INVESTIGATION OF THE ITEM-AND LIST-LEVEL PROPORTION CONGRUENCY EFFECTS ON COGNITIVE CONTROL

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ABSTRACT

INVESTIGATION OF THE ITEM-AND LIST-LEVEL PROPORTION CONGRUENCY EFFECTS ON COGNITIVE CONTROL

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Master of Science in Experimental Psychology

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The goal of this thesis is to investigate item and list level proportion congruency effect by increasing inter-trial interval than the normal proportion congruency effect experiment. The list-level proportion congruent (LLPC) and the item-level proportion congruent (ISPC) effects have been regarded as closely related. They are demonstrated by a larger Flanker interference in high proportion-congruent list (in the LLPC effect) or high proportion-congruent items (in the ISPC effect), compared to the low proportion-congruent list or items. In the present study, the time course of LLPC and ISPC effects was observed by using letter based on Eriksen Flanker task where stimulus onset asynchrony was manipulated by presenting the flanker letters first (-250 ms.), flanker target letter simultaneous (0 ms.), or the target letter first (+250 ms.). Critically, the inter-trial interval was increased to 3 seconds, far longer than a typical LLPC or ISPC experiment. It was hypothesized that; longer inter-trial intervals would increase the strength of S-R associations and it would affect the contingency learning and create different results as compared to standard LLPC and ISPC experiments. Results showed that, while the LLPC effect disappeared when the flanker was presented after the target, the ISPC effect did not. These results were the first to demonstrate a dissociation between LLPC and ISPC effects.

Keywords: Flanker, list-level proportion congruence, item-level proportion congruence, stimulus onset asynchrony.

ÖZET

MADDEYE ÖZGÜ UYUMLULUK ORANI VE LİSTE DÜZEYİ UYUMLULUK ORANI ETKİLERİNİN İNCELENMESİ

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Bu tezde liste düzeyi ve uyarıcı düzeyi uyumluluk oranı etkisi denemeler arası süre arttırılarak incelenmiştir. Liste düzeyi uyumluluk oranı etkisi ve uyarıcı düzeyi uyumluluk etkisi yakın olarak birbirleriyle ilişkilendirilmektedir. Flanker'ın karıştırıcı etkisi, çoğunlukla uyumlu listelerde veya çoğunlukla uyumlu uyarıcılarda, çoğunlukla uyumsuz listeler veya uyumsuz uyarıcılara nazaran daha büyük gözlemlenmektedir. Bu çalışmada, liste düzeyi uyumluluk oranı ve uyarıcı düzeyi uyumluluk oranı etkilerinin zamansal analizi Eriksen Flanker testin harf versiyonu kullanılarak incelenmiştir. Uyarıcılar, uyarıcı sunum eşzamanlılığı etkisinin uyarıcı tepki izlerliliği üzerindekini etkisini gözlemeyebilmek için, flanker harflerinin uyarıcıdan önce sunulduğu (-250 ms.), flanker ve görevin uyarıcı ile aynı anda sunulduğu (0 ms.) ve görevin uyarıcıdan önce sunulduğu (+250 ms.) koşulları kullanılarak manipüle edilmiştir. Çalışmadaki önemli noktalardan biri, denemeler arası süre 3 saniye olarak belirlenmiştir ve bu süre klasik uyumluluk oranı deneylerine nazaran daha uzun bir süredir. Denemeler arası sürenin arttırılmasının sonucunda, uyarıcı-tepki ilişkilendirilmesinin daha güçlü olması ve izlerliliğin arttırmasından dolayı tipik uyumluluk oranı etkileri sonucundan daha farklı bir sonuç elde edileceği beklenmiştir. Sonuç olarak, liste düzeyi uyumluluk oranı etkisi görevin uyarıcıdan önce geldiği (+250 ms.) koşulunda gözlemlenmezken, uyarıcı düzeyi uyumluluk oranı etkisinde böyle bir fark gözlemlenmemiştir ve bu sonuçlar liste ve uyarıcı düzeyi uyumluluk oranı etkilerinin birbirinden ayrıldığını gösteren ilk bulgudur.

Anahtar Kelimeler: Flanker Test, liste düzeyi uyumluluk oranı, uyarıcı düzeyi uyumluluk oranı, uyarıcı sunum eşzamanlılığı

I have dedicated to my family…

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

Introduction

In daily life, people are exposed to multiple stimuli and attentional control process works as a filtering system to select relevant information while inhibiting irrelevant stimuli (Cowan, 1997). This suggests that, attention plays a critical role in the selection of information and inhibition of irrelevant information in order to achieve goal directed behavior (Posner, 1985; Wühr, Frings, 2008). Selective attention provides the means to understand the nature of selection and the fate of unattended stimuli. According to ones of selective attention definition, attention can actively inhibit or suppress irrelevant information to achieve goal directed behavior. Selection works hand in hand with the process of inhibition. Thus, selective attention makes it easier to attend to relevant stimuli while other irrelevant stimuli are ignored. As mentioned above, humans tend to attend to goal-directed events while other distracting sources are ignored. These control processes and regulations are studied under the topic of cognitive control. Researchers defined the cognitive control system as an adaptive process which refers to the ability to flexibly regulating behavior that depend on specific goal-relevant information while ignoring irrelevant or distracting information (Botvinck et al., 2001; Miller & Cohen, 2001). Therefore, cognitive control is studied to shed light on cognitive processes such as working memory, response inhibition, response selection and response conflict (Blais & Bunge, 2010).

1.1. Dual Mechanisms of Cognitive Control

People get much information from the environment, and they generate multiple response alternatives, which can cause a conflict situation. In order to select an action, higher attentional control processes are required.

For Botvinck and colleagues (2001), response selection in the conflict situation might be learned actively, or for Egner (2008), it might be an automatic process. According to these two views, cognitive control process is divided into two parts: proactive and reactive control mechanisms (Braver et al., 2007; 2009; Braver, 2012) This is also known as the dual mechanisms of cognitive control.

Proactive control mechanism is a form of early selection mechanism that allows preparation of response selection before the stimulus arrives. This control mechanism is strategic and based on learning of the contextual information. Proactive control works in a goal driven manner before the occurrence of events, so the individual has to develop the expectation for upcoming conflict stimulus due to interaction with context before. In other words, individual has to be able to predict events before they occur (Braver et al., 2007; Miller & Cohen, 2011). In contrast, reactive control mechanism works as a late selection process which developed more local base. Response selection and detection of the stimulus occurs after the participants encounter events. According to Jacoby et al. (1999), reactive control mechanism occurs after the presentation of stimuli, so individuals cannot predict the response before the events occur. Therefore, reactive adjustment occurs trial by trial due to absence of anticipation or detection for upcoming events.

Generally, all of these cognitive control processes are studied in laboratory to explain, "how humans adapt their attention and behavior to different environmental conditions." Tipper (1985) proposed negative priming method to define inhibitory process of irrelevant stimuli to contrast facilitation effect of relevant stimuli. Stroop test, Eriksen Flanker test and Simon test are mainly used to define cognitive control and attentional control process by using negative priming effect method, which will be explained in the next section.

1.2. Cognitive Control Test Paradigms

As mentioned above, the Stroop paradigm is the most commonly used paradigm to study cognitive control and selective attention in cognitive control (Stroop, 1935; *for review:* Macleod, 1991). In this task, stimuli are divided into three types of trials (congruent, incongruent and neutral), depending on the consistency between words and colors (see table 1). During the incongruent item condition, words are presented in mismatching colors (e.g., the word BLUE displayed in red; BLUE_{red}) relative to congruent stimuli words are presented in matching colors (e.g., the word BLUE displayed in blue; $BLUE_{blue}$). In the first part of the task, participants are responsible for reading the words, and they name the color of the words in the second part. For the last session, participants are instructed to identify the color ink while they have to suppress reading written of the word. Scientists recognized that, during the experiment, reaction time differences are observed depending on the congruency between words and colors. The difference of reaction time between congruent and incongruent stimulus is called the Stroop effect. Stroop effect shows, the effect of "word reading process" on "color naming process". In the congruent trails (e.g., the word BLUE displayed in blue; $BLUE_{blue}$) the response time of the participants is observed as the fastest and the error rates were the lowest due to the fewer number of response alternatives. This reaction time distinction between congruent and incongruent stimuli is called the Stroop facilitation effect. However, the reaction time durations and error rates of the participants increase in the task which has inconsistency with the word dimension (e.g., the word BLUE displayed in red; $BLUE_{red}$), because of the greater number of response options. The reaction time and error rates difference that cause the incompatibility between the dimensions is called Stroop interference.

Table 1. Stroop task. Congruent, incongruent and neuter Stroop stimulus (Words and colors version).

Stroop Stimulus	Congruent	Incongruent	Neutral
BLUE	**BLUE**	**BLUE**	**BOAT**
RED	**RED**	**RED**	**LAMP**
YELLOW	**YELLOW**	**YELLOW**	**CHAIR**
GREEN	**GREEN**	**GREEN**	**PENCIL**

Other commonly used paradigms to study cognitive process and selective attentional process is called Eriksen flanker task (Eriksen & Eriksen, 1974) and Simon task (Simon & Rudell, 1967). In the Simon task, participants are required to press the button which is the same color as the target stimulus. (Figure 1). Distracting stimulus is located congruent or incongruent side of the target response (e.g., a left keypress for a stimulus on the right side of the screen) and participant has to press true button by ignoring location of target stimulus.

Similar to the Stroop effect, participants respond slower and make many response errors when distracting stimulus and response location are incompatible than when they are compatible with each other (Simon & Rudell, 1967). This effect is also called the "Simon effect" (*for review*: Lu and Proctor, 1995).

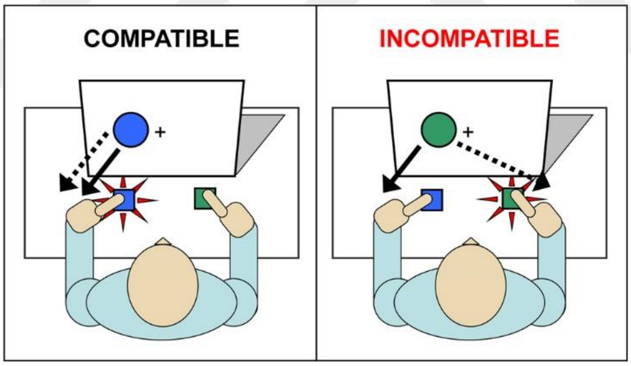

Figure 1. Simon Task. In the congruent trails, blue circle (target) located in its relevant keypress which activates correct response easier. In incongruent trials, green circle (target) is located on its opposite side of the button which cause interference with selection of correct response (Wildenberg et. al., 2010).

In the Eriksen flanker task; letters, words or arrows are used as a distracting stimulus located in the center of the target. In this task, participants are asked to respond to the letter at the center of the stimulus. Trials that have identic flanker stimulus with its center of target response are called congruent trials, and trials with distracting stimulus different from its flanker stimulus are called incongruent trials. In the condition when the neutral stimulus is used, there is no distracting stimulus that can influence the response (see Table 2).

Similar to the Stroop task and the Simon task, during the experiment, reaction time differences are observed depending on the congruency between target and flanker stimulus in the Flanker test. In the congruent trials, reaction time occurs faster and error rates are observed lower than the incongruent trials. The difference of reaction time between congruent and incongruent stimulus is called the Flanker effect. The reason for the faster reaction time and lower error rates in the congruent trials is the fewer response alternatives between flanker stimulus and target response, which is also the same as the Stroop effect. However, the reaction times and error rates of the participants increase in the task which is inconsistent with the target response and flanker stimulus, because of the greater number of response options. The reaction time and error rate difference that cause the incompatibility between the dimensions is called the Flanker interference.

Table 2. Flanker Task. Congruent, incongruent and neutral Flanker stimulus (Letters and arrows version).

Flanker Stimulus	Congruent	Incongruent	Neutral
<	<<<<<<<	<<<><<<	<<<V<<<
K	KKKKKKK	KKKHKKK	KKK3KKK

As mentioned above, reaction time slows down more while the participant performs the incongruent trials, as compared to congruent trials in the Flanker test (Bugg, 2015, Corballis & Gratton, 2003), similar to the Stroop test. In addition, the stimulus-response time difference occurs in the Stroop test is considered to be caused by the dominance effect of automatic word reading processes with the color naming task (Atalay & Mısırlısoy, 2011). However, there is no dominance effect of automatic word reading process, which influential effect on reaction time, in the Eriksen flanker test. Therefore, using the Flanker test in the attentional control and cognitive control research avoids the problem of interference of automatic word reading process. For that reason, the Eriksen flanker paradigm was used in this thesis to research attentional control.

Moreover, Gratton et al., (1992) showed that repeated presentation of stimulus affects magnitude of interference in the Eriksen Flanker test. They found that if the previous trial was incongruent, the duration of reaction time was observed shorter for the incongruent trials compared to if the previous trial was congruent. In contrast, for the congruent trials; reaction time was observed faster if the previous trial was congruent as compared to if it was incongruent. In other words, interference effect is observed smaller for incongruent trials, if the previous trial was incongruent. This phenomenon is known as the Gratton effect (Gratton et al.,1992; Kerns et al., 2004; Kunde, 2003) which has explanatory power the cause of reaction time difference between congruent and incongruent trials. According to this view, if the participant expected congruent stimulus, attention is set to respond more easily to congruent trials, which provide faster response to congruent trials than the incongruent trials. On the other hand, if an incongruent trial is expected, attention is regulated to facilitate response of incongruent trials, which creates benefit for incongruent trials. In order to this account, the Gratton effect reflects as a proactive control process which is based on participant’s expectation to upcoming stimulus.

By contrast, the conflict monitoring theory (Botvinick et al., 2001) accounts the congruency effect in terms of the amount of the incongruent stimulus. According to conflict monitoring theory, the size of incongruent trials in a task has an influence on facilitation and interference effect. If the number of incongruent trials is more than congruent trials in the task, performance for incongruent trials is improved, which reduces the interference effect. However, slower reaction time is observed among congruent trials when the number of incongruent trials is higher in the task, because the facilitation effect does not work efficiently due to a less number of congruent stimulus.

Both views, which reflect the conflict adaptation theory, point out the importance of trial type on the interference effect. According to these two main accounts of conflict adaptation theory, reaction time can be altered depending on the size of the congruent or incongruent stimulus that are presented in one block. Proportion congruency (PC) manipulation method is used to investigate the nature of interference effect by using Simon, Stroop or Flanker tests paradigms, which allows for an explanation of the conflict adaptation theory.

1.3. Proportion Congruency

Proportion congruency manipulation is used in the context of Stroop or other similar tests paradigms (Eriksen test or Simon test) to study selective attentional control where changes in the speed of reaction time and amount of error rates depend on proportion congruency of paradigm, that difference is called proportion congruency effect. Interference effect is observed larger in the lists that have higher proportion congruency of congruent stimulus (e.g., mostly congruent list; MC) while interference effect is observed smaller in list that have higher proportion congruency of incongruent stimulus (e.g., mostly incongruent list; MI) (Logan, Zbrodoff & Williamson,1984) (see Figure 2 for details). Two proportion congruency methods are commonly used to identify the interference effect, and it will be explained in the following section.

1.3.1. List Level Proportion Congruency Effect

In the list level proportion congruency paradigm, the Stroop effect is observed by analyzing reaction time difference between congruent and incongruent items in the two blocks (MC list vs. MI list) to examine proportion congruency effect on the control of selective attentional processes. (Logan, Zbrodoff & Williamson,1984). In the list level control, mostly congruent and mostly incongruent lists are presented randomly in different blocks. In addition, each stimulus placed in list are presented to participants by randomizing. If the number of congruent stimuli are higher than the incongruent in a block, it is called mostly congruent list (Figure 2) and if the number of incongruent stimuli are higher in a block, it is called mostly incongruent list (Figure 3). These figures were prepared based on the Stroop paradigm, but proportion congruency can be manipulated in other paradigms with same method. According to figures; All lists have eight stimuli. In the mostly congruent list, the number of congruent words (distractors) and colors (target) stimuli are six ($BLUE_{blue}$ or RED_{red}) while incongruent stimulus ($BLUE_{red}$ or RED_{blue}) are two. That means list has the mostly congruent items with 75% proportion congruency, while the incongruent items are less presented with 25% proportion congruency. However, in the mostly incongruent list (Figure 3), number of congruent words and colors stimuli ($Green_{green}$ or $Yellow_{yellow}$) is two, while incongruent stimulus ($Green_{yellow}$ or $Yellow_{green}$) are six, which shows list has higher number of incongruent items with 75% proportion congruency as the congruent stimuli are less presenting with 25% proportion congruency. According to proportion congruency effect research results, if the color and word are mismatching, the participants respond relatively slowly, so proportion congruency effect is observed large, in the mostly congruent list condition. In contrast, in the mostly incongruent list condition, if the color of ink and written word do not match, reaction time gets faster, so proportion congruency effect is observed smaller than the mostly congruent list condition (Figure 4). Therefore, it could be concluded that the Stroop effect is observed more in the mostly congruent list condition than the mostly incongruent list condition (Lindsay & Jacoby, 1994). Conflict monitoring theory, modulation hypothesis and S-R learning theory account for the list level proportion congruency effect in different perspectives.

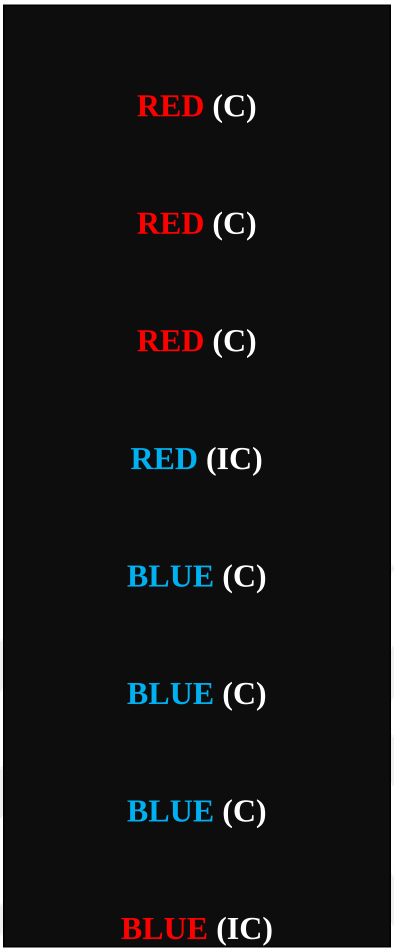

Figure 2. Illustration of stimuli and trial types in a mostly congruent list. Congruent trials demonstrate high (.75) contingency (BLUE$_{blue}$ or RED$_{red}$). C, refers to congruent trials, IC refers to incongruent trials.

Figure 3. Illustration of stimuli and trial types in mostly incongruent list. The total number of incongruent trials (.75) is higher than congruent trials ($\text{Green}_{\text{yellow}}$ or $\text{Yellow}_{\text{green}}$).

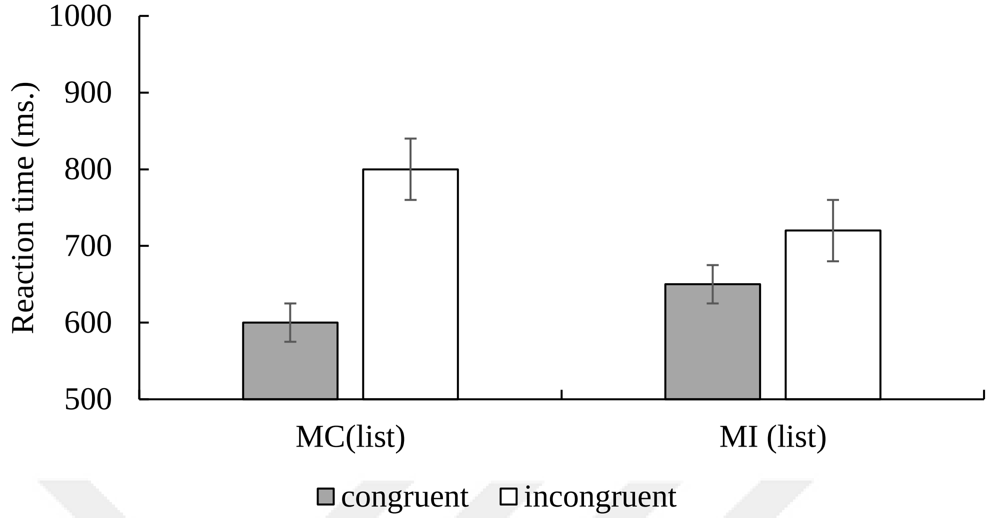

Figure 4. Participants average reaction time depending on proportion congruency (Bugg, 2011, experiment 2).

1.3.1.1. Modulation Hypothesis Account

The simplest explanation of the list level proportion congruency effect is modulation hypothesis which is also known as "strategic modulation of selective attention" (Lindsay & Jacoby, 1994; Lowe & Miller, 1982). According to modulation hypothesis, the reason for the higher interference effect in the mostly congruent list is the positive relation between response and distractor stimulus. This is because even participant modulates the attention in order to distractor stimulus, facilitation effect is observed openly due to positive correlation between target and distractor stimulus. Reaction time and error rates therefore decreased rapidly in the congruent items as compared to incongruent items where items were placed in mostly congruent list. In contrast, when the response and distractor stimulus generally mismatch, participants try to modulate attention to the target response while making full effort to ignore distractor stimulus. Therefore, facilitation effect does not work highly in mostly incongruent list for congruent items, and interference effect decreases for the incongruent items.

1.3.1.2. Stimulus- Response Learning and Response Prediction Account

According to Schmidt & Besner (2013), in the mostly congruent list condition, positive contingency with the distractors and response creates reducing effect on congruent stimulus reaction time, by contrast, it does not provide any effect on incongruent stimulus reaction time. Also, presenting much more congruent stimuli than incongruent stimuli caused to increased belief of upcoming stimulus will be congruent. Namely, participants can predict the congruent stimulus in the mostly congruent list easily before it is not presented, and the true response can actualize only word reading process. This positive contingency learning and predictability of upcoming stimulus create reducing effect on congruent stimulus reaction time. By contrast, it does not provide any reducing effect on incongruent stimulus reaction time. Therefore, interference effect is observed higher in the mostly congruent list condition.

On the other hand, in the mostly incongruent list condition, participants cannot generate any positive contingency relation between distractors and target. As a result of absence of the positive contingency relation, any reducing effect is not observed among congruent stimuli in mostly incongruent list condition. Moreover, presenting much more incongruent stimuli in a whole list helps participants to progress attentional strategy to upcoming stimulus will be incongruent. Therefore, participant can respond to faster incongruent stimulus when they face it. So, in the mostly incongruent condition interference effect is observed less compared to mostly congruent list condition. Shortly, there is no facilitation effect which occurs because of the positive contingency on reaction time in the mostly incongruent list by contrast that is observed in mostly congruent list condition. Therefore, interference effect is observed much more in mostly congruent list than the mostly incongruent list. To sum up, according to stimulus-response learning, list level proportion congruency effect occurs because of the predictability of upcoming stimulus (Schmidt & Besner, 2008; Schmidt, 2013). This is because; in the mostly congruent list condition, participants create expectancy that congruency of upcoming stimulus before the stimulus is presented, and this expectation causes higher conflict rate when incongruent stimulus is presented (Carter et al., 2000). Therefore, reaction time difference between congruent and incongruent stimulus is observed higher than the mostly incongruent list condition. So, research suggested that list level control is a proactive control mechanism.

1.3.1.3. Conflict Monitoring Account

Researchers have shown that, the brain part of the anterior cingulate cortex (ACC) is triggered when cognitive and emotional task is demanded, including stimulus-response selection, divided attention, motor-response selection, working memory and conflict adaption process (Bush et al., 2000). For this reason, conflict monitoring theory has exploratory power to explain the cognitive mechanism underlying the proportion congruency effects. According to conflict monitoring theory (Botvinick et al., 2001), ACC and dorsal lateral prefrontal cortex (DLPC) is activated when conflict situation is perceived. Also, it is known that, ACC relates to lateral prefrontal cortex (Carter et al.,2000).

Theory suggested and demonstrated by other researchers, (Barch et al., 2001; Carter et al., 2000, Blais & Bunge, 2010), that ACC has evaluative function of detecting response conflict and DLPC is triggered to reduce conflict by performing global control. In other words, in the brain system, mostly incongruent list creates more conflict than the mostly congruent list so more control of attention is needed when incongruent trial is presented the in mostly incongruent list as compared the mostly congruent list and the amount of the conflict determinates the magnitude of interference effect. Conflict monitoring theory is clearly explained by artificial neural network models (Botvinck et al., 2001).

Hebbian learning of cognitive control (Verguts & Notebaert, 2008) is a contemporary form of conflict monitoring which aims to explain the selective attentional control based on the neural network (Figure 5). In the Hebbian learning model, stimuli are defined as Stroop color test form (BLUE or YELLOW). As seen in figure, if participant response the color pathway more than word pathway, selective attentional control, where control by dorsal lateral prefrontal cortex (Bach et al., 2001; Blais & Bunge, 2010), creates stronger Hebbian networks between response layer and color pathway. In the congruent stimulus, conflict situation is not observed because word and color pathway are activated in by same response layer. In contrast, in the incongruent stimulus, word and color pathway create conflict in response layer because of the different response opportunities. Model based on the amount of conflict situation because if the conflict increases, Hebbian networks get stronger. For this reason, mostly incongruent list creates more conflict controlled by dorsal anterior cingulate cortex (Bach et al., 2001, Blais & Bunge, 2010). To summarize, raising the number of conflict stimuli causes more Hebbian networks to emerge.

Specifically, on account of the stimulus redound the conflict in the mostly incongruent list Hebbian networks related brain system create stronger form of neural networks than the mostly congruent list. Brain imaging studies support the conflict monitoring theory because activation of anterior cingulate cortex and dorsal lateral prefrontal cortex are observed more in the conflict condition (Bach et al., 2001).

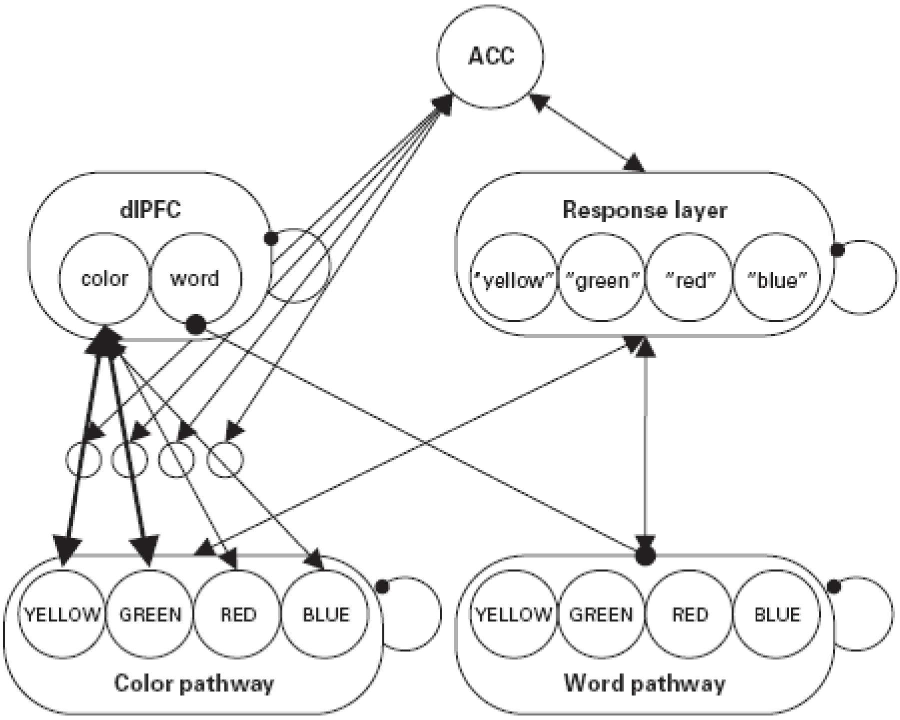

Figure 5. Attentional control of Hebbian Learning model. (Blais, 2010; Figure 6.2).

1.3.2. The Item- Specific Proportion Congruent Effect (ISPC):

On the basis of conflict explanation, Stroop interference is caused by presenting congruent (or incongruent) stimulus that exist in mostly congruent (or incongruent) list. For instance; in Figure 2 (MC list), each “RED” and “BLUE” stimulus is presented most frequently (.75 contingency in list) with the congruent form of words and colors, while each are presented less (.25 contingency in list) incongruent form. In contrast, in Figure 3 (MI list), “GREEN” and “YELLOW” stimulus are presented less frequently (.25 contingency in list) with congruent form of words and colors while they are presented mostly (.75 contingency in list) incongruent form. In other words, the proportion congruency of stimuli that exist in the lists are not controlled independently from the list. Therefore, the cause of the list-level proportion congruency effect might change from stimulus to stimulus or might be dynamic selective attentional control process which depend on item proportion congruency rather than the whole list of control. In conclusion, observations found the problematic results that, item-specific pairings determinates the proportion congruency effect (Schmidt, 2013). To solve the item level pairings effect, item-specific proportion congruency manipulation method is used to investigate conflict adaptation as well as list-level control (Jacoby et al., 2003). In the item-specific proportion congruency (ISPC) manipulation, congruency of list is manipulated at the level of item (Jacoby, Lindsay & Hessels, 2003).

To examine independency of list-level proportion congruency effect from the item proportion congruency effect, an experiment is designed which has equal number of congruent and incongruent stimulus at the item level, while stimuli are split mostly incongruent proportion congruency or mostly congruent proportion congruency group at the list level (Jacoby et al., 2003). Figure 6 shows the item-specific proportion congruency methods which based on manipulation of stimulus at the item-level. In the table, sixteen stimuli are used, and stimuli are integrated two groups (MC or MI list). First list is MC, second list is MI. In the MC item set, there are eight stimuli (BLUE & RED) and six are presented congruent form with words and colors, two are presented incongruent form. However, in the MI item set (YELLOW & GREEN), six stimuli are presented incongruent form, while two stimuli are presented congruent form. When the item sets are presented randomly to the participants in one block, there are an equal number of congruent and incongruent stimuli at the item level. Specifically, the word of RED and BLUE are mostly presented with its congruent color (high PC items (.75 contingency); e.g., RED_{red} or $BLUE_{blue}$) while the words "GREEN" and "YELLOW" are less presented with its congruent color (low PC items (.25 contingency); e.g., $GREEN_{green}$ or $YELLOW_{yellow}$). When the mostly incongruent and mostly congruent list are intermixed, contingency is 50% congruent, 50% incongruent. That means participant cannot foresee whether the upcoming stimulus is congruent or incongruent, so ISPC manipulation represents the reactive control mechanisms rather than global control. Several studies showed that Stroop effect is observed more in the mostly congruent list of items than the mostly incongruent list of items (Jacoby & Chanani, 2010; Atalay & Mısırlısoy, 2012) which is called ISPC effect (Figure 7). These findings proved that attention can be controlled strategically. In this case, modulation hypothesis is thought inadequate to explain interference effect, because even participant uses reactive control rather than proactive control mechanism, interference effect still maintained. To explain the ISPC effect, two explanations were suggested: contingency learning and conflict monitoring theory.

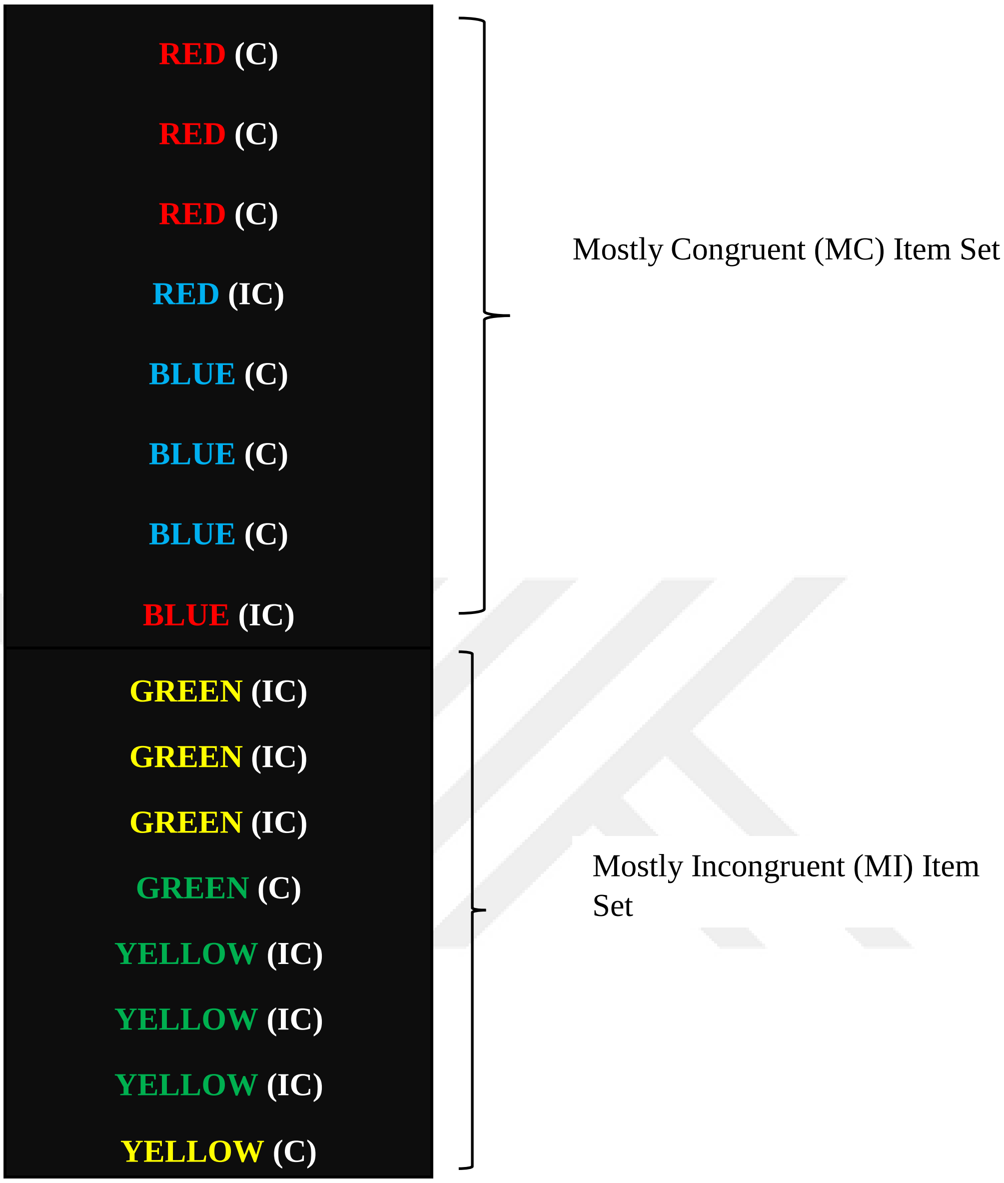

Figure 6. Demostrates the item-specific proportion congruency (ISPC) design (Jacoby et al., 2003). High (.75) contingency trial types are presented frequently within each item set (e.g., MC-congruent (REDr$_{ed}$ or BLUE$_{blue}$) & MI-incongruent (GREEN$_{yellow}$ or YELLOW$_{green}$)) as compared the low (.25) contingency trials are presented less within each item set (e.g., MC-incongruent (RED$_{blue}$ or BLUE$_{red}$) & MI-congruent (GREEN$_{green}$ or YELLOW$_{yellow}$)). Totally, medium (.50) contingency respresents in one block. Figure was adapted from Bugg, (2015).

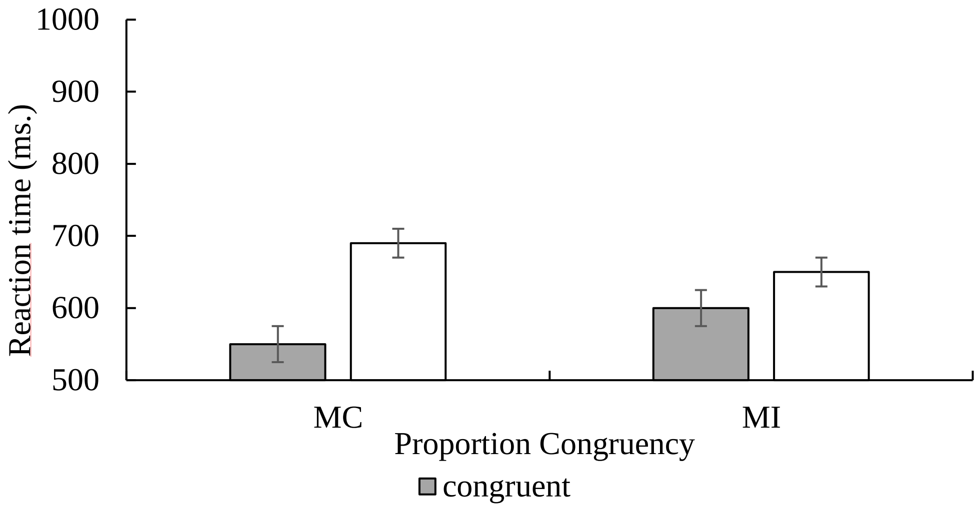

Figure 7. Participants average reaction time depend on item specific proportion congruency. Figure was adapted from Jacoby et al. (2003).

1.3.2.1. Contingency Learning Account

Contingency learning hypothesis explains the item specific proportion congruency effect in the same way that list level proportion congruency effects explanation (Bugg, 2012; Schmidt, 2013) in terms of the predictability of the distractor stimulus is associated with response (Schmidt et al., 2007). In 2008, Schmidt and Besner argued that, proportion congruency effect was confounded with contingency. According to contingency learning hypothesis, (Schmidt, 2013; Schmidt & Besner, 2008) reaction time of the congruent stimulus is faster in the mostly congruent list than the mostly incongruent list, because congruent stimulus creates high contingency between distractor stimulus and its response, and this strategy helps the participant to predict the response by using distractor stimulus (e.g., $BLUE_{blue}$; high contingency). However, this contingency strategy does not work in incongruent trials in this condition because positive contingency does not occur between distractor stimulus and response (e.g., $BLUE_{red}$; low contingency). Therefore, a greater interference effect is observed in incongruent trials while facilitation effect is observed in congruent trials in this condition. Likewise, incongruent stimulus that member of the mostly incongruent list creates smaller interference effect because incongruent stimulus is predicted by distractor stimulus due to high contingency between distractor stimulus and response in the mostly incongruent list (e.g., $RED_{blue;}$ high contingency), but this facilitation effect is not observed in congruent trials because the participant cannot use distractor stimuli as a predictor of response in this condition due to low contingency (e.g., RED_{red} ; low contingency). (Figure 8). In other words, they argued, even if participants do not control the attention, the same results would be achieved if the participant associates the stimulus and response during the experiment. In order to investigate accuracy of contingency learning, they reanalyzed ISPC effect experiment (Jacoby et al., 2003). They analyzed the proportion congruency effect (MC vs. MI) as a contingency (high proportion congruency vs. low proportion congruency) and they found consistent results with the Jacoby's ISPC effect experiment. So, Schmidt and Besner (2008) suggested that, S-R contingency has exploratory power in conflict adaptation, and therefore the control of attention is not necessary.

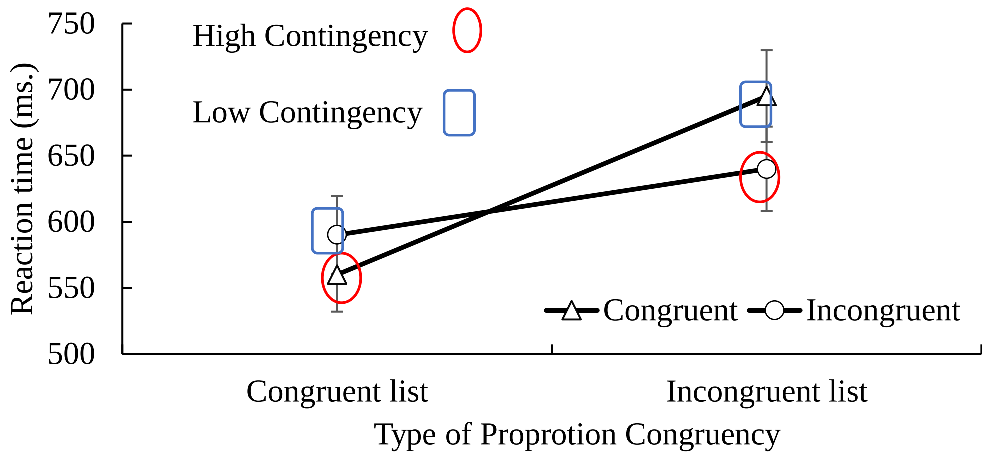

Figure 8: Participants average reaction time depend on contingency of stimulus (Jacoby et al., 2003, experiment 2).

On the basis of contingency learning explanation, in this thesis, LLPC effect and ISPC effect would be investigated with two different experimental paradigms by comparing reaction time results of participants.

It would be expected congruent items placed mostly in congruent list and high proportion congruent item set would be more advantageous than the congruent items placed mostly incongruent list and low proportion congruent item set. However, such facilitation effect would not be expected in incongruent items. Therefore, Flanker interference would be expected larger in mostly congruent list, and high proportion congruent item set as compared to the mostly incongruent list and low proportion congruent item set.

1.3.2.2. Conflict Monitoring Account

Jacoby et al., (2003) account the proportion congruency effect as a local process which refers conflict is controlled in the item level rather than block (ISPC effect). According to their findings, response conflict is associated with each item rather than list of blocks. In the ISPC condition, two lists (MC and MI) are intermixed with 50% congruent list that inhibits learning whether next item would be MC or MI. So, participants cannot prepare any strategy until stimulus is presented. Therefore, process occurs reactively, and response received ready post-stimulus onset (Hutchison et al., 2016). In other words, participants cannot predict the response until the stimulus is presented. This late selection mechanism is called reactive control mechanism, which is based on bottom-up process. Blais et al., (2007) used conflict monitoring theory in different perspective to explain ISPC effect. According to their account, ACC and DLPC neural network is associated in overall blocks of item, so conflict adaption also occurs item by item. Therefore, conflict adaption and neural network is strength by response association with each item in blocks. Moreover, brain imaging studies supposed to idea because ACC and DLPC activation is observed when reactive process occurred (Blais et al., 2007; Blais & Bunge, 2010). In conclusion, conflict monitoring supporters suggested that, conflict is strength step by depend on presentation of each individual stimulus and this attentional control process is generated by activation the brain area of dorsolateral prefrontal cortex and anterior cingulate cortex (Botvinick et al., 2001). Opposed to this account, contingency learning supporters (Schmidt, 2013) suggested, this moment to moment changes in conflict adaption also strengthens the contingency learning in ISPC condition. Therefore, there is a continuous debate whether proportion congruency is accounted by S-R learning or attentional control mechanism.

According to these explanations, this thesis aimed to investigate which of these hypotheses (conflict monitoring vs. contingency learning) have more exploratory power on the conflict adaptation process. To control this idea, contingency learning mechanism would be manipulated by stimulus onset asynchrony (SOA) which would be fully detailed below.

1.4. Stimulus Onset Asynchrony (SOA) Manipulation

Attentional control strategy can be manipulated by different methods. One factor is stimulus onset asynchrony (SOA). A time course analysis is needed to understand priming process. According to research, the interference effect does not occur immediately when the stimuli are presented. Several studies measured the interference effect by using SOA manipulation, which is time difference between prime stimuli and the onset of target stimuli (Neil, Valdes & Terry; 1995, *p.* 223). Glaser & Glaser (1982) applied the SOA manipulation method for the first time in a Stroop test paradigm. In the study, the colors were presented in a rectangle, and the words were presented in a solid color (e.g. black) in the middle of the rectangle. Participants were asked to say the color of the rectangle, ignoring the word. Critically, presentation time of word and color dimensions were manipulated in the experiments to observe the Stroop effect dependent on SOA manipulation. Glasser & Glasser study and many other studies (Hermans, Houwer & Eelen, 2001; Atalay & Mısırlısoy, 2014) demonstrated that interference effect and contingency learning are affected by stimulus onset asynchrony manipulation (SOA). According to these findings, SOA manipulation was used by presenting the flanker letters before (-250 ms.), at the same time with (0 ms.), or after the target letter (+250 ms.) in this thesis. The reason for using ± 250 ms. time difference between flanker and letter is that, Glasser and Glasser (1982) observed the Stroop effect at -400, -300, -200, -100, 0, +100, +200, +300, +400 milliseconds. Studies suggested that, interference effect was observed in the highest level at the 0 ms. and 100 ms. conditions while it was observed lower at the -400, -300, -200, -100, +200 milliseconds conditions. Finally, interference effect disappeared in the +300 and +400 ms. conditions.

Atalay & Mısırlısoy (2014) suggested that ISPC effect changed depending on SOA condition (-200ms., 0ms., +200ms.) in the Stroop test paradigm. Detailly, interference effect was observed smaller when SOA was determined +200 milliseconds as compared to the -200 milliseconds and 0 millisecond conditions. From this information, it was expected that the magnitude of the Flanker effect would change differently depending on SOA manipulation as similar to the Stroop paradigm result.

In the negative SOA condition (-250 ms.), when the flanker letter is presented before the flanker stimuli, larger Flanker interference would be expected, because priming the flanker letters before would increase the power of contingency learning mechanism which allows participants to predict response before the flanker stimuli are presented.

In the flanker target letter simultaneous condition (0 ms.), in which the flanker and letter stimuli are presented at the same time, the magnitude of Flanker interference would be expected larger in incongruent trials as compared to congruent trial, which is similar to classic conflict adaption study results.

In the positive SOA condition (+250 ms.), which the target letter is presented before the flanker stimuli, smaller flanker interference would be expected, because priming the target letter before blocked the prediction of response which caused to decrease power of contingency learning strategy.

1.5. Inter Trial Interval Effect (ITI):

Inter-trial interval (ITI) effect is defined as the short break between the offset of previous trial and onset of next trial. This effect is considered to influence the conflict adaptation process. Although a few studies used the inter-trial interval as a manipulation method, this time course effect should be thought seriously while searching distinction between the proactive and reactive control mechanisms. There are only three investigations which examined ITI effect on conflict adaptation, and all these researches suggested higher congruency effect was observed at the shorter ITI as compared to longer ITI (Notebaert et al., 2006; Wühr & Ansorge, 2005; Egner et al., 2010).

Wühr & Ansorge (2005) investigate the time course of sequential modulations (also known as Gratton effect) of Simon effect by manipulating ITI. In other words, they tested whether the Simon effect have changed with increasing ITI. In their first experiment, they searched the magnitude of Simon interference effect with the 1.5 seconds inter-trial interval and in their second experiment, they tested whether the results of experiment 1 were consisted when ITI was increased to 3 seconds. Their results suggested that, smaller congruency effect was observed when ITI was doubled to 3 seconds. More specifically, they indicated that, Simon effect was still observed in the incongruent trials in the experiment 2, but not observed in experiment 1. They interpret the reason for different congruency sequential modulation of the Simon effect between two experiments in terms of the different inter-trial interval. They conclude that, Simon effect diminished when ITI was increased. After the these finding, they manipulated the ITI as a within subject design to avoid the effects of individual difference in the experiment 3. In this experiment ITI was varied across 1500 milliseconds and 6000 milliseconds. They again reported, higher Simon effect was observed at shorter ITI than the longer ITI that is similar with other experiments results.

After the Wühr & Ansorge findings, Egner et al., (2010) designed the gender face-word Stroop task paradigm (Egner et al., 2008) to investigate the inter-trial interval effect and response stimulus effect on congruency sequential effect. They also aimed to create to contrast between the proactive and reactive control mechanisms by increasing ITI to search the difference between proactive and reactive control mechanisms. They have manipulated the inter-trial interval (ITI) and response stimulus interval (RSI) with two different experiments. More specifically, in the experiment 1, they applied fixed stimulus duration while manipulated ITI across 500-7.000 milliseconds and in the second experiment, RSI manipulation varied across 500-5.000 millisecond and stimulus was shown until participant gave an answer. Likewise, the Wühr and Ansorge results, congruency sequential effect was decreased when ITI duration was increased. Results also showed that, congruency effect was significantly larger in 1000 milliseconds ITI condition than in 3000 milliseconds ITI condition as similar with Wühr & Ansorge results. However, the biggest inconsistency between these two experiments was that, Egner et. all., could not find any significant sequential congruency effect when ITI length was determined above the 3000 milliseconds. Although this difference is thought due to different experimental procedure, two research results should be considered while searching congruency effect.

According to Egner and colleagues results, they interpreted that longer ITI/RSI are more favorable for the proactive control due to uniform distribution of ITI/RSI. In other words, temporal predictability, when the stimulus would occur, helps to increase S-R learning. This idea was also supported by Wendt & Kiesel (2011). They also suggested that proactive control is beyond the expectation of "what". It is also related with "when" to expected. So, knowing occurrence time is also helpful to prepare response and it provides to developed prediction ability of response. To this idea, longer ITI might be helpful in the manipulation method to strength the stimulus-response prediction.

Also, list level proportion congruency (LLPC) effect and item specific proportion congruency (ISPC) effect are thought independent control mechanisms (proactive control vs. reactive control). Gonthier et al., (2016) assessed the reactive and proactive control mechanism independency by using ISPC and LLPC manipulations with Stroop paradigm in the same participants, and they found these control mechanisms are distinct each other. Interestingly, they also found, interference effect in LLPC showed larger slowing in reaction time on congruent trials while smaller slowing reaction time was observed in ISPC condition. However, this idea still maintains uncertainty. Because there are a few findings about the investigation of the independency of proactive and reactive control mechanism.

As mentioned above, ITI might affect results of S-R learning, which also reflects proactive control mechanism. So, in this thesis, participants were given longer break time between the previous trial offset and onset of next trial than in usual ISPC and LLPC experiments and inter-trial interval was determined 3000 milliseconds to create contrast between reactive and proactive control mechanisms in terms of the regulation of behavior.

According to this knowledge, it would be expected that proactive control mechanism (as controlled LLPC effect) would be more influence from the increasing ITI than the reactive control mechanism (as controlled ISPC effect). This is because, probability of stimulus occurrence grew exponentially depending on time passing of ITI (Egner et al., 2008). As mentioned above (see section 1.3.1.2) anticipation to upcoming stimulus is defined as proactive control mechanism so that, increasing ITI provides to strength the stimulus response association which would be reflected dissociation between the ISPC and LLPC reaction time results.

In short, reactive and proactive mechanisms are thought different attentional control mechanisms (Gonthier et al., 2016 & Appelbaum et al., 2014) and these control mechanisms would be changed as different patterns depend on increasing inter-trial interval, congruency manipulation and SOA manipulation method. Idea would be controlled by comparing the mean ISPC and LLPC reaction times of participants.

1.6. Aim of the Thesis:

As it was discussed above, in this thesis, proportion congruency effect (LLPC & ISPC) was investigated in different SOA (-250ms., 0 ms., +250ms.) conditions by increasing ITI. In the light of previous findings, effect of proportion congruency manipulation on Flanker interference would be expected larger in mostly congruent list and high proportion congruent item set than the mostly incongruent list and high proportion congruent item set. Moreover, to manipulate the power of contingency learning mechanism, SOA manipulation was used in this thesis. It was thought that the largest flanker interference would be observed in -250 milliseconds SOA condition while smallest flanker interference would be observed in +250 milliseconds SOA condition. Finally, to create the contrast between ISPC and LLPC manipulation ITI was raised than the normal proportion congruency manipulation experiment. It was thought that effectiveness proportion congruency manipulations (LLPC & ISPC) on the Flanker interference would be differed across to lists and item sets depending on ITI.

CHAPTER 2

Method

2.1. List Level Proportion Congruency (LLPC) Manipulation (Experiment 1)

The major purpose of the list level proportion congruency experiment was to reveal insights into the proactive control mechanism.

2.1.1. Participants

The sample of the research was composed of healthy participants randomly selected from the Izmir University of Economics undergraduate student population. A total of 81 participants were used, and they were divided randomly into two groups based on the proportion congruency conditions (LLPC: MC list & MI list) to measure the reaction time differences depends on different proportion congruency conditions. Totally, 62 females and 19 males participated in the list level proportion congruency experiment. 40 participants attended mostly congruent list condition (mean age: 21.78), other 41 participants participated mostly incongruent list condition and mean age was (21.03).

Participation including process was the same for both conditions. Five participation criteria were determined for participation in this research. These criteria are;

1. Not having any visual problems,
2. Not using any psychoactive drugs that cause attentional deficit,
3. Not having any reading problems,
4. Not having attentional deficit disorder,
5. Being a native speaker of Turkish.

Participants who did not meet these criteria, were not accepted for the experiments.

2.1.2. Stimuli

In this project, letter-based flanker paradigm was applied. The reason for using the flanker paradigm is that, the Stroop test paradigm is thought to influence the participants reaction time because of the dominant process of reading the word rather than saying the color. However, the absence of such a confounding effect in the flanker test provides extra reliability in the examination of cognitive processes of attention control. (Melara & Algom, 2003). Therefore, flanker paradigms were presented to participants to investigate the effects of proportion congruency on attentional control mechanism.

Stimuli were arranged by D, F, J, K letters with different proportion congruent. D and F letters were determined as mostly congruent items in the list level control; J and K letters were determined as mostly incongruent items in list level control.

Also, each Flanker letters paradigms include different proportion congruency conditions (MC items condition or MI items condition) and those proportion congruency conditions were presented to the two different participant groups that would be described in detail below.

Experiment 1 was manipulated at the level of list (LLPC: MC items and MI items in the list) as a between subject factors. In the mostly congruent items list condition (MC); a total of 240 flanker trials were presented that consisted of 192 congruent, and 48 incongruent in one block. The sequence of congruent flanker stimuli was like; DDD, FFF, JJJ, KKK that each D, F, J, K flankers were presented 48 times as congruent form and each D, F, J, K flanker stimulus were presented 12 times as incongruent trials that was like DFD, FDF, JKJ, KJK. In the mostly incongruent items list condition (MI), a total of 240 trials were shown to participants in one block. There was 48 congruent, 192 incongruent trial and each D, F, J, K flankers were presented 12 times as a congruent form while each the letters of D, F, J, K were presented 48 times as incongruent stimulus (see Table 3).

Table 3. Frequency of Flanker stimuli presentation during in one block for the each proportion congruency condition.

Proportion Congruency	Flanker	Task D	Task F	Task J	Task K
Mostly Congruent Item List (LLPC)	D	48	12	0	0
	F	12	48	0	0
	J	0	0	48	12
	K	0	0	12	48
Mostly Incongruent Item List (LLPC)	D	12	48	0	0
	F	48	12	0	0
	J	0	0	12	48
	K	0	0	48	12

In both conditions (LLPC: MC list vs. MI list) stimulus onset asynchrony (SOA) manipulation was used to control the timing effect on attentional control mechanism. Flanker stimulus was presented randomly under the conditions of presenting the flanker letters first (-250 milliseconds), flanker target letter simultaneous (0 milliseconds) or target letter first (+250 milliseconds) to investigate proportion congruency effect, depend on stimulus onset asynchrony (SOA).

More specifically, flanker stimuli were divided into 3 groups equally to manipulate SOA within one block. More specifically, Flanker stimuli were presented 80 times for each SOA condition (-250 ms., 0 ms., +250ms.) in a block. In the flanker letters first condition, flanker letters stayed on the screen for 250 milliseconds and shortly after flanker stimulus was shown for 1250 milliseconds. As similar procedure was applied in the target letter first condition; immediately after the target letter stayed on the screen for 250 milliseconds; flanker stimulus was shown for 1250 milliseconds to participants. In the flanker target simultaneous condition, flanker stimulus was shown for 1500 milliseconds without any priming. The reason for the 250 ms. time difference between letter and flanker stimulus is that; The interference effect is observed in -400, -300, -200, -100, 0, 100, 200, 300, 400 milliseconds (Glasser & Glasser, 1982). Since the proportion congruency effect cannot be observed without the interference effect, SOA was determined as 250 milliseconds in this research.

Moreover, letters were written in Arial 36 font black on a white background which was placed in the middle of the computer screen. In addition, inter-trial interval was determined 3000 milliseconds, that was longer than in typical proportion congruency experiments, to increase the strength of S-R association.

2.1.3. Apparatus

2.1.3.1 Stimulus Presentation Program

E-prime 2.0 program was used to present the stimuli, on a desktop computer with the specifications of TECHNO PC 750GB HDD/4GB RAM/ AMD FX-6100 3.3Ghz/ 1GB VGA. Responses of the participants were stored in this computer. Both behavioral data obtained as correct, incorrect or invalid and reaction times are recorded.

2.1.3.2. Informed Consent

A form was prepared in order to explain participants' rights, experiment duration and procedure. All participants, who accepted to participate in the experiment, signed an informed consent form and they filled the evaluation form (see Appendix 1).

2.1.3.3. Participant Evaluation Form

The evaluation form was designed with six participation criteria in order to identify participation acceptability in the study (see Appendix 2).

Participants were required to report age, gender, native language and reported whether they have any reading or visual problems. Participants who had not met to criteria were not included in the experiment.

2.1.3.4. Participant Information Form

At the end of the experiment, each participant was given a form to give information about the experiment. The information form contains information that briefly summarizes the purpose of the experiment, such as what the Flanker task is, and what is the proportion congruency effect on cognitive processes. (see Appendix 3).

2.1.4. Data Acquisition

2.1.4.1. Procedure

Same experimental procedure was applied to both proportion congruency conditions.

Participation in the experiments is entirely voluntary, and those who want to participate in the experiment are informed by the researcher. Before the experiment started, the participants were requested to complete the evaluation form. The candidates who were eligible to participate in the experiment were given an attendant number and the experiment was started. Each participant could join at most one experimental work individually. The experiment was conducted in a room with a computer, which did not transmit sound. The participant sat 60 cm away from the computer screen. Then the researcher left the participant's side after starting the experiment.

In all proportion congruency conditions, the processing and the time of presentation of the stimuli in blocks are set to be the same for purpose of comparison among conditions. Before data collection was started, first, the participant was requested to put his/her hands on the computer keyboard on the keys with the letters D, F, J, K respectively. After a brief description of the expected task (deciding by pressing the keys what the middle letter is), and a brief description of what the stimuli are; the example list was shown to the participant in a block by presenting stimuli under the conditions of the flanker letter first, flanker target letter simultaneous or after the target letter first. Before the actual experiment began, participants were asked to practice the task expected in one block. At the beginning of the practice phase, a blank screen was shown for 3000 ms. Then in the middle of the screen for 500 milliseconds '+' sign appeared later, the participants had done a practice trial consisting of 36-unit flanker stimuli for each SOA condition. Flanker stimulus stayed for a fixed duration of 1500 milliseconds. Feedback was provided to each participant after each response to ensure that the answers they gave were correct. The practice phase was completed after almost 15 minutes, after that the actual experiment was started. After the participants finished the practice block, participants received information about the beginning of the actual experiment and they were able to start the real experiment when they were ready. Then the actual experiment was started, and the answers given by the participant were recorded. As it was in the practice phase, each experiment was started with a blank screen shown for 3000 milliseconds as followed by a '+' sign was shown for 500 milliseconds. Later, depending on the proportion congruency conditions (mostly congruent in list level control and item specific control (DF) vs. mostly incongruent in list level control and item specific control (JK)), 240 flanker stimuli in total had been shown to participants to answer the flanker stimulus. All SOA conditions (flanker letters first, flanker target letter simultaneous and target letter first) were presented randomly in one block and participants saw 80 flanker stimuli for each SOA condition (see Figure 9). All stimuli stayed on the screen for a fixed duration which was determined to be 1500 milliseconds. Also, participants received feedback in the form of 'correct, wrong or not responding' after every response. The total experiment lasted approximately 30-35 minutes and after the participants completed the experiment, they would have detailed information about the purpose of the experiment by giving an information form.

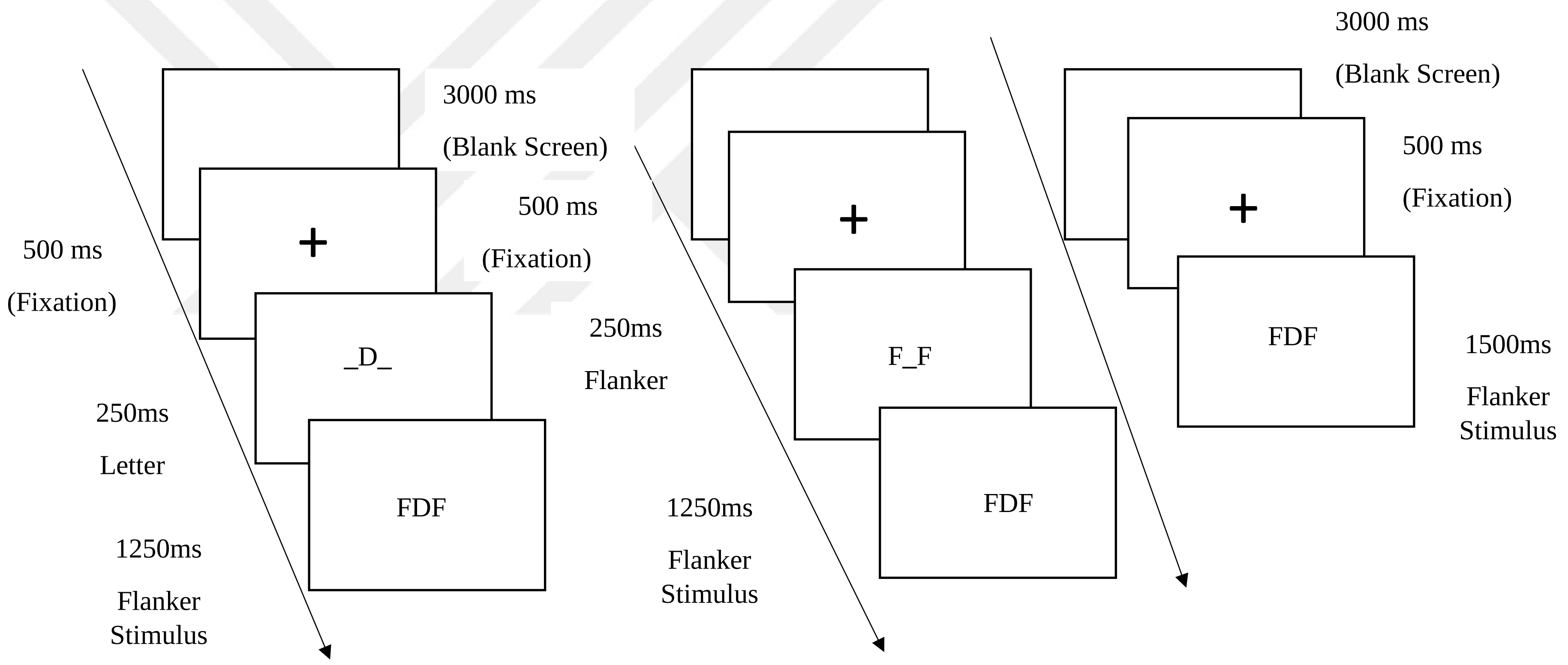

Figure 9. The trial sequence of experiments. Participants decided letter that placed in the middle of flanker stimulus. The letter appeared before (left), the flanker appeared before (middle), and at the same time (right). The durations were presented in parentheses.

2.1.5. Research Design

In this thesis, influential effect of LLPC manipulation and SOA manipulation on attentional control mechanism was investigated by measuring participant's reaction time and error rate. In other words, the reaction time of each participant was determined as a dependent variable while proportion congruency manipulation and SOA manipulation were determined as an independent variable. Also, ITI was increased to 3 seconds to create a contrast between attentional control mechanism (proactive vs. reactive control mechanism) by strengthening S-R association.

To investigate the LLPC effect, list level proportion congruency conditions (mostly congruent list and mostly incongruent list) were manipulated as between-subject factors and SOA conditions (-250 ms., 0ms. and +250 ms.) were manipulated as within-subject factors.

CHAPTER 3

Results

3.1. Results of the LLPC Experiment

3.1.1. Data Analysis Method of Reaction Time

Before the analysis of reaction time was conducted for experiment 1 (LLPC); incorrect trials with the previous trial were excluded from the analysis to avoid effects of sequential repetition (Mayr et al., 2003). Also, participants who had high error rates were excluded from the analysis. In the LLPC experiment, analysis was run with 91.67% trials. For all analysis, results were reported as statistically significant they reached at least 0.05 alpha level. Also, F values were reported with Greenhouse-Geisser correction and effect sizes were reported as a partial eta squared.

3.1.1.1. Results of the Reaction Time Analysis in LLPC Manipulation (Experiment 1)

2 (proportion congruency: MC and MI) x 2 (item type: congruent and incongruent) x 3 (SOA: flanker letter first, flanker target letter simultaneous, target letter first) mixed design factorial ANOVA was conducted to investigate whether reaction time was influenced by proportion congruency of items and item type depending on SOA. Variables (SOA and item type) were manipulated in one block as within subject factors while proportion congruency was manipulated between-subject factors.

Results showed the main effect of item type on reaction time was statistically significant, $F_{(1, 79)} = 174.53$, $MSE = 1487.32$ $p < .05$, $\eta^2 = .68$. As seen in Figure 10, incongruent trials had a higher reaction ($M = 722.63$, $SE = 11.93$) than congruent trials ($M = 676.84$, $SE = 12.16$) which tells Flanker interference was observed significantly in LLPC experiment.

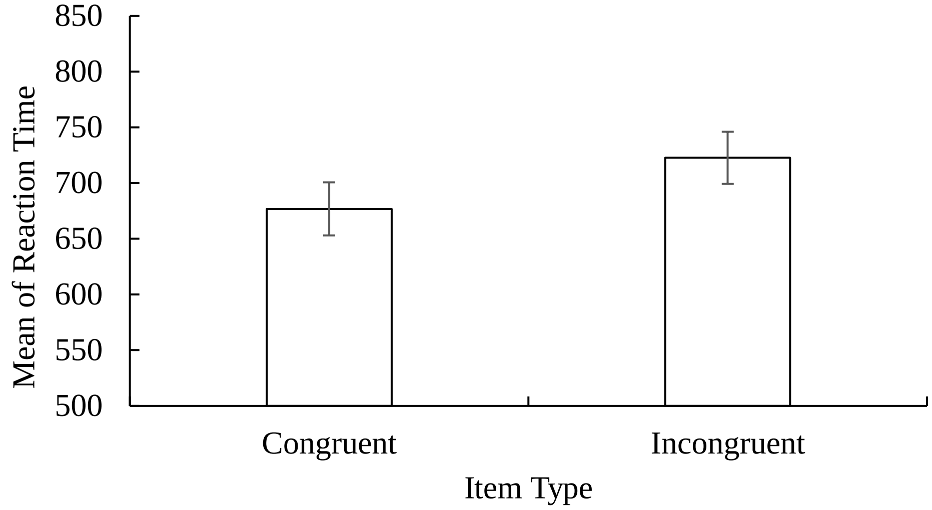

Figure 10. Mean (with 95% CI) reaction time of the participants depend on item type.

Moreover, the main effect of SOA was statistically significant, $F_{(1.98, 156.51)} = 26.77$, $MSE = 5014.65$, $p < .05$, $\eta^2 = .25$. Contrast revealed that, flanker target letter simultaneous condition ($M = 729.95$, $SE = 12.49$) was significantly higher reaction time than the both flanker letters first condition ($M = 673.06$, $SE = 12.13$); $F_{(1,79)} = 58.15$, $MSE = 263051.48$, $p < .05$, $\eta^2 = .42$ and target letters first condition ($M = 696.20$, $SE = 13.17$); $F_{(1,79)} = 17.12$, $MSE = 91776.44$, $p < .05$, $\eta^2 = .19$, (Figure 11).

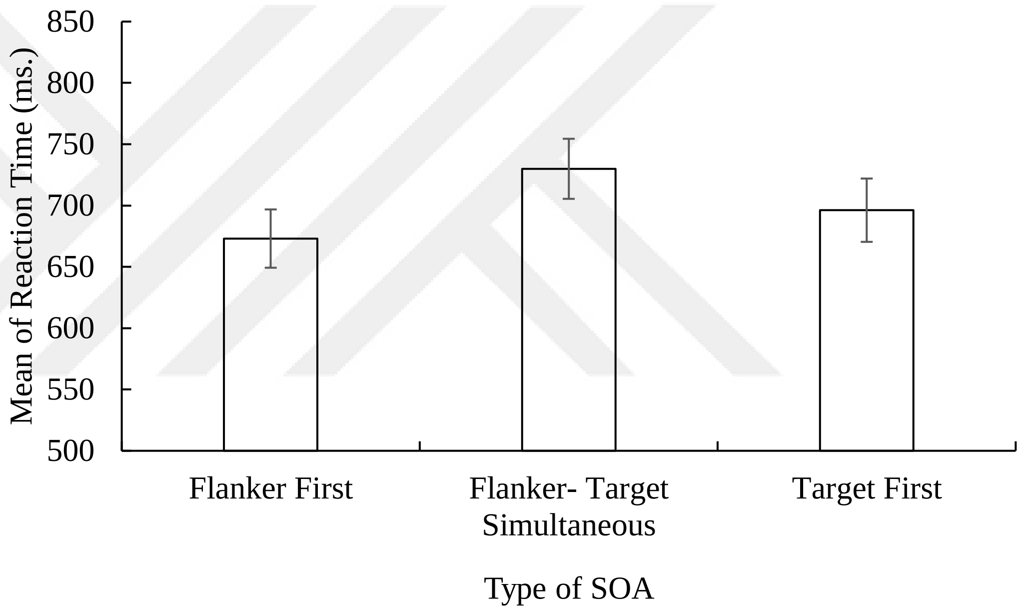

Figure 11. Mean (with 95% CI) reaction time of the participants SOA.

However, the results indicated that, the main effect of proportion congruency on reaction time was not statistically significant, $F_{(1, 79)} = 1.00$, $MSE = 11193.74$, $p > .05$

Also, there was significant interaction effect between item type and proportion congruency, $F_{(1,79)} = 101.25$, $MSE = 1487.32$, $p < .05$, $\eta^2 = .56$. Contrast compared each type of item across proportion congruency (MC and MI). As seen in Figure 12, item type effect on speed of reaction time was observed much more in MC list between congruent trials ($M = 647.08$, $SE = 18.88$) and incongruent trials ($M = 728.52$, $SE = 18.76$) as compared to between congruent trials ($M = 705.87$, $SE = 14.22$) and incongruent trials ($M = 716.88$, $SE = 15.04$) in the MI list.

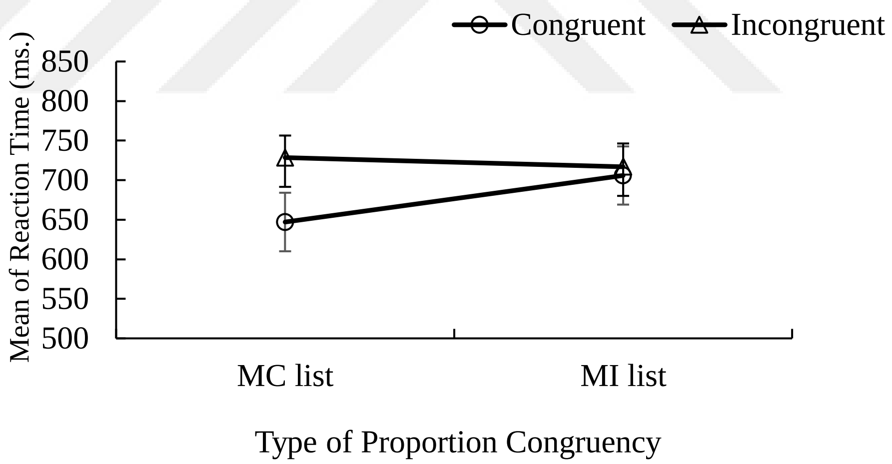

Figure 12. Mean (with 95% CI) reaction time of the participants in different proportion congruency conditions by item type.

Also, the interaction between SOA and item type was statistically significant, $F_{(1.94, 157.51)} = 46.96$, $MSE = 1765.43$, $p < .05$, $\eta^2 = .37$. As a follow-up test, flanker target letter simultaneous condition had significantly slower reaction time for both congruent ($M = 704.10$ $SE = 12.73$) and incongruent trials ($M = 755.80$, $SE = 13.30$) as compared to flanker letter first condition's congruent ($M = 629.40$, $SE = 14.36$) and incongruent ($M = 716.72$, $SE = 12.08$) trials; $F_{(1, 79)} = 14.45$, $MSE = 106485.50$, $p < .05$, $\eta^2 = .15$ and target letter first condition's congruent ($M = 697.03$, $SE = 13.20$) and incongruent trials ($M = 695.37$, $SE = 13.70$); $F_{(1,79)} = 32.89$, $MSE = 232174.29$, $p < .05$, $\eta^2 = .29$. As seen in Figure 13, duration of reaction time increased when SOA moved on to the flanker target letter simultaneous condition from the flanker letter first condition and then it again decreased when SOA moved to the target letters first condition. Also, as seen in the figure, the flanker effect was not observed when SOA moved to target letter first condition as compare the flanker letter first and flanker target letter simultaneous condition.

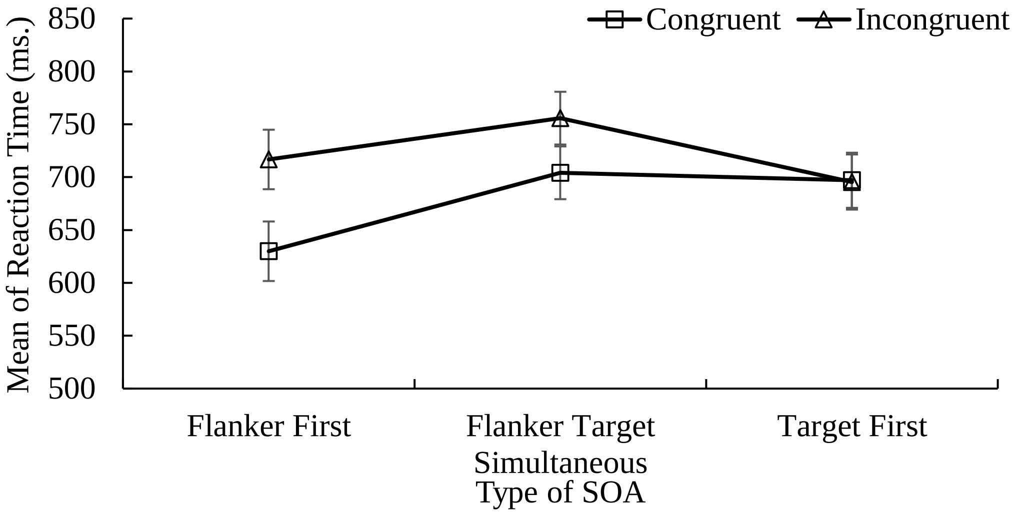

Figure 13. Mean (with 95% CI) reaction time of the participants in different SOA conditions by item type.

On the other hand, the interaction between proportion congruency and SOA was not statistically significant, $F_{(1.98, 156.51)} = 1.86$, *MSE* = 5014.65, $p > .05$.

Finally, three -way interaction between item type, SOA and proportion congruency was statistically significant, $F_{(1.94, 157.51)} = 28.51$, *MSE* = 1765.43, $p < .05$, $\eta^2 = .27$ which indicates item type x SOA interaction differed across MC and MI list. Contrast indicated that, while the flanker interference was observed statically significant between the conditions of flanker letters first and flanker target letter simultaneous, $F_{(1,79)} = 29.84$, *MSE* = 7370.59, $p < .05$, $\eta^2 = .27$; this interference was disappeared when SOA moved target letters first condition from the flanker target letter simultaneous condition, $F_{(1,79)} = 2.54$, *MSE* = 7060.12, $p > .05$ for both MC and MI list. As seen in Figure 14, in the flanker letter first condition; congruent trials that were placed in MC list (*M* = 571.80, *SE* = 19.59) and MI list (*M* = 685.59, *SE* = 17.02) had faster reaction time as compared the incongruent trials that were placed in MC list (*M* = 734.96, *SE* = 18.05) and MI list (*M* = 698.24, *SE* = 15.82). Similarly, in the flanker target letter simultaneous condition; congruent trials that were placed in MC list (*M* = 680.80, *SE* = 19.95) and MI list (*M* = 726.83, *SE* = 15.36) had faster reaction time as compared to the incongruent trials that were placed in MC list (*M* = 755.60, *SE* = 21.29) and MI list (*M* = 756.00, *SE* = 16.37). On the other hand, in the target letter first condition, reaction time difference was not observed both for the congruent trials that were placed in MC list (*M* = 688.65, *SE* = 20.44) and MI list (*M* = 705.20, *SE* = 16.96) and incongruent trials that were placed in MC list (*M* = 694.98, *SE* = 22.28) and MI list (*M* = 695.76, *SE* = 16.41). That means, flanker interference disappeared when SOA was moved to target letter first condition.

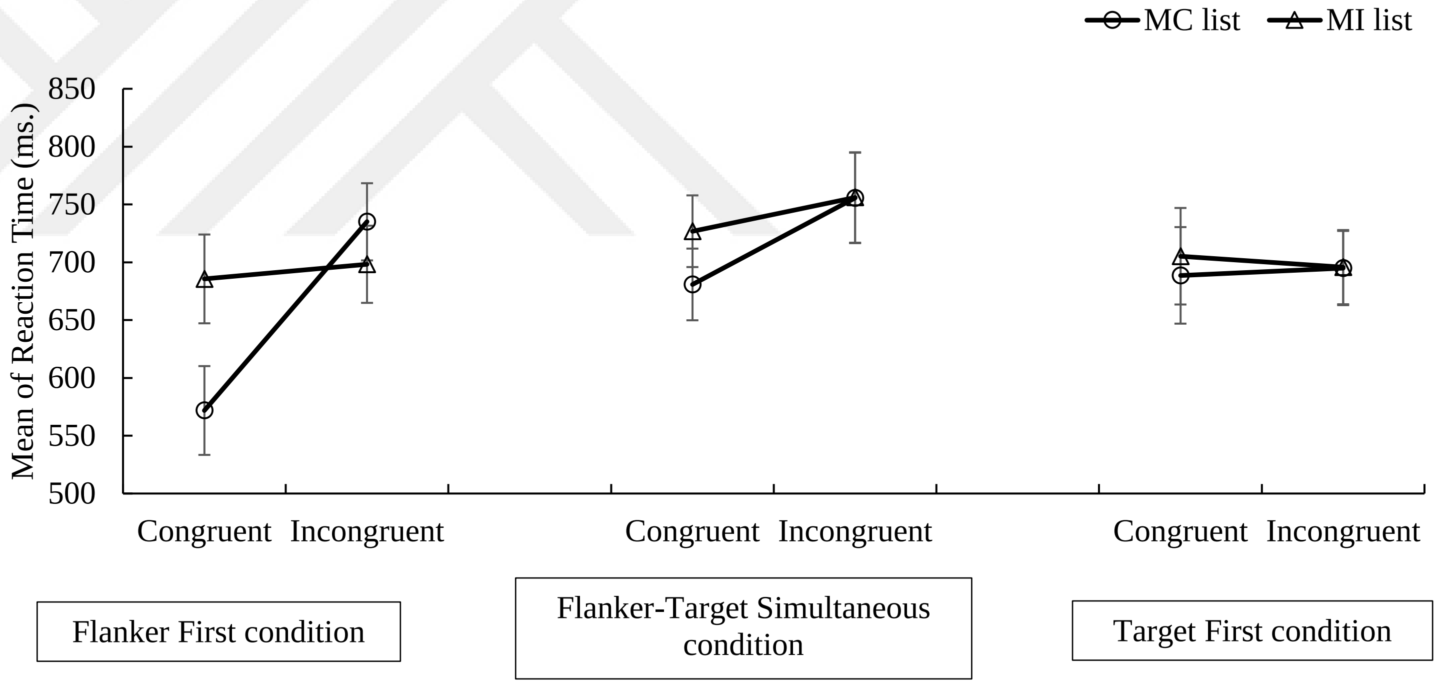

Figure 14. Mean (with 95% CI) reaction time of congruent and incongruent items in different type proportion congruency for each SOA condition.

3.1.2. Data Analysis Method of Error Rate

For experiment 1 (LLPC) error rate analysis of results were reported as statically significant when they reached at least 0.05 alpha level. Also, F values were reported with Greenhouse-Geisser correction and effect sizes were reported as a partial eta squared. Error rate means, and graphs were reported, even they were not significant, to prove error rate results were parallel with reaction time results.

3.1.2.2. Results of the Error Rate Analysis in LLPC Manipulation (Experiment 1)

2 (proportion congruency: MC and MI) x 2 (item type: congruent and incongruent) x 3 (SOA: flanker letter first, flanker target letter simultaneous, target letter first) mixed design factorial ANOVA was conducted to investigate whether number of error rate was influenced by proportion congruency of items and item type depend on SOA. Variables (SOA and item type) were manipulated in one block as a within subject factors while proportion congruency was manipulated between-subject factors.

Results showed the main effect of item type on error rate was statistically significant, $F_{(1, 79)} = 5.14$, $MSE = 29.17$, $p < .05$, $\eta^2 = .06$. As seen in Figure 15, incongruent trials had higher error rate ($M = 3.59$, $SE = .46$) than congruent trials ($M = 2.49$, $SE = .28$) which tells Flanker interference influenced the error rate significantly in LLPC experiment.

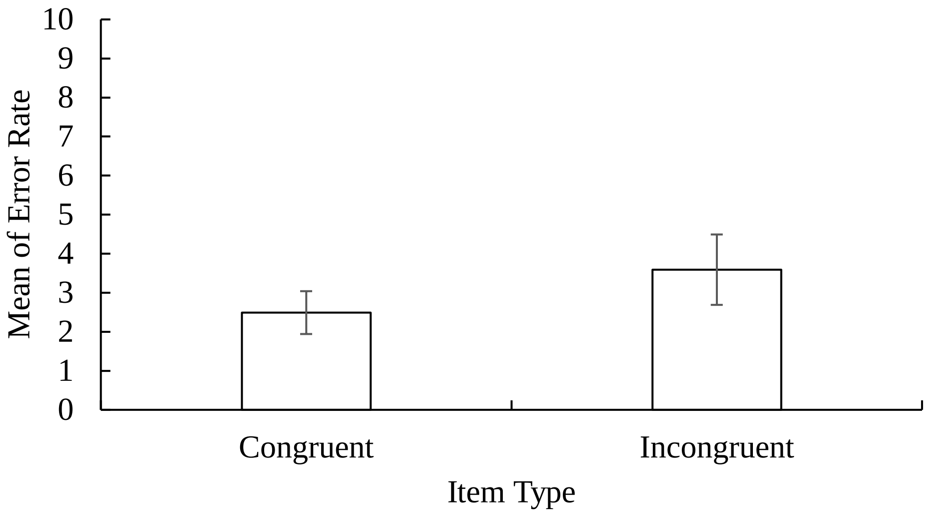

Figure 15. Mean (with 95% CI) error rate of the participants depend on item type.

However, the main effect of SOA was not statistically significant, $F_{(1.79, 141.64)} = .78$, $MSE = 16.76$, $p > .05$. Likely, results were parallel with SOA main effect of reaction time results. Flanker target letter simultaneous condition (M = 3.36, SE = .55) had significantly higher error rate number -even it was not significant-than the both flanker letters first (M = 2.77, SE = .32) and target letters first condition (M = 2.99, SE = .31); (see Figure 16).

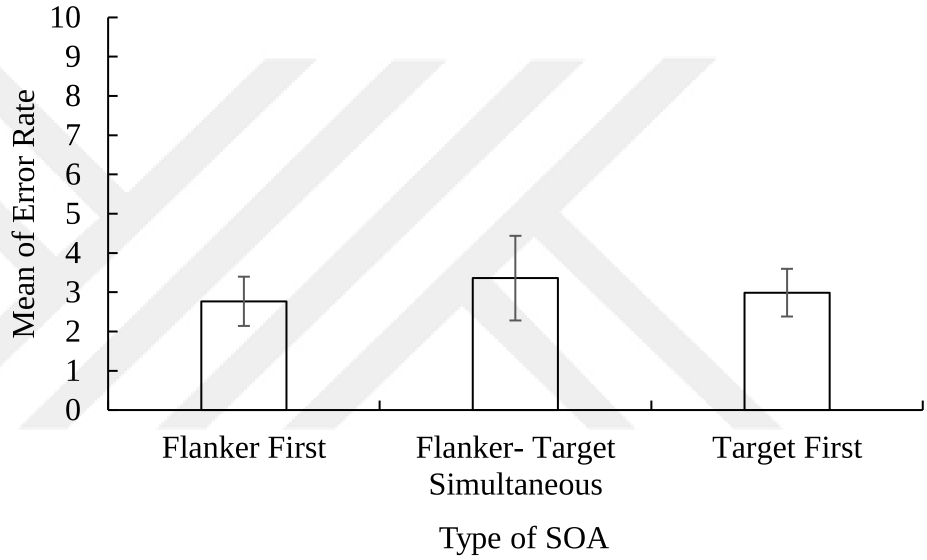

Figure 16. Mean (with 95% CI) reaction time of the participants SOA.

Also, the results indicated that, main effect of proportion congruency on error rate was not statistically significant, $F_{(1, 79)} = 1.26$, $MSE = 8.61$, $p > .05$ likewise reaction time results of LLPC experiment.

Moreover, results showed that, item type and proportion congruency interaction were not statistically significant, $F_{(1,79)} = .10$, $MSE = 29.17$, $p > .05$. As seen in Figure 17, item type effect on number of error rate was observed much more in MC list between congruent trials (*M* = 2.24, *SE* = .48) and incongruent trials (*M* = 4.00, *SE* = .88) as compared to between congruent trials (*M* = 2.74, *SE* = .28) and incongruent trials (*M* = 3.20, *SE* = .30) in the MI list demonstrates similar results with Figure 12.

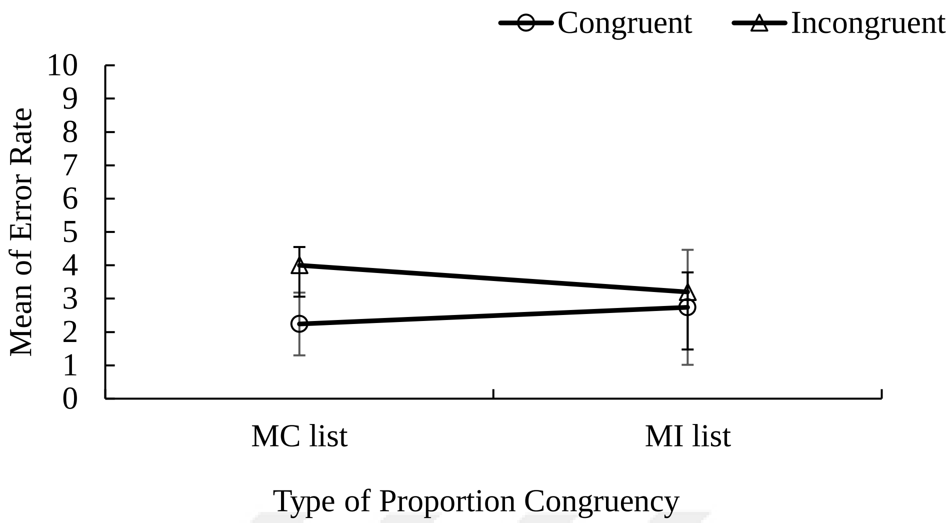

Figure 17. Mean (with 95% CI) error rate of the participants in different proportion congruency conditions by item type.

Also, the interaction between SOA and item type was statistically significant, $F_{(1.69, 133.77)} = 4.70$, $MSE = 19.31$, $p < .05$, $\eta^2 = .06$. As a follow-up test, even the results were not significant, flanker interference on the number of the error rate was observed much more in the flanker letters first condition between the congruent ($M = 2.05$, $SE = .46$) and incongruent trials ($M = 4.66$, $SE = .37$) and also interference was higher in the flanker target letter simultaneous condition of congruent ($M = 2.40$, $SE = .38$) and incongruent trials ($M = 3.14$, $SE = .93$) as compared to target letter first condition of the congruent ($M = 3.00$, $SE = .48$) and incongruent trials ($M = 2.97$, $SE = .47$). As seen in Figure 18, flanker interference was still observed when SOA moved on to the flanker target letter simultaneous condition from the flanker letter first condition and then its effect had disappeared when SOA moved to the target letters first condition.

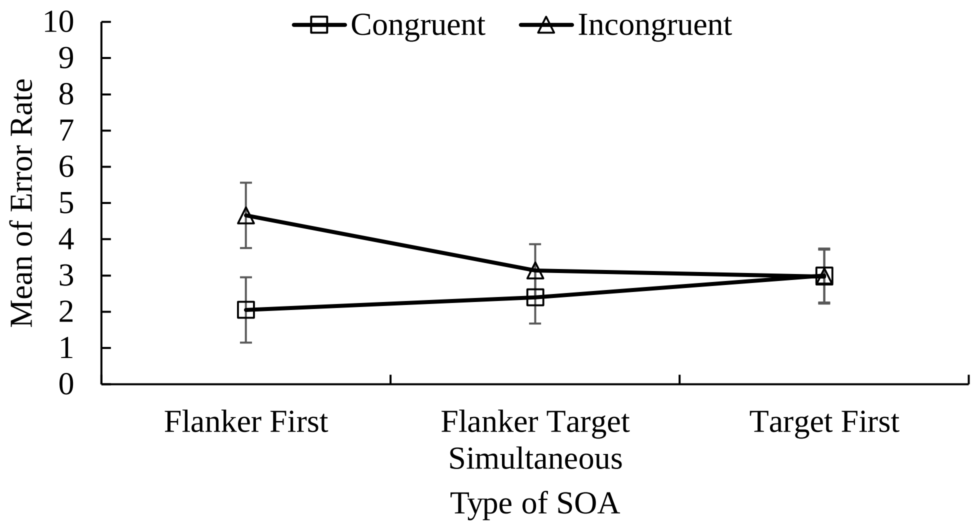

Figure 18. Mean (with 95% CI) reaction time of the participants in different SOA conditions by item type.

Also, the interaction between proportion congruency and SOA was statistically significant, $F_{(1.79, 141.63)} = 4.15$, $MSE = 21.54$ $p < .05$, $\eta^2 = .06$. As seen in Figure 19, in the mostly congruent list the number of error rate reached the top level when SOA at the flanker letter first condition ($M = 4.48$, $SE = .91$) and then it again decreased when SOA moved to flanker-letter simultaneous condition ($M = 2.89$, $SE = .51$) and the target letters first condition ($M = 2.74$, $SE = .47$). However, in the mostly incongruent list, error rate was observed at the highest level in the target letter first condition ($M = 3.24$, $SE = .43$) while it decreased in the flanker letter first condition ($M = 2.26$, $SE = .45$) and flanker target letter simultaneous condition ($M = 2.65$, $SE = .45$).

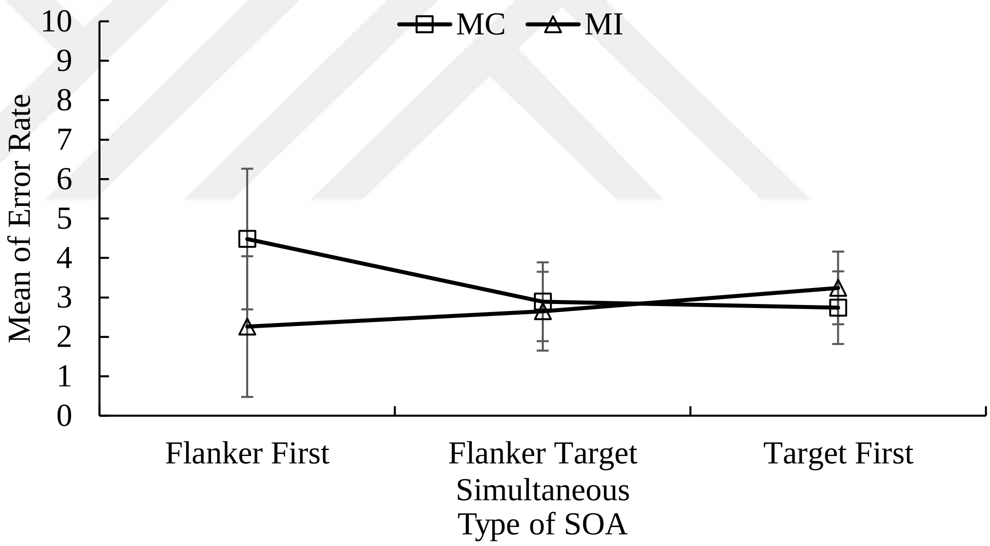

Figure 19. Mean (with 95% CI) reaction time of the participants in different SOA conditions by proportion congruency.

Finally, three-way interaction between item type, SOA and proportion congruency was also statistically significant, $F_{(1.69, 133.77)} = 6.11$, $MSE = 19.31$, $p < .05$, $\eta^2 = .07$ which indicates item type x SOA interaction differed across MC and MI list. Even contrasts were not meaningful error rate results for the three-way interaction seemed parallel with the reaction time results. As seen in Figure 20, in the flanker letter first condition; congruent trials that were placed in MC list (*M* = 2.27, *SE* = .31) and MI list (*M* = 1.83, *SE* = .85) had less error rate as compared the incongruent trials that were placed in MC list (*M* = 6.69, *SE* = .77) and MI list (*M* = 2.29, *SE* = .42). Interestingly, in the flanker target letter simultaneous condition, congruent trials that were placed in MC list (*M* = 2.50, *SE* = .41) and MI list (*M* = 2.29, *SE* = .61) had similar error rate difference with the incongruent trials that were placed in MC list (*M* = 3.28, *SE* = .80) and MI list (*M* = 3.01, *SE* = .49). Moreover, when SOA moved on to target letter first condition, congruent trials that were placed in MC list (*M* = 3.43, *SE* = .39) and MI list (*M* = 2.59, *SE* = .64) had higher error rates than the incongruent trials that were placed in MC list (*M* = 2.03, *SE* = .84) and MI list (*M* = 3.88, *SE* = .39). The critical point in these results is that, in the reaction time analysis flanker interference disappeared significantly when SOA was target letter first condition. Unlikely, in error rate analysis dissociation was started to observe in flanker target letter simultaneous condition. However, error rate analysis should be ignored due to non-significant contrast results.

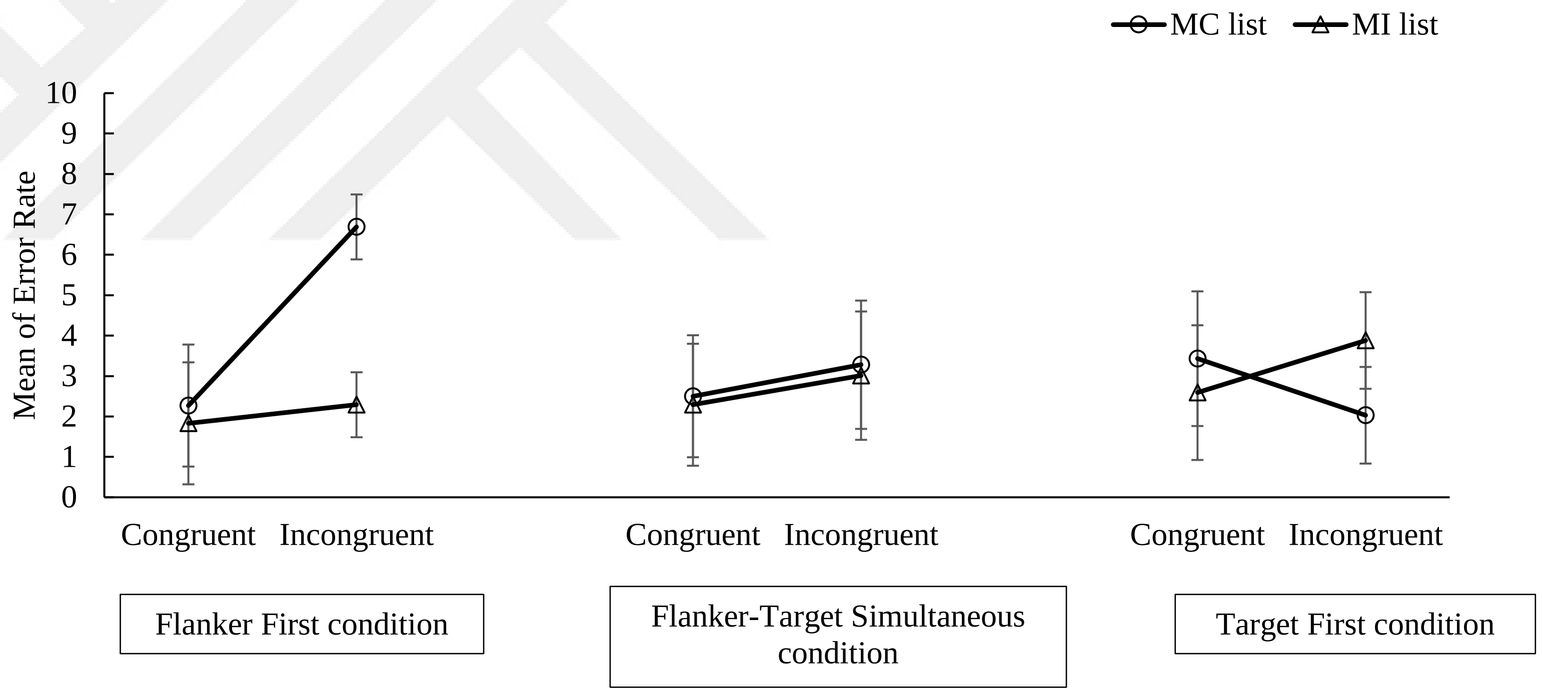

Figure 20. Mean (with 95% CI) error rate of congruent and incongruent items in different type proportion congruency for each SOA condition.

CHAPTER 4

Method

4.1. Item Specific Proportion Congruency Manipulation (Experiment 2)

The major purpose of the item specific proportion congruency experiment was to reveal insights into the reactive control mechanism.

4.1.1. Participants:

The sample of the research was composed of healthy participants randomly selected from the Izmir University of Economics undergraduate student population. Totally, 40 participants (32 females, 8 males) participated ISPC manipulation (experiment 2) to measure the reaction time differences depending on different proportion congruency conditions (low proportion congruent item set vs. high proportion congruent item set) and the mean age was 21.28.

Sample in Experiment 2, none of them had participated in LLPC experiment. Also, the same participation criteria were determined as those in Experiment 1.

4.1.2. Stimuli

Same stimuli were used as in experiment 1. Likewise, in LLPC experiment, stimuli were arranged by D, F, J, K letters with different proportion congruent (equal in list level: high proportion congruent in item set vs. low proportion congruent in item set). D and F letters were determined as mostly congruent items set; J and K letters were determined as mostly incongruent items set.

Also, Flanker letters paradigm include two different proportion congruency conditions (MC items set or MI items set) and those proportion congruency conditions were presented to the same participants that would be described in detail below.

Item-specific proportion congruency (ISPC) manipulation (experiment 2) was manipulated as a within subject factors and totally, 120 congruent and

120 incongruent stimuli were used randomly in one block. The sequence of congruent flanker stimuli was like; DDD, FFF, JJJ, KKK and incongruent trials was like DFD, FDF, JKJ, KJK. In the block, flanker stimulus which composed D and F letters were presented 48 times as congruent trials and 12 times as incongruent trials within the high proportion congruent items category while J and K letters were presented 12 times as a form of congruent trials and 48 times as incongruent trials within low proportion congruent items category (see table 4). Table 4 also include LLPC stimuli presentation method (as same table 3) to understand well, the difference between LLPC manipulation and ISPC manipulation stimuli presentation method.

Same stimulus onset asynchrony (SOA) manipulation method was used as experiment 1.

Table 4. Frequency of Flanker stimuli presentation during in one block for the each proportion congruency condition.

Proportion Congruency	Flanker	Task D	Task F	Task J	Task K
Mostly Congruent Item Set	D	48	12	0	0
	F	12	48	0	0
Mostly Incongruent Item Set	J	0	0	12	48
	K	0	0	48	12

4.1.3. Apparatus

The same apparatus was used as LLPC experiment.

4.1.4. Data Acquisition

4.1.4.1 Procedure

The procedure of ISPC experiment was identical to that of the LLPC experiment (see Figure 9).

4.1.5. Research Design

To investigate the ISPC effect (experiment 2); both item specific proportion congruency conditions (high proportion congruent item set and low proportion congruent item set) and both SOA conditions (-250 ms, 0 ms., +250 ms.) were manipulated as a within-subject factors in one block.

If the whole experiments designs were summarized, different participants were used to control the list level proportion congruency effect (LLPC: MC vs. MI lists) while the same participants were used to control item specific proportion congruency effect (ISPC: high proportion congruent item vs. low proportion congruent item sets). Finally, stimulus onset asynchrony (-250 ms., 0 ms., +250 ms.) was manipulated as a within subject factors in one block for both LLPC experiment and ISPC experiment.

CHAPTER 5

Results

5.1. Results of the ISPC Experiment

5.1.1. Data Analysis Method of Reaction Time

Before the analysis of reaction time was conducted for experiment 2 (ISPC); incorrect trials with the previous trial were excluded from the analysis to avoid effects of sequential repetition (Mayr et al., 2003). Also, participants who had high error rates were excluded from the analysis. In the ISPC experiment, analysis was run with 84.72% of trials. For all analysis, results were reported as statically significant when at least 0.05 alpha level was reached. Also, F values were reported with Greenhouse-Geisser correction and effect sizes were reported as a partial eta squared.

5.1.1.2. Results of the Reaction Time Analysis in ISPC Manipulation (Experiment 2)

2 (item type: congruent and incongruent) x 2 (ISPC: MC and MI) x 3 (SOA: flanker letter first, flanker target letter simultaneous and target letter first) repeated measures factorial ANOVA was conducted to investigate whether reaction time was influenced by proportion congruency of items and item type depend on SOA. Both variables (SOA, proportion congruency and item type) were manipulated in one block as a within subject factors.

The results indicated that the main effect of item type on reaction time was statistically significant, $F_{(1, 39)} = 40{,}30$, $MSE = 4789{,}453$ $p < .05$, $\eta_p^2 = .51$. As seen in Figure 21, incongruent trials had higher reaction time rate (M = 722.43, SE = 20.20) than congruent trials (M = 682.34, SE = 21.24) which demonstrated, Flanker interference was significantly observed in ISPC experiment.

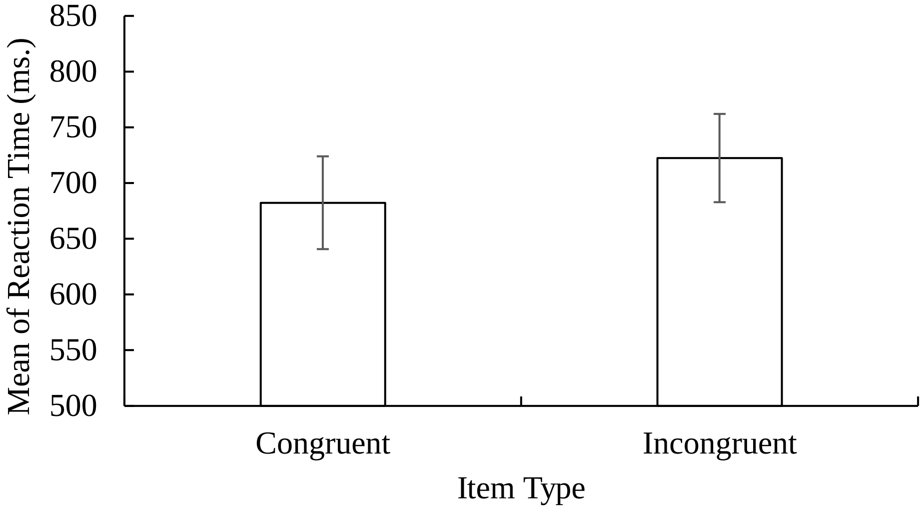

Figure 21. Mean (with 95% CI) reaction time of the participants depending on item type.

Also, the results showed that the main effect of SOA was statistically significant, $F_{(1.97,\ 76.81)} = 13.63$, $MSE = 12107,159$, $p < .05$, $\eta_p^2 = .26$. Contrast revealed that, flanker target letter simultaneous condition ($M = 739.16$, $SE = 20.53$) had significantly higher reaction time than both target letter first condition ($M = 683.30$, $SE = 20.90$); $F_{(1,39)} = 22.31$, $MSE = 5595,41$ $p < .05$, $\eta_p^2 = .36$ and flanker letter first condition ($M = 684.69$, $SE = 23.45$); $F_{(1,39)} = 21.35$, $MSE = 5560,81$, $p < .05$, $\eta_p^2 = .35$. As expected, the reaction time duration was significantly influenced by SOA manipulation (Figure 22).

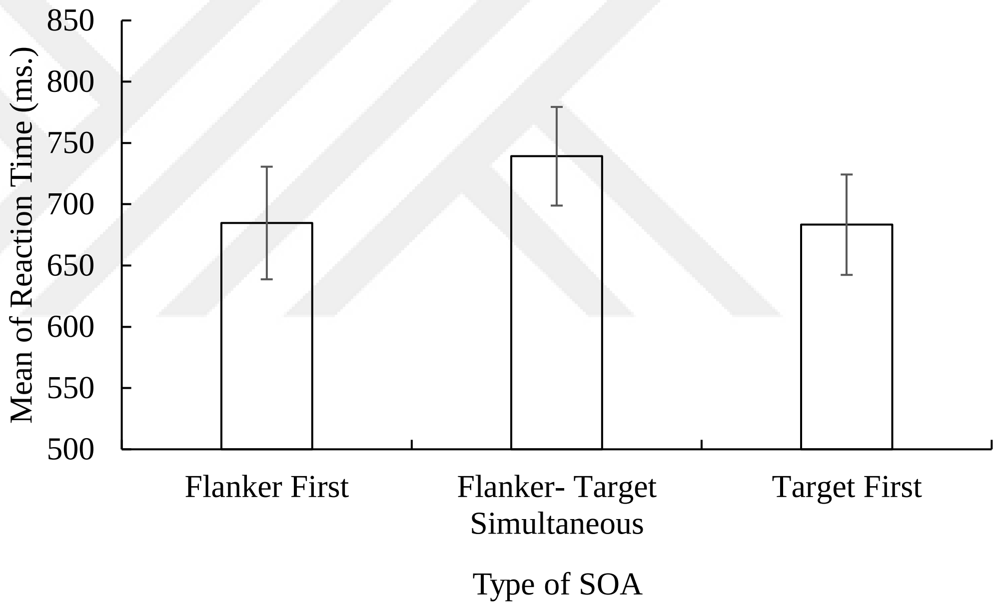

Figure 22. Mean (with 95% CI) reaction time of the participants SOA.

On the other hand, the main effect of proportion congruency was not statistically significant, $F_{(1,39)}$ =.45, *MSE* = 25270,834, $p > .05$.

The interaction between item type and proportion congruency was also statistically significant, $F_{(1, 39)} = 40.50$, *MSE* = 4668,383, $p < .05$, $\eta_p^2 = .51$. That means, the magnitude of Flanker interference was more robust in MC list as compared to the MI list. Detailly, reaction time was observed higher for the incongruent trials (*M* = 737.42, *SE* = 21.38) as compared to congruent trials (*M* = 657.64, *SE* = 21.74) for the mostly congruent list while such difference was not observed in MI list between the items of congruent (*M* = 707.03, *SE* = 21.74) and incongruent (*M* = 707.43, *SE* = 20.99), (Figure 23).

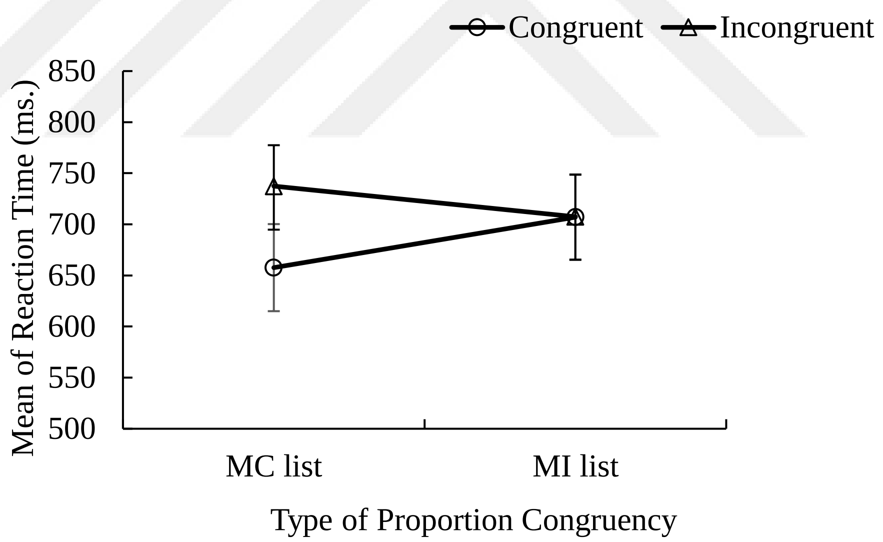

Figure 23. Mean (with 95% CI) reaction time of the participants in different proportion congruency conditions by item type.

Also, SOA was significantly interacted with item type, $F_{(1.91,\ 74.50)}$ = 10.82, *MSE* = 5326,924, $p < .05$, $\eta_p^2 = .22$. As a follow-up test, flanker target letter simultaneous condition had slower reaction time for congruent (*M* = 713.76.10 *SE* = 20.62) and incongruent trials (*M* = 764.56, *SE* = 21.51) as compared to flanker letter first condition's congruent (*M* = 649.36, *SE* = 26.40) and incongruent (*M* = 764.56, *SE* = 21.54) trials; $F_{(1,\ 39)}$ = 1.89, *MSE* = 15760.90, $p > .05$ but this flanker interference difference among SOA conditions was not meaningful. However, flanker target letter simultaneous condition had significantly longer reaction time for congruent (*M* = 713.76.10 *SE* = 20.62) and incongruent trials (*M* = 764.56, *SE* = 21.51) as compared to target letter first condition's congruent (*M* = 683.89, *SE* = 20.56) and incongruent trials (*M* = 682.71, *SE* = 23.04); $F_{(1,39)}$ = 8.89, *MSE* = 108056.03, $p < .05$, $\eta^2 = .19$ which indicates, flanker interference was not observed in target letter first condition. According to Figure 24, both for the congruent and incongruent items duration of reaction times increased when SOA was moved to flanker target letter simultaneous condition as compared the flanker letter first condition, by contrast reaction time length significantly decreased when SOA was moved to target letter first condition.

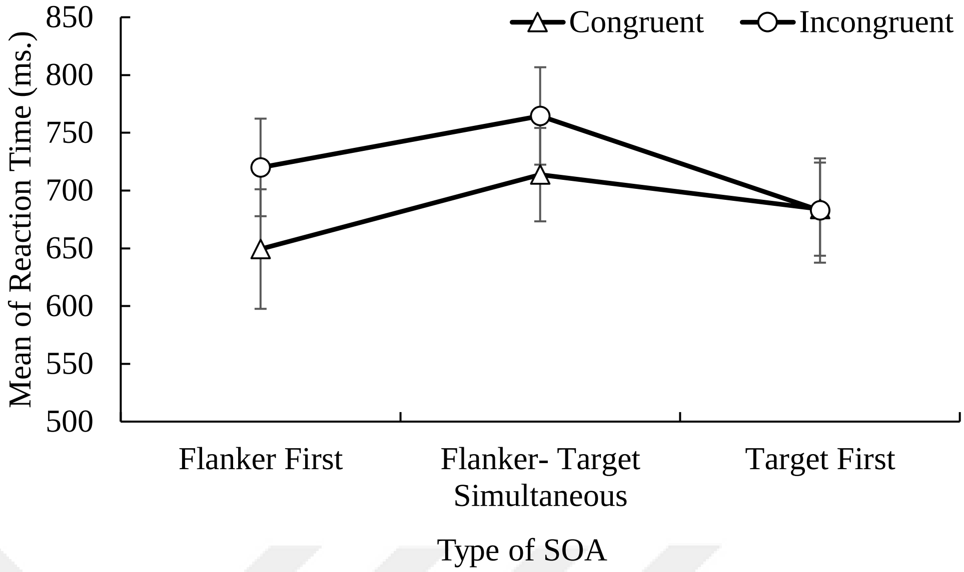

Figure 24. Mean (with 95% CI) reaction time of the participants in different SOA conditions by item type.

However, the two-way interaction between proportion congruency and SOA was not significant, $F_{(1.66, 64,70)} = 2.08$, $MSE = 5550,212$, $p > .05$.

Finally, the three-way interaction between item type, proportion congruency and SOA were not statistically significant, $F_{(1.90, 74.23)} = .52$, $MSE = 5562,343$, $p > .05$.

5.1.2. Data Analysis Method of Error Rate

For Experiment 2 (ISPC) error rate analysis of results were reported as statically significant when at least 0.05 alpha level was reached. Also, F values were reported with Greenhouse-Geisser correction and effect sizes were reported as a partial eta squared. Error rate means, and graphs were reported, even though they were not significant, to prove error rate results were parallel with reaction time results.

5.1.2.1. Results of the Error Rate Analysis in ISPC Manipulation (Experiment 2)

2 (item type: congruent and incongruent) x 2 (ISPC: MC and MI) x 3 (SOA: flanker letter first, flanker target letter simultaneous and target letter first) repeated measures factorial ANOVA was conducted to investigate whether error rate was influenced by proportion congruency of items and item type depending on SOA. Both variables (SOA, proportion congruency and item type) were manipulated in one block as a within subject factors.

The results indicated that main effect of item type on error rate was not statistically significant, $F_{(1, 38)} = 3.10$, $MSE = 141.02$, $p > .05$. However, as seen in Figure 25, incongruent trials had higher error rate numbers ($M = 5.50$, $SE = .82$) than the congruent trials ($M = 4.29$, $SE = .55$) which demonstrated, result was parallel with item type effect on reaction time (see Figure 21).

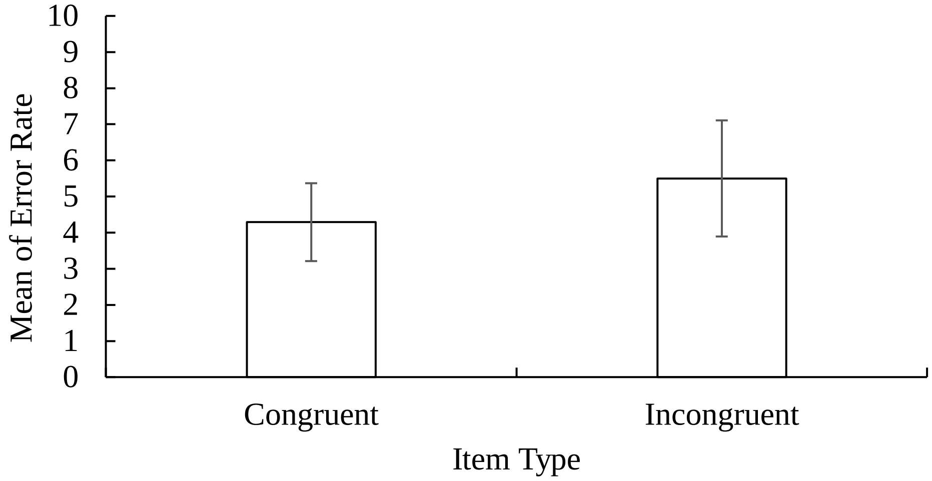

Figure 25. Mean (with 95% CI) error rate of the participants depend on item type.

Also, the results showed that the main effect of SOA was not statistically significant, $F_{(1.96,\ 74.63)} = .59$, $MSE = 21.92$, $p > .05$. On the other hand, when error rate means of SOA condition were compared; flanker target letter simultaneous condition ($M = 5.25$, $SE = .82$) had a higher error rate than both the target letter first condition ($M = 4.84$, $SE = .67$) and flanker letter first condition ($M = 4.59$, $SE = .72$), (Figure 26); as similar the mean reaction time duration in the manipulation of SOA (see Figure 22).

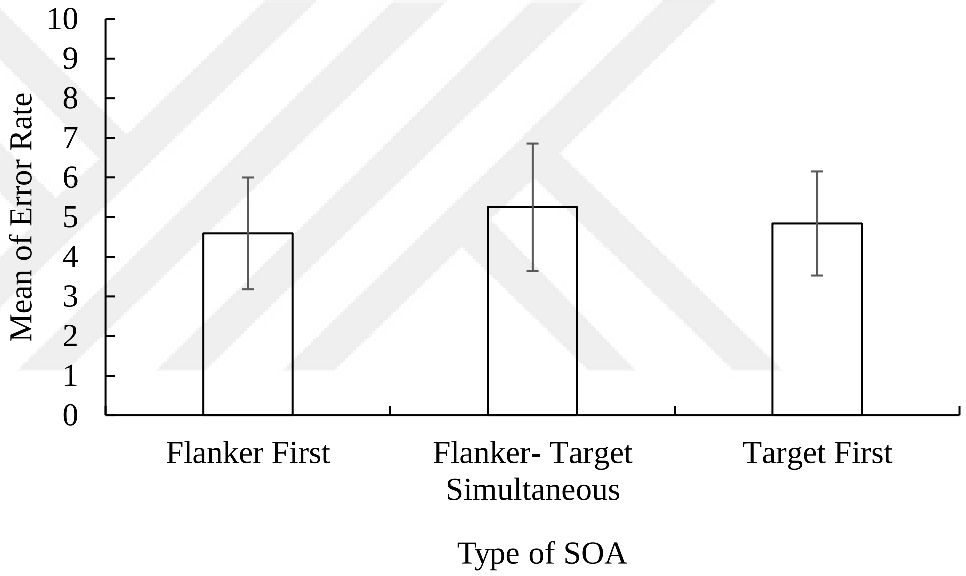

Figure 26. Mean (with 95% CI) error rate of the participants depend on SOA condition.

Moreover, the main effect of proportion congruency was not statistically significant, $F_{(1,38)} = 1.94$, $MSE = 153.93$, $p > .05$ likewise reaction time result of proportion congruency effect.

The interaction between item type and proportion congruency was not statistically significant, $F_{(1, 38)} = 2.37$, $MSE = 92.59$, $p > .05$. However, it seemed parallel with reaction time results of item type and proportion congruency interaction. Because, as seen in Figure 27, error rate was observed higher for the incongruent trials ($M = 3.20$, $SE = .47$) as compared to congruent trials ($M = 1.72$, $SE = .35$) for the mostly congruent list while such difference did was not observed in MI list between the items of congruent ($M = 5.37$, $SE = .97$) and incongruent ($M = 5.68$, $SE = .91$) which is similar to reaction time results (see Figure 23).

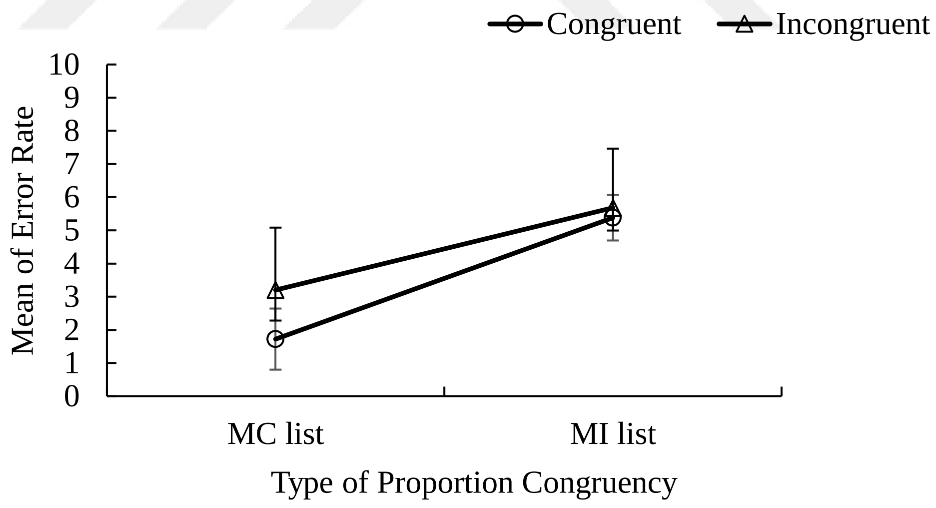

Figure 27. Mean (with 95% CI) error rate of the participants in different proportion congruency conditions by item type.

Also, the interaction between SOA and item type was not statistically significant, $F_{(1.99,\ 75.89)} = 1.25$, *MSE* = 35.24, $p > .05$. According to Figure 28 which was very similar to Figure 18, both for the congruent (*M* = 4.38, *SE* = .82) and incongruent items (*M* = 6.13, *SE* = .98) the number of error rates increased when SOA was moved to flanker target letter simultaneous condition as compared the flanker letter first condition's congruent (*M* = 3.69, *SE* = .79) and incongruent items (*M* = 5.50, *SE* = .91). In contrast, the number of error rate decreased when SOA moved on to target letter first condition both incongruent (*M* = 4.88, *SE* = .71) and congruent items (*M* = 4.80, *SE* = .95).

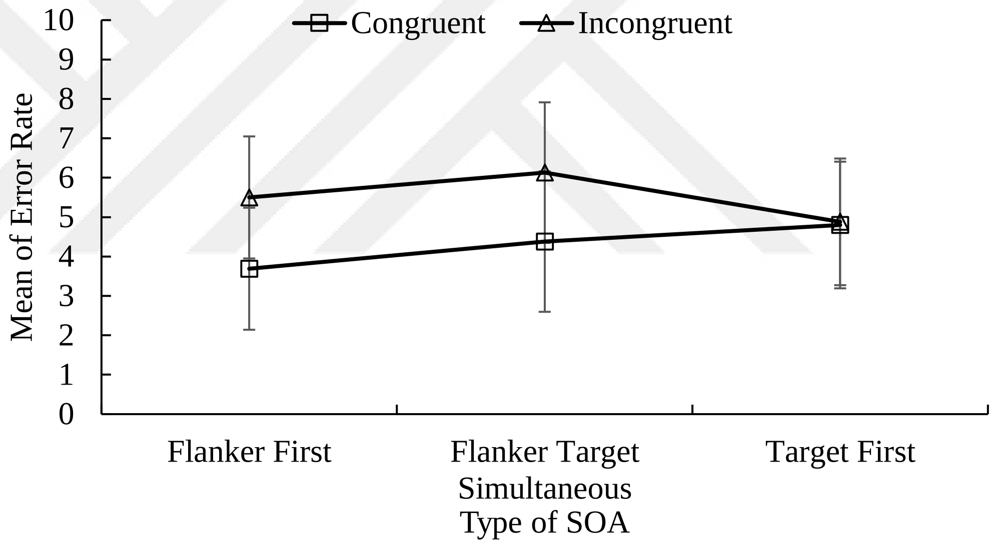

Figure 28. Mean (with 95% CI) error rate of the participants in different SOA conditions by item type.

Finally, the two-way interaction between proportion congruency and SOA; $F_{(1.91\ 72.90)} = 1.13$, $MSE = 43.19$, $p > .05$ and the three-way interaction between item type, proportion congruency and SOA were not statistically significant, $F_{(1.99,\ 75.98)} = 2.84$, $MSE = 65.73$, $p > .05$ as similar reaction time results of experiment 2.

CHAPTER 6

Discussion

In this thesis, proportion congruency effect was investigated with two different experimental paradigms (LLPC & ISPC) depend on SOA manipulation (-250ms., 0 ms., +250ms.). List level proportion congruency effect and item specific proportion congruency effect has been thought to activate different attentional control mechanisms. Because, while list level proportion congruency manipulation activates proactive control mechanism, item specific proportion congruency manipulation activates the reactive control mechanism. However, these two proportion congruency manipulations have been affected on conflict adaptation process closely similar way. In other words, the magnitude of interference effect is observed more in both mostly congruent list and mostly congruent item set conditions than the mostly incongruent list and mostly incongruent item set conditions. Here, to create the contrast between reactive and proactive control mechanisms, inter-trial interval was increased to 3000 milliseconds. Idea was that, higher duration of ITI caused to strength S-R learning association which also provided to growth proactive control mechanism.

Furthermore, as mentioned introduction part; especially two theories which are the contingency learning and conflict monitoring theory, have explanatory power to define the under the mechanisms of interference effect. These two theories have explained the conflict adaptation process in different perspectives (*for detail*s see section 1.3). Therefore, this research was also aimed to clarify the generalizability and validity of these two explanations depend on the results. In order to control this, contingency learning mechanism was manipulated in different SOA conditions. In detail, SOA was manipulated Flanker letter first, at the same time and target letter first conditions and reaction time difference was compared for both ISPC and LLPC experiments.

In the first experiment (LLPC), proportion congruency (mostly congruent list vs. mostly incongruent list) was manipulated with .75 contingency as a between subject factors while SOA manipulation was manipulated as within subject effect in one block. Second experiment (ISPC) was applied as a within subject effect both SOA manipulation, and congruency manipulation. Congruency of items were manipulated at the level of 50% contingency (high proportion congruent items vs. low proportion congruent items) in one block. Also, in the LLPC experiment, using different participants among the lists provided to increase the number of presented stimuli as compared to ISPC experiment. Therefore, validity of LLPC experiment result was improved.

In addition, using letter-based flanker paradigm as a conflict task provides more advantageous than using Stroop paradigm. Because, in the flanker test, flanker interference is only based on the task conflict rather than dominance effect of habitual tendency (i.e., reading the word instead of saying color) unlike Stroop test (Melara & Algom, 2003 and Bugg, 2015).

6.1. Effect of Proportion Congruency Manipulations on Flanker Interference

ISPC manipulation and LLPC manipulation experiments have shown similar pattern in terms of the interference effect. As it was expected, the magnitude of interference effect was observed less in MI item set and list than the MC item set and list both for experiment 1 and experiment 2. More specially, reaction time of congruent items had more advantageous in the MC list or mostly congruent items set than the MI list or mostly incongruent items set. However, such this advantageous was not observed in incongruent items when MC and MI lists or item sets were compared in both ISPC and LLPC experiment (see table 4). This result supports the contingency learning hypothesis account, because contingency learning explains the conflict adaption in terms of the associative learning between the stimulus and response (Schmidt & Besner, 2008) rather than conflict control of attention. As seen the results, participants easily have associated congruent items in MC list and congruent items set than the MI list and incongruent items set and this associative learning mechanism did not change depend on list level or item level congruency manipulations. Results also inconsistent with the item or list level attentional control account which explains the interference effect in terms of the amount of incongruent stimulus (Botvinck et al., 2001 and Bugg & Hutchison, 2013). According to these results, reaction time of incongruent items did not change across the MC or MI lists or items sets. Interference effect difference was occurred due to congruent items reaction time difference across lists. To conclude, reactive and proactive control mechanisms difference has not supported depend on congruency manipulation method. However, reaction time results support to contingency learning explanation both ISPC and LLPC manipulations effect.

6.2. Effect of SOA Manipulation on Flanker Interference

SOA manipulation had worked as expected both LLPC and ISPC experiment. In other words, SOA was significantly interacted with item type in experiment 1 and experiment 2. Detailly, incongruent items had longer reaction time than the congruent item in flanker letter first condition and flanker-target letter simultaneous condition. On the other hand, such reaction time difference between the congruent and incongruent items was not observed when SOA was target letter first condition. That means, the magnitude of flanker interference was changed depend on SOA conditions (Glasser & Glasser, 1982). As it was expected, contingency learning hypothesis is again supported with these results. Because, when flanker letter was used to predict response, flanker interference was observed highest. However, such magnitude of interference effect did not significantly differ between the flanker letter first and flanker-target at the same time condition. That means, contingency learning mechanism is worked as well as similar when it was strengthened SOA manipulation (-250 ms.) and the typical conflict task (0 ms.). Importantly, flanker interference significantly disappeared when target letter presented first (see table 4). Because, presenting target letter first obstruct to learn stimulus-response association. Summarize, ISPC and LLPC experiment demonstrated similar pattern under the SOA manipulation. Reaction time results also proved the SOA effect on flanker interference both ISPC and LLPC experimental manipulation.

Also, this finding considered, conflict adaptation is changed depend on experimental paradigm procedure. Because, Atalay & Mısırlısoy (2014) results referred, when the SOA was manipulated in the Stroop paradigm, Stroop interference was still observed significantly in the +200 SOA condition even it was smaller than other SOA conditions (-200, -100, 0, 100, 200 ms.).

6.3. Effects of Proportion Congruency Manipulations on Flanker Interference depend on SOA Manipulation

The most important finding for the results was that, dissociation was observed between the ISPC and LLPC experiment when flanker interference was compared across the lists (MC vs. MI) or (high proportion congruency items vs. low proportion congruency items) depend on SOA manipulation (see table 5).

In the LLPC experiment, flanker interference was significantly differed across the lists or item sets depend on SOA. Detailly, when SOA was flanker letter first and flanker target letter simultaneous conditions, congruent items reaction time was more advantageous in mostly congruent list than the congruent items that placed in mostly incongruent list. However, such advantageous was not observed when SOA was target letter first condition so, flanker interference was not observed in positive SOA manipulation across to lists. In other words, interference effect is observed in flanker letters first and flanker target simultaneous condition while such effect was not observed when SOA was target letter first condition. This result suggested that, S-R learning strategy became less useful when participant used target letter to predict response. Therefore, positive (+250 ms.) SOA condition significantly differed from the negative (-250 ms.) SOA and simultaneous (0 ms.) SOA conditions. Importantly, such significant interaction effect has not observed in ISPC experiment. Specially, flanker interference has not changed depend on SOA manipulation across to high proportion congruent items set vs. low proportion congruent items set. In other words, contingency learning mechanism had worked functional in ISPC experiment under the both condition of SOA manipulations. On the other hand, in LLPC experiment, contingency learning mechanism has not worked efficiently in target letter first condition. This result was the first demonstration of the distinction between proactive control (LLPC effect) and reactive control (ISPC effect) mechanisms. Findings are considered as an effect of inter-trial interval. In the LLPC experiment, participant used proactive control mechanism which based on ability to predict of upcoming stimulus (Schmidt & Besner, 2008; Schmidt, 2013 and Carter et al., 2000) and this control mechanism was strengthened by increasing ITI to 3000 milliseconds. Therefore, the magnitude of interference effect was observed much more due to strengthening S-R learning mechanism in SOA conditions where the contingency learning mechanism was developed more powerful (flanker letters first & flanker target letter simultaneous). However, when the contingency learning strategy was decreased (target letter first condition) ITI effect have also lost its efficiency. Because, participant did not used any strategy to associate stimulus and response in target letter first condition. Therefore, interference was not observed in this SOA condition. In other words, list level control of attention had a greater role than item level control of attention in the LLPC experiment. So, to strength the contingency learning strategy with the 3000 ms. ITI changed the LLPC effect between the SOA conditions. However, in the ISPC experiment, the magnitude of interference effect did not change significantly in both SOA condition across the lists. Because in experiment 2, learning occurred at the item level which refers, ISPC manipulation need to reactive control mechanism (Jacoby et al., 2003; Braver, 2012; Appelbaum et al., 2014 and Gonthier et al., 2016). This control mechanism has not been influenced by increasing length of ITI duration. For that reason, the magnitude of interference effect did not change across item sets depending on SOA conditions.

Table 5. Summary of Hypotheses

I. Effect of Proportion Congruency Manipulations on Flanker Interference	
1. Larger Flanker interference is observed in mostly congruent list and high proportion congruent item set than the mostly incongruent list and high proportion congruent item set.	Full Support
II. Effect of SOA Manipulation on Flanker Interference	
1. Larger Flanker interference effect is observed than the typical conflict adaptation paradigm results in the negative SOA (-250 ms.) condition.	Partial Support
2. The magnitude of Flanker interference is observed similar with typical conflict adaptation paradigm result in flanker- target letters at the same time (0 ms.) condition.	Full Support
3. Smaller Flanker interference effect is observed than the typical conflict adaptation paradigm results in the positive SOA (+250 ms.) condition.	Full Support
III. Effects of Increasing ITI on Proactive Control Mechanism and Reactive Control Mechanism	
1. Proactive control mechanism (LLPC effect) is influenced more from increasing ITI than the reactive control mechanism (ISPC effect).	Full Support

6.4. Limitations

Several limitations could be thought in this thesis. One is, between subject design was used in the LLPC experiment. Individual difference might have varied on reaction time results. So, the next study should consider a new experimental design which allows to manipulate LLPC experiment as a within subject factor.

The second limitation is, inter-trial interval effect was observed only one condition (3000 ms.) was observed. However, in order to test the effectiveness of ITI, research should be contained different ITI conditions. Because, comparative results would provide more detailed information about the ITI effect.

The final limitation is related to the total number of trials, which was decreased in ISPC experiment compared to LLPC experiment. This was due to increased inter-trial interval duration in the second experiment. As mentioned before, totally 240 stimuli were used to investigate ISPC effect. Half of the stimuli was presented as high proportion congruent item set while the other half was presented as low proportion congruent item set. Although the number of stimuli were enough to search ISPC effect, more amounts of stimuli generate greater reliability. Therefore, LLPC has higher reliability because 240 stimuli were used each condition (mostly congruent list and mostly incongruent list).

6.5. Directions for Future Research

Present thesis suggested that, cognitive control is defined as a performance of distinct mechanisms. This conclusion refers, conflict adaptation and proportion congruency effect are needed more than a single control mechanism. Therefore, future research should consider defining which mechanism is required in conflict adaptation and the way of adapting the behavior when faced with a conflict situation. Investigation of new factors, which are related to the timing process, in attentional control of conflict might be informed clearer about distinction of cognitive control mechanism (proactive control and reactive control).

Secondly, behavioral results of this thesis should be supported by neuroimaging techniques. Brain circuits activations, when participant is under the effect of proportion congruency and SOA manipulation, would be most important supporter for current study results. Because, brain mapping would help to better understand which mechanism is needed for conflict adaptation.

6.6. Conclusion

Current thesis focused on the proportion congruency effect (LLPC & ISPC) manipulating by SOA. Results of research replicated the previous findings on proportion congruency. Flanker interference was larger in mostly congruent list and high proportion congruent item set likewise the previous studies. Moreover, flanker interference was significantly influenced by the SOA manipulation. More specifically, when the contingency learning was decreased, flanker interference also decreased. Therefore, the results showed that, contingency learning mechanism and conflict adaptation process are related to each other (Schmidt & Besner, 2008). Furthermore, increasing inter-trial interval provides to dissociate ISPC and LLPC effect from each other. Flanker interference showed different patterns in positive SOA condition across to ISPC experiment and LLPC experiment. This finding suggested that, more than one mechanism exists under the conflict control.

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Appendix 1

KATILIM ONAY FORMU

"Dikkatin kontrolünde Uyumluluk oranı etkilerinin yarattığı davranışsal farkın incelenmesi" adlı araştırma projesine, özgürce ve kendi isteğim ile ve hiçbir baskı ve zorlamaya maruz kalmaksızın katılımcı olmayı kabul ediyorum.

Bu araştırma Sevgül Türkoğlu (Ekonomi Üniversitesi, Psikoloji Bölümü) tarafından yüksek lisans tez çalışması amacıyla yürütülmektedir. Bu araştırmanın amacı seçici dikkat süreçlerinin otomatik olarak değişiminin gözlemlendiği uyumluluk oranını etkisinin altında yatan bilişsel süreçleri incelemektir. Bu projede katılımcı olarak yer aldığımda bilgisayar ekranında harflerin görüleceğini ve ekranda sunulan harfler arasından ortadaki harfin ne olduğuna karar vereceğimi biliyorum. Deney süreci maksimum olarak 45 dakika sürecektir. Bütün sorularım araştırmacı tarafından cevaplandırılacaktır.

Bu projeye katılımın tamamıyla gönüllü olduğunu ve katılımımı istediğim zaman yarıda kesebileceğimi biliyorum. Araştırmada sorulara vereceğim bütün cevaplar gizli tutulacak ve katılımcı kod numarası ile anılacaktır. Adım, verdiğim cevapların hiçbirinde yer almayacaktır. Bu çalışma ile elde edilen bireysel sonuçlar rapor edilmeyecektir. Sadece gruplardan elde edilen sonuçlar rapor edilecektir.

Bu çalışmaya katılmanın bir yan etkisi olmadığını biliyorum. Çalışma süresince dinleyeceğim materyal ilgi çekici olmayabilir. Tekrar tekrar aynı konuda karar vermekten sıkılabilirim. Fakat bunun maddeye özgü uyumluluk oranı etkisinin altında yatan bilişsel süreçler ile ilgili bilgi toplamak için gerekli olduğunu anlıyorum. Tarafımdan bilinen bir işitme veya okuma problemim olması veya renk körü olmam nedeniyle bu projeye katılmamamın istenebileceğini anlıyorum.

Bu araştırma ile ilgili sorularım ve haklarım için Sevgül Türkoğlu (İzmir Ekonomi Üniversitesi, Psikoloji Bölümü, tel. 05339633970, email: sevgul_turkoglu@hotmail.com) ile temasa geçebileceğimi biliyorum.

Bu formu okudum, anladım ve onaylıyorum.

____

(Ad Soyad) (Tarih)

____

(İmza)

Appendix 2

Katılımcı Bilgi Formu

1) Yaşınız:

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2) Cinsiyetiniz:

----

3) Anadiliniz:

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4) Bildiğiniz diğer diller ve seviyeleri:

----

5) Görme probleminiz var mı? Varsa aşağıya açıklayınız.

☐ ☐

----

6) Okuma probleminiz var mı? Varsa aşağıya açıklayınız.

☐ ☐

----

7) Herhangi bir psikoaktif ilaç kullanıyor musunuz?

☐ ☐

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8) Dikkat dağınıklığı teşhisiniz var mı?

☐ ☐

Appendix 3

Katılım Sonrası Bilgi Formu

"Dikkatin kontrolünde Uyumluluk oranı etkilerinin davranışsal incelenmesi" başlıklı bu araştırma İzmir Ekonomi Üniversitesi, Psikoloji Bölümü tez çalışması olarak yürütülmektedir.

Flanker testi seçici dikkat araştırmalarında sıklıkla kullanılan bir yöntemdir. Flanker testin yarattığı bilişsel değişime bağlı olarak seçici dikkat süreçleri incelenir. Flanker araştırmasında katılımcılar bilgisayar ekranında gördükleri ortadaki harfi söylerken diğer sıralanan harfleri görmezden gelirler. Tüm harflerin aynı olduğu denemelerde, cevap süreleri ve hata oranları, ortadaki harflerin diğer harflerden farklı olduğu denemelere nazaran, daha düşük olarak gözlemlenmektedir. Bu sayede araştırmacılar deney süresince karşılaşılan uyumlu ve uyumsuz uyarıcıların oranını değiştirerek seçici dikkat süreçlerinde meydana gelen değişimleri gözlemlerler (bkz. MacLeod, 1991).

Maddeye özgü uyumluluk oranı değişimlemesinde (item-specific proportion congruency manipulation) çoğunlukla uyumlu harf sıralamasında gözlemlenen Flanker etkisi çoğunlukla uyumsuz olan denemelerde gözlemlenen etkiye nazaran daha azdır. Bu etkinin altında yatan bilişsel süreçlerle ilgili olarak iki önemli hipotez ortaya atılmıştır. Birinci hipoteze göre maddeye özgü uyumluluk oranı etkisi seçici dikkat süreçlerinde otomatik olarak meydana gelen bir değişimi yansıtır (Jacoby ve ark., 2003). Alternatif hipoteze göre ise bu etkisinin altında dikkat süreçleri değil, basit uyarıcı-tepki öğrenme mekanizmaları yatmaktadır (Schmidt ve Besner, 2008). Bugüne kadar her iki hipotezi de destekleyecek bulgular elde edilmiştir (Atalay & Misirlisoy, 2012; Bugg ve ark., 2011) ve maddeye özgü uyumluluk oranı etkisinin altında yatan bilişsel süreçler ile ilgili olarak kesin bir sonuca varılamamıştır. Bu araştırmada maddeye özgü uyumluluk oranı etkisinin altında yatan bilişsel süreçlerin incelenmesi amaçlanmaktadır.

Bu çalışma ile elde edilen bireysel sonuçlar rapor edilmeyecektir. Sadece gruplardan elde edilen sonuçlar rapor edilecektir. Katıldığınız için teşekkür ederiz. Sorularınız için araştırmacı ile istediğiniz zaman temasa geçebilirsiniz.

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