THE ROLE OF EXPECTATION AND EXPERIENCE IN THE CONTROL OF ATTENTION

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

MERVE İLERİ TAYAR

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
THE DEPARTMENT OF PSYCHOLOGY

AUGUST 2021

Approval of the thesis:

THE ROLE OF EXPECTATION AND EXPERIENCE IN THE CONTROL OF ATTENTION

submitted by **MERVE İLERİ TAYAR** in partial fulfillment of the requirements for the degree of **Master of Science in Psychology, the Graduate School of Social Sciences of Middle East Technical University** by,

Prof. Dr. Yaşar KONDAKÇI
Dean
Graduate School of Social Sciences ______________

Prof. Dr. Sibel KAZAK BERUMENT
Head of Department
Department of Psychology ______________

Prof. Dr. Mine MISIRLISOY
Supervisor
Department of Psychology ______________

Assoc. Prof. Dr. Nart Bedin ATALAY
Co-Supervisor
TOBB University of Economics and Technology
Department of Psychology ______________

Examining Committee Members:

Assoc. Prof. Dr. Aslı KILIÇ ÖZHAN (Head of the Examining Committee)
Middle East Technical University
Department of Psychology ______________

Prof. Dr. Mine MISIRLISOY (Supervisor)
Middle East Technical University
Department of Psychology ______________

Assist. Prof. Dr. Didem KADIHASANOĞLU
TOBB University of Economics and Technology
Department of Psychology ______________

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name: Merve İLERİ TAYAR

Signature:

ABSTRACT

THE ROLE OF EXPERIENCE AND EXPECTATION IN THE CONTROL OF ATTENTION

İLERİ TAYAR, Merve
M.S., The Department of Psychology
Supervisor: Prof. Dr. Mine MISIRLISOY
Co-supervisor: Assoc. Prof. Dr. Nart Bedin ATALAY

August 2021, 76 pages

Cognitive control is the ability to exhibit goal-directed and flexible behavior by suppressing automatic and unintended behaviors. The Stroop task, which contains congruent and incongruent items, is commonly used to investigate cognitive control. The participants are instructed to react to the color of the stimulus while ignoring its meaning. A typical observation in the Stroop task is the Stroop effect, which represents slower response times and higher error rates for the incongruent items compared to the congruent items. In the list-wide proportion congruence (LWPC) studies, the proportion of congruent and incongruent items in the list is manipulated, and mostly congruent (MC) and mostly incongruent (MI) lists are created. A larger Stroop effect in the MC list compared to the MI list is called the LWPC effect. There is a continuing debate on whether the LWPC effect is a result of expectation-driven or experience-driven mechanisms. Using the precued list paradigm, researchers are able to observe the unique influence of expectation and experience on the control of attention. The current thesis aims to investigate the relationship between experience and expectation by using valid and invalid cues within the same experimental paradigm. By comparing the influence of expectation on validly- and invalidly-cued lists, we aimed to test three possible hypotheses: (1) pure experience, (2) additive experience and expectation, and (3) interactive experience and expectation. The results supported the pure experience hypothesis and demonstrated that when expectations do not fully correspond with actual experiences, pure experience modulates attentional control settings.

Keywords: Stroop task, precued list paradigm, list-wide proportion congruence effect, expectation, experience

ÖZ

DİKKATİN KONTROLÜNDE BEKLENTİ VE DENEYİMİN ROLÜ

İLERİ TAYAR, Merve
Yüksek Lisans, Psikoloji Bölümü
Tez Yöneticisi: Prof. Dr. Mine MISIRLISOY
Ortak Tez Yöneticisi: Assoc. Prof. Dr. Nart Bedin ATALAY

Ağustos 2021, 76 sayfa

Bilişsel kontrol, otomatik ve istenmedik davranışlarımızı bastırarak amaca yönelik ve esnek davranış sergileme becerisidir. Uyumlu ve uyumsuz uyarıcılar içeren Stroop görevi bilişsel kontrolü araştırmada sıklıkla kullanılır. Katılımcılardan uyarıcının anlamını görmezden gelirken rengine tepki vermeleri istenir. Stroop görevinde gözlemlenen tipik bir sonuç, uyumsuz uyarıcılarda uyumlu uyarıcılara nazaran daha yavaş tepki süresi ve daha fazla hata oranı görülmesini ifade eden Stroop etkisidir. Liste düzeyi uyumluluk oranı (LDUO) çalışmalarında, uyumlu ve uyumsuz uyarıcıların oranları manipüle edilerek çoğunlukla uyumlu ve çoğunlukla uyumsuz listeler oluşturulur. Çoğunlukla uyumlu listede çoğunlukla uyumsuz listeye kıyasla daha büyük Stroop etkisi görülmesi, LDUO etkisi olarak adlandırılır. LDUO etkisinin deneyimlerden mi yoksa beklentilerden mi kaynaklandığı devam eden bir tartışma konusudur. Ön ipuçlu liste paradigmasını kullanarak deneyim ve beklentilerin dikkatin kontrolü üzerindeki biricik etkileri gözlemlenebilir. Bu tezde, geçerli ve geçersiz ipuçlarını deney içinde bir arada kullanarak deneyim ve beklentilerin ilişkisinin araştırılması amaçlanmaktadır. Beklentilerin ipucunun geçerli ve geçersiz olduğu listelerdeki etkisini karşılaştırarak üç alternatif hipotezin test edilmesi amaçlanmıştır: (1) yalnızca deneyim, (2) eklemeli deneyim ve beklenti ve (3) etkileşimli deneyim ve beklenti. Sonuçlar yalnızca deneyimin dikkatin kontrolü üzerinde etkili olduğu hipotezini desteklemiş ve deneyim ve beklentilerin her zaman tutarlı olmadığı durumlarda, tek başına deneyimin dikkatin kontrolünü modüle ettiğini göstermiştir.

Anahtar Kelimeler: Stroop görevi, ön ipuçlu liste paradigması, liste düzeyi uyumluluk oranı etkisi, beklenti, deneyim

To my beloved family

ACKNOWLEDGMENTS

First and foremost, I would like to show my deepest gratitude to my advisor Prof. Dr. Mine Mısırlısoy, and my co-advisor Assoc. Prof. Dr. Nart Bedin Atalay for their invaluable support and guidance through all the steps of my master's thesis. I am grateful for the time and effort they put into my development as a scientist. I am extremely lucky to have them in my academic journey and my life. Mine Hocam, it was a gift to me to know that I can come to you and talk with you whenever I feel lost. You were always a true mentor to me in every difficult time. Nart Hocam, years ago, when I was applying for master programs, you told me "Wherever you end up, I will always be proud of you, and you will always be my student.". You will always be my beloved teacher and I will be proud to be your student. I also have to say thank you for our 6-hour meetings and endless discussions, really. Thank you for always pushing me forward. Mine Hocam, I also want to say thank you for all our talks and laughter, probably accompanied by a cake. Mine Hocam and Nart Hocam, I feel so happy and lucky to know you personally. For all your encouragement, patience, and always being there for me, thank you.

Besides, I would like to express my gratitude to my thesis committee members, Assoc. Dr. Aslı Kılıç Özhan and Assist. Dr. Didem Kadıhasanoğlu, for their time and support. I would like to acknowledge all members of the METU Cognitive Psychology department, especially my lab mates Özge Bozkurt and Kumsal İpek Oker, for all their support and help during the process. I also would like to say thank you to my lovely students, for making teaching enjoyable to me.

I am sincerely grateful to my dear future Ph.D. advisor, Assoc. Dr. Julie M. Bugg, for her insightful feedback and support for my thesis, and for all the opportunities she provided to me for my development. Thank you for being such a kind and considerate person. Also, sorry for so many "Hi Julie, I need your help!" e-mails, in advance. I am looking forward to having so many confusions during my Ph.D.

My dear family, thank you so much for your amazing support and your patience when I need to work instead of spending time with you. I will try to allocate more time to you, but I cannot promise since I will start my Ph.D. soon. Of course, special thanks to my dear friend Zeynep Erdem, for listening to my endless ups and downs for hours and encouraging me all the time.

Last but not the least, I would like to thank my beloved husband, Tunahan, for being the best person in the world. It would not have been possible without you to work during the pandemic and complete my thesis. You are my best friend and my joy. Thank you Tunişim, for your unwavering support and belief in me.

The author was supported by the 2210-A Program of The Research and Technological Council of Turkey (TUBITAK).

This study was supported by METU Scientific Research Projects Coordination Unit. Grant No: TEZ-YL-104-2020-10218.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

PC	Proportion Congruence
LWPC	List-Wide Proportion Congruence
ISPC	Item-Specific Proportion Congruence
MC	Mostly Congruent
MI	Mostly Incongruent
RT	Response Time
PE	Percentage of Error

CHAPTER 1

INTRODUCTION

1.1. General Introduction

Cognitive control refers to the ability to meet the requirements of a task by suppressing automatic and unintended behavior and act in a goal-directed manner (Posner & Snyder, 1975; Logan, Zbrodoff & Williamson, 1984; Miller, 2000). In everyday life, there are various information sources around us. While some of them are relevant to our current task, some are irrelevant. We need to attend to task-relevant information sources while ignoring the task-irrelevant ones, according to our current task demands. For instance, when driving on a crowded road, the driver should attend to the task-relevant stimuli and ignore the others. Attending to the task-irrelevant items such as their phone or the roadside advertisements would harm the driving performance. On the contrary, attending to task-relevant items, such as other cars on the road or the rear-view mirrors of the car, would increase task performance. Cognitive control is the ability to guide one's attention to focus on task-relevant information in the face of task-irrelevant information.

The Stroop task (Stroop, 1935; MacLeod, 1992) is commonly used to investigate cognitive control in laboratory settings. In a classic color-word Stroop task, congruent (e.g. *blue* word in blue ink) and incongruent (e.g. *blue* word in yellow ink) items are presented to the participants. They are required to name the color of the word while ignoring its semantic meaning. Participants respond to the incongruent items more slowly and inaccurately compared to the congruent items. The difference between response times (or error rates) for the congruent and incongruent items is called the *congruency effect* or the *Stroop effect* (see MacLeod, 1991 for a review; MacLeod & MacDonald, 2000).

Since participants are instructed to attend to one dimension of the stimulus while ignoring the other dimension, the Stroop task is a measurement of selective attention. Difficulty in suppressing the influence of the word dimension on the response selection process signals the automaticity of word reading. While the color and the word dimensions activate the same response for the congruent items, they activate different responses for the incongruent items. It is argued that since word reading is more automatic than color naming, it interferes with the task and makes color naming more difficult for the incongruent items compared to the congruent items (Logan, 1980; Besner, Stolz & Boutilier, 1997). The attentional filtering system cannot perfectly filter out the irrelevant information, creating the Stroop effect. The nature of cognitive control mechanisms can be understood with the help of list-wide and item-specific proportion congruence manipulations (for reviews see Bugg & Crump, 2012; Braem et al., 2019). In this thesis, the main focus will be on the list-wide proportion congruence (LWPC) manipulation, but for a coherent narrative, list-wide and item-specific proportion congruence manipulations will be explained together in the following section.

1.2. List-Wide and Item-Specific Proportion Congruence Manipulations

Previous research has shown that the Stroop effect can be controlled, decreased, or even reversed with proportion congruence manipulations. Mostly congruent (MC) and mostly incongruent (MI) lists are obtained by changing the proportion of the congruent and incongruent items. For instance, in the MC list, words are presented with their congruent color (e.g. *blue* word in blue ink) in 75% of the trials, and with incongruent colors (e.g. *blue* word in yellow ink) in 25% of the trials (please see Table 1 for the typical stimulus organization in a list-wide proportion congruence experiment). As a robust observation, the Stroop effect is larger in the MC list compared to the MI list, which is known as the *list-wide proportion congruence (LWPC) effect* (Logan & Zbrodoff, 1979; Logan, Zbrodoff & Williamson, 1984; for reviews see Bugg, 2012; Bugg & Crump, 2012). As participants learn about the proportion congruence (PC) of the list through exposure to the congruent and incongruent items, they adopt a global attentional control setting to meet the task demands. For the MC list, the information coming from the word dimension signals the correct response for most of the trials, which makes that information valuable for achieving the task goal. Thus, participants increase the weight of the word dimension of the stimulus for the response selection process, which, in turn, increases the Stroop effect. However, for the MI list, the information coming from the word dimension does not signal the correct response, rather, it increases the conflict within the trial by activating an incorrect response. Therefore, participants decrease the weight of the word dimension of the stimulus for the response selection process, decreasing the Stroop effect.

Table 1

Typical Stimulus Organization in a List-Wide Proportion Congruence Experiment

Mostly Congruent					Mostly Incongruent				
	Color					Color			
Word	Blue	Yellow	Green	Pink	Word	Blue	Yellow	Green	Pink
Blue	90	10	10	10	Blue	30	30	30	30
Yellow	10	90	10	10	Yellow	30	30	30	30
Green	10	10	90	10	Green	30	30	30	30
Pink	10	10	10	90	Pink	30	30	30	30

While the LWPC effect is generally attributed to a global control strategy, one can still argue that the strategies are implemented not at the list level, but rather at the item level; indicating that the participants adopt different attentional control settings for different items (Jacoby, Lindsay & Hessels, 2003; Blais, Robidoux, Risko & Besner, 2007; Schmidt & Besner, 2008). In order to test whether control is implemented at a list or an item level, some items are used as MC while the others are used as MI. MC and MI items are mixed within the same list providing equal numbers of congruent and incongruent items in general. For instance, while *blue* (for 75% of trials with blue ink, and 25% of trials with yellow ink) and *yellow* (for 75% of trials with yellow ink, and 25% of trials with blue ink) words are MC items, *green* (for 75% of trials with pink ink, and 25% of trials with green ink) and *pink* (for 75% of trials with green ink, and 25% of trials with pink ink) words are MI items (please see Table 2 for the typical stimulus organization in an item-specific proportion congruence experiment).

Table 2

Typical Stimulus Organization in an Item-Specific Proportion Congruence Experiment

	Color			
Word	Blue	Yellow	Green	Pink
Blue	90	30		
Yellow	30	90		
Green			30	90
Pink			90	30

The *item-specific proportion congruence (ISPC) effect* refers to a larger Stroop effect for the MC items compared to the MI items. This influential finding shows that different control parameters can be implemented for different items without executing list-wide control strategies. Throughout the experiment, both MC and MI items are presented randomly, and participants cannot predict the congruency of the upcoming trial. Thus, according to the item-specific control account, participants implement strategies dynamically and automatically for each item after the stimulus presentation. Jacoby et al. (2003) proposed a stimulus-driven, dynamic attentional control process, namely, *automatic control*.

Alternative to the item-specific automatic control, *contingency learning* can also account for the ISPC effect (Jacoby et al., 2003; Schmidt & Besner, 2008). The fact that ISPC design creates contingencies between colors and words casts doubt on the origins of the ISPC effect. To be more specific, when an item is MC, it is mostly presented with its congruent color (e.g. *blue* word with blue ink); and when an item is MI, it is mostly presented with its incongruent color (e.g. *blue* word with yellow ink). Participants learn the contingencies between stimulus and response, and they can predict the response when they see each stimulus. Schmidt and Besner (2008) argued that the ISPC effect was not a result of the PC manipulation, but rather, the result of stimulus-response contingencies. Since participants are prone to giving high contingent responses, they will be faster and more accurate in the high contingent trials compared to the low contingent trials. This tendency favors the congruent trials for the MC items and incongruent trials for the MI items, which causes an increased Stroop effect for the MC items and decreased Stroop effect for the MI items, namely, the ISPC effect.

As the debate between top-down control, item-specific control, and contingency learning accounts continue, it is important to determine which mechanism is used for which exact condition. Since the LWPC manipulation is confounded with the ISPC manipulation, to show the unique contribution of list-wide control, the LWPC effect should be demonstrated with 50% congruent items (diagnostic items) mixed within an MC or MI list. Since it is not possible to use item-specific control or contingency learning for the diagnostic items, observing the LWPC effect with these items would provide unambiguous evidence for the top-down global control. However, there is conflicting evidence in terms of the LWPC effect for the diagnostic items. While some studies observed the LWPC effect with the diagnostic items (Bugg & Chanani, 2011; Bugg, 2014), some did not (Bugg, Jacoby, & Toth, 2008; Blais & Bunge, 2010).

Bugg (2014) proposed the "Associations as Antagonists to Top-Down Control" (AATC) hypothesis to account for the inconsistencies regarding the generalization of the LWPC effect to the diagnostic items. With the AATC hypothesis, she suggests that conflict-driven top-down control does not work directly as the first mechanism, rather, it is used as a last resort when contingency learning cannot be used effectively to complete the task. She used 4-item and 2-item set designs (please see Table 3 and 4 for the sample stimulus organization) and test the existence of the LWPC effect for the diagnostic items. In a 4-item set design, it is not effective to use contingencies for the color-word pairings. Since the correct response is not predictable, relying on stimulus-response contingencies would not be useful. However, for the 2-item set design, since there are reliable contingencies between the stimuli and the corresponding responses, participants are able to use these to predict the correct response.

In line with her predictions, Bugg (2014) found converging evidence for the AATC hypothesis. There was a significant LWPC effect for the diagnostic items when there was no reliable S-R learning (i.e., 4-item set design). The Stroop effect with the diagnostic items was larger when they were mixed within the MC items, compared to those mixed within the MI items. In other words, the conflict-triggered top-down control processes were implemented, and these strategies were generalized to the PC-unbiased diagnostic items. Since diagnostic items would not activate automatic item-specific control or contingency learning processes, these results cannot be attributed to stimulus-driven mechanisms. However, the LWPC effect was not observed for the diagnostic items when participants could rely on S-R contingencies (i.e., 2-item set design). Contingency learning, which is adaptive and effortless, was used as the first resource. When contingency learning was not reliable, conflict-driven control was engaged. In summary, these results showed that the LWPC effect was not negligible, and it could be observed in the absence of contingency learning and item-specific control processes. This study was critical in showing that the LWPC effect could be attributed to top-down control mechanisms without referring to any other control or learning mechanism. In the current thesis, we aim to investigate the underlying mechanisms of the top-down attentional control processes, therefore we will focus on the LWPC effect using a 4-item set design to avoid item-specific control and contingency learning confounds.

Table 3

Typical Stimulus Set for a 4-item Set Design

		Color							
	Word	Red	Blue	White	Purple	Pink	Green	Black	Yellow
MC Items	Red	36	4	4	4				
	Blue	4	36	4	4				
	White	4	4	36	4				
	Purple	4	4	4	36				
Diagnostic Items	Pink					12	4	4	4
	Green					4	12	4	4
	Black					4	4	12	4
	Yellow					4	4	4	12
MI Items	Red	12	12	12	12				
	Blue	12	12	12	12				
	White	12	12	12	12				
	Purple	12	12	12	12				
Diagnostic Items	Pink					12	4	4	4
	Green					4	12	4	4
	Black					4	4	12	4
	Yellow					4	4	4	12

Table 4

Typical Stimulus Set for a 2-item Set Design

		Color							
	Word	Red	Blue	White	Purple	Pink	Green	Black	Yellow
MC Items	Red	36	12						
	Blue	12	36						
	White			36	12				
	Purple			12	36				
Diagnostic Items	Pink					12	12		
	Green					12	12		
	Black							12	12
	Yellow							12	12
MI Items	Red	12	36						
	Blue	36	12						
	White			12	36				
	Purple			36	12				
Diagnostic Items	Pink					12	12		
	Green					12	12		
	Black							12	12
	Yellow							12	12

1.3. Expectation-Driven vs. Experience-Driven Control

The LWPC effect shows the flexibility of the attentional control mechanism. It is crucial to understand how the attentional control system is flexible and how it can be adjusted to the relevant task settings. So, what governs this flexible attentional control system? In some of the earliest explanations of the LWPC effect, the control of attention was attributed to *expectation-driven control mechanisms*. The LWPC effect was attributed to global and intentional strategies that the participants used. Being exposed to congruent and incongruent items leads participants to create expectations for the upcoming trials. For instance, when participants observe MC trials, they will expect to have a congruent item for the upcoming trials as well. Accordingly, participants may use their explicit expectations to develop strategies to differentially weigh the word and color dimensions of the stimulus in question.

For the MC lists, participants implement a relaxed attentional control strategy and increase the weight of the word dimension of the stimulus in response selection, since it generally leads to a correct response. This relaxed attentional control strategy increases both the speed and accuracy of the responses for the congruent trials while decreasing the speed and accuracy of the responses for the incongruent trials, which, in turn, increases the Stroop effect. In the MI lists, participants implement a focused attentional control strategy and decrease the weight of the word dimension of the stimulus in response selection, since it generally leads to an incorrect response. A focused attentional control strategy increases the speed and accuracy of the responses for the incongruent trials, while decreasing the speed and accuracy of the responses for the congruent trials, which, in turn, decreases the Stroop effect. Overall, explicit expectations about the upcoming trials modulate the attentional control settings and create the LWPC effect. Expectation-driven accounts emphasize the *strategic, intentional, and effortful control of attention* (Posner & Snyder, 1975; Logan & Zbrodoff, 1979; Lowe & Mitterer, 1982; West & Baylis, 1998).

Various accounts and cognitive models assume an expectation-driven control mechanism (Posner & Snyder, 1975; Shiffrin & Schneider, 1977; Norman & Shallice, 1986; Tzelgov, Henik, & Berger, 1992; Braver, Gray, and Burgess, 2007; Braver, 2012). *The dual-mechanisms of control* account is one of those that predict an expectation-driven control mechanism (Braver et al., 2007; Braver, 2012). Braver and his colleagues propose a proactive control mechanism that adjusts the attentional control settings in an anticipatory manner prior to the onset of the trial according to existing expectations.

A clear example showing the effect of expectation on the control of attention is Tzelgov et al. (1992). They manipulated the proportion of neutral items (i.e., series of same letters or noncolor words in different inks) compared to the congruent and incongruent items, and kept the number of congruent and incongruent items constant They observed a smaller Stroop effect when there were more color-words than neutral words, supporting the expectation-driven control account. When there were more neutral items than color-words, participants expected to observe neutral items, which were relatively easier than color-words for the color-naming task. They adopted a more relaxed attentional control setting and showed a larger Stroop effect. However, when there were more color-words than neutral items, participants expected to observe color-words which are relatively harder than neutral items for the color-naming task. In this case, they adopted a more focused attentional control setting and showed a smaller Stroop effect.

The alternative to expectation-driven control mechanisms are *experience-driven control mechanisms*. As participants are exposed to congruent and incongruent trials from the beginning of a list, information about trial type accumulates, and this information modulates the attentional control mechanisms. Even though both expectation-driven and experience-driven accounts originate from experiencing congruent and incongruent trials, expectation-driven control accounts emphasize the *strategic and explicit control of attention* while experience-driven control accounts emphasize the *automatic and implicit control of attention*. In this thesis, the broad aim is to understand the relationship between experience and expectation on the control of attention.

Experience-driven control mechanisms have been formalized with different cognitive control theories. In-depth critical discussions of various experience-driven accounts fall beyond the scope of this thesis, however, two such accounts will be briefly summarized to illustrate how experience can be placed in a cognitive control model. According to the *conflict-monitoring theory*, there is a top-down control mechanism that is triggered by higher levels of conflict. When the top-down control mechanism detects a conflict, it resolves this conflict by increasing the weight of the task-relevant dimension and decreasing the weight of the task-irrelevant dimension on the response selection process (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Botvinick, Cohen & Carter, 2004). In LWPC experiments, participants encounter higher levels of conflict in the MI lists compared to the MC lists. This differential experience creates the Stroop effect difference between the MC and MI lists by modulating the relative weights of task-relevant and task-irrelevant information. To exemplify experience-driven accounts, we can briefly explain the *tectonic theory* of Melara and Algom (2003). They propose that the adjustment of attentional control is based on the informational value of the irrelevant dimension (i.e., the word in the color-word Stroop task) of the stimulus. In the MC list, the word dimension often signals the correct response, which makes this dimension a valuable information source. On the contrary, in the MI list, the word dimension does not provide a reliable information source, since it usually activates an incorrect response. For both conflict-monitoring theory and tectonic theory, experiencing different types of trials shapes the attentional control settings.

An important study that compares the predictions of expectation-driven and experience-driven accounts is Blais, Harris, Guerrero, and Bunge (2012). Expectation-driven accounts imply that participants are aware of the PC of the lists and deliberately modulate the attentional control settings. This implies that the awareness of the participants should be related to their task performance. The LWPC effect should be higher for the participants whose awareness is higher as compared to the participants whose awareness is lower. Blais and his colleagues aimed to test this prediction of expectation-driven accounts. They used nineteen lists whose PC varied from 5% to 95% in increments of 5%. Participants completed each list on a different day and were asked to predict the PC of the list at the end of each session. The researchers observed no correlation between the LWPC effect and the awareness of the participants. This result casted doubt on the proposal that participants explicitly and strategically adapt an attentional control setting according to their expectations. Blais and his colleagues argued that modulation of attention was not strategic and explicit, rather, it was automatic and implicit.

However, the absence of a correlation between awareness and performance does not necessarily indicate that participants are not able to use explicit information about the list to strategically control their attention. If participants are given explicit cues to create expectations, they may modulate their attentional control settings accordingly. Entel, Tzelgov, and Bereby-Meyer (2014) provide direct evidence in that regard. They gave explicit cues to participants and stated that the list they would experience would be either an MC or an MI list. The first half of the list was 50% congruent for both conditions, and the second half was either MC or MI matching with the cue. Although the first half of the experiment was the same for both conditions and the cue was valid only for the second half of the experiment, they observed a significant LWPC effect for the first half of the experiment. Thus, the difference in the expectations created a significant LWPC effect while the experience was the same. This result could be taken as direct evidence indicating the role of explicit expectations in the control of attention.

1.4. Precued List Paradigm

As explained in the previous sections, in a classic LWPC experiment, both expectation-driven and experience-driven accounts originate from participants' exposure to the congruent and incongruent trials, in other words, from experience. The critical difference between these accounts is that, while experience-driven accounts suggest implicit control, expectation-driven accounts suggest explicit control. In a classic LWPC paradigm, both experience-driven and expectation-driven accounts would predict the same pattern of results, that is why it is hard to distinguish one account from the other with such a design. Critically, expectation cannot be systematically manipulated independent from experience in a classic LWPC experiment. In order to reveal the unique contribution of expectations, it is necessary to create explicit expectations about the PC of the list independent from experience. Bugg, Diede, Cohen-Shikora, and Selmeczy (2015) developed a novel method called the *precued list paradigm* to disentangle the effects of expectation vs. experience. They aimed to investigate the role of expectations independent of experience on the control of attention. In this paradigm, they presented multiple abbreviated MC and MI lists and gave cues to the participants at the beginning of the lists. By the virtue of creating explicit expectations for the upcoming list, they aimed to investigate the influence of expectation over and above experience.

In the precued list paradigm, multiple abbreviated MC and MI lists consisting of 10 or 20 Stroop trials are used. The lists are randomly presented to the participants either with or without a cue. In the cued condition, a valid cue showing the PC of the list is presented to the participants prior to each list. Participants are informed by "80% MATCHING" or "80% CONFLICTING" cues to create explicit expectations. In the uncued condition, question marks (e.g., "?????") are presented prior to the list, and participants are not informed about the PC of the upcoming list. Thus, the control of attention is mainly driven by experience during the list for the uncued condition. In the cued condition, on the other hand, the control of attention is driven by both experience and expectation. By comparing the Stroop effect in the cued and uncued lists, the influence of expectation on the control of attention over and above experience is investigated.

It is important to note that one cannot argue that expectation does not play a role in the uncued condition. As previously mentioned, just experiencing the list may well create expectations, and expectations may alter the effect of experience for both cued and uncued conditions. However, in that case, expectation would be a by-product of experience. While *expectation as a by-product of experience* may exist for both cued and uncued conditions, *expectation independent from experience* exists only for the cued condition.

Therefore, we can observe the influence of expectation over and above experience by comparing the cued and uncued conditions.

When participants expect to have an 80% conflicting list, they may adopt a focused attentional control setting. Contrarily, when they expect to have an 80% matching list, they may adopt a relaxed attentional control setting. If the MC cue leads participants to relax their attentional control settings, the Stroop effect in the cued-MC list should be larger than the Stroop effect in the uncued-MC list. The Stroop effect difference between the uncued- and the cued-MC lists is called *cue-induced MC shift* (Bugg et al., 2015). Similarly, if the MI cue leads participants to heighten their attentional control settings, the Stroop effect in the cued-MI list should be smaller than the Stroop effect in the uncued-MI list. The Stroop effect difference between the uncued- and cued-MI lists is called *cue-induced MI shift* (Bugg et al., 2015). If expectation does not influence the control of attention in addition to experience, there should be no observed Stroop effect difference between the cued and uncued lists for both MC and MI conditions.

Bugg et al. (2015) conducted five experiments to investigate the influence of expectation and experience on the control of attention. In Experiment 1, they presented multiple abbreviated MC or MI lists that were preceded by either a valid cue or no cue. As explained above, if the control of attention is expectation-driven, there should be a cue-induced MC shift and/or a cue-induced MI shift. If expectation does not affect attentional control settings over and above experience, there should be no difference between the cued and uncued lists. While they observed a cue-induced MC shift, a cue-induced MI shift was not observed. Participants relaxed, but did not heighten their attentional control settings according to their expectations. In Experiment 2, they aimed to replicate these results with a larger sample, also adding an equally congruent PC condition. Similarly, lists were presented either with a valid cue or no cue. They replicated the results of Experiment 1, and found a significant cue-induced MC shift, but not a cue-induced MI shift. In Experiments 3 and 4, they aimed to encourage the use of MI cues more than their previous experiments with additional manipulations. In Experiment 3, they created pressure on the participants by setting a shorter stimulus presentation. In Experiment 4, they incentivized task performance by presenting the experiment similar to a game that provided more points for better performance. Even so, the expectation for the MI lists did not affect performance beyond experience. They replicated the results of Experiments 1 and 2; in that, there was a significant cue-induced MC shift, but not a cue-induced MI shift, again. Finally, in Experiment 5, they only presented equally congruent (EC) lists with MC, MI, and EC cues. Thus, the experience was always the same, while the expectation differed according to the cue. In line with the previous experiments, there was a significant cue-induced MC shift (larger Stroop effect with the MC-cued EC list than EC-cued EC list), but not a significant cue-induced MI shift (smaller Stroop effect with the MI-cued EC list than EC-cued EC list).

The absence of a cue-induced MI shift was especially interesting considering the high task demand in the MI list due to the higher number of incongruent than congruent trials. It is intuitive to assume that participants would use the MI cues, which was surprisingly not the case. Bugg et al. (2015) proposed three possible explanations for the absence of a cue-induced MI shift: (1) bleed-over of awareness, (2) floor effect, and (3) default mode.

The *bleed-over of awareness* from cued to uncued lists explanation is based on the use of a within-subjects design in the precued list paradigm. Since cued and uncued lists were randomly presented, participants might have tried to guess the PC of the list when they saw the first trial. They might have expected to have an MI list when the first trial was incongruent, which was the case for most of the MI lists.[1] However, Bugg & Diede (2018) ruled out this possibility. They used the same paradigm with a between-subjects manipulation. Half of

[1] Even though the bleed-over of awareness explanation is not fully suitable to account for the observed cue-induced MC shift (if participants expect to observe an MC list when they first see a congruent item, there should not be a cue-induced MC shift either), Bugg & Diede (2018) tested that possibility.

the participants received a pre-cue, and the other half did not. They replicated the results of Bugg et al. (2015) with a between-subjects design; and eliminated the bleed-over of awareness argument for the absence of the cue-induced MI shift.

Another possible explanation is that there might be a *floor effect* in the MI list. Maybe, the Stroop effect in the MI list is decreased so much that it cannot be further reduced when the MI cue is explicitly given. However, a piece of counter-evidence was found in Experiment 5 of Bugg et al. (2015). As explained above, they presented 50% congruent lists with MC, MI, and EC cues. Although there was room for the Stroop effect to decrease for the EC list (i.e., the Stroop effect with the EC list is greater than the MI list), still, the MI cue did not decrease the Stroop effect. Thus, the failure to observe the cue induced MI shift cannot simply be explained by the floor effect argument.

Finally, according to the default mode explanation, since participants are required to ignore the word dimension while reacting to the color dimension of the Stroop stimulus, they are expecting conflict in the experiment by the nature of the Stroop task. Thus, participants' default attentional control setting might be a focused one in the Stroop task, in other words, the default mode might be compatible with the MI list. Accordingly, giving the MI cue does not change the current attentional control setting of the participants, resulting in no difference between the uncued and MI cued lists.

CHAPTER 2

THE CURRENT STUDY

2.1. Introduction

Previous studies showed that participants were able to relax, but not heighten their attentional control settings according to their expectations. Building on top of the current literature, we aimed to investigate the relationship between experience and expectation on the control of attention by using both valid and invalid cues in the same experimental paradigm. For the first time in the literature invalid cues that are used in the experiment were MC cues for the MI lists, and MI cues for the MC lists, which enabled to test two main points: (1) the relationship between experience and expectation and (2) the "default mode" explanation for the absence of the cue-induced MI shift.

In the study, multiple MC and MI lists were presented either with an MC cue, an MI cue, or no cue. For the cued conditions, prior to each list, an explicit expectation was created. The experience gained within the list was either compatible or incompatible with the expectation. Regarding our first aim, to examine the relationship between experience and expectation, we tested three possible hypotheses: (1) *pure experience*, (2) *additive experience and expectation*, and (3) *interactive experience and expectation*.

First, we aimed to understand whether only experience or both experience and expectation influence the control of attention. The LWPC effect (i.e., larger Stroop effect with the MC list than the MI list) shows the effect of experience on the modulation of attention. The cueing effect (i.e., cue-induced MC shift or cue-induced MI shift) shows the effect of expectation on performance beyond experience. If pure experience is the basis of attentional control, we should observe a significant LWPC effect, but not a significant cueing effect. In other words, the Stroop effect should not be modulated by expectations (please see Figure 1 for the illustration of the expected results). This would indicate that expectation does not have an influence on the control of attention over and above the experience.

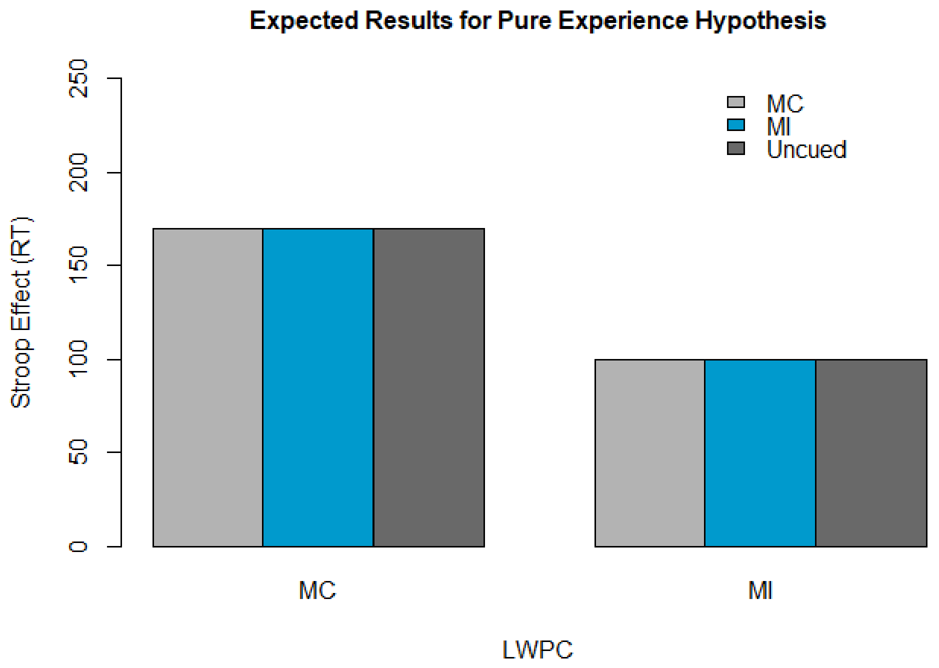

Figure 1. Illustration of expected results for the pure experience hypothesis. The illustrated data shows that there is a significant influence of experience on the control of attention (i.e., higher Stroop effect for the MC list than the MI list), but not a significant influence of expectation (i.e., no cue-induced MC or MI shift).

The second alternative hypothesis is that experience and expectation work in an additive manner. If we observe a significant LWPC effect, and also a significant cueing effect, it would show that both expectation and experience affect the control of attention. The effect of experience and expectation may be additive. In other words, both may modulate the Stroop effect independently. For instance, expecting an MC list may increase the Stroop effect by leading to a relaxed attentional control strategy. Then, experiencing an MC list may add on top of the effect of expectation, and increase the Stroop effect further, by automatically modulating the relative weights of the relevant dimensions. If the relaxation induced by the MC cue is the same for both the MC and MI list, that would indicate the additive influences of experience and expectation. In such a scenario, the cueing effect (the difference between the cued and uncued conditions) should be the same for the MC and MI lists (please see Figure 2 for the illustration of the expected results). This would indicate that expectation does not modulate the effect of experience, in other words, does not modulate the magnitude of the LWPC effect (i.e., the difference between the MC and MI lists should be constant independent of cueing).

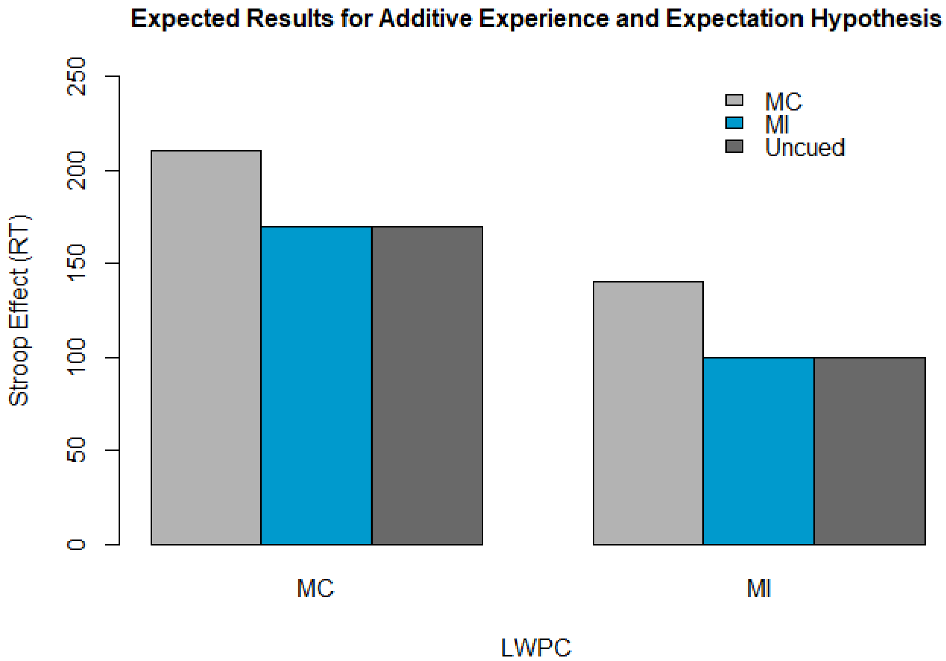

Figure 2. Illustration of expected results for the additive experience and expectation hypothesis. The illustrated data shows that there is a significant influence of experience (i.e., higher Stroop effect for the MC list than the MI list), a significant influence of expectation (i.e., cue-induced MC shift), but not a significant interaction between experience and expectation (i.e., relaxation induced by the MC cue is the same for the MC and MI lists). Please note that this figure illustrates only one example of additive experience and expectation

effect, and this result may be observed in different patterns (e.g., both cue-induced MC and MI shift, only cue-induced MC shift, only cue-induced MI shift).

Alternatively, both expectation and experience may modulate attentional control settings and their influence may be interactive. In other words, they may increase or decrease each other's influence on the control of attention, possibly depending on compatibility. If expectation and experience have interactive effects on performance, cueing effect should be different for the MC and MI lists (please see Figure 3 for the expected results). For instance, the MC cue might affect the performance both in the MC and MI lists, but the effect might be higher for the MC condition since experience and expectation is compatible. In addition, the MI cue might affect the performance only for the MC list, and not for the MI list.[2]

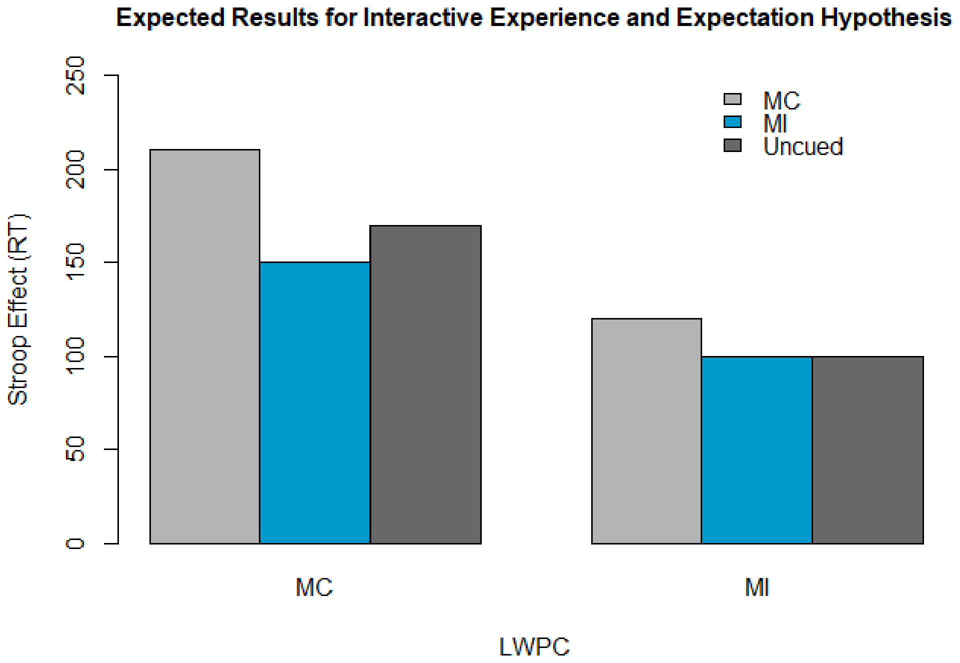

Figure 3. Illustration of expected results for the interactive experience and expectation hypothesis. The illustrated data shows that there is a significant influence of experience (i.e., higher Stroop effect for the MC list than the MI

[2] There are various patterns that we can observe an interaction between experience and expectation, and we do not theoretically favor a specific pattern.

list), a significant influence of expectation (i.e., cue-induced MC shift and MI shift), and a significant interaction between experience and expectation (i.e., relaxation induced by the MC cue is different for the MC and MI lists, and MI cue changes the Stroop effect only for the MC list). Please note that this figure illustrates only one example of interactive experience and expectation effect, and this result may be observed in various patterns (e.g., different magnitudes of cue-induced MC shift, different magnitudes of cue-induced MI shift, or the same magnitude of cue-induced MC shift but different magnitudes of cue-induced MI shift).

Please note that our design, using invalid cues mixed within valid cues, enables us to test these hypotheses and examine the relationship between experience and expectation. Otherwise, using only valid cues and comparing cued and uncued lists would inform us about the influence of expectation, but not the relationship between expectation and experience. To examine this relationship, it was essential to use invalid cues as well.

Finally, our design enabled us to test the default mode explanation of the absence of cue-induced MI shift in previous studies. To briefly remind the reader, according to the default mode explanation, the default attentional control setting is compatible with expecting conflict for the Stroop task. Thus, giving an MI cue does not change the current attentional control settings, resulting in the absence of the cue-induced MI shift. If default mode explanation can account for the absence of cue-induced MI shift, MI-cued should not change the Stroop effect for the MC list either (i.e., no difference in the Stroop effect for the MI-cued MC list than uncued MC list). By observing the effect of invalid cues, we were able to better understand the nature of the cues.

2.2. Method

Ethical approval of the study was obtained from the Human Research Ethics Committee of Middle East Technical University and the Human Research Ethics Committee of TOBB University of Economics and Technology (please see Appendix A and B). This study was preregistered to Open Science Framework prior to the creation of data. Research questions, hypotheses, study design, sample size rationale, and experiment scripts are available on this link:

https://osf.io/wf5ru (please see Appendix E for the script for data cleaning and analyses).

2.2.1. Participants

Eighty-seven participants from Middle East Technical University and TOBB University of Economics and Technology participated in the experiment either for course credit or voluntarily. The requirements for participants were being 18-25 years old native Turkish speakers, having normal or corrected to normal vision, having a right dominant hand, and not having color blindness or reading problems. Participants whose average percentage of error (PE) was higher than three standard deviations of the average PE for all participants and whose average RT was higher than three standard deviations of the average RT for all participants were excluded from all analyses. Participants who had more than 25% missing trials (i.e., trials in which no response is given) for the entire experiment were excluded from all analyses. Since we collected data remotely, we also controlled the timing sensitivity and excluded the participants whose device was not sensitive enough for the response time data. Two participants who were older than 25, one participant whose dominant hand was left, three participants whose average PE was higher than three standard deviations of the average PE for all participants, one participant whose average RT was higher than three standard deviations of the average RT for all participants, and five participants whose device was not sensitive enough for timing purposes were excluded from all analyses, resulting in seventy-five participants in total.

We calculated power analysis with the G*Power software (Faul, Erdfelder, Lang, & Buchner, 2007). A priori power analysis with Cohen's method showed that a sample size of 75 would provide .95 power to detect a moderate effect with an alpha set at .05. The effect size parameter (η_p^2 = .174) was the same as the smallest effect size with the largest sample size reported in Bugg et al. (2015) for the 3-way interaction, the smallest effect we were interested in.

2.2.2. Design

A 3 (cueing: MC cued, MI cued, uncued) x 2 (LWPC: MC, MI) x 2 (trial type: congruent, incongruent) within-subjects design was used. Cueing and LWPC conditions created 6 types of lists: MC cued-MC list, MC-cued-MI list, uncued-MC list, uncued-MI list, MI cued-MC list, and MI cued-MI list. Each list was presented eight times, resulting in forty-eight lists in total. There were equal numbers of validly cued, invalidly cued, and uncued lists. We used a very similar version of the original pre-cued list paradigm of Bugg et al. (2015). However, since validly cued lists were intermixed with invalidly cued lists, we used longer lists to reduce any possible awareness of participants. In the original pre-cued list paradigm, there were 10 trials in each list. Similarly, our primary interest was the first 10 trials of the list, despite using 5 more trials for each list. We presented 15 trials in each list and the first 10 trials were defined by the PC of the list. The remaining 5 trials were used to make the list closer to the expectation of the participants[3]. If we had not done such a manipulation, that would have been easier for the participants to realize that the cues were invalid, and they might have abandoned the usage of cues. For the first 10 trials, there were 8 congruent and 2 incongruent items for the MC lists, and vice versa for the MI lists. For the validly cued and uncued conditions the remaining 5 trials followed the same pattern: 4 congruent and 1 incongruent items for the MC lists, and vice versa for the MI lists. For the invalidly cued lists, the remaining 5 trials were the opposite of the first 10 trials: 4 incongruent and 1 congruent items for the MC lists, and vice versa for the MI lists (please see Table 5). We have pre-registered our design and analyses on Open Science Framework (https://osf.io/wf5ru).

[3] We would like to thank Dr. Julie M. Bugg for her helpful suggestion.

Table 5

The Number of Congruent and Incongruent Items in Each List

Condition	First 10 trials	Last 5 trials
Uncued-MC List	8 congruent, 2 incongruent	4 congruent, 1 incongruent
MC cued-MC List	8 congruent, 2 incongruent	4 congruent, 1 incongruent
MI cued-MC List	8 congruent, 2 incongruent	1 congruent, 4 incongruent
Uncued-MI List	2 congruent, 8 incongruent	1 congruent, 4 incongruent
MI cued-MI List	2 congruent, 8 incongruent	1 congruent, 4 incongruent
MC cued-MI List	2 congruent, 8 incongruent	4 congruent, 1 incongruent

2.2.3. Apparatus and Stimuli

Stimulus presentation and data collection were controlled automatically by the E-Prime 3 software (Psychology Software Tools, Pittsburgh, PA). We used the E-Prime Go extension to collect data remotely due to nationwide curfew restrictions in Turkey to stop the spread of COVID-19. All possible combinations of four Turkish color-words *mavi* (blue), *pembe* (pink), *sarı* (yellow), and *yeşil* (green); and their corresponding colors were used as stimuli. Color-words pairings were randomly selected from separate lists including all possible congruent and incongruent combinations for congruent and incongruent trials. The selection procedure was held without replacement to minimize the repetition of pairings within the list. Stimuli were presented at the center of the screen against a light gray (silver) background. The stimulus size in Arial font was adjusted so that the area it took up on the screen was 10% of the screen height for each participant. The response was given by pressing one of the buttons on the keyboard. Subjects were assigned to subject numbers according to the order of their enrollment in the experiment. The randomization process for the sequence of the lists within the experiment, trial order within the lists, and color-key response assignment were automatically randomized independently for each participant by the E-Prime 3 software.

2.2.4. Procedure

We followed the same procedure as Bugg et al. (2015). Participants attended the experiment individually and voluntarily. They read and signed the informed consent form before starting the study (please see informed consent in Appendix C). The study was vocally explained to the participants. First, they received the instructions for the Stroop task. The meaning of “congruent” and “incongruent” items was explained with examples. Then, they were informed that they would receive a pre-cue before starting each list. They were explained that “80% MATCHING” cue indicated that the upcoming list would have 80% congruent items, “80% CONFLICTING” cue indicated that the upcoming list would have 80% incongruent items, “?????” cue indicated that they were not given a cue for the proportion congruence of the upcoming list. They were alerted that pre-cues were very important; and that they needed to attend them to improve their performance.

At the beginning of the experiment, participants completed a color-response key learning session, which consisted of 48 trials of “XXXX” letters presented in either blue, pink, yellow, or green ink They were required to respond at least 80% of the trials accurately to pass the learning session, otherwise, they repeated it. Then, they practiced one MC cued-MC list and one MI cued-MI list. The aim of the practice session was to both familiarize them with the pre-cued lists, and to incentivize the use of cues by starting with validly cued lists. Following that, participants completed 48 experimental lists, each consisting of 15 trials.

During the experiment, prior to each list, a reminder screen showing the color-response key assignments was presented for 1000 ms to remind the color-response key assignments. Then, a pre-cue screen was presented until participants pressed the key when they were ready to start the list. There were 15 trials within each list. In each trial, first, a fixation was presented for 500 ms, then the stimulus was presented for 3000 ms or until a response was given, followed by a 500 ms blank screen (please see Figure 4 for the schematic illustration of the trial sequence). After the experimental session, participants answered some open-ended questions related to their strategies and opinions about the experiment (please see Appendix D). We aimed to learn about their awareness regarding the validity of the cues with these questions, please see the Discussion section for the detailed explanation on this. The total duration of the experimental session was approximately 50 minutes, which included 15 minutes of instructions and learning session, 30 minutes of experimental blocks, and 5 minutes of awareness questionnaire.

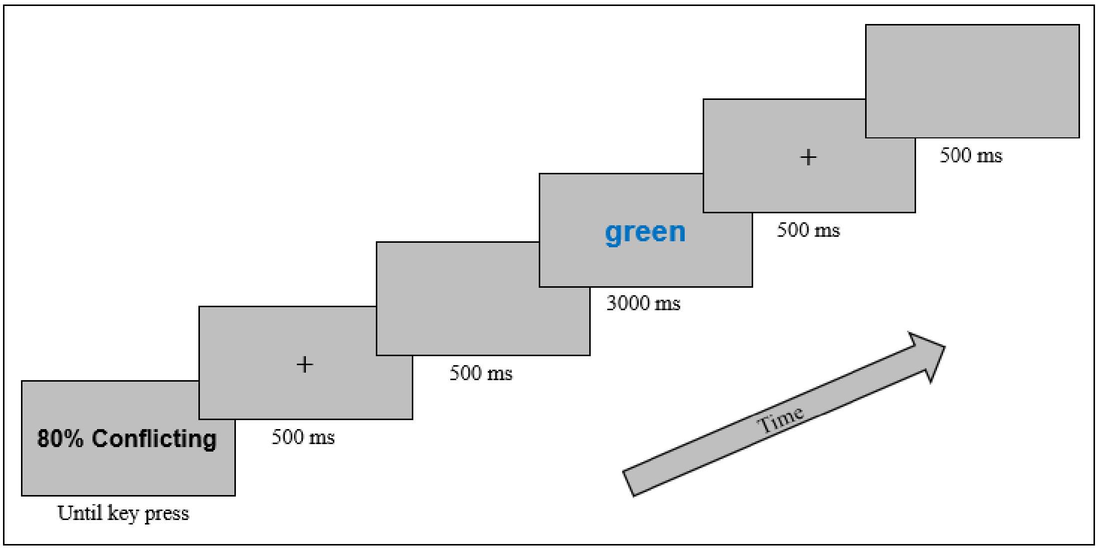

Figure 4. The schematic illustration of the trial sequence in the experiment. At the beginning of each list, a precue is presented (e.g., 80% conflicting, 80% matching, or ?????), followed by a 500 ms fixation screen, and a 500 ms blank screen. Then, a stimulus is presented for 3000 ms or until a response is given. After a response, fixation and blank screens are presented again, followed by the stimulus.

2.3. Results

2.3.1. Analysis Plan

Average RT and PE for all conditions of the experiment are presented in Table 6 and 7, respectively. Before the analyses, an outlier elimination procedure (please see Appendix E for the R codes) was followed. For the RT analyses, outlier elimination was conducted by excluding trials below or above the 3 standard deviations of the average RT of each participant. Also, incorrect trials and trials faster than 200 ms were removed.

Table 6

Average Response Times (RTs) for the Conditions

		RT		
LWPC	Cue	Congruent	Incongruent	Stroop Effect
MC	MC-cued	724	887	163
	Uncued	717	892	175
	MI-cued	730	893	163
MI	MC-cued	721	851	130
	Uncued	694	821	127
	MI-cued	718	830	112

Table 7

Average Percentage of Error (PE) for the Conditions

		PE		
LWPC	Cue	Congruent	Incongruent	Stroop Effect
MC	MC-cued	0.04	0.09	0.05
	Uncued	0.04	0.08	0.04
	MI-cued	0.04	0.08	0.04
MI	MC-cued	0.04	0.06	0.02
	Uncued	0.03	0.07	0.04
	MI-cued	0.04	0.06	0.02

After the outlier elimination procedure, we conducted two omnibus 3 (cueing: MC cued, MI cued, uncued) x 2 (LWPC: MC, MI) x 2 (trial type: congruent, incongruent) within-subjects ANOVAs for RTs and Pes separately. A two-way interaction between trial type and LWPC would indicate the influence of experience in the control of attention (i.e., the LWPC effect). A two-way interaction between trial type and cueing would indicate the influence of expectation in the control of attention (i.e., cueing effect). A three-way interaction between trial type, cueing, and LWPC would indicate the interaction between expectation and experience. We planned to conduct post-hoc comparisons with Bonferroni correction. We pre-registered all the steps of our analyses.

2.3.2. Response Time

There was a significant main effect of trial type, *F*(1, 74) = 284.30, *MSE* = 16353, $p < .001$, $\eta_p^2 = .79$. The responses given to the congruent trials (*M* = 718) were significantly faster compared to the incongruent trials (*M* = 862). The main effect of cueing was significant, *F*(2, 148) = 5.08, *MSE* = 4340, *p* = .007, $\eta_p^2 = .06$. The fastest responses were given for the uncued condition (*M* = 780), followed by the MI-cued (*M* = 793), and the MC-cued (*M* = 796) conditions. Bonferroni comparisons showed that, the RTs for the uncued condition were significantly faster compared to the MI-cued, *p* = .037; and the MC-cued conditions, *p* = .010. The MI-cued and MC-cued conditions were not significantly different in their RTs, *p* = .879. The main effect of LWPC was also significant, *F*(1, 74) = 50.44, *MSE* = 5222, $p < .001$, $\eta_p^2 = .41$. The responses given in the MI list (*M* = 773) were significantly faster compared to those in the MC list (*M* = 807). Importantly, the two-way interaction between trial type and LWPC was significant, *F*(1, 74) = 30.84, *MSE* = 3231, $p < .001$, $\eta_p^2 = .29$. There was a greater Stroop effect for the MC list (*M* = 165) compared to the MI list (*M* = 123), which showed the LWPC effect. Critically, the two-way interaction between trial type and cue ($F < 1$), the two-way interaction between cue and LWPC (*F*(2, 148) = 3.00, *MSE* = 5263, *p* = .053), and the three-way interaction between trial type, cue, and LWPC ($F < 1$) were not significant. The mean Stroop effects for each condition is presented in Figure 5.

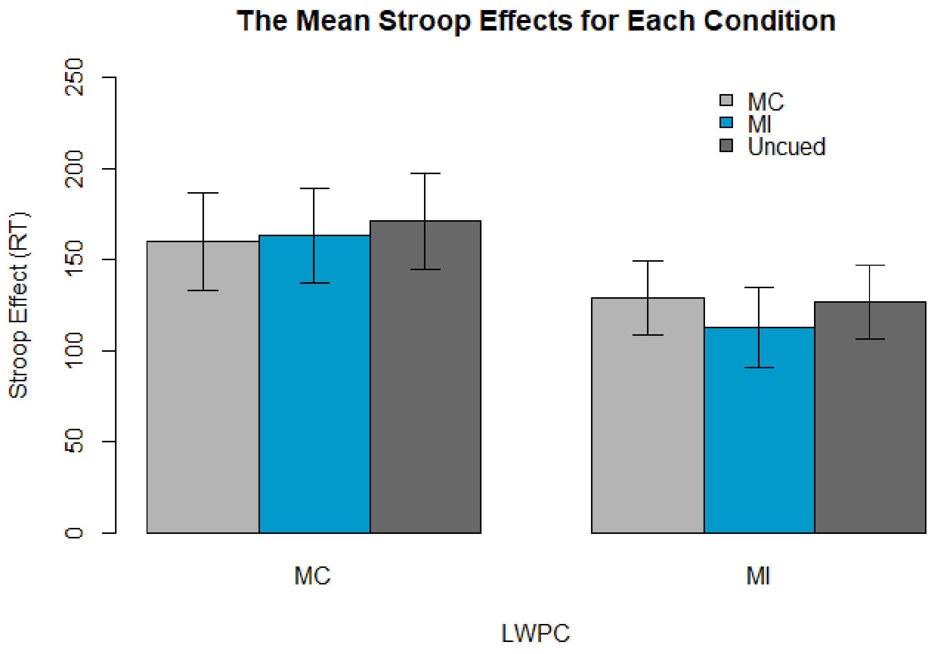

Figure 5. The mean Stroop effects with RT for each condition. Error bars represent the 95% confidence interval. While there is a significant LWPC effect, there is not a significant cueing effect.

2.3.3. Percentage of Error

There was a significant main effect of trial type, $F(1, 74) = 52.83$, $MSE = .005$, $p < .001$, $\eta_p^2 = .42$. The responses given to the congruent trials ($M = .04$) were significantly more accurate compared to the incongruent trials ($M = .07$). The main effect of cue was not significant, $F < 1$. PE for the uncued ($M = .06$), MI-cued ($M = .05$), and MC-cued ($M = .05$) conditions were not significantly different. The main effect of LWPC was significant, $F(1, 74) = 7.47$, $MSE = .003$, $p = .008$, $\eta_p^2 = .09$. The responses given in the MI list ($M = .05$) were significantly more accurate compared to those in the MC list ($M = .06$). Importantly, the two-way interaction between trial type and LWPC was significant, $F(1, 74) = 4.57$, $MSE = .002$, $p = .036$, $\eta_p^2 = .06$. There was a greater Stroop effect in the MC list ($M = .04$) compared to the MI list ($M = .03$), indicating the LWPC effect. Critically, the two-way interaction between congruency and cue ($F < 1$), the two-way interaction between cue and LWPC ($F < 1$), and three-way interaction between congruency, cue, and LWPC ($F(2, 148) = 2.51$, $MSE = .002$, $p = .085$) were not significant. The mean Stroop effects for each condition is presented in Figure 6.

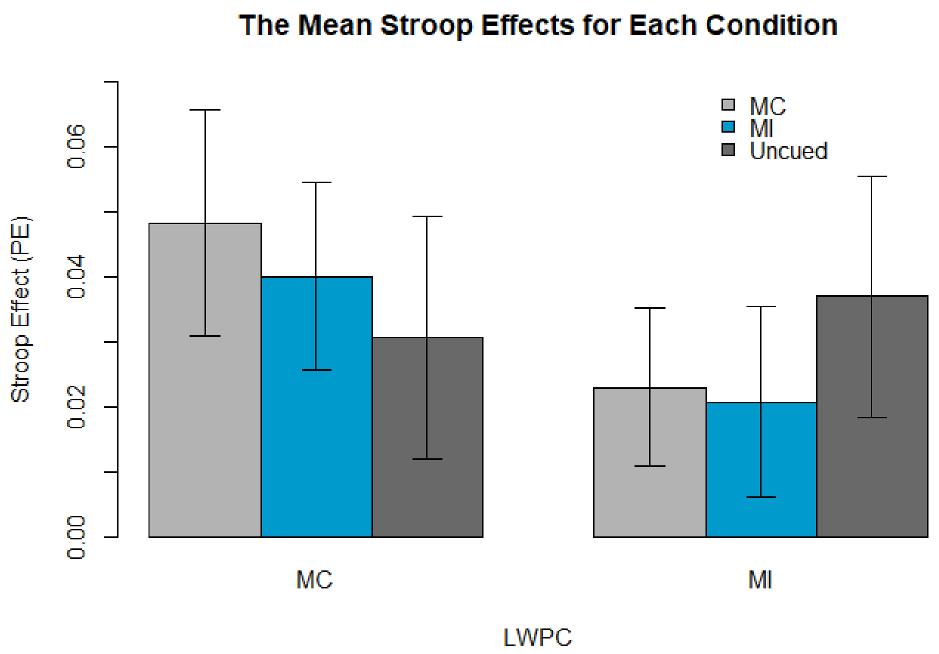

Figure 6. The mean Stroop effects with PE for each condition. Error bars represent the 95% confidence interval. While there is a significant LWPC effect, there is not a significant cueing effect.

2.4. Discussion

2.4.1. Overview

The current thesis aimed to investigate the relationship between experience and expectation on the control of attention. We intended to answer two central questions: (1) "Does expectation modulate attentional control settings over and above the experience?" and (2) "Are the effects of experience and expectation additive or interactive?". Regarding these questions, three possible hypotheses were presented: (1) pure experience, (2) additive experience and expectation, and (3) interactive experience and expectation.

In our experimental paradigm, we presented multiple abbreviated MC and MI lists with or without a cue. Precues were either valid (e.g., MC cue for the MC list) or invalid (e.g., MC cue for the MI list). The influence of experience was to be signaled by the two-way interaction between trial type and LWPC, indicating different Stroop effects for different lists. The influence of expectation was to be demonstrated by the two-way interaction between trial type and cueing, indicating different Stroop effects for different cues. An additive relationship between expectation and experience would show itself as the absence of the three-way interaction between trial type, cueing, and LWPC. An interactive relationship of expectation and experience would manifest itself as the existence of the three-way interaction between trial type, cueing, and LWPC.

Our RT and PE results supported the pure experience account. There was a significant influence of experience on the control of attention indicated by the LWPC effect, for both RT and PE. However, there was no influence of expectation on the control over and above experience. In other words, cueing did not modulate the Stroop effect for the MC or the MI lists.

We also aimed to test the default mode explanation of the absence of the cue-induced MI shift. According to this explanation, the default attentional control setting is compatible with expecting conflict, thus, it is compatible with the MI list. Giving the MI cue does not change the default setting and leads to the absence of the cue-induced MI shift. We aimed to test the MI-cue induced shift together for MC and MI lists, and see if there would be a cueing effect with the MC list as well as the MI list. Observing a non-significant cueing effect with the MC list in addition to the MI list would support the default mode explanation. However, we did not observe an effect of expectation over and above experience in general, not just for the MI cues. The default mode explanation would predict a significant effect for the MC cues. Because being given an MC cue should create expectations that are different from the default mode and change the Stroop effect. However, we did not observe that either. To sum up, the default mode explanation is not suitable to account for the current results.

2.4.2. Possible Explanations for the Absence of Cue-Induced Shift: The Role of Cue Validity

In previous studies using the precued list paradigm (Bugg et al., 2015; Bugg and Diede, 2018), there was a significant cue-induced MC shift but not a cue-induced MI shift. We did not observe either of these shifts. The cue-induced MC shift is a finding that has been replicated several times before (Bugg et al., 2015; Bugg and Diede, 2018). The reason why we did not observe this effect might be related to the use of invalid cues. As explained previously, using invalid cues was critical for examining the relationship between experience and expectation. If there were only valid cues, we would be able to see if there was an influence of expectation over and above experience by comparing the cued and uncued lists. However, it was the use of invalid cues that enabled our design to test the relationship between expectation and experience through the comparison of validly- and invalidly-cued lists. In the following paragraphs, we will discuss why and how invalid cues might have caused the absence of a cue-induced shift in our experiment.

We were aware of the risks of using invalid cues, namely, the possibility of participants noticing the presence of invalid cues and ignoring the cues in general. Trying to eliminate this risk, we used filler items which were the last 5 items of the lists as described in the Method section in detail. Following our pre-registered analysis plan, we analyzed the first 10 items that reflected the PC of the list. The filler items served as the list that was signaled by the cue. For instance, when a participant expected to observe an MC list but observed an MI list for the first 10 trials, we presented an MC list for the remaining 5 trials to push the list closer to participants' expectations. We also considered the possibility that the participants might still realize the invalid cues despite the filler items. This is why, we included a questionnaire at the end of the experiment to have a better understanding regarding the participants' awareness about the validity of the cues. We asked participants some open-ended questions such as "Did you attend to the cues given prior to each list?" and "Are there any thoughts you would like to share about the study?". We did not directly ask about the validity of the cues for not to be suggestive (please see Appendix D for the questions). There were a large number of participants who indicated that they realized that cues were not valid and consequently ignored them (N = 23, 31% of the participants) or they thought the cues were not beneficial for their performance and did not use the cues (N = 17, 23% of the participants). Some participants did not answer the questions (N = 22, 29% of the participants). Critically, only 13 participants out of 75 (17% of the participants) reported that they attended to the cues. These answers somewhat indicate that some participants were aware of the invalid cues and deliberately ignored them to prevent any misleading guidance. Participant's intentional strategy of ignoring the cues might be the reason that we observed the influence of pure experience in our design.

Additionally, in previous studies that observed a significant cue-induced MC shift, the expectation was always supported by experience (Bugg et al., 2015; Bugg & Diede, 2018). Thus, the influence of expectations might still be dependent on being compatible with experience. While experience is based on participants' own practice during the experiment, expectation is signaled by external sources. Experiencing the trials on their own might have been a more reliable information source compared to extraneous information. In addition to that, since the conflict signal coming from the cues was not always reliable, noticing the inconsistencies between expectation and experience might have further decreased the weight of the expectation in the attentional control modulation process. We know that participants are able to dynamically modulate their attentional control settings in an online manner (Jacoby et al., 2003; Blais et al., 2007). Participants might have used both experience and expectation to modulate the attentional control settings when experience supported expectation. However, when experience and expectation were in conflict, they might have stuck to their own experience to maintain the task goal.

People have limited attentional resources that need to be distributed to competing sources (Kahneman, 1973), and using cues requires allocation of cognitive resources (Jiménez, Méndez, Abrahamse, & Braem, 2020). Signaling this issue, in the questionnaire at the end of the experiment, some participants reported that "I felt like attending to the cues decreased my performance, I was faster when I did not look at the cues.". Allocating their attention to the cues might have decreased their performance by leaving less available cognitive resources for the color-naming task. Since precues are not always valid, the competition between experience and expectation might have favored the reliable experiences and participants might have not allocated their limited attentional resources to cues.

Moreover, the task demands and the required attention might have been higher for the precued list paradigm compared to a classic LWPC paradigm. In a classic LWPC paradigm, participants experience either an MC or an MI list throughout the experimental session. Thus, the environment is stable, and they may well use the same attentional control setting all through the experiment. In our design, participants experienced constantly changing PCs and they needed to adapt to a new list several times. This dynamic environment might have increased the task demand and participants might have needed to be alert most of the time, which made our task more effortful compared to a traditional LWPC task.

We can evaluate the current results from a "mental effort" perspective (Kool, McGuire, Rosen, & Botvinick, 2010; Shenhav, Botvinick, & Cohen, 2013; Braver et al. 2014). Shenhav et al. (2013) proposed *the expected value of control (EVC) model* to explain cognitive control processes. According to the "law of least mental effort", cognitive control processes are actually decision-making processes. There is a cost vs. benefit analysis in the mind that determines the perceived value of cognitive effort. They argue that dorsal anterior cingulate cortex (dACC) evaluates the expected value of control based on three aspects: (1) the expected payoff of allocating control, (2) the amount of needed control, and (3) the cost as the mental effort. They proposed that dACC integrates this information and determines the control processes. If the perceived value of achieving the current goal is higher than the perceived cost of the mental effort that is required for the task goal, participants are motivated to make a mental effort to meet the task demands. In our study, precues had perceived value, since they might have helped participants in the task. However, there was also a perceived cost of using the cues. In addition to the resources allocated for attending to the cues and keeping them in mind during the experiment, there was an additional cost due to the risk of relying on an invalid cue (Posner, 1980; Wright, Richard, & McDonald, 1995; Ling & Carrasco, 2006). Considering the tradeoff between the reward and cost, the perceived value was probably lower than the perceived cost. Therefore, the participants might have not wanted to exert mental effort for an unreliable source, namely, the precues.

Finally, a methodological difference between the current study and previous studies observing the cue-induced shift is the response modality. While participants responded vocally in the previous studies, they responded manually using the keyboard in our study. It is known that there are inconsistencies between results with vocal and manual responses, and vocal responses produce more interference than manual responses (White, 1969; Lu & Proctor, 1995; Sharma & McKenna, 1998; Fennell & Ratcliff, 2019). There might be a higher need for control in the vocal response condition due to the automaticity of word reading, which is more powerful for the vocal response modality than manual response modality. Thus, participants might need to facilitate the cues more with a vocal response condition, and that might be the reason for the absence of the cueing effect with a manual response.

2.4.3. Implications for Proportion Congruence Studies

There are two key differences between the classic LWPC paradigm and the precued list paradigm. First, the expectation in a classic LWPC paradigm stems from being exposed to congruent and incongruent items, in other words, from experience. In the precued list paradigm, the expectation is deliberately created in advance of any prior experience. The second key difference is that while classic LWPC studies involve a single long list of trials creating a particular PC, the precued list paradigm involves multiple short lists with different PCs.

Having a larger Stroop effect in the MC list compared to the MI list is a robust observation with a classic LWPC paradigm. Critically, we also observed the same pattern with the precued list paradigm. In this paradigm, there were only 10 trials in each list, so the lists were very short compared to those in classic LWPC experiments. Participants had a very limited opportunity to gain the experience to guide their attention within the list. However, interestingly, these short lists of trials were sufficient to produce a significant LWPC effect. Observing the LWPC effect with abbreviated lists signal the automatic and fast learning processes in the PC paradigms. Participants are able to swiftly adjust their attentional control settings according to the PC. Thus, future studies may not always need to use very long list of trials, instead, abbreviated lists could be used in accordance with the research questions.

As explained in the introduction, there is a continuing debate between the list-wide control, item-specific control, and contingency learning accounts. Please note that, the precued list paradigm does not include ISPC or contingency learning confounds. Since multiple abbreviated lists are presented and the pairings are randomly presented within the list, it is not possible to learn contingencies between stimulus and response. All words are paired with all colors similar to a 4-item set design and there are only 10 stimuli within each list. For instance, in one list, participants might see blue-green and blue-yellow pairings, while in the other they might see blue-pink and blue-blue pairings. The pairings are randomly distributed. Therefore, the design does not create consistent contingencies between the colors and words. The only resource that participants can use to modulate their attentional control settings is the PC of the current list and the explicit expectation given by the precues. Using multiple abbreviated lists, either with or without cues, could be a way of preventing item-specific control and contingency learning confounds when top-down control mechanisms are investigated.

2.4.4. Limitations

Because of the global pandemic, we collected data remotely with the E-Prime Go extension of E-Prime 3 software. Participants attended the experiment with their own computers and in a home environment. Since we use RT to measure behavior, timing sensitivity was especially important for us. We tested the timing sensitivity of participants' devices and excluded the ones that were not sensitive enough[4]. Since the screen sizes might be different in different devices and the area that the stimuli cover on the screen might affect the results, we adjusted the stimulus size so that the area it took up on the screen was 10% of the screen height for each participant. Even though we controlled many factors that might influence the results, there might still some problems regarding the online data collection. These problems are especially related to difficulty in controlling the environment that the participants attended to the experiment. We cannot verify if they followed our instructions, for instance, keeping their positions constant, keeping their fingers on the keyboard, not performing any other activities such as texting or watching television, or not talking with someone during the experiment. These problems might confound

[4] We used the criterion that is suggested by Psychology Software Tools for timing sensitivity verification. If the sample rate was less than 4 and/or if the number of trials in which timing error is above 11 ms is above 0.01% of all trials, these participants were excluded. We also verified that the computers of participants met the minimal requirements to run E-Prime Go 1.0 / E-Prime 3.0. If the minimum requirements were not met, the experiment did not run on these computers.

the results. However, considering the overall error rate is low (M = .06), we think that participants followed the instructions in general. We also conducted an outlier elimination procedure as described in the Method section to exclude potential participants not following the instructions.

2.4.5. Conclusion and Future Directions

In the current thesis, we used the precued list paradigm to disentangle the influence of expectation and experience on the control of attention. We also included valid and invalid cues in our design to examine the relationship between experience and expectation, and contrasted predictions of three hypotheses: (1) pure experience, (2) additive experience and expectation, and (3) interactive experience and expectation. Our results supported a pure experience account of cognitive control. In conclusion, we can argue based on our results that when expectations do not always correspond to the actual experience within the list, pure experience guides the attentional control settings.

In future studies, the proportion of invalid lists might be decreased to prevent the practice of abandoning the cues. When there are relatively more valid lists than invalid lists, participants might either not realize the invalid ones, or they might still decide to use the cues. Because, even if the cues sometimes provide incorrect information, the information coming from the cues might still be valuable when they provide correct information most of the time. Also, the awareness of participants might be assessed more systematically to better understand the influence of invalid cues on participants' strategies.

REFERENCES

Besner, D., Stolz, J. A., & Boutilier, C. (1997). The Stroop effect and the myth of automaticity. *Psychonomic Bulletin & Review*, *4*(2), 221-225.

Blais, C., & Bunge, S. (2010). Behavioral and neural evidence for item-specific performance monitoring. *Journal of Cognitive Neuroscience, 22*(12), 2758-2767.

Blais, C., Harris, M. B., Guerrero, J. V., & Bunge, S. A. (2012). Rethinking the role of automaticity in cognitive control. *Quarterly Journal of Experimental Psychology*, *65*(2), 268-276.

Blais, C., Robidoux, S., Risko, E. F., & Besner, D. (2007). Item-specific adaptation and the conflict-monitoring hypothesis: A computational model. *Psychological Review*, *114*(4), 1076–1086.

Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. *Psychological Review*, *108*(3), 624-652.

Botvinick, M. M., Cohen, J. D., & Carter, C. S. (2004). Conflict monitoring and anterior cingulate cortex: an update. *Trends in Cognitive Sciences*, *8*(12), 539-546.

Braem, S., Bugg, J. M., Schmidt, J. R., Crump, M. J., Weissman, D. H., Notebaert, W., & Egner, T. (2019). Measuring adaptive control in conflict tasks. *Trends in Cognitive Sciences*, *23*(9), 769-783.

Braver, T. S. (2012). The variable nature of cognitive control: a dual mechanisms framework. *Trends in Cognitive Sciences*, *16*(2), 106-113.

Braver, T. S., Gray, J. R., & Burgess, G. C. (2007). Explaining the many varieties of working memory variation: Dual mechanisms of cognitive control. *Variation in Working Memory*, *75*, 106.

Braver, T. S., Krug, M. K., Chiew, K. S., Kool, W., Westbrook, J. A., Clement, N. J., ... & Somerville, L. H. (2014). Mechanisms of motivation–cognition interaction: challenges and opportunities. *Cognitive, Affective, & Behavioral Neuroscience*, *14*(2), 443-472.

Bugg, J. M. (2012). Dissociating levels of cognitive control: The case of Stroop interference. *Current Directions in Psychological Science*, *21*(5), 302-309.

Bugg, J. M. (2014). Conflict-triggered top-down control: Default mode, last resort, or no such thing? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *40*(2), 567-587.

Bugg, J. M., & Chanani, S. (2011). List-wide control is not entirely elusive: Evidence from picture–word Stroop. *Psychonomic Bulletin & Review*, *18*(5), 930-936.

Bugg, J. M., & Crump, M. J. (2012). In support of a distinction between voluntary and stimulus-driven control: a review of the literature on proportion congruent effects. *Frontiers in Psychology*, *3*, 367.

Bugg, J. M., & Diede, N. T. (2018). The effects of awareness and secondary task demands on Stroop performance in the pre-cued lists paradigm. *Acta Psychologica*, *189*, 26-35.

Bugg, J. M., Diede, N. T., Cohen-Shikora, E. R., & Selmeczy, D. (2015). Expectations and experience: Dissociable bases for cognitive control?. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *41*(5), 1349-1373.

Bugg, J. M., Jacoby, L. L., & Toth, J. P. (2008). Multiple levels of control in the Stroop task. *Memory & Cognition, 36*(8), 1484-1494.

Entel, O., Tzelgov, J., & Bereby-Meyer, Y. (2014). Proportion congruency effects: Instructions may be enough. *Frontiers in Psychology*, *5*, 1108.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175-191.

Fennell, A., & Ratcliff, R. (2019). Does response modality influence conflict? Modelling vocal and manual response Stroop interference. *Journal of*

Experimental Psychology: Learning, Memory, and Cognition, *45*(11), 2098.

Jacoby, L. L., Lindsay, D. S., & Hessels, S. (2003). Item-specific control of automatic processes: Stroop process dissociations. *Psychonomic Bulletin & Review*, *10*(3), 638-644.

Jiménez, L., Méndez, C., Abrahamse, E., & Braem, S. (2020). It is harder than you think: On the boundary conditions of exploiting congruency cues. *Journal of Experimental Psychology: Learning, Memory, and Cognition.* Advance online publication.

Kahneman, D. (1973). *Attention and effort* (Vol. 1063, pp. 218-226). Englewood Cliffs, NJ: Prentice-Hall.

Kool, W., McGuire, J. T., Rosen, Z. B., & Botvinick, M. M. (2010). Decision making and the avoidance of cognitive demand. *Journal of Experimental Psychology: General*, *139*(4), 665.

Ling, S., & Carrasco, M. (2006). When sustained attention impairs perception. *Nature Neuroscience, 9*(10), 1243-1245.

Logan, G. D. (1980). Attention and automaticity in Stroop and priming tasks: Theory and data. *Cognitive Psychology*, *12*(4), 523-553.

Logan, G. D., & Zbrodoff, N. J. (1979). When it helps to be misled: Facilitative effects of increasing the frequency of conflicting stimuli in a Stroop-like task. *Memory & Cognition*, *7*(3), 166-174.

Logan, G. D., Zbrodoff, N. J., & Williamson, J. (1984). Strategies in the color-word Stroop task. *Bulletin of the Psychonomic Society*, *22*(2), 135-138.

Lowe, D. G., & Mitterer, J. O. (1982). Selective and divided attention in a Stroop task. *Canadian Journal of Psychology/Revue Canadienne de Psychologie*, *36*(4), 684.

Lu, C. H., & Proctor, R. W. (1995). The influence of irrelevant location information on performance: A review of the Simon and spatial Stroop effects. *Psychonomic Bulletin & Review*, *2*(2), 174-207.

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: an integrative review. *Psychological Bulletin*, *109*(2), 163.

MacLeod, C. M. (1992). The Stroop task: The “gold standard” of attentional measures. *Journal of Experimental Psychology: General*, *121*(1), 12-14.

MacLeod, C. M., & MacDonald, P. A. (2000). Interdimensional interference in the Stroop effect: Uncovering the cognitive and neural anatomy of attention. *Trends in Cognitive Sciences*, *4*(10), 383-391.

Melara, R. D., & Algom, D. (2003). Driven by information: a tectonic theory of Stroop effects. *Psychological Review*, *110*(3), 422-471.

Miller, E. K. (2000). The prefrontal cortex and cognitive control. *Nature reviews. Neuroscience*, *1*(1), 59.

Norman, D. A., & Shallice, T. (1986). Attention to action. In *Consciousness and self-regulation* (pp. 1-18). Springer, Boston, MA.

Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology*, *32*(1), 3-25.

Posner, M. I., & Snyder, C. R. R. (1975). Attention and cognitive control. In R. L. Solso (Eds.), *Information Processing and Cognition: The Loyola Symposium* (pp. 55–85). Hillsdale, NJ: Erlbaum.

Psychology Software Tools, Inc. [E-Prime 3.0]. (2016). Retrieved from https://support.pstnet.com/.

Psychology Software Tools, Inc. [E-Prime Go]. (2020). Retrieved from https://support.pstnet.com/.

Schmidt, J. R., & Besner, D. (2008). The Stroop effect: why proportion congruent has nothing to do with congruency and everything to do with contingency. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34*(3), 514-523.

Sharma, D., & McKenna, F. P. (1998). Differential components of the manual and vocal Stroop tasks. *Memory & Cognition*, *26*(5), 1033-1040.

Shenhav, A., Botvinick, M. M., & Cohen, J. D. (2013). The expected value of control: an integrative theory of anterior cingulate cortex function. *Neuron*, *79*(2), 217-240.

Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending and a general theory. *Psychological Review, 84*(2), 127.

Stroop, J. R. (1935). Studies on interference in serial verbal reactions. *Journal of Experimental Psychology, 18*, 643-661.

Tzelgov, J., Henik, A., & Berger, J. (1992). Controlling Stroop effects by manipulating expectations for color words. *Memory & Cognition*, 20(6), 727-735.

West, R., & Baylis, G. C. (1998). Effects of increased response dominance and contextual disintegration on the Stroop interference effect in older adults. *Psychology and Aging*, *13*(2), 206.

White, B. W. (1969). Interference in identifying attributes and attribute names. *Perception & Psychophysics*, *6*(3), 166-168.

Wright, R. D., Richard, C. M., & McDonald, J. J. (1995). Neutral location cues and cost/benefit analysis of visual attention shifts. *Canadian Journal of Experimental Psychology/Revue Canadienne de Psychologie Expérimentale*, *49*(4), 540.

APPENDICES

A. APPROVAL OF THE METU HUMAN SUBJECTS ETHICS COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr
www.ueam.metu.edu.tr

Sayı: 28620816 /

22 MART 2021

Konu : Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi : İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof.Dr. Mine MISIRLISOY ve Dr. Nart Bedin ATALAY

Danışmanlığını yürüttüğünüz Merve İleri TAYAR'ın "The Role of Expectation and Experience in the Control of Attention**"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve **077-ODTU-2021** protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

Dr.Öğretim Üyesi Ali Emre TURGUT
İAEK Başkan Vekili

B. APPROVAL OF THE TOBB ETU HUMAN SUBJECTS ETHICS COMMITTEE

Evrak Tarih ve Sayısı: 02.06.2021-E.6595

T.C.
TOBB EKONOMİ VE TEKNOLOJİ ÜNİVERSİTESİ
İnsan Araştırmaları Değerlendirme Kurulu

Sayı : E-27393295-100-6595 02.06.2021
Konu : 2021-22 Numaralı Başvuru

Sayın Doç. Dr. Nart Bedin ATALAY

İnsan Araştırmaları Değerlendirme Kurulu'na etik yönden değerlendirilmek üzere sunmuş olduğunuz 2021-22 kayıt numaralı "Dikkatin Kontrolünde Beklenti ve Deneyimin Rolü" başlığını taşıyan projeniz etik yönden uygun görülerek onaylanmasına karar verilmiştir.

Bilgilerinizi rica ederiz.

Prof. Dr. Tayyibe Nur ÇAĞLAR
Kurul Başkanı

Bu belge, güvenli elektronik imza ile imzalanmıştır.

Belge Doğrulama Kodu :BSMZ1BCMB Belge Doğrulama Adresi : https://www.turkiye.gov.tr/tobb-universitesi-ebys

Söğütözü Caddesi No:43 06560 Söğütözü/Ankara
Telefon No:(0312) 292-4000 Faks No:(0312) 287-1946
e-Posta:bilgi@etu.edu.tr İnternet Adresi:www.etu.edu.tr
Kep Adresi:tobbetu@hs01.kep.tr

Bilgi için: Nimet Zorlu
Sekreter

C. INFORMED CONSENT

ARAŞTIRMAYA GÖNÜLLÜ KATILIM FORMU

Bu çalışma ODTÜ Psikoloji Bölümü öğretim üyesi Prof. Dr. Mine Mısırlısoy, TOBB ETÜ Psikoloji Bölümü öğretim üyesi Doç. Dr. Nart Bedin Atalay ve ODTÜ Psikoloji Bölümü araştırma görevlisi Merve İleri Tayar tarafından yürütülmektedir. Bu form sizi araştırma koşulları hakkında bilgilendirmek için hazırlanmıştır.

Çalışmanın Amacı Nedir?

Çalışmanın amacı Stroop görevinde liste düzeyi uyumluluk oranına dair ipuçlarının verilmesinin performansa etkisini anlamaktır.

Bize Nasıl Yardımcı Olmanızı İsteyeceğiz?

Araştırma online olarak yapılacak ve yaklaşık 50 dakika sürecektir. Çalışmada, size çeşitli renklerdeki kelimeler gösterilecek ve bu kelimelerin anlamını görmezden gelirken rengine tepki vermeniz ve yanıtınızı bilgisayar klavyesi kullanarak renge karşılık gelen tuşa basarak vermeniz istenecektir.

Katılımınızla ilgili bilmeniz gerekenler:

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

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

Çalışmaya katıldığınız için şimdiden teşekkür ederiz.

Araştırmayla ilgili daha fazla bilgi almak isterseniz:

Çalışmayla ilgili soru ve yorumlarınızı araştırmacılara mmine@metu.edu.tr veya mileri@metu.edu.tr adresinden iletebilirsiniz.

Lütfen yukarıdaki bilgileri okuyup bu çalışmaya tamamen gönüllü olarak katılıyorsanız aşağıdaki kutucuğu işaretleyerek devam ediniz.

☐ ***Yukarıdaki bilgileri okudum ve bu çalışmaya tamamen gönüllü olarak katılıyorum.***

D. OPEN-ENDED QUESTIONS AT THE END OF THE EXPERIMENT

1. Were you alone and in a quiet place during the experiment? Did you need to talk to someone or take a break? Please let us know if there is any problem you had during the experiment.

2. Did you attend to the cues given prior to each list? Did you follow a strategy using these cues?

3. Did you follow any strategy during the experiment?

4. Is there anything about the experiment that you generally noticed or would like to let us know?

E. OUTLIER ELIMINATION AND ANALYSIS SCRIPT-R STUDIO CODE

```
#This script is prepared for performing outlier elimination, data organization,
and analyses by Merve İleri Tayar for her master's thesis.

#load some packages
library(tidyverse)
library(ggpubr)
library(rstatix)
library(lsr)
library(sciplot)
library(ggplot2)
library(psych)
library(dplyr)
library(afex)
library(emmeans)


## OUTLIER ELIMINATION AND CLEANING DATA

#read data
data_raw <- read.csv(file="merged_data.csv", sep=";", header=T, na.strings =
"")
data <- data_raw
#treat subject variable as factor
data$Subject <- as.factor(data$Subject)

#look at all RTs
hist(data$Stimulus.RT.SubTrial.)

#exclude participants whose device is not sensitive enough for timing
for (i in c(37,39,82,92,102)) {
  data <- data[data$Subject != i,]
}
#update levels of subject
data$Subject <- factor(data$Subject)

#exclude learning and practice trials
```

```
data <- data[data$PracticeMode == "no",]

#exclude participants not suitable for our criterion
data <- data[data$ReadingDisability == "hayir",]
data <- data[data$ColorBlindness == "hayir",]
data <- data[data$Handedness == "sag",]
data <- data[data$Age >= 18 & data$Age <= 25,]

data$Subject <- factor(data$Subject)

#calculate the proportion of missing data for each subject
Missing <- tapply(data$Stimulus.RT.SubTrial.,data$Subject, function(x)
{length(which(x==0))/length(x)})
print(Missing)
data$Missing <- Missing[data$Subject]

#exclude participants having more than 25% missing data (no response)
data <- data[data$Missing < 0.25,]

#exclude 11-15 trials
data <- data[data$SubTrial != 11 & data$SubTrial != 12 & data$SubTrial !=
13 &
        data$SubTrial != 14 & data$SubTrial != 15,]

#exclude faster than 200 ms trials
data <- data[data$Stimulus.RT.SubTrial. >= 200,]

#calculate mean PEs for each participant, grand PE, and sd of PEs
meanPEs <- tapply(data$Stimulus.ACC.SubTrial.,data$Subject,function(x)
{1-mean(x)})
print(meanPEs)

grandPE <- mean(meanPEs)
print(grandPE)

sdPE <- sd(meanPEs)
print(sdPE)

#cutoff error rate
cutoffPE <- grandPE + 3*sdPE
print(cutoffPE)
data$cutoffPE <- cutoffPE

#exclude participants having more than 3sd error
data$meanPEs <- meanPEs[data$Subject]
```

```
data <- data[data$meanPEs < data$cutoffPE,]
data$Subject <- factor(data$Subject)

#create dataframe for accuracy analysis
ACC <- data$Stimulus.ACC.SubTrial.
Subject <- as.factor(data$Subject)
TrialNo <- data$SubTrial
Cue <- as.factor(data$Cue)
LWPC <- as.factor(data$LWPC)
Congruency <- as.factor(data$ItemType.SubTrial.)
Color <- as.factor(data$StroopColorName.SubTrial.)
Word <- as.factor(data$StroopWord.SubTrial.)
Block <- as.factor(data$Blocks.Sample)
CueType <- as.factor(data$CueType)

data_ACC <-
data.frame(Subject,TrialNo,LWPC,Cue,Congruency,Color,Word,ACC,Block,
CueType)

#continue with outlier elimination for the RT analyses

#exclude incorrect trials
data <- data[data$Stimulus.ACC.SubTrial. == 1,]

#calculate mean RTs for each participant, grand RT, and sd of RTs
meanRTs <- tapply(data$Stimulus.RT.SubTrial.,data$Subject, mean)
print(meanRTs)

grandRT <- mean(meanRTs)
print(grandRT)

sdRT <- sd(meanRTs)
print(sdRT)

#cutoff RT
cutoffRTmax <- grandRT + 3*sdRT
print(cutoffRTmax)
cutoffRTmin <- grandRT - 3*sdRT
print(cutoffRTmin)

data$cutoffRTmax <- cutoffRTmax
data$cutoffRTmin <- cutoffRTmin

#exclude participants having more or less than than 3sd RT
data$meanRTs <- meanRTs[data$Subject]
```

```
data <- data[data$meanRTs < data$cutoffRTmax,]
data <- data[data$meanRTs > data$cutoffRTmin,]

data$Subject <- factor(data$Subject)

#calculate mean and sd of RTs individually for each participant
meanRTs <- tapply(data$Stimulus.RT.SubTrial.,data$Subject, mean)
sdRTs <- tapply(data$Stimulus.RT.SubTrial.,data$Subject,sd)
print(sdRTs)

#cutoffs for each participant
cutoffRTmaxPart <- meanRTs + 3*sdRTs
cutoffRTminPart <- meanRTs - 3*sdRTs
print(cutoffRTmaxPart)
print(cutoffRTminPart)

#exclude trials having more than 3sd RT for each participant
data$cutoffRTmaxPart <- cutoffRTmaxPart[data$Subject]
data$cutoffRTminPart <- cutoffRTminPart[data$Subject]
data <- data[data$Stimulus.RT.SubTrial. < data$cutoffRTmaxPart &
            data$Stimulus.RT.SubTrial. > data$cutoffRTminPart,]

#clean data frame for RT analysis
RT <- data$Stimulus.RT.SubTrial.
Subject <- as.factor(data$Subject)
TrialNo <- data$SubTrial
Cue <- as.factor(data$Cue)
LWPC <- as.factor(data$LWPC)
Congruency <- as.factor(data$ItemType.SubTrial.)
Color <- as.factor(data$StroopColorName.SubTrial.)
Word <- as.factor(data$StroopWord.SubTrial.)
Block <- as.factor(data$Blocks.Sample)
CueType <- as.factor(data$CueType)

data_RT <-
data.frame(Subject,TrialNo,LWPC,Cue,Congruency,Color,Word,Block,CueT
ype,RT)


## MEAN-LEVEL RT AND PE ANALYSES

#calculate mean RT for each subject in each condition
data_meanRT  <- describeBy(data_RT$RT,
                    list(data_RT$Congruency,
                       data_RT$Cue,
```

```
                    data_RT$LWPC,
                    data_RT$Subject),
                 mat=TRUE)
colnames(data_meanRT)[2:5] <- c("Congruency", "Cue", "LWPC", "Subject")

#before creating data frame for PE, exclude the participant with outlier (slow)
RT
data_ACC <- data_ACC[data_ACC$Subject != 30,]
data_ACC$Subject <- as.factor(data_ACC$Subject)

#calculate mean PE for each subject in each condition
data_meanPE  <- describeBy(data_ACC$ACC,
                  list(data_ACC$Congruency,
                     data_ACC$Cue,
                     data_ACC$LWPC,
                     data_ACC$Subject),
                  mat=TRUE)
data_meanPE$mean <- 1-data_meanPE$mean
colnames(data_meanPE)[2:5] <- c("Congruency", "Cue", "LWPC", "Subject")

#conduct anova for RT
RTaov1 <- aov(formula = mean ~ Congruency*Cue*LWPC +
Error(Subject/(Congruency*Cue*LWPC)),
              data = data_meanRT)
summary(RTaov1)


#same analysis with another package
data_meanRT %>%
  group_by(Congruency, Cue, LWPC) %>%
  get_summary_stats(mean, type = "mean_sd")

bxp <- ggboxplot(
  data_meanRT, x = "Congruency", y = "mean",
  color = "Cue", palette = "jco",
  facet.by = "LWPC", short.panel.labs = FALSE
)
bxp

res.aov <- anova_test(
  data = data_meanRT, dv = mean, wid = Subject,
  within = c(Congruency, LWPC, Cue),
  effect.size = "pes",
)
get_anova_table(res.aov)
```

```
#post-hoc comparisons
model1 <- aov_ez(data_meanRT,
            id="Subject",
            dv="mean",
            within=c("Congruency","Cue","LWPC"))

comp1 <- lsmeans(model1,specs = ~ Cue, adjust = "bonferroni")
contrast(comp1,method="pairwise")

comp2 <- lsmeans(model1,specs = ~ Congruency*LWPC, adjust =
"bonferroni")
contrast(comp2,method="pairwise")

#condition means
mean(data_meanRT$mean[data_meanRT$Congruency=="congruent"])
mean(data_meanRT$mean[data_meanRT$Congruency=="incongruent"])
mean(data_meanRT$mean[data_meanRT$Cue=="MC"])
mean(data_meanRT$mean[data_meanRT$Cue=="MI"])
mean(data_meanRT$mean[data_meanRT$Cue=="Uncued"])
mean(data_meanRT$mean[data_meanRT$LWPC=="MC"])
mean(data_meanRT$mean[data_meanRT$LWPC=="MI"])

#conduct anova for PE
PEaov1 <- aov(formula = mean ~ Congruency*Cue*LWPC +
Error(Subject/(Congruency*Cue*LWPC)),
         data = data_meanPE)
summary(PEaov1)

#excluded participant
data_meanPE <- data_meanPE[data_meanPE$Subject != 30,]

#post-hoc comparison
model2 <- aov_ez(data_meanPE,
            id="Subject",
            dv="mean",
            within=c("Congruency","Cue","LWPC"))

comp3 <- lsmeans(model2,specs = ~ Congruency*LWPC, adjust =
"bonferroni")
contrast(comp3,method="pairwise")


#condition means
```

```
mean(data_meanPE$mean[data_meanPE$Congruency=="congruent"])
mean(data_meanPE$mean[data_meanPE$Congruency=="incongruent"])
mean(data_meanPE$mean[data_meanPE$Cue=="MC"])
mean(data_meanPE$mean[data_meanPE$Cue=="MI"])
mean(data_meanPE$mean[data_meanPE$Cue=="Uncued"])
mean(data_meanPE$mean[data_meanPE$LWPC=="MC"])
mean(data_meanPE$mean[data_meanPE$LWPC=="MI"])

mean(data_meanPE$mean[data_meanPE$LWPC=="MC" &
data_meanPE$Congruency=="congruent"])
mean(data_meanPE$mean[data_meanPE$LWPC=="MC" &
data_meanPE$Congruency=="incongruent"])

mean(data_meanPE$mean[data_meanPE$LWPC=="MI" &
data_meanPE$Congruency=="congruent"])
mean(data_meanPE$mean[data_meanPE$LWPC=="MI" &
data_meanPE$Congruency=="incongruent"])

#same analysis with another package
data_meanPE %>%
  group_by(Congruency, Cue, LWPC) %>%
  get_summary_stats(mean, type = "mean_sd")

bxp2 <- ggboxplot(
  data_meanPE, x = "Congruency", y = "mean",
  color = "Cue", palette = "jco",
  facet.by = "LWPC", short.panel.labs = FALSE,
  ylim = c(-0.2, 0.6)
)
bxp2

res.aov2 <- anova_test(
  data = data_meanPE, dv = mean, wid = Subject,
  within = c(Congruency, LWPC, Cue),
  effect.size = "pes",
)
get_anova_table(res.aov2)

#calculate Stroop effects for each condition
#create functions to calculate Stroop effects
MCcuedMCStroop <- function(Sno) {
  incong <- (data_meanRT$mean[data_meanRT$Congruency ==
"incongruent" &
              data_meanRT$Cue == "MC" &
              data_meanRT$LWPC == "MC" &
```

```
                data_meanRT$Subject == Sno])
  cong <- (data_meanRT$mean[data_meanRT$Congruency == "congruent" &
                 data_meanRT$Cue == "MC" &
                 data_meanRT$LWPC == "MC" &
                 data_meanRT$Subject == Sno])
  return(incong-cong)
}

UncuedMCStroop <- function(Sno) {
  incong <- (data_meanRT$mean[data_meanRT$Congruency ==
"incongruent" &
                           data_meanRT$Cue == "Uncued" &
                           data_meanRT$LWPC == "MC" &
                           data_meanRT$Subject == Sno])
  cong <- (data_meanRT$mean[data_meanRT$Congruency == "congruent" &
                         data_meanRT$Cue == "Uncued" &
                         data_meanRT$LWPC == "MC" &
                         data_meanRT$Subject == Sno])
  return(incong-cong)
}

MIcuedMCStroop <- function(Sno) {
  incong <- (data_meanRT$mean[data_meanRT$Congruency ==
"incongruent" &
                           data_meanRT$Cue == "MI" &
                           data_meanRT$LWPC == "MC" &
                           data_meanRT$Subject == Sno])
  cong <- (data_meanRT$mean[data_meanRT$Congruency == "congruent" &
                         data_meanRT$Cue == "MI" &
                         data_meanRT$LWPC == "MC" &
                         data_meanRT$Subject == Sno])
  return(incong-cong)
}

MIcuedMIStroop <- function(Sno) {
  incong <- (data_meanRT$mean[data_meanRT$Congruency ==
"incongruent" &
                           data_meanRT$Cue == "MI" &
                           data_meanRT$LWPC == "MI" &
                           data_meanRT$Subject == Sno])
  cong <- (data_meanRT$mean[data_meanRT$Congruency == "congruent" &
                         data_meanRT$Cue == "MI" &
                         data_meanRT$LWPC == "MI" &
                         data_meanRT$Subject == Sno])
  return(incong-cong)
```

```
}

UncuedMIStroop <- function(Sno) {
  incong <- (data_meanRT$mean[data_meanRT$Congruency ==
"incongruent" &
                                data_meanRT$Cue == "Uncued" &
                                data_meanRT$LWPC == "MI" &
                                data_meanRT$Subject == Sno])
  cong <- (data_meanRT$mean[data_meanRT$Congruency == "congruent" &
                              data_meanRT$Cue == "Uncued" &
                              data_meanRT$LWPC == "MI" &
                              data_meanRT$Subject == Sno])
  return(incong-cong)
}

MCcuedMIStroop <- function(Sno) {
  incong <- (data_meanRT$mean[data_meanRT$Congruency ==
"incongruent" &
                                data_meanRT$Cue == "MC" &
                                data_meanRT$LWPC == "MI" &
                                data_meanRT$Subject == Sno])
  cong <- (data_meanRT$mean[data_meanRT$Congruency == "congruent" &
                              data_meanRT$Cue == "MC" &
                              data_meanRT$LWPC == "MI" &
                              data_meanRT$Subject == Sno])
  return(incong-cong)
}

data_StroopRT <- data.frame()

#there is no participant for these Snos
noSno <-
c(37,39,82,92,102,3,11,12,22,24,30,34,45,55,57,61,66,67,68,71,73,77,78,86,8
7,89,90,91,95)

#calculate Stroop effects and put them to the dataframe
for(i in 1:104) {
  if (any(i %in% noSno)) { next }
    data_StroopRT[i,1] <- i
    data_StroopRT[i,2] <- MCcuedMCStroop(i)
    data_StroopRT[i,3] <- UncuedMCStroop(i)
    data_StroopRT[i,4] <- MIcuedMCStroop(i)
    data_StroopRT[i,5] <- MIcuedMIStroop(i)
    data_StroopRT[i,6] <- UncuedMIStroop(i)
    data_StroopRT[i,7] <- MCcuedMIStroop(i)
```

```
}

colnames(data_StroopRT)[1:7] <-
c("Subject","MCcuedMC","UncuedMC","MIcuedMC","MIcuedMI","Uncued
MI","MCcuedMI")

data_StroopRT <- na.omit(data_StroopRT)
data_StroopRT$Subject <- as.factor(data_StroopRT$Subject)

#convert to long format
library(tidyr)
data_StroopRT <- gather(data_StroopRT, condition, measurement,
MCcuedMC:MCcuedMI, factor_key=TRUE)

for (i in 1:length(data_StroopRT$Subject)) {
  if(data_StroopRT$condition[i] == "MCcuedMC" |
data_StroopRT$condition[i] == "MCcuedMI") {
    data_StroopRT$Cue[i] <- "MC"}
    else if(data_StroopRT$condition[i] == "UncuedMC" |
data_StroopRT$condition[i] == "UncuedMI") {
      data_StroopRT$Cue[i] <- "Uncued"}
      else if(data_StroopRT$condition[i] == "MIcuedMC" |
data_StroopRT$condition[i] == "MIcuedMI") {
       data_StroopRT$Cue[i] <- "MI"}
}

for (i in 1:length(data_StroopRT$Subject)) {
  if(data_StroopRT$condition[i] == "MCcuedMC" |
data_StroopRT$condition[i] == "UncuedMC" | data_StroopRT$condition[i]
== "MIcuedMC"){
    data_StroopRT$LWPC[i] <- "MC"}
  else if(data_StroopRT$condition[i] == "MCcuedMI" |
data_StroopRT$condition[i] == "UncuedMI" | data_StroopRT$condition[i] ==
"MIcuedMI") {
    data_StroopRT$LWPC[i] <- "MI"}
}

#anova with the stroop effect for RT
RTaov2 <- aov(formula = measurement ~ Cue*LWPC +
Error(Subject/(Cue*LWPC)),
             data = data_StroopRT)
summary(RTaov2)

#condition means
mean(data_StroopRT$measurement[data_StroopRT$Cue=="MC"])
```

```
mean(data_StroopRT$measurement[data_StroopRT$Cue=="MI"])
mean(data_StroopRT$measurement[data_StroopRT$Cue=="Uncued"])
mean(data_StroopRT$measurement[data_StroopRT$LWPC=="MC"])
mean(data_StroopRT$measurement[data_StroopRT$LWPC=="MI"])

tapply(data_StroopRT$measurement, data_StroopRT$condition, mean)

#draw graph for condition means
bargraph.CI( x.factor = LWPC, # grouping variable
        response = measurement, # outcome variable
        group = Cue, # second grouping variable
        data = data_StroopRT, # data frame with the variables
        ci.fun = ciMean, # name of the function to calculate CIs
        xlab = "LWPC", # x-axis label
        ylab = "Stroop Effect (RT)", # y-axis label
        legend = TRUE, # show legends
        ylim = c(0,250),
        col = c("gray70","deepskyblue3","dimgray"),
        main = "The Mean Stroop Effects for Each Condition"
)


#calculate Stroop effects for each condition for PE
#create functions to calculate Stroop effects
MCcuedMCStroop.PE <- function(Sno) {
  incong <- (data_meanPE$mean[data_meanPE$Congruency == "incongruent"
&
                              data_meanPE$Cue == "MC" &
                              data_meanPE$LWPC == "MC" &
                              data_meanPE$Subject == Sno])
  cong <- (data_meanPE$mean[data_meanPE$Congruency == "congruent" &
                            data_meanPE$Cue == "MC" &
                            data_meanPE$LWPC == "MC" &
                            data_meanPE$Subject == Sno])
  return(incong-cong)
}

UncuedMCStroop.PE <- function(Sno) {
  incong <- (data_meanPE$mean[data_meanPE$Congruency == "incongruent"
&
                              data_meanPE$Cue == "Uncued" &
                              data_meanPE$LWPC == "MC" &
                              data_meanPE$Subject == Sno])
  cong <- (data_meanPE$mean[data_meanPE$Congruency == "congruent" &
                            data_meanPE$Cue == "Uncued" &
```

```
                         data_meanPE$LWPC == "MC" &
                         data_meanPE$Subject == Sno])
  return(incong-cong)
}

MIcuedMCStroop.PE <- function(Sno) {
  incong <- (data_meanPE$mean[data_meanPE$Congruency == "incongruent"
&
                           data_meanPE$Cue == "MI" &
                           data_meanPE$LWPC == "MC" &
                           data_meanPE$Subject == Sno])
  cong <- (data_meanPE$mean[data_meanPE$Congruency == "congruent" &
                         data_meanPE$Cue == "MI" &
                         data_meanPE$LWPC == "MC" &
                         data_meanPE$Subject == Sno])
  return(incong-cong)
}

MIcuedMIStroop.PE <- function(Sno) {
  incong <- (data_meanPE$mean[data_meanPE$Congruency == "incongruent"
&
                           data_meanPE$Cue == "MI" &
                           data_meanPE$LWPC == "MI" &
                           data_meanPE$Subject == Sno])
  cong <- (data_meanPE$mean[data_meanPE$Congruency == "congruent" &
                         data_meanPE$Cue == "MI" &
                         data_meanPE$LWPC == "MI" &
                         data_meanPE$Subject == Sno])
  return(incong-cong)
}

UncuedMIStroop.PE <- function(Sno) {
  incong <- (data_meanPE$mean[data_meanPE$Congruency == "incongruent"
&
                           data_meanPE$Cue == "Uncued" &
                           data_meanPE$LWPC == "MI" &
                           data_meanPE$Subject == Sno])
  cong <- (data_meanPE$mean[data_meanPE$Congruency == "congruent" &
                         data_meanPE$Cue == "Uncued" &
                         data_meanPE$LWPC == "MI" &
                         data_meanPE$Subject == Sno])
  return(incong-cong)
}

MCcuedMIStroop.PE <- function(Sno) {
```

```
  incong <- (data_meanPE$mean[data_meanPE$Congruency == "incongruent"
&
                              data_meanPE$Cue == "MC" &
                              data_meanPE$LWPC == "MI" &
                              data_meanPE$Subject == Sno])
  cong <- (data_meanPE$mean[data_meanPE$Congruency == "congruent" &
                            data_meanPE$Cue == "MC" &
                            data_meanPE$LWPC == "MI" &
                            data_meanPE$Subject == Sno])
  return(incong-cong)
}

data_StroopPE <- data.frame()

#calculate Stroop effects and put them to the dataframe
for(i in 1:104) {
  if (any(i %in% noSno)) { next }
  data_StroopPE[i,1] <- i
  data_StroopPE[i,2] <- MCcuedMCStroop.PE(i)
  data_StroopPE[i,3] <- UncuedMCStroop.PE(i)
  data_StroopPE[i,4] <- MIcuedMCStroop.PE(i)
  data_StroopPE[i,5] <- MIcuedMIStroop.PE(i)
  data_StroopPE[i,6] <- UncuedMIStroop.PE(i)
  data_StroopPE[i,7] <- MCcuedMIStroop.PE(i)
}

colnames(data_StroopPE)[1:7] <-
c("Subject","MCcuedMC","UncuedMC","MIcuedMC","MIcuedMI","Uncued
MI","MCcuedMI")

data_StroopPE <- na.omit(data_StroopPE)
data_StroopPE$Subject <- as.factor(data_StroopPE$Subject)

#convert to long format
library(tidyr)
data_StroopPE <- gather(data_StroopPE, condition, measurement,
MCcuedMC:MCcuedMI, factor_key=TRUE)

for (i in 1:length(data_StroopPE$Subject)) {
  if(data_StroopPE$condition[i] == "MCcuedMC" |
data_StroopPE$condition[i] == "MCcuedMI") {
    data_StroopPE$Cue[i] <- "MC"}
  else if(data_StroopPE$condition[i] == "UncuedMC" |
data_StroopPE$condition[i] == "UncuedMI") {
    data_StroopPE$Cue[i] <- "Uncued"}
```

```
  else if(data_StroopPE$condition[i] == "MIcuedMC" |
data_StroopPE$condition[i] == "MIcuedMI") {
    data_StroopPE$Cue[i] <- "MI"}
}

for (i in 1:length(data_StroopPE$Subject)) {
  if(data_StroopPE$condition[i] == "MCcuedMC" |
data_StroopPE$condition[i] == "UncuedMC" | data_StroopPE$condition[i]
== "MIcuedMC"){
    data_StroopPE$LWPC[i] <- "MC"}
  else if(data_StroopPE$condition[i] == "MCcuedMI" |
data_StroopPE$condition[i] == "UncuedMI" | data_StroopPE$condition[i] ==
"MIcuedMI") {
    data_StroopPE$LWPC[i] <- "MI"}
}


#condition means
mean(data_StroopPE$measurement[data_StroopPE$Cue=="MC"])
mean(data_StroopPE$measurement[data_StroopPE$Cue=="MI"])
mean(data_StroopPE$measurement[data_StroopPE$Cue=="Uncued"])
mean(data_StroopPE$measurement[data_StroopPE$LWPC=="MC"])
mean(data_StroopPE$measurement[data_StroopPE$LWPC=="MI"])

tapply(data_StroopPE$measurement, data_StroopPE$condition, mean)

#draw graph for condition means
bargraph.CI( x.factor = LWPC, # grouping variable
        response = measurement, # outcome variable
        group = Cue, # second grouping variable
        data = data_StroopPE, # data frame with the variables
        ci.fun = ciMean, # name of the function to calculate CIs
        xlab = "LWPC", # x-axis label
        ylab = "Stroop Effect (PE)", # y-axis label
        legend = TRUE, # show legends
        ylim = c(0,.07),
        col = c("gray70","deepskyblue3","dimgray"),
        main = "The Mean Stroop Effects for Each Condition"
)


### END OF THE SCRIPT ###
```

F. TURKISH SUMMARY / TÜRKÇE ÖZET

1. BİRİNCİ BÖLÜM

1.1. Giriş

Bilişsel kontrol, bir görevin gereksinimlerini karşılama amacıyla otomatik davranışları bastırarak göreve ilişkin ve istemli davranışları sergileme becerisidir (Posner ve Snyder, 1975; Logan, Zbrodoff ve Williamson, 1984; Miller, 2000). Günlük hayatta çevremizde pek çok farklı bilgi kaynağı bulunur. Bazıları mevcut görevimiz ile ilgiliyken, bazıları ilgisizdir. Mevcut görev gereksinimlerimize bağlı olarak görevle ilgili bilgi kaynaklarına dikkat ederken görevle ilgisiz olanları görmezden gelmemiz gerekir.

Stroop görevi (Stroop, 1935; MacLeod, 1992), bilişsel kontrolü laboratuvar ortamında araştırmak için yaygın olarak kullanılır. Kelime-renk Stroop görevinde, uyumlu (mavi renkte yazılmış mavi kelimesi gibi) ve uyumsuz (sarı renkte yazılmış mavi kelimesi gibi) uyarıcılar katılımcılara sunulur. Katılımcılardan kelimelerin anlamını görmezden gelirken rengine tepki vermeleri istenir. Uyumsuz uyarıcılara uyumlu uyarıcılara kıyasla daha yavaş ve hatalı tepki verilmesi Stroop etkisi olarak adlandırılır (MacLeod, 1991; MacLeod ve McDonald, 2000).

Katılımcıların uyarıcının görev ile ilgili boyutuna odaklanırken görev ile ilgisiz boyutunu görmezden gelmeleri gerektiğinden, Stroop görevi seçici dikkati ölçer. Uyarıcının renk ve kelime boyutları uyumlu uyarıcı için aynı, uyumsuz uyarıcı için farklı tepkileri aktive eder. Kelime okuma otomatik bir süreç olduğu için uyarıcının kelime boyutundan gelen bilginin tepki seçimi üzerindeki etkisini bastırmak zordur. Bilişsel kontrol mekanizmalarının çalışma şekli, liste düzeyi ve uyarıcı düzeyi uyumluluk oranı manipülasyonları yardımıyla anlaşılabilir (Bugg & Crump, 2012; Braem vd., 2019). Bu tezde odağımız liste düzeyi uyumluluk oranı (LDUO) manipülasyonları üzerinde olacaktır. Ancak bütün bir anlatım amacıyla liste ve uyarıcı düzeyi uyumluluk oranı manipülasyonları bir sonraki kısımda bir arada açıklanmıştır.

1.2. Liste Düzeyi ve Uyarıcı Düzeyi Uyumluluk Oranı Manipülasyonları

Önceki araştırmalar Stroop etkisinin uyumluluk oranı manipülasyonları ile kontrol edilebileceğini, azaltılabileceğini ve hatta tersine çevrilebileceğini göstermiştir. Liste içindeki uyumlu ve uyumsuz uyarıcıların oranları manipüle edilerek çoğunlukla uyumlu ve çoğunlukla uyumsuz listeler elde edilir. Çoğunlukla uyumlu listelerde çoğunlukla uyumsuz listelere nazaran daha büyük Stroop etkisi görülmesi LDUO etkisi olarak adlandırılır (Logan ve Zbrodoff, 1979; Logan, Zbrodoff ve Williamson, 1984; Bugg, 2012; Bugg ve Crump, 2012). Katılımcılar, liste boyunca uyumlu ve uyumsuz uyarıcılara maruz kalarak listenin uyumluluk oranını öğrenir ve görev gereksinimlerini karşılamak amacıyla liste genelinde bir dikkat kontrolü parametresi benimser. Uyarıcının kelime boyutundan gelen bilgi, çoğunlukla uyumlu listede genellikle doğru yanıtı aktive ederken çoğunlukla uyumsuz listede yanlış bir yanıtı aktive eder. Bu durum, tepki seçim işlemi sürecinde kelime boyutundan gelen bilginin ağırlığının çoğunlukla uyumlu listede artmasına, çoğunlukla uyumsuz listede ise azalmasına neden olur. Sonuç olarak çoğunlukla uyumlu listede gözlemlenen Stroop etkisi çoğunlukla uyumsuz listede gözlemlenen etkiye kıyasla daha büyük olur.

LDUO etkisinin genellikle liste genelinde uygulanan bir kontrol stratejisine atfedilmesinin yanında, uygulanan stratejilerin liste düzeyinde değil de uyarıcı düzeyinde olduğu da iddia edilebilir (Jacoby, Lindsay ve Hessels, 2003; Blais, Robidoux, Risko ve Besner, 2007; Schmidt ve Besner, 2008). Kontrolün liste düzeyinde mi yoksa uyarıcı düzeyinde mi uygulandığını test etmek için uyarıcı düzeyi uyumluluk oranı (UDUO) manipülasyonu kullanılır.

Bazı uyarıcılar çoğunlukla uyumlu, bazı uyarıcılar çoğunlukla uyumsuz sunulurken liste genelindeki uyumlu ve uyumsuz uyarıcı sayısı eşit tutulur. Liste düzeyinde bir manipülasyon olmamasına rağmen, çoğunlukla uyumlu uyarıcılarda çoğunlukla uyumsuz uyarıcılara nazaran daha büyük Stroop etkisi görülmesi UDUO etkisi olarak adlandırılır. UDUO etkisi farklı uyarıcılar için farklı kontrol parametrelerinin dinamik ve otomatik bir şekilde uygulanabileceğini gösterir.

UDUO manipülasyonu uyarıcılar ve tepkiler arasında bir izlerlik oluşturur. Bu nedenle, UDUO etkisi uyarıcılara özgü uygulanan kontrol parametrelerinden kaynaklanabileceği gibi, uyarıcı-tepki öğrenmesinden de kaynaklanabilir (Jacoby vd., 2003; Schmidt ve Besner, 2008). Bazı kelimelerin bazı renklerle daha sık eşleşmesi nedeniyle, katılımcılar bu ilişkileri öğrenebilir ve bir uyarıcıyı gördüklerinde doğru cevabı tahmin edebilir. Katılımcılar sık eşleşmelere göre tepki vermeye eğilimli olduklarından, çoğunlukla uyumlu listelerde uyumlu uyarıcılara, çoğunlukla uyumsuz listelerde ise uyumsuz uyarıcılara daha hızlı ve doğru tepki verirler. Bu durum da UDUO etkisine neden olur.

Liste düzeyi kontrol, uyarıcı düzeyi kontrol ve uyarıcı-tepki öğrenme mekanizmalarından hangisinin hangi koşulda dikkatin kontrolünden sorumlu olduğuna dair bir açıklama getirmek amacıyla Bugg (2014) "Yukarıdan Aşağıya Kontrole Karşı İzlerlik" hipotezini geliştirmiştir. Bu hipoteze göre uyarıcı-tepki izlerliğini öğrenmenin verimli olarak kullanılamadığı durumlarda liste düzeyi kontrol süreçleri aktive edilmektedir.

1.3. Beklenti Odaklı Kontrol ve Deneyim Odaklı Kontrol

LDUO etkisinin altında beklentinin mi yoksa deneyimin mi yattığı bir tartışma konusudur. LDUO etkisine getirilen ilk açıklamalar, dikkatin kontrolünü genellikle beklenti odaklı kontrol mekanizmalarına atfetmiştir. Bu açıklamalara göre, katılımcılar uyumlu ve uyumsuz uyarıcılara maruz kaldıkça ileride görecekleri uyarıcı türüne dair beklentiler geliştirir ve bu beklentilere bağlı olarak liste düzeyi bir strateji uygular. Katılımcılar uyarıcının kelime ve renk boyutuna tepki seçimi sürecinde verilen ağırlığı modüle ederek liste düzeyi bir kontrol parametresi belirler. Çoğunlukla uyumlu listede daha rahat bir kontrol stratejisi benimserken çoğunlukla uyumsuz listede daha odaklı bir kontrol stratejisi benimserler. Listelerde uygulanan strateji farklılığı da LDUO etkisini ortaya çıkarır. Beklenti odaklı açıklamalar, stratejik, istemli ve çaba gerektiren dikkat kontrolünü vurgular (Posner ve Snyder, 1975; Logan ve Zbrodoff, 1979; Lowe ve Mitterer, 1982; West ve Baylis, 1998).

Beklenti odaklı kontrol mekanizmalarına alternatif olarak deneyim odaklı kontrol mekanizmaları öne sürülmüştür (Botvinick, Braver, Barch, Carter, ve Cohen, 2001; Melara ve Algom, 2003; Botvinick, Cohen ve Carter, 2004). Katılımcılar listenin başından itibaren uyumlu ve uyumsuz uyarıcıları tecrübe ettikçe, bu bilgi birikir ve kontrol mekanizmalarını düzenler. Hem beklentiye dayalı hem de deneyime dayalı açıklamalar, uyumlu ve uyumsuz uyarıcıların deneyimlenmesinden kaynaklansa da, beklenti odaklı kontrol açıklamaları dikkatin stratejik ve istemli kontrolünü vurgularken, deneyim odaklı kontrol açıklamaları dikkatin otomatik ve kendiliğinden kontrolünü vurgular. Bu tezin amacı, dikkatin kontrolünde deneyim ve beklentilerin rolünü ve bu iki mekanizmanın birbirleriyle olan ilişkisini araştırmaktır.

1.4. Ön İpuçlu Liste Paradigması

Klasik bir LDUO deneyi deneyim ve beklentilerin dikkatin kontrolü üzerindeki etkisini açıklamak için ideal değildir. Zira klasik bir LDUO manipülasyonunda hem beklentiye hem de deneyime dayalı açıklamalar aynı sonuçları öngörür. Daha da önemlisi, bu yöntemle beklenti deneyimden bağımsız olarak sistematik bir şekilde manipüle edilemez. Beklentinin etkisini deneyimden bağımsız olarak inceleyebilmek için, katılımcılarda listenin uyumluluk oranı hakkında açık beklentiler oluşturmak gereklidir. Bugg, Diede, Cohen-Shikora ve Selmeczy (2015), beklenti ve deneyimin etkilerini ayrıştırmak için ön ipuçlu liste paradigması adı verilen yeni bir yöntem geliştirmiştir. Bu paradigmada, pek çok kısaltılmış liste katılımcılara sunulur ve bazı listelerin öncesinde listenin uyumluluk oranına dair bir ipucu verilir. Bu sayede katılımcılarda açık bir şekilde beklentiler oluşturulur. İpucu verilen ve verilmeyen listelerdeki Stroop etkisi karşılaştırılarak, beklentinin dikkatin kontrolü üzerindeki etkisi deneyimden bağımsız olarak incelenir.

Eğer beklentiler katılımcıların kontrol süreçlerini etkiliyorsa, çoğunlukla uyumsuz listede katılımcıların daha odaklı, çoğunlukla uyumlu listede ise daha rahat bir dikkat kontrolü benimsemiş olmaları beklenir. Bu durumda, ipucu verilmiş çoğunlukla uyumlu listede ipucu verilmemiş çoğunlukla uyumlu listeye kıyasla daha büyük bir Stroop etkisi görülmelidir. İpucu verilmiş çoğunlukla uyumsuz listede ise ipucu verilmemiş çoğunlukla uyumsuz listeye kıyasla daha küçük bir Stroop etkisi görülmelidir. Yapılan çalışmaların sonucunda (Bugg vd., 2015; Bugg ve Diede, 2018) çoğunlukla uyumlu listede beklenti etkisi görülürken çoğunlukla uyumsuz listede ipucu vermek Stroop etkisini değiştirmemiştir.

Çoğunlukla uyumsuz listede görevin daha fazla çatışma içerdiği göz önüne alındığında, çoğunlukla uyumsuz ipucunun verilmesinin sonuçları etkilememesi ilginç bir bulgudur. Çoğunlukla uyumlu ipucu dikkatin kontrolünü etkilerken çoğunlukla uyumsuz ipucunun etkilememesine üç alternatif açıklama getirilmiştir: (1) ipucu verilmiş listelerden verilmemiş listelere farkındalığın taşınması, (2) çoğunlukla uyumsuz listede taban etkisi görülmesi ve (3) varsayılan mod.

İpucu verilmiş listelerden verilmemiş listelere farkındalığın taşınması açıklaması, çoğunlukla uyumsuz listede beklenti etkisinin görülmemesini denek içi desen kullanılmasına atfeder. Bu açıklama, katılımcılar bazı listelerde ipucu alıp bazılarında almadıkları için, ipucu almadıkları listelerde de uyumluluk oranını ilk gördükleri uyarıcıya göre tahmin etmeye çalıştıklarını ve bu nedenle ipucu verilen ve verilmeyen çoğunlukla uyumsuz listelerde bir fark görülmediğini ifade eder. Fakat Bugg ve Diede (2018) denekler arası desenle aynı sonuçları tekrarlayarak bu açıklamaya karşı çıkmıştır.

Bir başka olası açıklama, çoğunlukla uyumsuz listede taban etkisi olabileceğidir. Çoğunlukla uyumlu listede Stroop etkisi olabildiğince azaltılmış ve daha fazla azaltılabilecek bir imkan kalmamış olabilir. Bu nedenle de çoğunlukla uyumsuz ipucunun verilmesi davranış üzerinde etkili olmamıştır. Ancak Bugg ve arkadaşları (2015) çalışmanın beşinci deneyinde bu açıklamayı zayıflatacak bir bulgu elde etmişlerdir. Eşit derecede uyumlu listelere çoğunlukla uyumlu ve çoğunlukla uyumsuz ipuçlarını verdiklerinde, çoğunlukla uyumlu ipucu Stroop etkisini değiştirirken çoğunlukla uyumsuz ipucu değiştirmemiştir. Eşit derecede uyumlu listelerde Stroop etkisini azaltabilecek bir imkan bulunurken çoğunlukla uyumsuz ipucu önceki deneylerde olduğu gibi dikkatin kontrolünü etkilememiştir.

Son olarak, varsayılan mod açıklamasına göre, katılımcılar Stroop görevinin doğası gereği zaten çatışma deneyimlemeyi beklemektedir. Bu nedenle, katılımcıların varsayılan modu odaklı bir kontrol parametresiyle uyumludur. Çoğunlukla uyumsuz ipucunu vermek katılımcıların varsayılan modunu değiştirmediğinden, ipucu verilmeyen durumla aralarında bir farklılık bulunmamıştır.

2. İKİNCİ BÖLÜM

2.1. Araştırmanın Amacı ve Hipotezler

Önceki çalışmalar katılımcıların beklentilerine bağlı olarak dikkatlerini azalttıklarını fakat arttırmadıklarını göstermiştir. Mevcut alanyazını temel alarak, bu tezde, ön ipuçlu liste paradigması ile hem geçerli hem de geçersiz ipuçlarını bir arada kullanarak dikkatin kontrolünde deneyim ve beklentilerin rolü ve deneyim ve beklenti arasındaki ilişkinin doğası araştırılmıştır. Deneyim ve beklenti arasındaki ilişkiyi incelemek için üç olası hipotez test edilmiştir: (1) yalnızca deneyim, (2) eklemeli deneyim ve beklenti ve (3) etkileşimli deneyim ve beklenti.

LDUO etkisi deneyimin dikkatin kontrolü üzerindeki rolünü gösterirken ipucu etkisi beklentinin deneyimden bağımsız olarak dikkatin kontrolü üzerindekini rolünü gösterir. Beklenti etkisinin çoğunlukla uyumlu ve uyumsuz listelerde aynı olması deneyim ve beklentinin dikkatin kontrolü üzerindeki etkilerinin eklemeli olduğunu, farklı olması ise etkileşimli olduğunu gösterir.

Deney tasarımımız özellikle deneyim ve beklentilerin birbirleriyle olan ilişkisini anlamak için önemlidir. Yalnızca geçerli ipuçları kullanıldığında, beklentinin deneyimden bağımsız bir etkisi olup olmadığı araştırılabilirken, geçerli ve geçersiz ipuçları bir arada kullanıldığında buna ek olarak beklenti ve deneyimin birbirleriyle olan ilişkisi de araştırılabilmektedir.

Son olarak, bu çalışmada çoğunlukla uyumsuz ipucunun Stroop etkisini değiştirmemesinin varsayılan mod ile açıklanıp açıklanamayacağı test edilmiştir. Eğer varsayılan mod çoğunlukla uyumsuz ipucunun davranışı değiştirmemesini açıklıyorsa, çoğunlukla uyumsuz ipucu yalnızca çoğunlukla uyumsuz listede değil, ek olarak çoğunlukla uyumlu listede de Stroop etkisini değiştirmemelidir.

2.2. Yöntem

2.2.1. Katılımcılar

Hedeflenen katılımcı sayısı güç analizi ile belirlenmiştir (Faul, Erdfelder, Lang ve Buchner, 2007). Kullanılan deney deseni ile %95'lik bir güç elde etmek için 75 katılımcıya ihtiyaç duyulduğu hesaplanmıştır. Orta Doğu Teknik Üniversitesi ve TOBB Ekonomi ve Teknoloji Üniversitesi'nden 87 katılımcı, ders kredisi karşılığında ya da gönüllü olarak deneye katılmışlardır. Katılımcıların 18-25 yaş aralığında olması, anadilinin Türkçe olması, normal veya normale düzeltilmiş görüşe sahip olması, sağ elini baskın olarak kullanıyor olması ve renk körlüğü veya okuma problemi olmaması kriterleri getirilmiştir. Ortalama hata oranı ve tepki süresi tüm katılımcıların ortalamasının üç standart sapma üstünde olan katılımcılar ve bilgisayarlarının zamanlama hassasiyeti yeterli olmayan katılımcılar tüm analizlerden çıkarılarak toplamda yetmiş beş katılımcı analizlere dahil edilmiştir.

2.2.2. Desen ve Uyarıcılar

Bu çalışmada 3 (İpucu: çoğunlukla uyumlu, çoğunlukla uyumsuz, ipuçsuz) x 2 (LDUO: çoğunlukla uyumlu, çoğunlukla uyumsuz) x 2 (uyarıcı türü: uyumlu, uyumsuz) denek içi desen kullanılmıştır. Altı tür listenin her biri sekiz kez sunulmuş ve deney kırk sekiz bloktan oluşmuştur. Bugg ve arkadaşlarının (2015) ön ipuçlu liste paradigması geçersiz ipuçları dahil edilerek kullanılmıştır. Katılımcıların bazı ipuçlarının geçersiz olduğuna dair olası farkındalığını azaltmak için 10 yerine 15 uyarıcılı listeler kullanılmıştır. Önceki çalışmalarla uyumlu şekilde yalnızca ilk 10 uyarıcı analiz edilmiş ve bu uyarıcılar listenin uyumluluk oranını belirlemiştir. Geriye kalan 5 uyarıcı ise katılımcıların geçersiz ipucu verilen listelerdeki farkındalığını azaltmak adına ipucu ile uyumlu olacak şekilde sunulmuştur. Bu sayede katılımcıların deneyimledikleri uyarıcı türlerinin sayıları beklentilerine yakın olacak şekilde düzenlenmiştir.

Uyarıcı sunumu ve veri toplama işlemi E-Prime 3 yazılımı (Psychology Software Tools, Pittsburgh, PA) tarafından otomatik olarak kontrol edilmiştir. COVID-19 salgını nedeniyle uzaktan veri toplamak için E-Prime Go eklentisi kullanılmıştır. Mavi, pembe, sarı ve yeşil kelimeleri uyumlu ya da uyumsuz renkleriyle bilgisayar ekranında sunulmuş ve katılımcılardan kelimenin anlamını görmezden gelirken rengine tepki vermeleri istenmiştir.

2.2.3. İşlem Yolu

Deneyin işlem yolu Orta Doğu Teknik Üniversitesi ve TOBB Ekonomi ve Teknoloji Üniversitesi etik kurulları tarafından onaylanmıştır. COVID-19 salgını nedeniyle veri toplama süreci uzaktan yürütülmüştür. Katılımcılar deneye bireysel ve gönüllü olarak kendi bilgisayarları ile katılmışlardır. Katılımcılara deney işlem yolu sesli olarak anlatılmış, uyarıcı türü, liste düzeyi uyumluluk oranı ve liste öncesinde gelecek olan ipuçlarıyla ilgili bilgi verilmiştir.

Deneyin başında katılımcılar mavi, pembe, sarı ve yeşil renklerinde sunulan “XXXX” uyarıcılarına tepki vererek klavyede renklere karşılık gelen tuşları öğrenmişlerdir. Daha sonra geçerli ipucu verilmiş bir çoğunlukla uyumlu liste ve geçerli ipucu verilmiş bir çoğunlukla uyumsuz liste ile pratik yapmışlardır. Bunu takiben deneye başlanmış ve katılımcılar her biri 15 denemeden oluşan 48 deney listesini tamamlamışlardır. Deney sırasında, her bir listeden önce, klavyede renge karşılık gelen tuşlar hatırlatılmıştır. Ardından katılımcılara başlayacakları liste için verilen ipucu sunulmuş ve katılımcılar hazır olduklarında listeyi başlatmışlardır. Her denemeden önce 500 milisaniye fiksasyon, ardından 3000 milisaniye ya da tepki verilene kadar uyarıcı, ardından da 500 milisaniye boş ekran gösterilmiştir.

2.3. Bulgular

Tepki süresi analizi yürütülmeden önce alıştırma denemeleri, hatalı tepkiler, tepki verilmeyen denemeler ve 200 milisaniyeden daha hızlı tepkiler çıkarılmış ve uç değer eleme prosedürü izlenmiştir. Hata oranı analizinde ise tek farklılık hatalı tepkilerin çıkarılmamasıdır.

Deneyimin dikkatin kontrolü üzerindeki etkisi hem tepki süresi hem de hata oranı analizi ile anlamlı bir LDUO etkisi gözlemlenerek gösterilmiştir. Çoğunlukla uyumlu listede tepki süresi ile gözlemlenen Stroop etkisi çoğunlukla uyumsuz listeye kıyasla daha büyüktür, $F(1, 74) = 30.84$, $MSE = 3231$, $p < .001$, $\eta_p^2 = .29$. Benzer şekilde, çoğunlukla uyumlu listede hata oranı ile gözlemlenen Stroop etkisi çoğunlukla uyumsuz listeye kıyasla daha büyüktür, $F(1, 75) = 4.50$, $MSE = .002$, $p = .037$, $\eta_p^2 = .06$. Kritik olarak, ne tepki süresi ne de hata oranları ile ipucu vermek Stroop etkisi ya da LDUO etkisi üzerinde anlamlı bir değişikliğe yol açmamıştır.

2.4. Tartışma

Bu tezde dikkatin kontrolünde deneyim ve beklentilerin rolünün araştırılması amaçlanmıştır. Tepki süresi ve hata oranı analizleri, yalnızca deneyimin dikkatin kontrolü üzerinde etkili olduğu hipotezini desteklemiştir. Beklentilerin dikkatin kontrolü üzerinde deneyimden bağımsız bir etkisi gözlemlenmemiştir. Başka bir deyişle, çoğunlukla uyumlu ya da çoğunlukla uyumsuz ipucunu vermek listelerde gözlemlenen Stroop etkisini değiştirmemiştir.

Bu sonuçlar ışığında, varsayılan mod açıklaması desteklenmemiştir. Çünkü her ne kadar bu yaklaşım çoğunlukla uyumsuz ipucunun çoğunlukla uyumlu ve çoğunlukla uyumsuz listede Stroop etkisini değiştirmemesini beklese de, çoğunlukla uyumlu ipucunun Stroop etkisini değiştirmesini beklenirdi. Çoğunlukla uyumlu ipucunu vermek katılımcıların varsayılan moddan sapma yaşamasına neden olacağı için Stroop etkisini modüle etmesi gerekirken, ne çoğunlukla uyumlu ne de çoğunlukla uyumsuz ipucunun dikkatin kontrolü üzerinde bir etkisi gözlemlenmemiştir. Bu nedenle, elde ettiğimiz sonuçlar varsayılan mod açıklamasını desteklemek için uygun değildir.

2.4.1. Beklenti Etkisi Gözlemlenmemesinin Olası Açıklamaları: İpucu Geçerliliğinin Rolü

Bu çalışmada beklentinin dikkatin kontrolü üzerinde etkisinin gözlemlenmeme nedeni deney içinde kullandığımız geçersiz ipuçları olabilir. Peki, neden deneyin üçte birinde geçersiz ipucu verilmesi, deney genelinde beklenti etkisinin görülmemesine neden olmuş olabilir? Bu sonuç için alternatif açıklamaları sonraki paragraflarda tartışacağız.

İlk olarak, katılımcılar deneyde bazı ipuçlarının geçersiz olduğunu fark etmiş ve bu nedenle tüm ipuçlarını görmezden gelmiş olabilirler. Bu ihtimali incelemek için katılımcıların farkındalığı hakkında fikir sahibi olmak adına deneysel oturumun sonuna bir anket eklenmişti. Katılımcılara "Listelerden önce verilen ipuçlarına dikkat ettiniz mi?" ya da "Bu çalışma hakkında bizimle paylaşmak istediğiniz herhangi bir düşünceniz var mı?" gibi açık uçlu sorular sorulmuştu. Katılımcıların büyük bir çoğunluğu ipuçlarının geçerli olmadığını anladıklarını ve bu nedenle ipuçlarını görmezden geldiklerini (23 kişi, katılımcıların %31'i) veya ipuçlarının faydalı olmadığını düşündüklerini ve bu nedenle ipuçlarına dikkat etmediklerini (17 kişi, katılımcıların %23'ü) belirtmiş, ya da sorulara cevap vermemişlerdir (22 kişi, katılımcıların %29'u). Yalnızca 13 katılımcı, yani toplam katılımcıların %17'si, ipuçlarına dikkat ettiklerini belirtmişlerdir. Bu cevaplar katılımcıların geçersiz ipuçlarının farkında oldukları ve bu nedenle kasıtlı olarak tüm ipuçlarını görmezden geldikleri açıklamasını desteklemektedir.

Ek olarak, beklentilerin dikkatin kontrolü üzerinde etkisi olması için deneyimler tarafından desteklenmesine ihtiyaç duyuluyor olabilir. Literatürde beklenti etkisi gözlemlenen çalışmalarda ipuçları her zaman geçerli olduğu için, beklenti her zaman deneyim tarafından desteklenmektedir. Kullandığımız paradigmada tecrübe deney sırasında katılımcının pratiğine dayanırken, beklenti dış kaynaklar tarafında verilmektedir. Katılımcının kendi kendine uyarıcıları deneyimlemesi, dışarıdan gelen bilgilere göre daha güvenilir bir bilgi kaynağı olabilir. Buna ek olarak, beklenti ve deneyim arasındaki tutarsızlıkları fark etmek, dikkatin kontrolünde ipuçlarının ağırlığını azaltabilir. Deneyimin her zaman performansı desteklemediği durumlarda katılımcılar, hem beklenti hem de deneyimden gelen bilgileri kullanmak yerine, yalnızca deneyim bilgisini dikkatin kontrolünü düzenlemek için kullanıyor olabilir.

Ayrıca, beklenti etkisinin görülmemesi ipuçlarının algılanan değeri ile ilişkilendirilebilir. Klasik bir LDUO paradigmasına kıyasla, ön ipuçlu liste paradigmasında görev yükü ve ihtiyaç duyulan dikkat muhtemelen daha yüksektir. Klasik bir LDUO paradigmasında, katılımcılar deneysel oturumun tamamında çoğunlukla uyumlu ya da çoğunlukla uyumsuz bir liste deneyimlerler. Yani katılımcılar sabit bir ortamdadırlar ve deney boyunca aynı kontrol parametresini sürdürebilirler. Bizim kullandığımız yöntemde ise, sürekli olarak değişen uyumluluk oranlarına maruz kalındığı için, katılımcılar daha dinamik bir ortamda bulunurlar ve dikkatlerini yüksek tutmaları gerekir. Bu durumu "zihinsel çaba" perspektifinde değerlendirebiliriz (Kool, McGuire, Rosen ve Botvinick, 2010; Shenhav, Botvinick ve Cohen, 2013; Braver vd. 2014). Bu yaklaşıma göre, mevcut hedefe ulaşmanın algılanan değeri, hedefe ulaşma için gerekli olan zihinsel çabanın algılanan maliyetinden daha yüksekse, katılımcılar görev taleplerini karşılamak için çaba göstermeye motive olurlar. Bizim desenimizde, ipuçları bir yandan katılımcılara yardımcı olabildikleri için algılanan bir değere sahipken, bir yandan da bazen yanıltıcı olabildikleri için algılanan bir maliyete sahiptirler. Bu nedenle katılımcılar geçersiz bir ipucuna güvenme riskinin getirdiği maliyeti ipucu kullanmanın değerinden yüksek görerek, sınırlı dikkat kaynaklarını ipuçlarına ayırmıyor olabilirler.

2.4.2. Uyumluluk Oranı Çalışmaları İçin Çıkarımlar

Geleneksel olarak denekler arası desen ve uzun listelerle gözlemlenen LDUO etkisinin, denek içi desen ve çok sayıda kısa liste ile gözlemlenebiliyor olması önemli bir bulgudur. Listeler çok kısa olmalarına ve katılımcılar dikkatlerini yönlendirmek için çok az deneyim şansına sahip olmalarına rağmen, liste içindeki 10 deneme LDUO etkisini ortaya çıkarmak için yeterli olmuştur. Bu durum LDUO çalışmalarındaki otomatik ve hızlı öğrenme süreçlerine işaret eder ve deneylerde her zaman çok uzun listeler kullanılmasına gerek olmayabileceğini gösterir.

Giriş bölümünde açıklandığı gibi, liste düzeyi kontrol, uyarıcı düzeyi kontrol ve uyarıcı-tepki öğrenme yaklaşımları arasında devam eden bir tartışma vardır. Ön ipuçlu liste paradigması uyarıcı düzeyi kontrol ve uyarıcı-tepki öğrenmesi karıştırıcı değişkenlerini içermemektedir. Deney içinde pek çok kısaltılmış liste sunulmuş ve eşleştirmeler liste içinde rastgele dağıtılmıştır. Tüm kelimeler tüm renklerle eşleştirilmiştir. Her listede yalnızca 10 uyarıcı olduğu ve bu uyarıcılar olası tüm eşleşmelerden rastgele seçilerek atandığı için uyarıcı ve tepki arasında tutarlı bir izlerlik oluşmamıştır. Bu nedenle, ön ipuçları ile sunulsa da sunulmasa da, kısaltılmış pek çok listeyi bir arada kullanmak, liste düzeyi kontrol süreçlerini uyarıcı düzeyi kontrol ve uyarıcı-tepki öğrenmesi karıştırıcı değişkenlerinden bağımsız olarak araştırmak için iyi bir seçenek olabilir.

2.4.3. Genel Sonuç, Çalışmanın Kısıtları ve Öneriler

Küresel COVID-19 salgını nedeniyle, E-Prime 3 yazılımının E-Prime Go uzantısını kullanarak deney verileri uzaktan toplanmıştır. Katılımcılar deneye kendi bilgisayarlarıyla ve laboratuvar dışında bir alanda katılmıştır. Bağımlı değişken olarak tepki süresi kullanıldığından deney yürütülen bilgisayarın zamanlama hassasiyeti özellikle önemlidir. Bu nedenle katılımcıların bilgisayarlarının zamanlama hassasiyeti ve bilgisayarlarının E-Prime 3 ve E-Prime Go çalıştırmak için yeterli özelliklere sahip olup olmadığı kontrol edilmiştir. Sonuçları etkileyebilecek birçok faktörü kontrol etmemize rağmen, uzaktan veri toplama süreci bazı kontrol edilemeyen sorunlara neden olmuş olabilir. Bu sorunlar özellikle katılımcıların deney boyunca bulundukları ortamı kontrol edemememizden kaynaklanmaktadır. Ancak, genel hata oranının düşük olduğu dikkate alındığında katılımcıların genel olarak yönergeleri takip ettiği düşünülmektedir. Ayrıca, yönergeleri takip etmeyen potansiyel katılımcıları analizlerden çıkarmak için önceki bölümlerde açıklandığı şekilde uç değer eleme prosedürü uygulanmıştır.

Bu tezde, beklenti ve deneyimin dikkatin kontrolü üzerindeki etkileri araştırılmış ve üç olası hipotez test edilmiştir: (1) yalnızca deneyim, (2) eklemeli deneyim ve beklenti ve (3) etkileşimli deneyim ve beklenti. Tepki süresi ve hata oranı sonuçları, deneyim ve beklentilerin her zaman uyumlu olmadığı bir deney deseninde, dikkatin kontrolünün yalnızca deneyim tarafından yönlendirildiğini göstermiştir.

İlerideki çalışmalarda, ipuçlarının terk edilmesini önlemek için geçersiz ipuçlarının oranı azaltılabilir. Geçerli liste sayısı geçersiz liste sayısından nispeten daha fazla olduğunda, katılımcılar geçersiz olanları fark etmeyebilir ya da fark etseler dahi ipuçlarını kullanmayı seçebilirler. Zira ipuçları çoğu zaman doğru bilgi verdiğinde, bazen yanlış bilgi verseler de, ipucundan gelen bilgi dikkatin kontrolü için değerli olabilir. Ayrıca, katılımcıların farkındalıkları daha sistematik bir şekilde ölçülerek geçersiz ipuçlarının etkileri daha detaylı olarak incelenebilir.

G. THESIS PERMISSION FORM / TEZ İZİN FORMU

(Please fill out this form on computer. Double click on the boxes to fill them)

ENSTİTÜ / INSTITUTE

Fen Bilimleri Enstitüsü / Graduate School of Natural and Applied Sciences ☐

Sosyal Bilimler Enstitüsü / Graduate School of Social Sciences ☒

Uygulamalı Matematik Enstitüsü / Graduate School of Applied Mathematics ☐

Enformatik Enstitüsü / Graduate School of Informatics ☐

Deniz Bilimleri Enstitüsü / Graduate School of Marine Sciences ☐

YAZARIN / AUTHOR

Soyadı / Surname : İleri Tayar
Adı / Name : Merve
Bölümü / Department : Psikoloji / Psychology

TEZİN ADI / TITLE OF THE THESIS (**İngilizce** / English): The Role of Expectation and Experience in the Control of Attentional

TEZİN TÜRÜ / DEGREE: Yüksek Lisans / Master ☒ **Doktora** / PhD ☐

1. **Tezin tamamı dünya çapında erişime açılacaktır. /** Release the entire work immediately for access worldwide. ☒
2. **Tez iki yıl süreyle erişime kapalı olacaktır.** / Secure the entire work for patent and/or proprietary purposes for a period of **two years. *** ☐
3. **Tez altı ay süreyle erişime kapalı olacaktır.** / Secure the entire work for period of **six months**. ***** ☐

***** *Enstitü Yönetim Kurulu kararının basılı kopyası tezle birlikte kütüphaneye teslim edilecektir. /*
A copy of the decision of the Institute Administrative Committee will be delivered to the library together with the printed thesis.

Yazarın imzası / Signature .... **Tarih** / Date ....
(Kütüphaneye teslim ettiğiniz tarih. Elle doldurulacaktır.)
(Library submission date. Please fill out by hand.)

Tezin son sayfasıdır. / This is the last page of the thesis/dissertation.