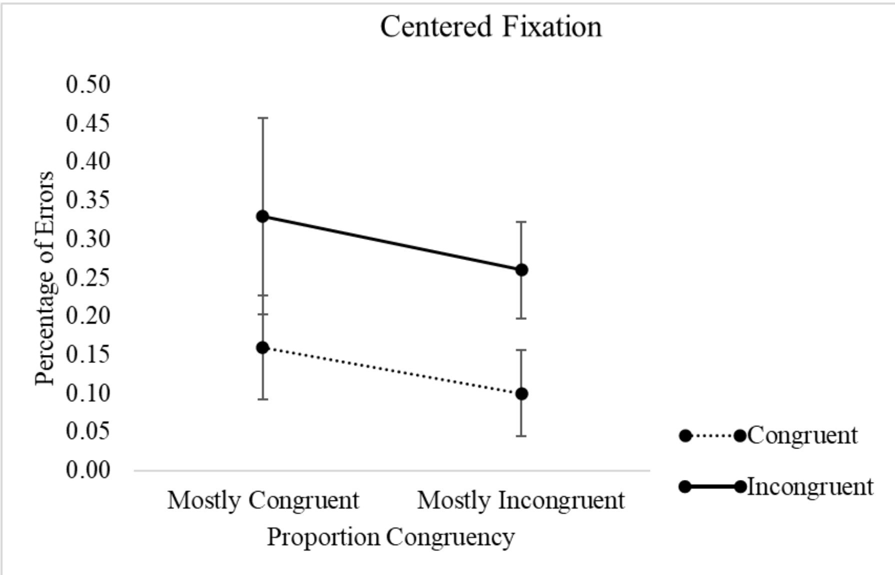

Figure 5. Percentage of errors as a function of proportion congruency and item type in the centered fixation condition. Bars represent standard errors.

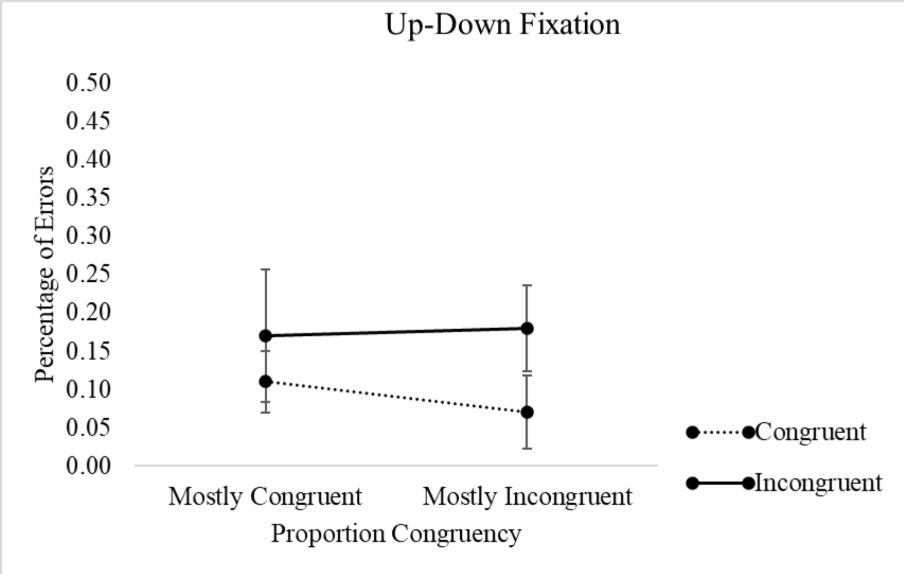

Figure 6. Percentage of errors as a function of proportion congruency and item type in the up-down fixation condition. Bars represent standard errors.

2.4. Discussion

The current study aimed to investigate the underlying mechanisms of the CSPC effect since the recent studies failed to replicate it (Atalay et al, in preparation; Crump et al, 2016, Experiment 2; Hutcheon & Spieler, 2016) and the result of these studies were not consistent with the initial ones (i.e., Crump et al., 2006). Note that, the common point of the studies which observed the CSPC effect with the Stroop task is that almost all of these studies used a prime-probe version (Crump et al., 2006; Crump et al., 2008; Crump & Milliken, 2009). Moreover, it was stated as a footnote in Crump et al. (2008) that the classic integrated version of the Stroop task did not produce the CSPC effect. In the current study, the experimental procedure of this task was closely inspected, in order to examine what made the prime-probe version of the Stroop task unique in giving rise to the CSPC effect. This inspection revealed that the nature of the prime-probe Stroop task might be different from the classic integrated Stroop tasks. In the integrated Stroop task, the color and the word dimensions are embedded, and they are presented simultaneously. However, in the prime-probe task –which is very uncommon in the proportion congruency literature– the color and the word dimension are separated both temporally and spatially. The word dimension is presented at the center of the screen for 100 ms before the color dimension and it disappears as the color presented at the top or bottom half of the screen. In this procedure, participants always know the location of the word: at the center. However, they do not know or can guess the location of the color, since it is assigned randomly to a fixed location at either the top or bottom half of the screen. This procedure, unlike the integrated Stroop task, creates a spatial uncertainty on the color dimension (Crump et al., 2006). Conceivably, the spatial uncertainty of the color dimension might make it easier to associate certain information coming from the context, and in turn, lead to the emergence of the CSPC effect that is limited to the prime-probe procedure.

For the reasons described above, the main aim of the current study was to eliminate the uncertainty of the prime-probe Stroop task to reveal whether the CSPC effect originated from strong context dependent control strategies or it was an artifact of the spatial uncertainty that came from the nature of the task. To that end, location of the word and the location of the fixation cross was manipulated in a mixed design CSPC experiment. In the first condition of the experiment, namely the centered fixation condition, the fixation cross was presented at the center of the screen. The word was presented randomly at the top or the bottom half of the screen which consequently eliminated the spatial uncertainty from the color dimension. In this way, it was possible to observe the role of the uncertainty of the color dimension on the CSPC effect.

In the second condition, the up-down fixation, in order to eliminate the uncertainty for the both word and color dimension, the fixation cross was assigned to the same location as the word and the color: top or bottom half of the screen. Therefore, once the fixation cross appeared, the location of the word and the color could be known. Consequently, this procedure directly eliminated the spatial uncertainty for both dimensions. By virtue of this manipulation, the contribution of the spatial uncertainty of the word dimension –which was present in the centered fixation condition– to the CSPC effect was eliminated (but see alternative explanation in Section 2.1). As a result of these manipulations we did not expect to find a CSPC effect since we eliminated this possible confound. Accordingly, reaction time results showed that there was no overall CSPC effect in the study. Moreover, the three-way interaction between item type, proportion congruency, and fixation condition was significant; implying that the CSPC effect was different across the levels of the fixation condition. As planned, the levels of this fixation condition were analyzed separately to determine where the observed effect came from. In line with the expectations, results demonstrated that the CSPC effect (-4 ms) was not significant in the centered fixation condition. However, the interaction between item type and proportion congruency, namely the CSPC effect, was significant in the up-down fixation condition. Nevertheless, this effect (9 ms and $\eta_p^2 = .06$, $p = .04$) was not as large as the previous CSPC effects and other proportion congruency effects (i.e., ISPC effect: 56 ms, $\eta_p^2 = .67$, Bugg & Hutchison, 2013 and LWPC: 40 ms, $\eta_p^2 = .19$, Bugg, 2014). In addition, in order to examine whether the CSPC effect in the up-down fixation condition would also be evident with other statistical approaches other than the frequentist ones, a Bayesian analysis was conducted with JASP software (version: 0.9.2, JASP Team, 2018). A Bayesian repeated measures of ANOVA revealed that there was anecdotal evidence (Lee & Wagenmakers, 2014) for the null hypothesis (no CSPC effect in this analysis) for interaction of proportion congruency and item type in the up-down fixation condition ($BF_{10} = 0.65$). This analysis also supports our hypothesis that the CSPC effect may disappear if we eliminate the uncertainty of the stimulus.

Overall, the observed results support our hypothesis for the most part, which presumes that the CSPC effect is probably limited to the prime-probe procedure that produces uncertainty on the color dimension. This finding has theoretical importance in terms of understanding the nature of the context dependent control mechanisms. In the next sections, parallel findings from the spatial attention (Chajut, Schupak, & Algom, 2009) and evidence accumulation (Kinoshita, de Wit, Aji, & Norris, 2017) literature will be evaluated and combined with the CSPC literature and the current results.

2.4.1. Spatial Separation of the Dimensions

Under the scope of the attention literature, Chajut, et al. (2009) questioned whether spatial and dimensional attention were the same or different processes. They claimed that for spatial attention, spatial aspects of the stimulus (i.e. location) was important and that attention would be modulated by using these aspects in an overarching manner. However, for dimensional attention, it was essential to separate the stimulus into task related (i.e., target) and unrelated dimensions (i.e., distractor). The item itself was critical rather than its spatial features. Accordingly, it was stated that different kinds of attention paradigms highlighted different kinds of attentional processes. For instance, Posner's (1980) orientation task is accepted as a spatial attention task. In this task, the location of the target stimulus is validly cued by an arrow most of the time (probability of .8) and it is invalidly cued by an arrow other times (probability of .2). In other words, while participants know where to expect the stimulus in the valid cue condition, they do not in the invalid cue condition. In this way, responses are faster in the valid cue condition as compared to the invalid cue condition; signaling the orientation of spatial attention (Posner, 1980). Also, Chajut et al. (2009) stated that the flanker task also highlights spatial attention, since the nature of the task requires spatially separating targets and distractors (flankers), in order to respond correctly. However, they claimed that the Stroop task highlights dimensional attention since the primary aim in this task was dissociating the color and the word dimension that were presented at the same location. Therefore, spatial attention may not play a significant role in the Stroop task. In line with this presumption, they integrated the flanker and the Posner tasks in order to investigate spatial attention. In addition, they integrated the Posner task with both a hierarchical letter variant (Navon, 1977), a classic color-word variant, and a spatially separated variant of the Stroop task, in separate experiments, in order to investigate the relation of spatial and dimensional attention. That is to say, they added location and expectancy (cue) factors to both the flanker and the Stroop tasks by combining them with the Posner task. In harmony with this manipulation and their presumptions about the paradigms, they expected that the flanker effect and the Posner effect should interact as an indication of spatial attention (Experiment 2). However, it was expected that the Stroop effects from the classic color-word and hierarchical letter variant of the Stroop task should not interact with the Posner effect since the Stroop task is related to dimensional attention (Experiment 1 and 3). Critically, they also predicted that the Stroop effect and the Posner effect should interact when a spatially separated variant of the Stroop task was used, since the separation of dimensions may direct attention to the spatial features of the stimulus (Experiment 4). This interaction would be signified by the larger Stroop effect for the unexpected (invalid cue) location than the expected location (valid cue). They conducted four experiments to test these predictions and the results were in line with their expectations. This study has very important implications for the CSPC literature for several reasons.

The most important take-home message from the Chajut et al. (2009) is that spatial attention was more pronounced in the flanker task as compared to the Stroop task. This finding is in line with the context dependent control literature. As mentioned in the previous sections (1.4.3), the CSPC effect was observed with the flanker task and flanker-like tasks several times. However, its replicability with the Stroop task is still questionable (section 1.4.4). This discrepancy between the Stroop and the flanker paradigms for the CSPC effect supports the presumptions of Chajut et al. (2009) which specify that the flanker task taps the spatial features of the attention while the Stroop task taps the dimensional features of attention. Furthermore, the studies that found a significant CSPC effect with the Stroop task always used the prime-probe version, and the stimulus was both temporally and spatially separated. Chajut et al. (2009) also observed supporting finding. In detail, they observed orientation of spatial attention when they used a spatially separated version of the Stroop task in combination with the Posner task (Experiment 4). Overall, Chajut et al. (2009) in specific, and the CSPC literature in general demonstrate that observing context dependent control (i.e., CSPC effect) or spatial attention with the classic Stroop task is not very common due to nature of the task. Furthermore, to observe the CSPC and CSPC-like effects with the Stroop task, modifications must be done such as spatially separating the dimensions, which results in the uncertainty of the location of the color. Accordingly, the current study investigated one of these modifications and revealed that when the spatial separation, and hence, the spatial uncertainty was eliminated from the color dimension in the Stroop task (centered fixation condition), the CSPC effect disappeared. Even though a CSPC effect was observed in the up-down fixation condition, it was relatively weak and small in magnitude (9 ms). Besides, this weak effect may have indirectly stemmed from certain critical manipulations, as explained in the previous sections (section 2.1). Particularly, both the fixation, the word, and the color were presented at the same location in the up-down fixation condition. Therefore, participants had extra time to look at the same location on the screen. This longer engagement with the location may have helped participants to develop strategies to respond correctly. In detail, participants may bind the strong location information coming from the fixation + word + color (Shcmidt & Lemercier, 2018) thanks to the extra time provided by the fixation cross. Hence, the observed CSPC effect in the up-down fixation condition might be originating from the strengthened context information that leads participants to use contingency learning strategies rather than context-dependent control strategies.

To summarize, the spatial attention literature provides explanations for discrepancies in the CSPC literature in addition to supporting the current findings on the spatial uncertainty to a large extent.

2.4.2. Temporal Separation of the Dimensions

In addition to the explanations from the spatial attention literature investigating the spatial separation of the stimulus, there is also evidence related to how the temporal separation of the dimensions changes the nature of the Stroop task. Kinoshita et al. (2017) investigated how priming (presenting the word dimension prior to the color dimension) affected the reaction time distributions. In this study, a classic integrated version of the Stroop task and a primed Stroop task was used. In the primed Stroop task, the word was presented for 460 ms before the presentation of the color dimension, and in the integrated version, the color and word were presented simultaneously. In both tasks, three types of items were used: congruent, incongruent, and neutral. Reaction times for these tasks were rank ordered for all conditions and this ordered data were split into 10% quantiles to create delta plots. These delta plots demonstrated the reaction time distributions from fastest to slowest making it possible to observe distributional shifts in the reaction times for all conditions. By using this technique, Kinoshita et al. (2017), concluded that reaction time distributions were significantly different for the integrated and the primed Stroop tasks. In particular, the Stroop effect steadily increased through the quantiles producing a positively sloped line in the delta plot of the integrated Stroop task. In contrast, in the primed Stroop task, the Stroop effect was slightly attenuated toward the last quantiles which produced a relatively flat line in the delta plot (see Figure 7).

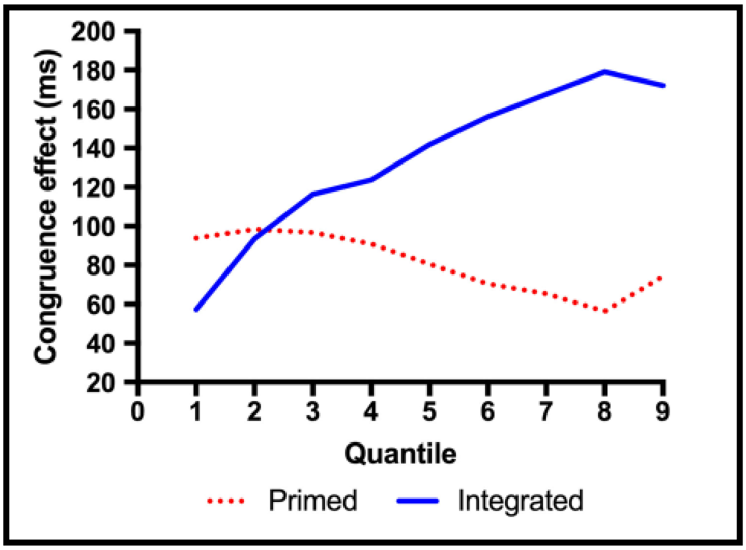

Figure 7. Delta plot of the Stroop effect (congruence effect) for the primed and the integrated Stroop task. Taken from "Evidence Accumulation in the Integrated and Primed Stroop Tasks," by S. Kinoshita, B. de Wit, M. Aji, and D. Norris, 2017, *Memory & Cognition*, *45*(5), p.831, https://doi.org/10.3758/s13421-017-0701-8. Copyright 2017 by Creative Commons Attribution 4.0 International License. (https://creativecommons.org/licenses/by/4.0/)

It was claimed that the positively sloped delta plot in the integrated Stroop task was mostly conflict based, since the word and the color dimension were presented simultaneously. Therefore, evidence accumulation started at the same time for both of the dimensions. However, in the primed Stroop task, the word prime was presented earlier than the color, enabling a head start which resulted in reduced conflict, and consequently a shift in the distribution (Kinoshita et al., 2017). Besides, it was observed that while interference (the Stroop effect: incongruent reaction time minus congruent reaction time) was dominant in the integrated Stroop task, facilitation (neutral reaction time minus congruent reaction time) was dominant in the primed Stroop task. Kinoshita et al. (2017) stated that this facilitation, which stemmed from the speeded responses on congruent trials, might be explained by the contingency learning account (Schmidt & Besner, 2008), since the word prime and correct responses of congruent items had high contingency.

Overall, Kinoshita et al. (2017) has demonstrated that there were differences between the classic integrated Stroop task and the primed Stroop task. This may shed light on the question of why the CSPC effect is observed only in the prime-probe version of the Stroop task. As stated, in the primed version of the Stroop task, the observed reaction time patterns mostly stemmed from the facilitation effect (fast congruent responses) and the conflict between the congruent and incongruent items was not as strong as that of the conflict in the integrated Stroop task (Kinoshita et al., 2017). This finding supported our hypothesis that the CSPC effect may be an artifact of the prime-probe procedure, rather than the strong control-based –in other words conflict-based– contextual strategies. If the priming of the word, speeds up the responses on the congruent responses, this might direct participants to use contingency-based strategies rather than the control-based strategies. Therefore, there is a possibility that the observed CSPC effect in the previous studies, could have been driven by contingency learning rather than control-based strategies, since the using the word as a cue was more advantageous in the prime-probe Stroop task. Even tough prime durations were not identical in Crump et al. (2006), Kinoshita et al. (2017) and the current study, theoretical explanations of Kinoshita et al. (2017) are still valuable in terms of conceptualizing the differences between the integrated and the primed Stroop task.

In addition, there is support to our claim that the prime-probe Stroop task and integrated Stroop task may have different underlying mechanisms from the *congruency sequence effect (CSE)* literature. The CSE effect is generally signified by a smaller congruency effect (i.e. Stroop effect or flanker effect) after an incongruent trial as compared to the congruent trial (Egner, 2007). Specifically, Weissman, Hawk, and Egner (2015) demonstrated that the prime-probe (sequential) arrow task produced the larger CSE than the and integrated (simultaneous) arrow task. Therefore, this finding may also imply that the underlying mechanisms of the prime-probe tasks and the integrated Stroop task could be different from each other.

Furthermore, observing the CSPC effect in the up-down fixation condition but not in the centered condition in the current study might be explained in light of the findings of Kinoshita et al. (2017). In the centered fixation condition, only the word and the color dimensions may have contributed to evidence accumulation. However, in the up-down fixation condition, fixation cross could also contribute to evidence accumulation in addition to the word and the color dimensions. In other words, evidence accumulation may start earlier, helping bind or associate information coming from the context + fixation + word + color dimensions, and in turn, the CSPC effect (see Schmidt & Lemercier, 2018).

2.4.3. Conclusion

The current study investigated the role of spatial uncertainty on the CSPC effect. Results demonstrated that eliminating the uncertainty of the color dimension also eliminated the CSPC effect. However, eliminating the uncertainty of both the word and the color dimension by presenting the fixation cross at the same location, resulted in a weaker CSPC effect that probably was a result of longer engagement with the context. One might claim that increasing the prime duration may result in a significant CSPC effect in the up-down fixation condition. However, this is not a strong argument since the prime durations were equal in both the centered and the up-down fixation conditions. Therefore, observing a significant CSPC effect in the up-down fixation condition, but not in the centered fixation could not be easily explained by the increased prime word duration. Besides, by virtue of the evidence from the flanker task and spatially separated version of the Stroop task, the spatial attention literature also supports our findings. The findings of these studies together with our results strongly suggested that spatial separation was essential to observe the CSPC and CSPC-like effects in the Stroop task. Moreover, the demonstration that the integrated and the primed Stroop task produced different reaction time distributions from the evidence accumulation literature, also supports our hypothesis. In conclusion, the prime-probe version of the Stroop task is not identical to the classic Stroop task, and observing the CSPC effect seems to be limited to the prime-probe Stroop task that creates uncertainty on the color dimension.

2.4.4. Limitations and Future Directions

Our hypotheses were supported for the most part. Nevertheless, we should be cautious while interpreting the results because of the certain limitations. The first limitation is that although the current study has a relatively large sample size, there is always the possibility of a Type II error. For this reason, caution must be taken while interpreting null results. The other limitation might be that the data from 6% of the participants were removed from the analyses due to their excessive number of scratch trials. In order to prevent this situation, experimenters may be trained better to instruct the participants to respond loudly and more clearly. Additionally, although a very close replication of Crump et al. (2006) Experiment 2A was conducted by using button responses in our laboratory (Atalay et al., in preparation), we did not conduct exact replication of Experiment 2A (Crump et al., 2006) for the current study because of the limited time and resources. A direct replication of this initial study with a larger sample size could give more straightforward information when combined with the current results. Furthermore, in the current study, the prime word was presented for 1000 ms, due to the nature of our task, however, extending the duration of the stimulus might have possibly changed the underlying cognitive processes even though a reliable Stroop effect was observed. For this reason, experiments with shorter prime durations could be more informative. Overall, future studies which have designs eliminating these limitations, should be conducted in order to obtain more precise results.

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APPENDICES

A: APPROVAL OF METU HUMAN SUBJECTS ETHICS COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

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15 ARALIK 2017

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Doç.Dr. Mine MISIRLISOY ve Yrd.Doç.Dr. Nart Bedin ATALAY ;

Danışmanlığını yaptığınız yüksek lisans öğrencisi Özge BOZKURT'un **"Is Spatial Uncertain Necessary fort he Context Specific Proportion Congruency Effect?"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2017-SOS-202** protokol numarası ile **15.12.2017-30.08.2019** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Ş. Halil TURAN
Başkan V

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Doç. Dr. Yaşar KONDAKÇI
Üye

Doç. Dr. Zana ÇITAK
Üye

Yrd. Doç. Dr. Pınar KAYGAN
Üye

Yrd. Doç. Dr. Emre SELÇUK
Üye

B: INFORMED CONSENT / GÖNÜLLÜ KATILIM FORMU

ARAŞTIRMAYA GÖNÜLLÜ KATILIM FORMU

Bu çalışma Doç. Dr. Mine Mısırlısoy ve Yrd. Doç. Dr. Nart Bedin Atalay danışmanlığında ODTÜ Psikoloji Bölümü Bilişsel Psikoloji alanı yüksek lisans öğrencisi Özge Bozkurt tarafından yüksek lisans tezi kapsamında yürütülmektedir. Bu form sizi araştırma koşulları hakkında bilgilendirmek için hazırlanmıştır.

Çalışmanın Amacı Nedir?

Çalışmanın amacı seçici dikkat süreçlerini Stroop testi aracılığı ile bağlam düzeyinde incelemektir.

Bize Nasıl Yardımcı Olmanızı İsteyeceğiz?

Çalışmaya katılmayı kabul ettiğinizde size bilgisayar ekranından çeşitli renk ve kelimeler gösterip bunlarla ilgili kararlar vermenizi isteyeceğiz ve çalışma yaklaşık 30 dakika sürecek.

Katılımınızla ilgili bilmeniz gerekenler:

Bu çalışmaya katılmak tamamen gönüllülük esasına dayalıdır. Herhangi bir yaptırıma veya cezaya maruz kalmadan çalışmaya katılmayı reddedebilir veya çalışmayı bırakabilirsiniz.

Araştırmaya katılanlardan toplanan veriler tamamen gizli tutulacak, veriler ve kimlik bilgileri herhangi bir şekilde eşleştirilmeyecektir. Katılımcıların isimleri bağımsız bir listede toplanacaktır. Bu araştırmanın sonuçları bilimsel ve profesyonel yayınlarda veya eğitim amaçlı kullanılabilir, fakat katılımcıların kimliği gizli tutulacaktır.

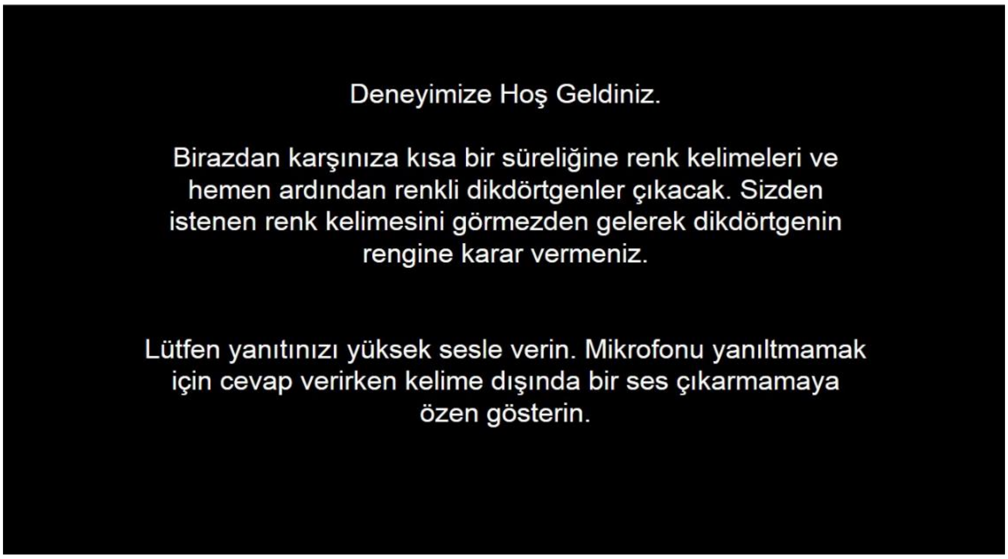
Araştırmayla ilgili daha fazla bilgi almak isterseniz:

Çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışmayla ilgili soru ve yorumlarınızı araştırmacıya ozgebozkurt1@gmail.com adresinden iletebilirsiniz.

Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum.
(Formu doldurup imzaladıktan sonra yürütücüye geri veriniz).

Katılımcı İsim Soyad	Tarih ---/----/-----	İmza
Yürütücü İsim Soyad	Tarih ---/----/-----	İmza

C: INSTRUCTION SCREEN-1 / YÖNERGE EKRANI-1



D: INSTRUCTION SCREEN-2 / YÖNERGE EKRANI-2

E: RECURSIVE OUTLIER ELIMINATION AND ANALYSIS SCRIPT-R STUDIO CODE

```
# Recursive outlier elimination function was coded by Nart Bedin
# Atalay. The script was adapted, and analyses were conducted by Ozge
# Bozkurt for the current study.

#Load some necessary (and unnecessary) libraries
library(lme4)
library(Hmisc)
library(psych)
library(coda)
library(reshape)
library(gplots)
library(lattice)

#
# The Recursive Outlier Elimination function based on
# Van Selst, M., & Jolicoeur, P. (1994). A solution to the effect of
sample size on outlier elimination. The Quarterly Journal of
Experimental Psychology Section A, 47(3), 631-650
# pseudocode:
# 1 exclude the highest
# 2 compute the mean and std
# 3 include the highest
# 4 calculate the cutoff based on sample size GetSdCriterion
# 5 compare the highest and lowest with the cutoff
# 6 remove if they lie beyond
# 7 repeat 1-5 until no outlier is removed or repeat until the set
size, including the highest, is below four
#
RecursiveOutlierElimination = function(RTs){

  noMoreMax = 0
  noMoreMin = 0

  while(noMoreMax < 1 | noMoreMin < 1){
    highest = max(RTs, na.rm = TRUE)
    lowest = min(RTs, na.rm = TRUE)

    tempmean = mean(RTs[RTs<highest], na.rm = TRUE)
    tempsd = sd(RTs[RTs<highest], na.rm = TRUE)
    tempsamplesize = length(which(!is.na(RTs[RTs<highest])))


    if(tempsamplesize < 3)
```

```
    {break}

    sdcriterion = GetSdCriterion(tempsamplesize)

    if(highest > (tempmean + (tempsd*sdcriterion)))
    {
      noMoreMax = 0
      RTs[RTs==highest] = NA
      print(highest)
    }
    else{
      noMoreMax = 1
    }

    if(lowest < (tempmean - (tempsd*sdcriterion)))
    {
      noMoreMin = 0
      RTs[RTs==lowest] = NA
      print(lowest)
    }
    else{
      noMoreMin = 1
    }
  }
  RTs
}
GetSdCriterion = function(samplesize){
  SdCriterionValues = c(8, 8, 8, 8, 6.2, 5.3, 4.8, 4.475, 4.25, 4.11,
4, 3.92, 3.85, 3.8, 3.75, 3.728, 3.706, 3.684,
                        3.662, 3.64, 3.6134, 3.6088, 3.6042, 3.5996,
3.595, 3.586, 3.577, 3.568, 3.559, 3.55, 3.548,
                        3.546, 3.544, 3.542, 3.54, 3.538, 3.536,
3.534, 3.532, 3.53, 3.528, 3.526, 3.524, 3.522, 3.52,
                        3.518, 3.516, 3.514, 3.512, 3.51, 3.5098,
3.5096, 3.5094, 3.5092, 3.509, 3.5088, 3.5086, 3.5084,
                        3.5082, 3.508, 3.5078, 3.5076, 3.5074, 3.5072,
3.507, 3.5068, 3.5066, 3.5064, 3.5062, 3.506,
                        3.5058, 3.5056, 3.5054, 3.5052, 3.505, 3.5048,
3.5046, 3.5044, 3.5042, 3.504, 3.5038, 3.5036,
                        3.5034, 3.5032, 3.503, 3.5028, 3.5026, 3.5024,
3.5022, 3.502, 3.5018, 3.5016, 3.5014, 3.5012, 3.501,
                        3.5008, 3.5006, 3.5004, 3.5002)

  if(samplesize<100){
    SdCriterion = SdCriterionValues[samplesize]
  }
  else{
    SdCriterion = 3.5
  }

  SdCriterion
}
```

```
#read the raw data
UpDownCenteredFixCSPC = read.csv2(file.choose())

#extract the data to be used in data preperation and analysis.
#Get the subject number and convert to factor values
Subject = UpDownCenteredFixCSPC$Subject
Subject = factor(Subject)

##age
Age = UpDownCenteredFixCSPC$Age
Age = factor(Age)

#gender
Gender = UpDownCenteredFixCSPC$Sex
levels(Gender) = c(levels(Gender),"Female", "Male")
Gender[Gender=="Kadin"] = "Female"
Gender[Gender=="Erkek"] = "Male"
Gender =factor(Gender)


#Get the stage of the Experiment Session
#ExperimentSession = [Practice, Test]
ExperimentSession = UpDownCenteredFixCSPC$Running
levels(ExperimentSession) = c(levels(ExperimentSession),"Practice",
"Test")
ExperimentSession[ExperimentSession == "PracticeList"] = "Practice"
ExperimentSession[ExperimentSession == "ExperimentList"] = "Test"
ExperimentSession = factor(ExperimentSession)


#Get the Fixation Cross's position-between subject variable
#FixCondition = [updown, centered]
FixCondition = UpDownCenteredFixCSPC$FixationPosition
FixCondition = factor(FixCondition)

#Get the Fixation Cross's position
#FixLocation = [bottom, top, center]
FixLocation = UpDownCenteredFixCSPC$FixationLocation
FixLocation = factor(FixLocation)


#Experiment Names: CenteredFix_MC_Bottom, CenteredFix_MC_Top,
UpDownFix_MC_Bottom, UpDownFix_MC_Top
#Gets the Counter balancing condition from experiment names
#PCLocationCounterBalance =[MCTop, MCBottom]
PCLocationCounterBalance = UpDownCenteredFixCSPC$ExperimentName
levels(PCLocationCounterBalance) =
c(levels(PCLocationCounterBalance),"MCBottom", "MCTop")
PCLocationCounterBalance[PCLocationCounterBalance ==
"CenteredFix_MC_Bottom"] = "MCBottom"
```

```
PCLocationCounterBalance[PCLocationCounterBalance ==
"CenteredFix_MC_Top"] = "MCTop"
PCLocationCounterBalance[PCLocationCounterBalance ==
"UpDownFix_MC_Bottom"] = "MCBottom"
PCLocationCounterBalance[PCLocationCounterBalance ==
"UpDownFix_MC_Top"] = "MCTop"
PCLocationCounterBalance = factor(PCLocationCounterBalance)


#Get the  PC -within subject variable
#PC = [PC75, PC25]
PC = UpDownCenteredFixCSPC$PC
PC = factor(PC)


#Get the congruency
#ItemType = [congruent, incongruent]
ItemType = UpDownCenteredFixCSPC$ItemType
ItemType = factor(ItemType)

#Get the block number
BlockNo = UpDownCenteredFixCSPC$ExperimentListCycle
BlockNo = factor(BlockNo)

#Separate the Experiment into 2 half
#Halves = [FirstHalf, SecondHalf]
Halves = UpDownCenteredFixCSPC$ExperimentListCycle
levels(Halves) = c(levels(Halves),"FirstHalf", "SecondHalf")
Halves[Halves == "1"] = "FirstHalf"
Halves[Halves == "2"] = "FirstHalf"
Halves[Halves == "3"] = "SecondHalf"
Halves[Halves == "4"] = "SecondHalf"
Halves = factor(Halves)


#Get the trial number
#TrialNoinBlock = [1...384]
TrialNo = UpDownCenteredFixCSPC$ExperimentListSample

#Color of the trial
#Color = [Ayesil, Asari, Amavi, Akirmizi, Yyesil, Ysari, Ymavi,
Ykirmizi ]
Color = UpDownCenteredFixCSPC$Color
Color = factor(Color)

#Word of the trial
#Word = [Ayesil, Asari, Amavi, Akirmizi, Yyesil, Ysari, Ymavi,
Ykirmizi ]
Word = UpDownCenteredFixCSPC$Word
Word = factor(Word)

#The RT to the response given to the probe stimuli
```

```
#RT = 0 indicates no response RT > 0 indicates response
RT = UpDownCenteredFixCSPC$color1RT

#Get response code
#Experimenters coded each response after
#1 Correct Response, 2 Incorrect Response, 3 Scratch Response
ResponseCode = UpDownCenteredFixCSPC$Coding


#Code accuracy
#Scratch trials and no response trials are  NA
#Training trials are coded NA
ACC = ResponseCode
ACC[ACC == 2] = 0
ACC[ACC == 3] = NA
ACC[RT == 0] = NA
ACC[is.na(BlockNo)] = NA

#Gets if the Previous trial is incorrect
PACC = c(NA, ACC[1:length(ACC)-1])

#Converts the code of Accuracy (in which Correct = 1, Incorrect = 0),
to the code of Incorrect (in which Correct = 0, Incorrect = 1)
IncorrectR = (ACC - 1) * -1

#Removes the RT of incorrect and scratch trials, and if the previous
trial is incorrect or scracth
#Removes training trials
CorrectRT = RT
CorrectRT[ACC == 0] = NA
CorrectRT[PACC == 0] = NA
CorrectRT[is.na(ACC)] = NA
CorrectRT[is.na(PACC)] = NA
CorrectRT[is.na(BlockNo)] = NA

#Remove RTs smaller than 200 ms
CorrectRTClean = CorrectRT
CorrectRTClean[CorrectRTClean < 200] = NA

#Recursive Outlier elimination  for each participant for each
condition
Participants = unique(Subject)
for (index1 in Participants){


	MostlyCongruentCongruentSI = which(Subject == index1 & PC ==
"PC75" & ItemType == "Congruent")
	MostlyCongruentIncongruentSI = which(Subject == index1 & PC ==
"PC75" & ItemType == "Incongruent")
	MostlyIncongruentCongruentSI = which(Subject == index1 & PC ==
"PC25" & ItemType == "Congruent")
  MostlyIncongruentIncongruentSI = which(Subject == index1 & PC ==
"PC25" & ItemType == "Incongruent")
```

```
  CorrectRTClean[MostlyCongruentCongruentSI] =
RecursiveOutlierElimination(CorrectRTClean[MostlyCongruentCongruentSI]
)
  CorrectRTClean[MostlyCongruentIncongruentSI] =
RecursiveOutlierElimination(CorrectRTClean[MostlyCongruentIncongruentS
I])


       CorrectRTClean[MostlyIncongruentCongruentSI] =
RecursiveOutlierElimination(CorrectRTClean[MostlyIncongruentCongruentS
I])
       CorrectRTClean[MostlyIncongruentIncongruentSI] =
RecursiveOutlierElimination(CorrectRTClean[MostlyIncongruentIncongruen
tSI])

       }

#The proportion of trials excluded with recursive outlier elimination
#(sum(is.na(CorrectRTClean)) - sum(is.na(CorrectRT))) /
sum(!is.na(CorrectRT)) * 100

#Builds a new data.frame with the neede variables for data analysis

UpDownCenteredFixCSPCData = data.frame(Subject, Age, Gender, BlockNo,
Halves, TrialNo,
                                       PCLocationCounterBalance,
FixCondition, PC, ItemType,
                                       Color, Word,
                                       PACC, ACC, IncorrectR,
                                       RT, CorrectRT, CorrectRTClean)


#Calculates average RT for each subject for each condition for Context
Level PC
AverageRTContextLevel  =
describeBy(UpDownCenteredFixCSPCData$CorrectRTClean,
list(UpDownCenteredFixCSPCData$ItemType, UpDownCenteredFixCSPCData$PC,
UpDownCenteredFixCSPCData$Subject), mat=TRUE)
colnames(AverageRTContextLevel)[which(names(AverageRTContextLevel) ==
"group1")] <- "ItemType"
colnames(AverageRTContextLevel)[which(names(AverageRTContextLevel) ==
"group2")] <- "PC"
colnames(AverageRTContextLevel)[which(names(AverageRTContextLevel) ==
"group3")] <- "Subject"

#Calculates average RT for each subject for each condition and each
half for Context Level PC
AverageRTContextLevelFirstSecondHalves  =
describeBy(UpDownCenteredFixCSPCData$CorrectRTClean,
list(UpDownCenteredFixCSPCData$ItemType, UpDownCenteredFixCSPCData$PC,
```

```
UpDownCenteredFixCSPCData$Halves, UpDownCenteredFixCSPCData$Subject),
mat=TRUE)
colnames(AverageRTContextLevelFirstSecondHalves)[which(names(AverageRT
ContextLevelFirstSecondHalves) == "group1")] <- "ItemType"
colnames(AverageRTContextLevelFirstSecondHalves)[which(names(AverageRT
ContextLevelFirstSecondHalves) == "group2")] <- "PC"
colnames(AverageRTContextLevelFirstSecondHalves)[which(names(AverageRT
ContextLevelFirstSecondHalves) == "group3")] <- "Halves"
colnames(AverageRTContextLevelFirstSecondHalves)[which(names(AverageRT
ContextLevelFirstSecondHalves) == "group4")] <- "Subject"


#Calculates average proportion of error (PE) for each subject for each
condition for context Level PC
AveragePEContextLevel  =
describeBy(UpDownCenteredFixCSPCData$IncorrectR,
list(UpDownCenteredFixCSPCData$ItemType, UpDownCenteredFixCSPCData$PC,
UpDownCenteredFixCSPCData$Subject), mat=TRUE)
colnames(AveragePEContextLevel)[which(names(AveragePEContextLevel) ==
"group1")] <- "ItemType"
colnames(AveragePEContextLevel)[which(names(AveragePEContextLevel) ==
"group2")] <- "PC"
colnames(AveragePEContextLevel)[which(names(AveragePEContextLevel) ==
"group3")] <- "Subject"

#Calculates average PE for each subject for each condition and each
half for Context Level PC for first and second halves
AveragePEContextLevelFirstSecondHalves  =
describeBy(UpDownCenteredFixCSPCData$IncorrectR,
list(UpDownCenteredFixCSPCData$ItemType, UpDownCenteredFixCSPCData$PC,
UpDownCenteredFixCSPCData$Halves, UpDownCenteredFixCSPCData$Subject),
mat=TRUE)
colnames(AveragePEContextLevelFirstSecondHalves)[which(names(AveragePE
ContextLevelFirstSecondHalves) == "group1")] <- "ItemType"
colnames(AveragePEContextLevelFirstSecondHalves)[which(names(AveragePE
ContextLevelFirstSecondHalves) == "group2")] <- "PC"
colnames(AveragePEContextLevelFirstSecondHalves)[which(names(AveragePE
ContextLevelFirstSecondHalves) == "group3")] <- "Halves"
colnames(AveragePEContextLevelFirstSecondHalves)[which(names(AveragePE
ContextLevelFirstSecondHalves) == "group4")] <- "Subject"


#Calculates the grand proportion of error (PE) for each subject
GrandPE  = describeBy(UpDownCenteredFixCSPCData$IncorrectR,
list(UpDownCenteredFixCSPCData$Subject), mat=TRUE)
colnames(GrandPE)[which(names(GrandPE) == "group1")] <- "Subject"


#Add the between subject varible FixPosition for AverageRTContextLevel
& PE
AverageRTContextLevel$FixCondition = 0
AveragePEContextLevel$FixCondition = 0
```

```
#Add the counter balance varible for AverageRTContextLevel & PE
AverageRTContextLevel$PCLocationCounterBalance = 0
AveragePEContextLevel$PCLocationCounterBalance = 0

#Add the Fix Condition and counter balance varible for
AverageRTContextLevelFirstSecondHalves & PE
AverageRTContextLevelFirstSecondHalves$FixCondition = 0
AverageRTContextLevelFirstSecondHalves$PCLocationCounterBalance = 0

AveragePEContextLevelFirstSecondHalves$FixCondition = 0
AveragePEContextLevelFirstSecondHalves$PCLocationCounterBalance = 0

#Add the Age to the AverageRTContextLevel
AverageRTContextLevel$Age = 0

#Add the Gender to the AverageRTContextLevel
AverageRTContextLevel$Gender = 0


  for (index1 in unique(UpDownCenteredFixCSPCData$Subject)){
    SubjectIndex = which(UpDownCenteredFixCSPCData$Subject == index1)
    SubjectIndex1 = which(AverageRTContextLevel$Subject == index1)
    SubjectIndex2 = which(AveragePEContextLevel$Subject == index1)

    SubjectIndex3 =
which(AverageRTContextLevelFirstSecondHalves$Subject == index1)
    SubjectIndex4 =
which(AveragePEContextLevelFirstSecondHalves$Subject == index1)

    SubjectIndex5 = which(AverageRTContextLevel$Subject == index1)
    SubjectIndex6 = which(AverageRTContextLevel$Subject == index1)


  FixConditionBuffer =
UpDownCenteredFixCSPCData$FixCondition[SubjectIndex]
  PCLocationCounterBalanceBuffer =
UpDownCenteredFixCSPCData$PCLocationCounterBalance[SubjectIndex]
  AgeBuffer = UpDownCenteredFixCSPCData$Age[SubjectIndex]
  GenderBuffer = UpDownCenteredFixCSPCData$Gender[SubjectIndex]


  AverageRTContextLevel$FixCondition[SubjectIndex1] =
as.character(unique(FixConditionBuffer[!is.na(FixConditionBuffer)]))
  AveragePEContextLevel$FixCondition[SubjectIndex2] =
as.character(unique(FixConditionBuffer[!is.na(FixConditionBuffer)]))


  AverageRTContextLevel$PCLocationCounterBalance[SubjectIndex1] =
as.character(unique(PCLocationCounterBalanceBuffer[!is.na(PCLocationCo
unterBalanceBuffer)]))
```

```
  AveragePEContextLevel$PCLocationCounterBalance[SubjectIndex2] =
as.character(unique(PCLocationCounterBalanceBuffer[!is.na(PCLocationCo
unterBalanceBuffer)]))

  AverageRTContextLevelFirstSecondHalves$FixCondition[SubjectIndex3] =
as.character(unique(FixConditionBuffer[!is.na(FixConditionBuffer)]))
  AveragePEContextLevelFirstSecondHalves$FixCondition[SubjectIndex4] =
as.character(unique(FixConditionBuffer[!is.na(FixConditionBuffer)]))


AverageRTContextLevelFirstSecondHalves$PCLocationCounterBalance[Subjec
tIndex3] =
as.character(unique(PCLocationCounterBalanceBuffer[!is.na(PCLocationCo
unterBalanceBuffer)]))

AveragePEContextLevelFirstSecondHalves$PCLocationCounterBalance[Subjec
tIndex4] =
as.character(unique(PCLocationCounterBalanceBuffer[!is.na(PCLocationCo
unterBalanceBuffer)]))

  AverageRTContextLevel$Age[SubjectIndex5] =
as.character(unique(AgeBuffer[!is.na(AgeBuffer)]))
  AverageRTContextLevel$Gender[SubjectIndex6] =
as.character(unique(GenderBuffer[!is.na(GenderBuffer)]))

  }




write.csv2(AverageRTContextLevel, "UpDownCenteredFixCSPC_RT.csv")
write.csv2(AveragePEContextLevel, "UpDownCenteredFixCSPC_PE.csv")
write.csv2(GrandPE, "UpDownCenteredFixCSPC_GrandPE.csv")


write.csv2(AverageRTContextLevelFirstSecondHalves,
"UpDownCenteredFixCSPCFirstSecondHalves_RT.csv")
write.csv2(AveragePEContextLevelFirstSecondHalves,
"UpDownCenteredFixCSPCFirstSecondHalves_PE.csv")



###########

#ANALYSES


#Removing the replaced participants from the data
cleanRTdata= subset(AverageRTContextLevel, !(Subject %in% c(
"1015","1066","1104", "1112", "1121", "1123", "1130", "1135", "1140",
"1055", "1057","1059", "1075", "1086")))
```

```
cleanPEdata= subset(AveragePEContextLevel, !(Subject %in% c(
"1015","1066","1104", "1112", "1121", "1123", "1130", "1135", "1140",
"1055", "1057","1059", "1075", "1086")))


#after removing participants, checking row number. (128 participants *
4 = 512)
nrow(cleanRTdata)
nrow(cleanPEdata)

#design: FixCondition(between) X PC(within) X ItemType(within)
#aov(DV~IVB*IVW1*IVW2 + Error(Subjects/(IVW1*IVW2), dataframe)
#2 within IV and 1 between IV

#RT analysis
RTanalysis128= aov(mean~FixCondition*ItemType*PC +
Error(Subject/(ItemType*PC)), cleanRTdata)
summary(RTanalysis128)
#same result with jasp

#RT mean table
model.tables(RTanalysis128, "means")

#PE analysis (caution: these are proportion of errors, not percentage
of errors!)
PEanalysis128= aov(mean~FixCondition*ItemType*PC +
Error(Subject/(ItemType*PC)), cleanPEdata)
summary(PEanalysis128)
#same result with jasp

#PE mean table: caution !JASP analysis was conducted with the
percentage of errors so the means are different
model.tables(PEanalysis128, "means")


#distrubution of the RT data
hist(cleanRTdata$mean)


# In order to analyze the levels of FixCondition separtely data were
splitted to subsets: centered & updown


#creating "centered" condition with 64 participants
centeredRTdata = cleanRTdata[cleanRTdata$FixCondition == "centered", ]
centeredPEdata = cleanPEdata[cleanPEdata$FixCondition == "centered", ]
nrow(centeredRTdata)
nrow(centeredPEdata)


#aov(DV ~ IV1 * IV2 + Error(Subjects/IV1 * IV2), dataframe)
```

```
#Centered condition RT analysis (design:  PC x ItemType)
RTCenteredFixAnalysis64 = aov(mean ~ ItemType*PC +
Error(Subject/ItemType * PC), centeredRTdata)
summary(RTCenteredFixAnalysis64)
model.tables(RTCenteredFixAnalysis64, "means")
#same result with jasp


#Centered condition PE analysis (design:  PC x ItemType)
PECenteredFixAnalysis64 = aov(mean ~ ItemType*PC +
Error(Subject/ItemType * PC), centeredPEdata)
summary(PECenteredFixAnalysis64)
model.tables(PECenteredFixAnalysis64, "means")
#same result with jasp: caution! JASP analysis was conducted with the
percentage of errors do the means are different



#creating "updown" condition with 64 participants
updownRTdata = cleanRTdata[cleanRTdata$FixCondition == "updown", ]
updownPEdata = cleanPEdata[cleanPEdata$FixCondition == "updown", ]
nrow(updownRTdata)
nrow(updownPEdata)

#aov(DV ~ IV1 * IV2 + Error(Subjects/IV1 * IV2), dataframe)

#updown condition RT analysis (design: PC x item type)
RTUpdownFixAnalysis64 = aov(mean ~ ItemType*PC +
Error(Subject/ItemType * PC), updownRTdata)
summary(RTUpdownFixAnalysis64)
model.tables(RTUpdownFixAnalysis64, "means")
#same result with jasp


#updown condition PE analysis (design: PC x item type)
PEUpdownFixAnalysis64 = aov(mean ~ ItemType*PC +
Error(Subject/ItemType * PC), updownPEdata)
summary(PEUpdownFixAnalysis64)
model.tables(PEUpdownFixAnalysis64, "means")
#same result with jasp: caution! JASP analysis was conducted with the
percentage of errors do the means are different




###### COUNTERBALANCE CONDITION ANALYSİS #######

#four-way anova- for counterbalance condition
#aov(y~(W1*W2*B1*B2)+Error(Subject/(W1*W2))+(B1*B2),
data=mydataframe); https://www.statmethods.net/stats/anova.html
#RT
```

```
counterbalanceRTanalysis128 =
aov(mean~PCLocationCounterBalance*FixCondition*PC*ItemType +
Error(Subject/(PC*ItemType))+(PCLocationCounterBalance*FixCondition),
cleanRTdata )
summary(counterbalanceRTanalysis128)

#PE
counterbalancePEanalysis128 =
aov(mean~PCLocationCounterBalance*FixCondition*PC*ItemType +
Error(Subject/(PC*ItemType))+(PCLocationCounterBalance*FixCondition),
cleanPEdata )
summary(counterbalancePEanalysis128)
## same result with jasp



###### BLOCK ANALYSIS #####



#removing the replaced participants from the
AverageRTContextLevelFirstSecondHalves data
cleanRTdataHalves= subset(AverageRTContextLevelFirstSecondHalves,
!(Subject %in% c( "1015","1066","1104", "1112", "1121", "1123",
"1130", "1135", "1140", "1055", "1057","1059", "1075", "1086")))
cleanPEdataHalves= subset(AveragePEContextLevelFirstSecondHalves,
!(Subject %in% c( "1015","1066","1104", "1112", "1121", "1123",
"1130", "1135", "1140", "1055", "1057","1059", "1075", "1086")))


#separating the centered condition
centeredRTHalvesData =
cleanRTdataHalves[cleanRTdataHalves$FixCondition == "centered", ]
centeredPEHalvesData =
cleanPEdataHalves[cleanPEdataHalves$FixCondition == "centered", ]

#separating the first and second block for centered condition
centeredRTFirstHalf = centeredRTHalvesData[centeredRTHalvesData$Halves
== "FirstHalf", ]
centeredRTSecondHalf =
centeredRTHalvesData[centeredRTHalvesData$Halves == "SecondHalf", ]

#RT Centered condition first half analysis.
centeredRTFirstHalfAnalysis = aov(mean ~ ItemType * PC +
Error(Subject/ItemType * PC ), centeredRTFirstHalf)
summary(centeredRTFirstHalfAnalysis)
#same result with jasp

#RT Centered condition second half analysis.
centeredRTSecondHalfAnalysis = aov(mean ~ ItemType * PC +
Error(Subject/ItemType * PC ), centeredRTSecondHalf)
summary(centeredRTSecondHalfAnalysis)
#same result with jasp
```

```
#separating updown condition
updownRTHalvesData = cleanRTdataHalves[cleanRTdataHalves$FixCondition
== "updown", ]
updownPEHalvesData = cleanPEdataHalves[cleanPEdataHalves$FixCondition
== "updown", ]

#separating first and second block  for updown condition
updownRTFirstHalf= updownRTHalvesData[updownRTHalvesData$Halves ==
"FirstHalf", ]
updownRTSecondHalf= updownRTHalvesData[updownRTHalvesData$Halves ==
"SecondHalf", ]


#RT updown condition first half analysis.
updownRTFirstHalfAnalysis = aov(mean ~ ItemType * PC +
Error(Subject/ItemType * PC ), updownRTFirstHalf)
summary(updownRTFirstHalfAnalysis)
#same result with jasp

#updown condition second half analysis.
updownRTSecondHalfAnalysis = aov(mean ~ ItemType * PC +
Error(Subject/ItemType * PC ), updownRTSecondHalf)
summary(updownRTSecondHalfAnalysis)
#same result with jasp


## end ##
```

F: TURKISH SUMMARY/ TÜRKÇE ÖZET

1. Giriş

Bilişsel kontrol, dikkati amaca yönelik bir davranış üzerinde sınırlandırma becerisi olarak tanımlanır (Amer, Campbell ve Hasher, 2016). Rutin bir davranışı bastırarak daha az rutin bir davranışı sergilemek istediğimizde bilişsel kontrole ihtiyaç duyarız (Matsumoto ve Tanaka, 2004). Bilişsel psikoloji alanyazında, bilişsel kontrol en çok Stroop ve Flanker görevi gibi seçici dikkat görevleri ile birlikte çalışılır (MacLeod, 1991). Bu tezde ana odak Stroop görevindedir.

Stroop görevi (Stroop, 1935), bilişsel kontrol ve seçici dikkat alanyazında en çok kullanılan araçlardan biridir (MacLeod, 2005). Standart bir Stroop görevinde, bir renk ve bir renk kelimesi katılımcılara sunulur ve katılımcılardan kelimeyi görmezden gelerek uyarıcının rengini sesli olarak söylemeleri istenir (MacLeod, 1991). Bu görevde genellikle üç tip uyarıcı bulunur: uyumlu, uyumsuz ve nötr. Renk kelimesi ve rengin aynı (mavi renkle yazılmış mavi kelimesi) olduğu uyarıcılar uyumlu uyarıcı olarak adlandırılır. Renk kelimesi ve renk birbirinden farklı (kırmızı renkle yazılmış mavi kelimesi) ise bu uyarıcıya uyumsuz uyarıcı denir. Son olarak ise renklerle ilgisiz kelimeler, kelime olmayan harf kümeleri ve harf olmayan işaret kümeleri renkli bir şekilde sunulduğunda (kırmızı renkle yazılmış %%%% işareti) bu uyarıcılara nötr uyarıcılar denir (MacLeod, 2005). Stroop görevindeki kritik nokta, uyumsuz bir uyarıcı sunulduğunda kelime ve renk arasında bir çatışma oluşmasıdır. Katılımcılar, uyumsuz bir uyarıcıya doğru tepki verebilmek için görece otomatik bir işlem olan kelime okumayı baskılamaya ihtiyaç duyarlar.

Bu baskılama işlemi de uyumsuz uyarıcılarda tepkiyi yavaşlatır ve daha fazla hata yapılmasına neden olur. Ancak uyumlu uyarıcılarda kelime ve renk birbiriyle aynı olduğu için tepkiler daha hızlı ve daha hatasızdır. Bu iki uyarıcı arasındaki tepki süresi farkına *Stroop etkisi* denir (Botvinick, Braver, Barch, Carter ve Cohen, 2001).

Stroop etkisi çeşitli değişimlemelerle artırılabilir veya azaltılabilir ve bu sayede bilişsel kontrolün altında yatan mekanizmaların anlaşılması kolaylaşır. Uyumlu uyarıcıların bir liste içindeki oranını değiştirmek en yaygın değişimlemelerden biridir. Bir liste içindeki uyarıcılardan çoğu uyumlu olduğunda Stroop etkisi büyür. Bir listedeki uyarıcılardan çoğu uyumsuz olduğunda ise Stroop etkisi küçülür (Logan ve Zbrodoff, 1979; Logan, Zbrodoff ve Williamson, 1984). Bu iki listedeki Stroop etkisi arasındaki farka ise *uyumluluk oranı etkisi* denir (Bugg ve Crump, 2012). Bu etki, Stroop görevindeki stratejik kontrol işlemlerinin bir işareti olarak kabul edilir.

Alanyazında, uyumluluk oranı etkisi üç farklı değişimleme ile çalışılmaktadır: liste düzeyi uyumluluk oranı (LDUO), uyarıcı düzeyi uyumluluk oranı (UDUO) ve bağlam düzeyi uyumluluk oranı (BDUO). LDUO'nun amaca yönelik ve global bir bilişsel kontrolün göstergesi olduğu öne sürülmektedir. Ancak UDUO ve BDUO'nun ise daha dinamik ve hızlı bir kontrolün göstergesi olduğu düşünülmektedir (Bugg ve Crump, 2012).

Uyumluluk oranı etkileri, tüm seviyelerde (LDUO, UDUO, BDUO) kuramsal tartışmalara konu olmaktadır. Ancak BDUO etkisinin tekrar edilebilirliği ile ilgili spesifik bir tartışma bulunmaktadır. Bazı araştırmacılar, bağlamın özellikle de uyarıcının konumunun uyumluluk oranını işaret edebileceğini öne sürerken (Crump, Gong ve Milliken, 2006; Crump ve Milliken, 2009, Crump, Vaquero ve Milliken, 2008), bazı araştırmacılar ise BDUO etkisini tekrar edememektedir (Atalay vd., hazırlık aşamasında; Crump, Brosowsky ve Milliken, 2016, Deney 2; Hutcheon ve Spieler, 2016). Bu çalışma da alanyazındaki uyuşmazlığı çözümlemek için bir dizi sistematik değişimleme ile BDUO etkisini incelemeyi amaçlamaktadır. Sonraki bölümlerde uyumluluk oranı etkilerinin her seviyesinden detaylı olarak bahsedilecek ve sonunda bu çalışmanın araştırma fikri sunulacaktır.

1.1 Liste Düzeyi Uyumluluk Oranı

Tarihsel olarak kullanılan ilk uyumluluk oranı değişimlemesi LDUO değişimlemesidir. LDUO çalışmalarında iki tip liste bulunur: çoğunlukla uyumlu ve çoğunlukla uyumsuz. Çoğunlukla uyumlu listelerde uyarıcıların %67-80'i uyumlu, geri kalanı uyumsuz olarak sunulur. Çoğunlukla uyumsuz listelerde ise uyarıcıların %67-80'i uyumsuz, geri kalanı ise uyumlu olarak sunulur (Bugg ve Crump, 2012). Çoğunlukla uyumlu listelerde gözlemlenen Stroop etkisi, çoğunlukla uyumsuz listelerde gözlemlenen Stroop etkisine kıyasla daha büyüktür. Bu iki Stroop etkisi arasındaki farka *LDUO etkisi* denir (Logan ve Zbrodoff, 1979; Logan, Zbrodoff ve Williamson, 1984).

LDUO konusundaki ilk çalışmalardan sonra pek çok çalışma LDUO ve LDUO benzeri etkileri çeşitli deney ve desenlerle tekrar etmiştir (Lindsay ve Jacoby, 1994; Tzelgov, Henik ve Berger, 1992). Ayrıca, bazı araştırmacılar LDUO etkisinin uyumluluk oranı bakımından nötr uyarıcılara da transfer edilebildiğini göstermişlerdir (Bugg, 2014; Bugg ve Chanani, 2011; Gonthier, Braver ve Bugg, 2016). Örneğin, Bugg (2014) %50 uyumluluk oranına sahip bir grup uyarıcıyı çoğunlukla uyumlu (%75 uyumlu) ve çoğunlukla uyumsuz (%75 uyumsuz) listelerin içine eklemiş ve %67 oranında uyumlu ve uyumsuz listeler elde etmiştir. Bu listeler farklı katılımcılara verilmiş ve tüm uyarıcılar liste içinde seçkisiz bir sırada sunulmuştur. Çalışmanın sonuçlarına göre LDUO etkisi nötr transfer uyarıcılarında da gözlemlenmiştir. Bir başka deyişle çoğunlukla uyumlu liste içinde sunulan uyumluluk oranı bakımından nötr (%50) uyarıcılarda gözlemlenen Stroop etkisi, çoğunlukla uyumsuz listedeki nötr uyarıcılarda gözlemlenen Stroop etkisine kıyasla daha büyüktür. Bu da bize katılımcıların liste içindeki tüm uyarıcılara aynı bilişsel kontrol stratejisini uyguladığını ve dikkatlerini global bir şekilde yönlendirebildiklerini göstermektedir (Bugg, 2014).

Yukarıda belirtilen çalışmalar dikkatin global bir şekilde yönlendirilebildiğini öne sürse de bazı çalışmalar LDUO etkisinin uyarıcı düzeyinde gerçekleşen kontrol mekanizmalarından ortaya çıkabileceğini göstermektedir (Blais ve Bunge, 2010; Bugg, Jacoby ve Toth, 2008). Buna ek olarak bazı araştırmacılar ise LDUO etkisinin zamansal öğrenme (temporal learning) süreçlerinden kaynaklandığını iddia etmektedir (Schmidt, 2017). Özetle, birçok çalışma LDUO etkisini göstermiş olsa da etkinin hangi mekanizmadan geldiğine dair tartışmalar devam etmektedir.

1.2 Uyarıcı Düzeyi Uyumluluk Oranı

UDUO etkisini ortaya ilk koyan klasik çalışma Jacoby, Lindsay ve Hessels’e (2003) aittir. İsminden anlaşılacağı gibi bu çalışmada uyumluluk oranı uyarıcı düzeyinde değişimlenmiştir. Çalışmada altı renk kullanılmış ve bu renkler iki kümeye ayrılmıştır: çoğunlukla uyumlu ve çoğunlukla uyumsuz. Çoğunlukla uyumlu kümede bulunan uyarıcılar %80 oranında uyumlu sunulurken çoğunlukla uyumsuz kümedeki uyarıcılar %80 oranında uyumsuz sunulmuştur. Bu çalışmadaki kritik nokta, bu iki kümenin bir arada ve seçkisiz bir sırada sunulmasıdır. Bu sayede çalışmadaki LDUO %50’de sabitlenmiş ve katılımcıların global kontrol stratejilerini kullanmasının önüne geçilmiştir. Çalışmanın sonuçları göstermiştir ki Stroop etkisi çoğunlukla uyumlu kümede çoğunlukla uyumsuz kümedeki etkiye kıyasla daha büyüktür. Bu iki küme arasındaki Stroop etkisi farkına *UDUO etkisi* denir.

Jacoby ve diğerlerinin çalışması (2003) kuramsal açıdan önem arz etmektedir. Bu çalışma sayesinde bilişsel kontrolün hızlı bir şekilde uyarıcı düzeyinde de işleyebildiği ve bu kontrol işleminin uyarıcının kendisinden tetiklendiği ortaya çıkarılmıştır. Bu çalışma, çoğunlukla uyumlu ve çoğunlukla uyumsuz uyarıcılar için farklı kontrol mekanizmalarının kullanılabileceğini ve katılımcıların bu mekanizmalar arasında hızlıca, neredeyse otomatik bir biçimde, geçiş yapabileceğini göstermiştir.

UDUO etkisinin kuramsal katkılarına rağmen bazı araştırmacılar bu etkinin tamamıyla uyarıcı-tepki öğrenmesi mekanizmasıyla açıklanabileceğini öne sürmüştür (Schmidt ve Besner, 2008). Bu alternatif açıklamaya göre Jacoby ve diğerlerinin (2003) kullandığı desende uyarıcı-tepki öğrenmesini tetikleyen karıştırıcı bir etki bulunmaktadır. Schmidt ve Besner'e göre Jacoby ve diğerlerinin (2003) deseni kelime ve doğru cevap arasında farklı derecelerde izlerlik oluşturmaktadır. Örneğin, çoğunlukla uyumlu kümedeki uyumlu uyarıcıların kelime boyutu doğru cevaplarla yüksek derecede izlerliğe sahiptir. Bu sebeple katılımcılar bu izlerlik bilgisini kullanarak doğru cevabı tahmin edebilirler. Çoğunlukla uyumlu kümedeki uyumsuz uyarıcıların kelime boyutu ise doğru cevapla yüksek izlerliğe sahip değildir. Benzer şekilde çoğunlukla uyumsuz kümedeki uyumsuz uyarıcılar doğru cevapla yüksek oranda izlerliğe sahiptir ve katılımcılar bu izlerliği doğru cevabı tahmin etmek için kullanabilirler. Bu karıştırıcı etkiyi ortadan kaldırmak için yüksek izlerliğe sahip uyarıcılar kendi arasında, düşük izlerliğe sahip uyarıcılar ise kendi arasında karşılaştırılmalıdır. Schmidt ve Besner, Jacoby ve diğerlerinin (2003) verisini kendi önerdikleri şekilde yeniden analiz ettiğinde izlerlik (yüksek ve düşük) ve uyarıcı türü (uyumlu ve uyumsuz) arasında bir etkileşim bulamamışlardır. Bu bulgu uyarıcı-tepki öğrenmesi hipotezini desteklemektedir. Ancak UDUO etkisi hakkında tartışma burada bitmemiştir ve UDUO etkisinin belli koşullar altında bilişsel kontrol süreçlerinden de kaynaklanabildiğini öne süren bulgular da bulunmaktadır (Bugg ve Hutchison, 2013; Bugg, Jacoby ve Chanani, 2010).

Kısaca UDUO etkisi hakkındaki kuramsal tartışma hala devam etmektedir ve bazı çalışmalar uyarıcı-tepki öğrenmesi görüşünü desteklerken bazı çalışmalar ise her iki mekanizmanın da gerekli olduğunda kullanılabildiğini öne sürmektedir (Bugg ve Crump, 2012).

1.3. Bağlam Düzeyi Uyumluluk Oranı

Uyumluluk oranı alanyazında bağlam düzeyinde işleyen bilişsel kontrol süreçleri ilk defa Corballis ve Gratton (2003) tarafından bir diğer seçici dikkat görevi olan Flanker görevi ile gösterilmiştir. İlgili çalışmada, bilgisayar ekranının sol tarafında çıkan uyarıcılar çoğunlukla uyumlu iken (HHHHH), sağ tarafında çıkan uyarıcılar ise çoğunlukla uyumsuzdur (SSHSS). Çalışmanın sonuçlarına göre çoğunlukla uyumlu bağlamda (sol) gözlemlenen Flanker etkisi, çoğunlukla uyumsuz bağlamda (sağ) gözlemlenen Flanker etkisine kıyasla daha büyüktür. Bu sonuç da bize bilişsel kontrol süreçlerinin farklı bağlamlar için farklı şekillerde, hızlı ve dinamik bir biçimde kullanılabileceğini gösterir.

1.3.1. BDUO Etkisi ve Stroop Görevi

Crump ve diğerleri 2006 yılında, Gratton ve Corballis' in (2003) bulgularını uzamsal olarak ayrık (UOA) hazırlayıcı (prime-probe) Stroop görevi kullanarak tekrar etmişlerdir. Bu özel Stroop görevinde uyarıcının renk ve kelime boyutu hem uzamsal hem de zamansal olarak ayrıktır. Kelime boyutu ekranın ortasında 100 milisaniyeliğine sunulur. Renk boyutu ise ekranın alt veya üst yarısında sabit bir konumda sunulur ve tepki kaydedilene kadar ekranda kalır. Gratton ve Corballis'in (2003) çalışmasından farklı olarak Crump ve diğerlerinin (2006) ilk deneyinde bağlam olarak hem şekil hem de uyarıcının konumu kullanılmıştır. Örneğin çoğunlukla uyumlu (%75 uyumlu) kümeye atanan uyarıcılar ekranın hep üst yarısında ortaya çıkmakta ve renk boyutu hep kare biçiminde sunulmaktadır. Buna karşın çoğunlukla uyumsuz (%75 uyumsuz) kümeye atanan uyarıcılar ise ekranın hep alt yarısında ortaya çıkmakta ve renk boyutu hep daire biçiminde sunulmaktadır. Her iki uyarıcı kümesi de aynı deney oturumunda seçkisiz bir sırada sunulmaktadır. Bu sayede LDUO oranı %50'ye sabitlenmiş ve katılımcıların global kontrol stratejilerine yönelmesinin önüne geçilmiştir. Çalışmanın sonuçlarına göre, çoğunlukla uyumlu bağlamda gözlemlenen Stroop etkisi, çoğunlukla uyumsuz bağlamda gözlemlenen Stroop etkisine kıyasla daha büyüktür. Bu iki Stroop etkisi arasındaki farka *BDUO etkisi* denir ve uyumluluk oranı ve uyarıcı çeşidi arasındaki anlamlı etkileşim sayesinde ortaya çıkar. Daha önce belirtildiği gibi bu deneyde şekil ve konum bağlamları bütünleşiktir. Bu nedenle BDUO etkisinin nereden geldiğini anlamak için Crump ve diğerleri (2006) şekil ve konum bağlamını birbirinden ayırarak, iki ayrı deney yapmışlardır. Bu deneyenlerin ilkinde sadece uyarıcının konumu, ikincisinde ise uyarıcının şekli bağlam olarak kullanılmıştır. Sonuçlara göre, konum değişimlemesinin kullanıldığı deneyde BDUO etkisi gözlemlenirken, şekil değişimlemesinin kullanıldığı deneyde BDUO etkisi gözlemlenmemiştir. Bu sonuç da şekil ve konum değişimlemesinin aynı anda kullanıldığı ilk deneyde gözlemlenen BDUO etkisinin, şekil değil konum değişimlemesinden geldiğini göstermektedir.

1.3.2. Uyarıcı-Tepki Öğrenmesi ve BDUO Etkisi

Bazı araştırmacılar BDUO etkisini uyumluluk oranı bakımından nötr uyarıcılarda da gözlemlemiş ve BDUO etkisinin öğrenme mekanizmalarından gelmediğini öne sürmüşlerdir (Crump ve Milliken, 2009). Buna karşın Schmidt, Lemercier ve De Houver (2018), BDUO etkisinin öğrenme mekanizmaları ile ilgili olduğunu ve katılımcıların, kelime + bağlam + doğru tepki arasındaki izlerliği kullanarak doğru tepkiyi tahmin edebileceğini öne sürmüşlerdir. Bu sayede, yüksek izlerliğe sahip uyarıcıların, uyumluluk oranından bağımsız olarak hızlı cevaplandığını iddia etmişlerdir. Özetle, BDUO etkisi için hem öğrenme hem de kontrol mekanizmalarını destekleyen çalışmalar bulunmaktadır.

1.3.3. BDUO Etkisi ve Flanker Görevi

BDUO Etkisi Stroop görevinin yanı sıra Flanker ve Flanker benzeri görevlerle çeşitli bağlamlar kullanılarak tekrar edilmiştir. Örneğin, Wendt, Kluwe ve Vietze (2008) aynı görüş alanı içindeki farklı bölgeler için Flanker görevi kullanarak BDUO etkisi gözlemlemiştir. Vietze ve Wendt (2009) ise bağlam olarak renk kullanmış ve hem klasik harfli hem de sayısal Flanker görevi kullanarak BDUO etkisi gözlemlemiştir. Bunun yanı sıra, Wendt ve Kiesel (2011) bağlam olarak zamansal ipucu (temporal cue) kullanmış ve BDUO etkisi gözlemiştir. Ek olarak King, Korb ve Egner (2012), insan yüzlerinin ve bu yüzlerinin bakış açısının bulunduğu bir Flanker görevi kullanmış ve uyarıcının konumunu uyumluluk oranının belirleyicisi olarak atamış ve anlamlı bir BDUO etkisi gözlemlemiştir. Bugg ve Weidler (2015) ise BDUO etkisinin yakın konuma da transfer edilebileceğini Flanker görevi ile ortaya çıkarmıştır (ayrıca bakınız: Weidler, Dey ve Bugg, 2018). Genel olarak, bu çalışmalar BDUO etkisinin Flanker görevi ile çeşitli desenler ve bağlamlar kullanılmasına rağmen kolayca gözlemlenebildiğini göstermiştir.

1.3.4. Alanyazındaki BDUO Etkisine İlişkin Tutarsız Bulgular

BDUO etkisi Flanker ve benzeri görevlerle birçok defa tekrar edilmiş olsa da bu etkinin Stroop görevi ile tekrar edilebilirliği tartışmalıdır. Ek olarak, Flanker görevinin aksine, King ve diğerleri (2012) hariç, BDUO etkisini Stroop görevi ile gösteren tüm çalışmalarda, klasik olan bütünleşik Stroop görevi yerine UOA hazırlayıcı Stroop görevi kullanılmıştır (Crump vd., 2006; Crump vd., 2008; Crump ve Milliken, 2009; Crump vd., 2016). UOA hazırlayıcı Stroop görevinden başka bir Stroop görevi kullanan araştırmacılar BDUO etkisini gözlemleyememiştir. Örneğin Atalay ve diğerleri (hazırlık aşamasında) uzamsal olarak bütünleşik Stroop görevi ve kelime ve rengin farklı zamanlarda sunulması (SOA) değişimlemesi kullanarak bir BDUO çalışması yapmışlardır. Ancak Crump ve diğerleri (2006, 2008) ile aynı uyarıcı kümesini kullanmalarına rağmen bağlam uyarıcılarında BDUO etkisi gözlemleyememişlerdir. Bu ilginç sonuçtan sonra, Atalay ve diğerleri UOA hazırlayıcı Stroop görevi kullanarak Crump ve diğerlerinin (2006) çalışmasına çok yakın bir tekrar çalışması yapmışlar ve anlamlı bir BDUO etkisi bulmuşlardır. Bu sonuç, BDUO etkisinin UOA hazırlayıcı Stroop görevi ile ilgili olabileceğini düşündürmektedir. Bunu destekler biçimde Crump ve diğerleri (2008), bütünleşik Stroop görevi kullandıkları pilot bir çalışmada BDUO etkisi bulamadıklarını dipnot olarak belirtmişlerdir.

Alanyazındaki bu tutarsızlıkların çeşitli nedenleri olabilir. Bu nedenlerden en makul olanı BDUO etkisinin LDUO ve UDUO etkileri kadar güçlü olmadığıdır. Önceki çalışmalarda gösterildiği üzere, BDUO etkisi deneysel işlemde yapılan küçük değişikliklerle dahi ortadan kalkmaktadır ve bu da BDUO etkisinin zayıf bir etki olduğu fikrini desteklemektedir. Bu nedenle UOA hazırlayıcı Stroop görevi kullanarak anlamlı BDUO etkisi bulan çalışmalardaki deneysel yöntemin incelenmesi gerekmektedir. Crump ve diğerlerinin (2006) çalışmasında ilk önce bir odaklanma işareti ardından da boş bir ekran çıkmaktadır. Ardından bir renk kelimesi ekranın ortasında 100 milisaniyeliğine sunulmakta ve bunu ekranın üst veya alt yarısında çıkan ve tepki kayıt edilene kadar ekranda kalan renkli bir dikdörtgen takip etmektedir. Bu işlem yolunu birebir uygulamayan çalışmalar BDUO etkisi bulamamışlardır. Ayrıca bazı çalışmalar bu işlem yolunu kullansalar dahi BDUO etkisi gözlemleyememişlerdir (Hutcheon ve Spieler, 2016; Crump vd., 2016, Deney 2). Bu sebeple deney işlemi ile alakalı süreçlerin BDUO etkisine katkı sağladığı ihtimali göz önünde bulundurulmalıdır. UOA hazırlayıcı Stroop görevinde kelime ekranın ortasında sunulmakta ve katılımcıların renk için ekranın üst veya alt kısmına bakması gerekmektedir. Bu da ekstra süre gerektirmektedir. Bu iddiayı destekler biçimde, Crump ve diğerlerinin (2006) çalışmasında şekil deneyinde tepki süreleri daha kısayken, konum deneyinde tepki süreleri daha uzundur. Buna ek olarak, bu işlem yolunda katılımcılar kelime boyutunun konumu her zaman bilmelerine rağmen renk boyutunun konumu uyarıcı çıkana kadar belirsizdir. Uyarıcının ilgili boyutu (renk) üzerinde bulunan belirsizliğin Stroop etkisini büyütebileceğine dair iddialar bulunmaktadır (MacLeod, 1991). Buna paralel olarak, uyarıcının bir boyutu üzerinde bulunan belirsizlik ve şaşırtıcılığın katılımcıların o boyuttan gelen bilgiyi kullanmasını kolaylaştırdığı iddia edilmektedir (Melara ve Algom, 2003). Bu sebeplerle, UOA hazırlayıcı Stroop görevinde renk boyutu üzerinde bulunan belirsizlik katılımcıların bağlam bilgisini işlemesini kolaylaştırmış ve BDUO etkisinin sadece bu göreve özgü olarak ortaya çıkmasına neden olmuş olabilir.

2. Araştırmanın Amacı ve Hipotezler

Yukarıda verilen bilgiler ve BDUO çalışmalarında bulunan muhtemel karıştırıcı etkiler göz önüne alındığında, bu çalışma, uzamsal belirsizliğin

BDUO etkisi üzerindeki rolünü incelemeyi amaçlamaktadır. Bu sebeple uzamsal belirsizliği değiştirme amacı ile kritik bir değişimleme eklenerek klasik bir BDUO deneyi yapılmıştır. Kullanılan değişimlemenin ilk koşulunda kelime boyutu, renk boyutu ile aynı yerde sunularak renk üzerindeki uzamsal belirsizlik ortadan kaldırılmıştır. Böylelikle katılımcı kelimeyi gördüğünde, rengin konumunu da bilebilmektedir ve bu koşul merkezi odaklanma işareti koşulu olarak adlandırılmıştır. Ancak bu değişimleme kelime boyutunun belirsiz olmasına neden olmuştur. Bu sebeple, ikinci bir koşula ihtiyaç duyulmuştur. İkinci koşulda odaklanma işareti, kelime ve renk ile aynı yerde sunulmuş böylece hem kelime hem de renk üzerindeki belirsizlik ortadan kaldırılmıştır. Katılımcı odaklanma işaretini gördükten sonra hem kelime hem de rengin yerini bilebilmektedir ve bu koşul üst/alt odaklanma işareti koşulu olarak adlandırılmıştır. İki koşul arasındaki tek fark odaklanma işaretinin konumudur. Bu sebeple bu değişkene odaklanma işareti koşulu denmiştir. Odaklanma işareti koşulunun her iki seviyesinde de olası bir karıştırıcı etki ortadan kaldırıldığı için BDUO etkisinin gözlemlenmemesi beklenmektedir.

2.1.Yöntem

2.1.1. Katılımcılar

Çalışamaya davet edilecek kişi sayısı güç analizi ile belirlenmiştir. Bu çalışmada kullanılan deney deseni ile orta büyüklükteki bir etkiyi (f = .25) gözlemlemek için 128 kişiye ihtiyaç vardır (G*Power 3.1, Faul, Erdfelder ve Buncher, 2014). Çalışmaya toplam 143 üniversite öğrencisi davet edilmiş ancak çeşitli nedenlerle bazı katılımcıların verisi kullanılamamış ve analizler 128 kişi ile yapılmıştır (100 kadın, $Ort_{yaş}$ = 21,04)

2.1.2. Uyarıcılar ve Desen

Deneyin işlem yolu üniversitenin etik komitesi tarafından onaylanmıştır. Deneyde UOA hazırlayıcı Stroop görevi kullanılmıştır. Dört renk ve bu renklere karşılık gelen kelimeler kullanılmış (kırmızı, mavi, sarı, yeşil). Kelimeler beyaz renkle siyah arka plana yazılmıştır. Renkler ise bir dikdörtgenin içinde ekranın üst veya alt yarısında sabit bir noktada sunulmuştur.

Çalışmada, 2 (uyumluluk oranı: çoğunlukla uyumlu, çoğunlukla uyumsuz) x 2 (uyarıcı türü: uyumlu, uyumsuz) x 2 (odaklanma işareti koşulu: merkezi, üst/alt) karışık faktörlü deney deseni kullanılmıştır. Uyumluluk oranı ve uyarıcı türü denek içi, odaklanma işareti koşulu ise denekler arası değişkendir.

2.1.3. İşlem Yolu

Deneyler sessiz bir odada, yürütücü gözetiminde, bilgisayar üzerinden E-Prime 2.0 programı aracılığı ile yürütülmüştür. Deney başlatılmadan önce her katılımcıya gönüllü katılım formu imzalatılmış ve katılımcıların demografik bilgileri alınmıştır. Deney esnasında katılımcıların tepki süreleri ve tepkileri, seri tepki kutusu ve harici ses kartına bağlı bulunan birer adet mikrofon ile ayrı ayrı kaydedilmiştir. Katılımcılar ilk önce bir odaklanma ekranı (1000 milisaniye), ardından boş bir ekran (250 milisaniye) ve kelime (1000 milisaniye) ile karşılaşmışlardır. Kelimeden sonra renk boyutu belirmekte ve tepki kayıt edilene kadar ekranda kalmaktadır. Katılımcıların yarısı merkezi odaklanma işaretine, diğer yarısı ise üst/alt odaklanma işaretine seçkisiz olarak atanmıştır. Uyarıcı kümesi Crump ve diğerleri (2006) ile aynıdır ve toplam 384 adet uyarıcı bulunmaktadır. Bu uyarıcıların yarısı çoğunlukla uyumlu, diğer yarısı ise çoğunlukla uyumsuz bağlamda seçkisiz bir sırada sunulmuştur. Deney bittikten sonra bir laboratuvar asistanı kaydedilen tüm tepkileri tek tek dinleyerek doğru, yanlış veya geçersiz olarak kodlamıştır ve bu kodlamalar yazar tarafından kontrol edilmiştir.

2.2 Bulgular

Tepki süresi analizinden önce alıştırma denemeleri, geçersiz tepkiler, tepki verilmeyen denemeler, hatalı tepkiler ve 200 milisaniyeden kısa tepkiler veriden atılmış ve uç değerler özyineli uç değer eleme yöntemi (recursive outlier elimination) ile analizden çıkarılmıştır. Hata oranı için ise yalnızca geçersiz ve tepki verilmemiş denemeler analizden çıkarılmıştır. Her iki analiz için de koşulların ortalamaları hesaplanmış ve analizde kullanılmıştır.

Tepki süresi analizinin sonuçlarına göre deneydeki genel BDUO etkisi yani uyumluluk oranı ve uyarıcı türü arasındaki etkileşim anlamlı değildir, $F(1, 126) = 1.05$, $MSE = 220.83$, $p = .31$, $\eta_p^2 = .01$. Ancak uyumluluk oranı, uyarıcı türü ve odaklanma işareti arasındaki üçlü etkileşim anlamlıdır, $F(1, 126) = 6.12$, $MSE = 220.83$, $p = .01$, $\eta_p^2 = .05$. Bu etkileşimin kaynağını anlamak için merkezi odaklanma işareti ve üst/alt odaklanma işareti koşulları ayrı ayrı analiz edilmiştir. Sonuçlara göre BDUO etkisi merkezi odaklanma işareti koşulunda anlamlı değilken, $F(1, 63) = .1.75$, $MSE =132.59$, $p = .19$, $\eta_p^2 = .03$; üst/alt odaklanma işareti koşulunda anlamlıdır , $F(1, 63) = 4.37$, $MSE = 309.06$, $p = .04$, $\eta_p^2 = .06$.

Hata oranları oldukça düşüktür (%0,17) ve hata oranı analizinde yalnızca uyarıcı türü temel etkisi anlamlı bulunmuştur. Hiçbir etkileşim anlamlı değildir.

2.3. Tartışma

Bu çalışma BDUO etkisinin altında yatan mekanizmaları, uyarıcıların renk ve kelime boyutunun üzerindeki uzamsal belirsizliği sistematik bir şekilde ortadan kaldırarak incelemeyi amaçlamıştır. Bu amaçla iki farklı koşul tasarlanmış, merkezi odaklanma işareti koşulunda renk üzerindeki uzamsal belirsizlik, üst/alt odaklanma işareti koşulunda ise hem renk hem de kelime üzerindeki uzamsal belirsizlik ortadan kaldırılmıştır. Her iki koşulda BDUO etkisinin ortaya çıkmaması beklenmiştir. Merkezi odaklanma işareti koşulunda anlamlı bir BDUO etkisi bulunmazken, üst/alt odaklanma işareti koşulunda beklenmedik şekilde anlamlı ama kısmen zayıf bir BDUO etkisi gözlemlenmiştir. Bu sonuçlar, BDUO etkisinin UOA hazırlayıcı Stroop görevinin ürettiği uzamsal belirsizliğin BDUO etkisine katkı sağladığı hipotezini büyük oranda desteklemektedir. Üst/alt odaklanma işareti koşulunda anlamlı çıkan BDUO etkisi, katılımcılar bağlamla daha fazla vakit geçirdikleri için ortaya çıkmış olabilir. Ayrıca, BDUO etkisi, üst/alt odaklanma işareti koşulunda anlamlı olsa da bu etki diğer uyumluluk oranı etkilerine göre küçüktür ve yapılan Bayesyen analizde etkinin anlamlı olmadığı yönünde anekdotsal kanıt olduğu görülmüştür.

Genel olarak, bu çalışmanın sonuçları hipotezlerimizi büyük oranda desteklemektedir ve BDUO etkisinin altında yatan mekanizmaları anlamak için kuramsal bir öneme sahiptir. Ek olarak, sonraki bölümlerde uzamsal dikkat ve kanıt toplama alanyazınlarından benzer bulgular incelenmiş ve bu çalışmanın sonuçları ile birlikte yorumlanmıştır.

2.3.1. Boyutların Uzamsal Olarak Ayrılması

Dikkat alanyazınında Chajut, Schupak ve Algom (2009), uzamsal ve boyutsal (dimensional) dikkatin aynı mı yoksa farklı süreçlere mi karşılık geldiğini sorgulamışlardır. Uzamsal dikkat uyarıcının uzamsal özellikleriyle (konum vs.) ilgiliyken, boyutsal dikkat uyarıcıyı görevle ilgisiz ve ilgili boyutlara ayırmak ile ilgilidir. İddialarına göre, farklı seçici dikkat görevleri dikkatin farklı yönlerini ön plana çıkarır. Örneğin, Posner görevi (Posner, 1980) ve Flanker görevi uzamsal dikkati ön plana çıkarırken, Stroop görevi boyutsal dikkati ön plana çıkarır. Chajut ve diğerlerine (2009) göre Flanker görevinin doğası gereği, uyarıcının merkezinde sunulan görev ile ilgili boyut ve bu boyutun her iki yanında sunulan görev ile ilgisiz boyut uzamsal olarak ayrıştırılır. Bununla birlikte Stroop görevinde ise bu ayrım uzamsal olarak değil boyutsal olarak yapılır çünkü görev ile ilgili (renk) ve ilgisiz (kelime) boyut iç içedir. Chajut ve diğerleri (2009) bu fikirlerini test etmek amacı ile Posner görevi ile Flanker ve Stroop görevini birbiriyle bütünleştirilerek bir dizi deney yapmışlardır. Çalışmanın sonuçlarına göre, Flanker görevi ile uzamsal dikkat kolayca gözlemlenmişken, klasik Stroop görevi kullanıldığında uzamsal dikkat gözlemlenememiştir. Bunun yanı sıra, Chajut ve diğerleri (2009) Stroop görevinde boyutları uzamsal olarak birbirinden ayırdıklarında, bu görevde de uzamsal dikkat gözlemlendiğini rapor etmişlerdir.

Yukarıda bahsedilen bulgular BDUO alanyazını ile uyum içindedir. Bahsedildiği gibi bağlama bağlı bilişsel kontrol bir başka deyişle BDUO etkisi Flanker görevi ile kolayca gözlemlenirken, bütünleşik Stroop görevi ile gözlemlenememektedir. Ayrıca, BDUO etkisinin gözlemlendiği UOA hazırlayıcı Stroop görevi isminden anlaşılacağı üzere uzamsal olarak ayrıktır. Chajut ve diğerleri (2009) de Stroop görevinin boyutlarını uzamsal olarak ayırdıklarında uzamsal dikkat gözlemleyebilmişlerdir. Bu tez çalışması da boyutların uzamsal olarak ayrılmasının ortaya çıkardığı belirsizliği incelemiş ve bu durumun BDUO etkisinde önemli bir rolü olduğunu ortaya çıkarmıştır. Özetle, uzamsal dikkat alanyazını çalışmamızın sonuçlarını desteklemekte ve alternatif açıklamalar sunmaktadır.

2.3.2. Boyutların Zamansal Olarak Ayrılması

Uzamsal dikkat alanyazınının yanı sıra, cevap hakkında kanıt toplama (evidence accumulation) alanyazınından bazı bulgular, kelime boyutunu renk boyutundan önce sunmanın Stroop etkisinin altında yatan mekanizmaları değiştirdiğini göstermiştir. Kinoshita, de Wit, Aji ve Norris (2017), kelime boyutunun renk boyutundan önce sunulduğu hazırlayıcı (primed) Stroop görevinde, bütünleşik Stroop görevinden farkı bir tepki süresi dağılımı oluştuğunu gözlemlemiştir. Her iki görev için de Stroop etkisinin dağılımı ile oluşturulan delta grafiklerine (delta plot) bakıldığında, bütünleşik Stroop görevinde Stroop etkisi dağılımının pozitif eğimli (positively sloped) bir delta çizgisi oluşturduğu görülmektedir. Hazırlayıcı Stroop görevinde ise kısmen düz bir delta çizgisi oluştuğu gözlemlenmiştir. Bütünleşik Stroop görevinde gözlemlenen pozitif eğimli delta çizgisi çoğunlukla çatışma temellidir çünkü kelime ve renk boyutu aynı anda sunulmuştur ve bu yüzden cevap hakkında kanıt toplama işlemi her iki boyut için de aynı anda başlamıştır. Ancak hazırlayıcı Stroop görevinde kelime renkten önce sunulmuş ve kanıt toplama işlemi kelime için daha önce başlamıştır. Bu durum da kelime ve renk arasında oluşan çatışmayı azaltmış ve kısmen düz bir delta çizgisinin oluşmasına neden olmuştur. Ayrıca Kinoshita ve diğerleri (2017) bütünleşik Stroop görevinde gözlemlenen Stroop etkisinin çoğunlukla bozucu etki (interference: uyumsuz ve uyumlu uyarıcı arasındaki tepki süresi farkı) temelli olduğunu, hazırlayıcı Stroop görevinde gözlemlenen etkisinin ise kolaylaştırıcı etki (facilitation: nötr ve uyumlu uyarıcı arasındaki tepki süresi farkı) temelli olduğunu söylemişlerdir. Bir başka deyişle, hazırlayıcı Stroop görevinde gözlemlenen etki uyumlu uyarıcılarda gözlemlenen hızlı tepkilerden kaynaklanmaktadır ve bu da uyarıcı-tepki öğrenmesi tarafından açıklanabilir. Genel olarak, bu çalışma, hazırlayıcı ve bütünleşik Stroop görevlerinin arasında farklar olduğunu göstermiştir. Bu da

Stroop görevinde gözlemlenen BDUO etkisinin, güçlü bağlam düzeyi kontrol mekanizmaları yerine hazırlayıcı Stroop göreviyle ilgili olabileceği hipotezini desteklemektedir. Ayrıca kelimeyi önce sunmak uyumlu uyarıcılardaki tepkiyi hızlandırıyorsa, önceki çalışmalarda gözlemlenen BDUO etkisinin de uyarıcı-tepki öğrenmesi temelli olma ihtimali bulunmaktadır.

2.4. Genel Sonuç, Çalışmanın Limitleri ve Öneriler

Bu çalışma, uzamsal belirsizliğin BDUO etkisi üzerindeki rolünü incelemiştir. Çalışmanın sonuçlarına göre, renk üzerindeki uzamsal belirsizliğin ortadan kaldırılması BDUO etkisini de ortadan kaldırırken hem kelime hem de renk üzerinde uzamsal belirsizliğin ortadan kaldırılması zayıf bir BDUO etkisinin ortaya çıkmasına neden olmuştur. Buna ek olarak BDUO alanyazını ile birlikte düşünüldüğünde uzamsal dikkat çalışmaları da bu bulguları desteklemektedir ve uyarıcının boyutlarını uzamsal olarak ayırmanın BDUO etkisi veya uzamsal dikkat gözlemlemek için gerekli olduğu fikrini güçlendirmektedir. Ayrıca bütünleşik ve hazırlayıcı Stroop görevlerinin farklı tepki süresi dağılımları üretmesi de hipotezimizi desteklemektedir. Sonuç olarak, UOA hazırlayıcı Stroop görevi ve bütünleşik Stroop görevi tamamen aynı değildir. Buna ek olarak BDUO etkisi, renk boyutu üzerinde uzamsal belirsizlik yaratan UOA hazırlayıcı Stroop görevine özgü olarak ortaya çıkıyor olabilir.

Hipotezimiz büyük oranda desteklense de Tip II hata türünden kaçınmak için anlamlı çıkmayan sonuçlar değerlendirilirken dikkatli olunmalıdır. Ek olarak, Crump ve diğerlerinin (2006) orijinal çalışmasındaki sonuçların daha fazla katılımcı ile tekrar edilmesi bu çalışmanın sonuçları ile birleştirildiğinde daha net sonuçlar verebilir. Bu yüzden gelecekte yapılacak çalışmalarda ilgili çalışmanın bire bir tekrar edilmesi önem arz etmektedir. Son olarak, bu çalışmada, kullanılan görevin doğası gereği kelimenin gösterilme süresi 1000 milisaniyeye çıkarılmıştır. Güvenilir bir Stroop etkisi elde edilse dahi bu değişimin, görevi ne yönde değiştirdiği bilinmemektedir. Bu sebeple, bu çalışmadan elde edilen sonuçların kelime için daha kısa gösterilme süreleri kullanılarak tekrar edilmesi daha bilgi verici olabilir. Daha net sonuçlar almak için gelecekteki çalışmalarda bu öneriler göz önünde bulundurulmalıdır.

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<u>TEZİN ADI / </u><u>TITLE OF THE THESIS</u> (**İngilizce** / English): Is Spatial Uncertainty Necessary For The Context Specific Proportion Congruency Effect?

<u>TEZİN TÜRÜ</u> / <u>DEGREE</u>**:** **Yüksek Lisans** / Master [x] **Doktora** / PhD [ ]

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