THE RELATIONSHIPS AMONG WORKING MEMORY, INHIBITION AND TEMPERAMENT IN THE THIRD YEAR OF LIFE

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Thesis Abstract

Begüm Özdemir, "The Relationships among Working Memory, Inhibition and Temperament in the Third Year of Life"

The third year of life depicts the transition period during which children gradually become more competent in controlling their thoughts and emotions. Recent studies with preschool children suggest that delay inhibition and conflict inhibition are the two types of inhibition, the former requiring the child to suppress a dominant behavior, while the latter requiring not only to suppress it but also to enact a subdominant behavior conflicting with it. The aim of the present study is to investigate whether or not delay inhibition and conflict inhibition relate to working memory and temperament differentially in younger children. Thirty-four Turkish children aged 24-to-36 months and their mothers participated in the study. Two separate sessions were arranged for each child individually. For half of the children, the first session involved Imitation Sorting Tasks (IST) as the working memory measure, and the second involved a total of six inhibition measures including three tasks for delay inhibition and three for conflict inhibition; whereas for the other half, the order of the sessions were reversed. The mothers rated temperament of their children on the very short form of Early Childhood Behavior Questionnaire (ECBQ). Using hierarchical regression, it was found that working memory capacity predicted conflict inhibition performance beyond delay inhibition performance even when controlled for age. Contrary to the expectations, temperamental characteristics measured by the ECBQ in terms of negative affectivity, surgency and effortful control did not predict delay inhibition performance. Nor there was any relationship between conflict inhibition performance and any of the temperamental characteristics. However, there was a significant association between conflict and delay inhibition even after age was controlled. These results support both the distinction and the relation between delay inhibition and conflict inhibition as well as highlight the role of working memory capacity in predicting conflict inhibition performance in the third year of life.

Tez Özeti

Begüm Özdemir, "2 Yaşındaki Çocuklarda Çalışan Bellek, Ketleme ve Mizaç Arasındaki İlişkiler"

2 yaş, çocukların duygu ve düşüncelerini denetleme becerisinin giderek artmaya başladığı bir geçiş dönemidir. Okul öncesi dönemindeki çocuklarla yapılan son çalışmalar çatışan davranışı ketleme (conflict inhibition) ve süreli ketleme (delay inhibition) olarak iki farklı tür ketleme olduğunu varsaymaktadır, öyle ki süreli ketleme baskın olan bir davranışı ketlemeyi gerektirirken, çatışan davranışı ketleme sadece baskın davranışı ketlemekle kalmayıp yerine bu davranışla çelişen daha az baskın bir davranışı sergilemeyi gerektirir. Bu çalışmanın amacı daha küçük yaştaki çocuklarda çatışan davranışı ketleme ve süreli ketleme becerilerinin çalışan bellek ve mizaç ile farklı ilişkiler kurup kurmadığını araştırmaktır. Çalışmaya 24 ay ile 36 ay arasında 36 Türk çocuğu ve annesi katılmıştır. Her bir çocuk birebir çalışılan iki farklı seans düzenlenmiştir. İlk seansta çocukların yarısı çalışan bellek kapasitesini ölçen Taklit Ederek Sınıflandırma (IST-Imitation Sorting Task) Testini, diğer yarısı ise üç oyun çatışan davranışı ketleme, üç oyun süreli ketleme için olmak üzere toplam altı oyun tamamlamıştır. Anneler çocuklarının mizaç özelliklerini Erken Çocukluk Dönemi Davranış Anketi Kısa Formu (ECBQ- Early Childhood Behavior Questionnaire) üzerinden değerlendirmişlerdir. Hiyerarşik regresyon analizleri kullanılarak, yaşın etkisi kontrol edildiğinde dahi, çalışan bellek kapasitesinin çatışan davranışı ketlemeyi süreli ketlemeye göre daha yüksek bir oranda yordadığı ortaya koyulmuştur. Beklentilerin tersine, Erken Çocukluk Dönemi Davranış Anketi aracılığıyla olumsuz duygulanım, kabarma ve kendini denetleme becerileri açısından ölçülen mizaç özellikleri süreli ketlemeyi yordamamıştır. Çatışan davranışı ketleme ve herhangi bir mizaç özelliği arasında da ilişki görülmemiştir. Öte yandan, yaşın etkisi kontrol edildiğinde dahi, çatışan davranışı ketleme ve süreli ketleme arasında anlamlı bir ilişki bulunmuştur. Bu sonuçlar, 2 yaşındaki çocuklarda süreli ketleme ve çatışan davranışı ketleme arasındaki ayrım ve ilişkiyi desteklerken bir yandan da çalışan belleğin çatışan davranışı ketlemeyi yordamadaki rolüne dikkat çekmektedir.

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CONTENTS

CHAPTER 1

INTRODUCTION

Executive function has recently been an issue of great interest for separate research areas, from cognitive neuroscience and clinical psychology to socio-emotional development and temperament (Zhou, Chen, & Main, 2011). This interest in studying executive function results from its crucial role in development. It has been well-established that improvement in executive abilities brings along different cognitive and social-emotional skills whereas deficiencies in these abilities might lead to disorders/malfunctioning (see McAuley & White, 2011, for a review).

Research on the development of executive function mostly focuses on the improvements in diverse skills extending from preschool ages to early childhood. In fact, it has been admitted that these abilities begin to emerge by the second half of the first year and follows a rapid development through preschool years having considerable implications for school readiness (see Garon, Bryson, & Smith, 2008, for a review; McClelland, Cameron, Connor, Farris, Jewkes, & Morrison, 2007). Although toddlerhood has long been a period of mystery due to methodological problems, the importance of these years cannot be overlooked due to the fact that toddler years designate the transition period from an externally stimulated infant to an endogenously controlled child (Colombo & Cheatham, 2006).

Considering these issues, the present study focused on executive function in the third year of life and specifically investigated the relationships among working memory, inhibition and temperament in 24-to-36 months of age Turkish children.

The introduction is composed of four sections. The first section will cover the definition of executive functions and the debates about the nature of these functions. Then the focus will be on the working memory and inhibition as the core components of executive functioning in early childhood, respectively. Lastly, temperament research will be reviewed in relation with executive functions. It should be noted that the studies reviewed are mostly on the development of executive functions in normally developing non-clinical preschool children rather than an exhaustive summary of executive function literature.

Executive Function: Definition, Components and Developmental Correlates

The term “executive function” encompasses a group of distinct but related processes necessary for higher-order cognition (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). These processes enable the individual to direct, plan and organize complex behaviors in the pursuit of a specified goal and in accordance with the novel and conflicting situational demands. Executive function refers to an umbrella term for diverse capabilities such as working memory, cognitive flexibility, inhibition, shifting, planning necessary for the acquisition and improvement of other cognitive and socio-emotional skills (Riggs, Blair, & Greenberg, 2003). In other words, development of executive function can be considered as increasing voluntary control and regulation of perceptions, thoughts, emotions and behaviors so that children become more competent in achieving specified goals, solving problems and adapting themselves to the changing environment (Garon et al., 2008).

It has been found that as children become more able to regulate their behaviors, their academic achievement increases; they perform better in literacy, vocabulary and mathematic skills which highlight the role of executive control for school readiness (McClelland et al., 2007; Blair & Razza, 2007; Espy, McDiarmid, Cwik, Stalets, Hamby, & Senn, 2003). Moreover, children who are more competent in controlling their thoughts, emotions and behaviors were found to demonstrate less externalizing and internalizing problem behaviors (Riggs et al., 2003; Murray & Kochanska, 2002). On the other hand, deficiencies concerning executive processes during preschool years were found to be early signs of disorders such as Attention Deficit/Hyperactivity Disorder (ADHD) in elemantary school (Von Stauffenberg & Campbell, 2007). Moreover, children with Autism Spectrum Disorders were found to demonstrate impaired performance in terms of inhibitory control, planning and self-monitoring compared to typically developing children of same age, IQ and verbal ability, implying the importance of proper executive functioning in later typical development (Robinson, Goddard, Dritschel, Wisley, & Howlin, 2009).

Despite an enormous amount of study focusing on the current and future implications of executive function, there is a persistent debate concerning the nature of this complex faculty; whether it is unitary or a set of distinct processes. Its unitary nature lies in the fact that it is necessary for purposeful, goal-directed behavior. Executive functioning can be defined as higher-order, self-regulatory, cognitive processes that aid monitoring and controlling thought and action (Carlson, 2005). On the other hand, currently executive function is presumed as being composed of a number of interrelated subskills such as planning, attentional control and cognitive flexibility (Anderson, 1998). Miyake et al. (2000) modeled executive function as a unitary and diverse construct; consisting of working memory, inhibition and shifting as distinct but interrelated processes bound by some common underlying process. This unity and diversity can be considered such that executive function operates at macro- levels as well as micro-levels; for example, problem solving as a macro-level entity was best predicted by working memory and inhibition which are thought to be highly correlated micro-level variables (Senn, Espy, & Kaufmann, 2004).

Research in diverse age groups revealed that the degree of unity and diversity of executive function might change according to the age group under study (see Best & Miller, 2010, for a review). A study with children of 8-13 years of age supported Miyake's (2000) tripartite model of executive function and found three factors determining the performance: working memory, inhibition and shifting (Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003). Another study found that preschool childrens' performance in several executive tasks dissociate into three factors: attentional flexibility, inhibitory control and working memory (Hughes, 1998). Though these two studies called the third component of executive function with different names as "shifting" and "attentional flexibility", these names, in fact, designate the same construct which enables children to direct their attention from irrelevant information to the relevant information. However, in the study by Hughes (1998) the distinctions between working memory, inhibition and attentional flexibility were less clear when age, verbal ability and nonverbal ability were also considered such that performance in working memory tasks loaded equally on two factors and one of the inhibition tasks performance loaded on a different factor. On the other hand, the meta-analysis by Carlson (2005) on research with young children (2 to 6 years) revealed that working memory and inhibition are the core executive processes necessary for goal-directed behavior. Despite their surface differences, various tasks used to measure executive function mainly have two requirements; children must hold newly learned rules/instructions in mind and simultaneously must inhibit their prepotent response tendency. Indeed, in young children, it has been found that abilities required for higher-order processes have not been yet differentiated much. In line with this study, another study using path analysis showed that working memory and inhibition are two separate but interrelated components in the prediction of problem solving performance in 2-to-6 year-old children while cognitive flexibility did not relate to the former two, neither contributed to the performance (Senn et al., 2004).

To sum up, the broad term "executive function" is a multidimensional construct including specific abilities such as planning, monitoring, working memory, inhibition of prepotent responses, updating information, shifting attention, mental flexibility which together enable the individual to control and adapt their thoughts and actions according to the constantly changing environment. Early precursors of executive functioning are argued to emerge by the second half of the first year and follow a protracted development through the childhood to adolescence showing varying levels of diversity (Garon et al., 2008). While in later childhood, executive functions might be more differentiated, it was shown that preschool children's performance in complex executive function tasks was influenced by the individual differences in working memory and inhibition which served as the driving abilities for producing organized and purposeful behavior at this age range (Senn et al., 2004).

Research on Executive Function in Early Childhood

Most of the previous research has mainly focused on the preschool years; specifically on what kinds of errors preschoolers do due to their immature executive control, and how this type of errors change with age, comparing the performance of 3 to 5 years old preschoolers. Dimensional Card Sorting Task (DCCS) was used in these studies as a measure of executive control and revealed that 3 year old children have great difficulty to switch previously relevant dimension and sort by the currently relevant dimension resulting in perseverative errors. It has been observed that only by 4-5 years, under certain circumstances, children are able to inhibit the previously learned sorting criteria and perform successfully (e.g., Perner & Lang, 2002; Deak, Ray, & Pick, 2004). There are controversies about what accounts for the development from 3 years to 5 years that children gradually become able to switch their sorting criteria. Some argue that lack of inhibitory control might cause younger children to fail the task (e.g., Diamond, Carlson, & Beck, 2005). Other researchers attribute perseverative errors to the limited working memory capacity (Blackwell, Cepeda, & Munakata, 2009).

Bjorklund and Harnishfeger (1990, as cited in Wilson & Kipp, 1998) suggested that better performance in higher-order frontal tasks results from better inhibitory control in that irrelevant information cannot enter the limited-capacity working memory and processing efficiency increases. Accordingly, with age children become more competent in inhibiting the irrelevant information so that working memory is less occupied and as a result children can engage in more efficient mental processing. However, there is both behavioral and physiological evidence that acting appropriately in complex situations requires better inhibition efficiency as well as higher working memory capacity (Roberts, Hager, & Heron, 1994; Roberts & Pennington, 1996). Individual differences in complex cognitive processes are caused by the competition between the inhibition of incorrect prepotent responses and the activation of working memory resources to generate a correct response. In fact, increased working memory load caused inefficient inhibition and led to low performance in a nonpatient sample comparable to patients with prefrontal dysfunction, indicating that inhibition itself tax working memory. Furthermore, brain imaging studies show that common neural circuits get activated while performing executive tasks. Dorsolateral prefrontal areas are found to be most active during the tasks demanding a combination of working memory and inhibition (Diamond & Goldman-Rakic, 1989; cited in Garon et. al, 2008). These findings together highlight the fact that executive functions require a specific coordination of prefrontal processes which are basically working memory and inhibition.

Considering the research reviewed above, executive function in preschool years was mostly studied within the framework of what caused inefficient performances of 2-to-3 year old children compared to 4-to-6 year olds in certain executive function tasks. The focus was on the relative roles of inhibition and working memory in executive functioning. Some researchers argue that it is the inefficient working memory resulting in poor performance of younger children in executive control while others argue that it is the inefficient inhibitory control resulting in that. In fact, behavioral data from young children together with physiological data from adults support the cooperation of working memory and inhibition in goal-directed behavior. In this regard, neither working memory nor inhibition itself can account for the individual differences in executive functioning. Rather they must be treated as two distinct yet highly related components of executive function which have crucial role in preschool children's performance in complex executive tasks (Garon et. al, 2008).

Working Memory and Its relation to Higher-Order Cognition

Working memory, as modeled by Baddeley (1983; cited in Hitch & Towse, 1995), designates a domain-general limited mental resource enabling the individual actively maintain information and manipulate this information in the service of a specified action. According to the model, working memory is composed of two domain-specific temporary buffers, articulatory loop and visuospatial loop, controlled by a domain-free executive mechanism, called the central executive. Articulatory and visuospatial loops are responsible for keeping fresh phonologically coded information and visuospatial information respectively. The central executive on the other hand is responsible for the coordination of these peripheral buffers. Despite its popularity, this model has been recently challenged for being a simplistic conceptualization of working memory. The model could not provide sound explanation for the individual differences and age-related increase in the amount of information children can hold in active representation. Although it attempted to explain empirical evidence by referring to the developments in temporary stores and efficiency in rehearsal mechanism associated with different modalities of information, the exact process which the central executive component engages during cognitive processes was not specified. Indeed, age-related increases or individual differences in performance during tasks that require complex reasoning and higher-order cognition could not be accounted for by an appeal to the efficient rehearsal alone. This shortcoming of the model was overcome by highlighting the conceptual distinction between short-term memory and working memory, and more specifically emphasizing the crucial role of controlled attention in goal-directed behavior (Cowan, 1995, as cited in Engle, Tuholski, Laughlin, & Conway, 1999). Short-term memory corresponds to the information retrieved from long-term memory and activated above a threshold. Working memory, however, is more than the information stored in the short-term memory (Engle et al., 1999). Working memory is considered as the capacity for voluntary control of attention enabling the maintenance of the stored representations in an active state in order to process those representations in the presence of internal/external distracters or interfering information (Reznick, 2009; Cowan, Naveh-Benjamin, Kilb, & Saults, 2006). In other words, the critical component working memory involves is "controlled attention" (corresponds to the central executive of Baddeley & Hitch, 1983) through which the information in the short-term memory can be the focus of attention and worked on (Conway, Cowan, Bunting, Therriault, & Minkoff, 2002). In this sense, what develops with age appears to be the controlled attention component as well as acquired skills and strategies.

Research has revealed that by the second half of the first year, early forms of working memory are evident though the manifestation of this capacity depends on the specific technique employed in its measurement (Reznick, 2009). In one study, children as early as 9 months were able to successfully find a toy hidden in one of the three distinct locations even after a 2-to-3s delay (Reznick, Fueser, & Bosquet, 1998). In a similar delayed response task, there was a linear increase in the performance of infants in terms of both multiple alternative locations and longer delays between the ages 6-12 months (Pelphrey, Reznick, Goldman, Sasson, Donahoe, & Hodgson, 2004).

Development of working memory as a domain-general capacity has great implications for later cognitive development and general intelligence. A study investigating the relationship among processing speed, working memory and fluid intelligence in older children and adolescents children (ages 7-to-19) revealed that age-related increase in fluid intelligence was largely explained by age-related increases in working memory capacity and processing speed while age-related increases in working memory is accounted by age-related increases in processing speed (Fry & Hale, 1996). Although the findings of the study was interpreted as building a developmental cascade from age-related increases in processing speed leading to increased working memory and this in turn leading to increased fluid intelligence, there was methodological problems with regard to the measurement of processing speed and working memory. The finding that processing speed mediated the relationship between age and working memory was argued by Conway and his colleagues (2002) as a result of the fact that two of the processing speed tasks rely heavily on controlled attention. Moreover, the study by Fry and Hale (1996) overlooked the distinction between working memory and short-term memory by generating a composite score from simple span and complex span tasks. Regarding these problems, the study by Conway et al. (2002) utilized tasks that better differentiate working memory, short-term memory and processing speed in adults and investigated their unique contribution to the individual differences in fluid intelligence. By using structural equation model (SEM), it was shown that working memory shared a significant portion of common variance with fluid intelligence whereas neither short-term memory nor processing speed predicted fluid intelligence, indicating that individual differences in working memory capacity, distinguished from short-term memory and independent of processing speed predicts individual differences in fluid intelligence. In order to test whether the relationships found in adults are generalizable to children, Alp and Ozdemir (2007) investigated the same constructs in first graders by employing varying complexity of processing speed tasks in addition to short-term memory, working memory tasks and nonverbal fluid intelligence task. The results were congruent with that of Conway and his colleagues in that relatively pure measures of speed did not predict fluid intelligence while working memory capacity was the main factor predicting fluid intelligence. However, the most complex speed task which relied on conceptual choice tended to relate to fluid intelligence indicating the fact that the association found between speed and fluid intelligence is presumably caused by the extent to which speed measures require controlled attention.

In addition to its contribution to fluid intelligence, research reveals that individual differences in working memory capacity also predict performance in other cognitive tasks such as Stroop, Antisaccade and Dichotic Listening tasks (see Engle, 2002 for a review). It was shown that high and low working memory span individuals differed in their performances during the interference conditions of these different modal tasks while they showed almost equal performances in conditions devoid of any interference from the previously learned information. Engle (2002) suggested that the relation of working memory to these tasks as well as its relation to fluid intelligence results from the “controlled attention” component of working memory which enables the individual to focus attention and maintain relevant information while suppressing irrelevant information and avoid distraction in cognitive tasks including conflicts between the response alternatives. In fact, Engle (2002) argues that higher working memory capacity corresponds to higher executive attention and lower distraction rather than a large memory store.

This characterization of working memory as “executive attention” is supported by another study focusing on the perseverative behaviors of 5-6 year-old children (Blackwell et al., 2009). The study grouped children as switchers and perseverators with regard to their performances on a computerized three-dimensional card sorting task. Although perseverators and switchers were equally successful in answering the simple queries regarding the current sorting rule, perseverators could not sort using the relevant criteria in the following trials. To better understand what caused this discrepancy, the study compared the rates of perseverators and switchers’ responses to the simple queries regarding the sorting rule in a condition where there was only one sorting dimension. The switchers were faster in their responses to the queries about the sorting rule to be followed. The slower responses of perseverating children even in the absence of any conflict implied that working memory as controlled attention provided greater top-down support; thus speeded up responses. The more active were the rule representations, the faster were the responses. This finding implies the crucial role of working memory beyond processing speed and inhibition in predicting performance in complex tasks which required children to flexibly switch between different sorting categories.

Regarding the research reviewed above, it can be summarized that working memory capacity characterized by Engle and colleagues (1999) as "…the ability to maintain the activation of knowledge units in the focus of attention" (p. 312) emerges in the very beginning of life and traces a linear increase with age. Considering its high reliance on controlled attention and its role in predicting performance in complex cognitive tasks, the present study integrated working memory as one of the core components of executive functioning and investigated its relation to other components of executive functioning.

Working memory in preschool children and beyond is mostly measured through span tasks (e.g., forward digit span, backward digit span, letter span...etc). Working memory measurement in infancy, on the other hand is restricted to delayed response tasks and search tasks in which responses are coded through eye-monitoring devices. However, there is hardly any age-appropriate measure for working memory in the transition period from infancy to preschool years. The present study utilized Imitation Sorting Task (IST) developed by Alp (1994) as a valid and reliable tool for measuring working memory in children between 12 months to 36 months. The task exploits the imitation tendency of infants and very young children in order to make them sort diverse objects into two groups as demonstrated. Unlike delayed response tasks where working memory capacity is assessed in terms of the duration children can maintain information active between presentation and performance (Reznick, 2009), IST measures working memory capacity by assessing the number of objects the child can correctly relocate during a sorting activity.

The findings by Alp (1994) supported the neo-Piagetian perspective that information processing capacity of children by nature has some limits yet these limits are subject to age-related changes. It is well-established that there was a linear increase in the number of items children can process from 12 to 36 months; which was one approximately one unit every six-months. Moreover, the scores remained pretty much the same within the two weeks of the original assessment implying that this increase was not due to learning. These findings are congruent with the Theory of Constructive Operators (TCO) by Pascual-Leone (1970, as cited in Alp, 1994). According to the TCO, cognitive development refers to the process by which children acquire units of situation-specific information (*scheme*s) in their action repertoire through environmental learning and the content-free resources (*silent operators*) which they employ to activate these schemes increase through maturation. One of the critical resources that supply the activation energy is *M* (mental energy or mental capacity) whose development from birth to adolescence accounts for the improvement of children's competency in cognitive tasks. In other words, the cognitive performance of children is determined by "the amount of *M* available for an individual at any given age, *M* power" which "…is defined as the maximum number of independent schemes that can be simultaneously brought to hyperactivation without any contribution from other silent operators" (p. 126). The theory proposes that by the second year, children become able to employ the *M* operator in order to activate the relevant *schemes* and actively manipulate these *schemes* to achieve a specified goal implying that the *M* power might be considered as the working memory capacity. In light of this theory, the present study conceptualizes working memory as the mental capacity children utilize to simultaneously store and process necessary information in the pursuit of goal-directed behavior.

Inhibition: The Distinction between Delay Inhibition and Conflict Inhibition

Inhibition, also called as inhibitory control, refers to the ability to suppress a dominant response/irrelevant information, and/or activate a subdominant response/relevant information (Simpson & Riggs, 2007). As Harnishfeger (1995, as cited in Wilson & Kipp, 1998) put it, there are two types of inhibition: voluntary and involuntary inhibition. Involuntary inhibition takes place automatically, when the activation of irrelevant information is suppressed without conscious awareness. Voluntary inhibition, on the other hand, is within the control of the individual who consciously decides that information is irrelevant to the current task demands, and must be suppressed.

The focus of the present study was voluntary inhibition due to its relevance to goal-directed behavior. However, voluntary inhibition itself does not tap into a single process, ather the review by Garon et al. (2008) showed that the tasks used to measure inhibition in early childhood differ in their complexity. According to the authors, some inhibition tasks such as delay of gratification tasks require mere withholding /delaying or suppressing automatic or dominant response while other tasks requires suppression of a dominant or automatic response and additionally responding in a novel and conflicting way congruent with the task rules. The first type of inhibition is called as simple inhibition while the second type is called as complex inhibition. The same distinction is supported by other researches using different terminology. Among them, Carlson and Moses (2001) defined the distinction as delay and conflict inhibition, corresponding to simple and complex inhibition, respectively.

In line with the conceptualization of Carlson and Moses (2001), the present study attempts to investigate inhibition under two subcategories.

Delay inhibition refers to the ability to delay, slow down or suppress a well-practiced impulsive response. In other words, it is *simple* behavioral inhibition. This type of inhibition is measured by tasks in which successful performance requires suppression of a prepotent/dominant motor response. For instance, in a task called Snack Delay, the child is required to hold his/her hands on the table and wait to eat the candy till the experimenter rings the bell. Here, the prepotent response tendency of the child is to immediately reach and eat the candy. The task asks him/her to withhold this prepotent response and wait till the bell rings. This type of simple inhibition is argued to develop by the first year of life, as evident from the infants' growing ability to comply with the parents' "Don't!" commands. By the second year, children get more and more capable of delaying their urge to reach/get attractive toys or treats in delay of gratification tasks (see Garon et al., 2008, for a review).

On the other hand, conflict inhibition is the ability to suppress a well-practiced impulsive response as in the case of delay inhibition yet instead to enact a specified novel response which interferes with the prepotent response to be suppressed. Therefore, conflict tasks impose a higher cognitive load on children by requiring them to resist the interference of their prepotent response tendency with the newly learned response. For example, a commonly used task, Day/Night Task requires children to say day when they are shown a picture of the moon and to say night when they are shown a picture of the sun. In this task, children need to suppress their natural/automatic response to the moon/sun picture holding the rule in mind as well as say "sun/moon". Most of the studies focusing on the complex sorting tasks (e.g. DCCS) found that children can perform successfully in conflict inhibition tasks by the age of 4-5. However, studies on children as young as 22 months suggest that this ability starts to develop by the end of the second year of life onward (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Hughes & Ensor, 2005).

Despite the fact that delay and conflict inhibition differ in the cognitive load they place on the children, these two constructs have overlapping characteristics which is the ability to suppress a prepotent/automatic response tendency. This is certainly a goal-directed and voluntary capacity and requires planned and organized action, directed and focused attention to some extent. In fact, the research investigating inhibition by using conflict and delay inhibition tasks concomitantly, found that the total performance in these tasks related to affect regulation, self-restraint and conscience development, thus having implications for socio-emotional development (Kochanska, Murray, & Harlan, 2000; Kochanska & Knaack, 2003). Moreover, inhibitory control was found to predict emergent mathematical skills in preschool children, having implications for academic achievement and school readiness (Espy et al., 2003)

On the other hand, the distinction between conflict and delay inhibition is supported by several studies. Among them, Carlson, Moses, and Breton (2002) investigated the relationship between executive function and theory of mind (ToM) in preschool children and found that conflict and delay inhibition predicted the performance on false belief tasks differentially. While the conflict inhibition performance significantly predicted ToM, even when controlled for other factors like age and intelligence, there was no significant correlation between delay inhibition performance and false belief performance. The study also provided evidence that working memory was related to conflict inhibition but not to delay inhibition. The performance of children on span tasks of working memory correlated significantly with their performance on conflict inhibition tasks.

In another study referring to the distinction between delay and conflict inhibition as hot and cool aspects of executive function, it was expected that performance in these two types of tasks would be associated with socio-emotional and cognitive abilities differentially (Hongwanishkul et al., 2005). Though cool executive function performance was found to relate to intellectual abilities, hot executive function performance lacked such relation. However, contrary to the expectations, hot executive function performance did not relate to temperament either. Moreover, hot executive function tasks lacked coherence, implying that this construct needs to be better understood.

Brain-based accounts of executive function highlight the fact that hot and cool aspects of executive function may be related to different brain regions (Zelazo & Müller, 2002; as cited in Hongwanishkul et al., 2005). It is proposed that hot executive function corresponds to more affective processing, including regulation of emotions and motivations, and thus is more related to activation in ventral-medial prefrontal cortex. On the other hand, cool executive functions operate at the level of more abstract and emotionally-neutral context, and thus more related to activation in dorsolateral prefrontal cortex. However, it is hard to fully distinguish cool aspects from hot aspects and it is obvious that most of the executive function tasks used in the literature necessitates a cooperation of the two. Thus it is a continuum rather than a strict dissociation such that some tasks may relatively require more emotion-regulation while others may require more efficient control of mental representations (Hongwanishkul et al., 2005).

Finally, Espy & Bull (2005) provided evidence for the relation between working memory and conflict inhibition. Consistent with the previously reviewed research, they dissociated inhibition into two types yet their conceptualization differed such that they called delay inhibition as “response suppression” and conflict inhibition as “attentional control”. The study categorized preschool children as high and low span groups by employing the forward digit span task and compared their performance on inhibition tasks varying in the nature of the stimulus (verbal/nonverbal), response type (motor/naming), conflict type (proactive interference/distraction) and inhibitory processes (attentional control/response suppression). They found that performance of high and low span children on inhibitory tasks differed only on those that required attentional control whereas there was no difference between the performance of the two groups on the tasks that require response suppression or any other dimensions.

In the light of the research reviewed above, the present study proposed that there are two types of inhibition; delay (simple) inhibition and conflict (complex) inhibition which have inevitably common demands due to tapping the ability to suppress dominant response tendency. However, the brain regions activated during these two types of inhibition process appear to be different. Moreover, there is evidence that performance in delay and conflict inhibition tasks relate differentially to other cognitive tasks. Relying on these evidences, the present study investigated whether delay and conflict inhibition performances associate with cognitive and emotional aspects of executive function differentially.

Temperament in Relation to the Development of Self-Regulation

While cognitive development literature highlights the importance of executive processes in terms of their relations to higher-order cognition and goal-directed behavior, the construct of executive function does not solely relate to cognitive outcomes. Rather, executive function is as well critical for social and emotional development (Zhou et al., 2011).

Research on socio-emotional development highlights the significance of temperament with respect to children's increasing competency in controlling their emotions, physical behaviors, motivation and attention in order to adapt to the situational demands of their social environment (Liebermann, Giesbrecht, & Müller, 2007; Kochanska, Coy, & Murray, 2001). Temperament is defined as the "…individual differences in basic psychological processes…" (Rothbart & Bates, 1998, p.108) such as affect, activity and attention which are already apparent by the time of birth (Rothbart, 2011). Research showed that temperamental characteristics demonstrate substantial stability and change through the first years of life such that children's rank order in certain temperamental characteristics did not change over almost one-to-two years while children get more competent in controlling their positive and negative affect, actions and attention as they get older (Kochanska et al., 2000; Kochanska & Knaack, 2003).

Rothbart (2011) argue that temperament is composed of reactive and regulatory processes. According to the author, reactive processes are evident by the time of birth and refer to the innate tendencies that infants display such as anger, fear, and approach (p. 11). On the other hand, regulatory processes emerge by the end of the first year evident by the infants' initiating, maintaining or ceasing a certain behavior in compliance with the social demands, and supposed to evolve into regulation of behavior in the absence of an external control mechanism and adapt their behaviors to the changing situations by the third year (Kopp, 1982, as cited in Kochanska, Coy, & Murray, 2001).

Concerning the development of self-regulation in preschool years, the focus of the previous research has been on the term "effortful control" which is regarded as a regulatory aspect of temperament; enabling the children to control their behaviors in an active, voluntary and internally guided manner (Rueda, Posner, & Rothbart, 2005; Kochanska et al., 2000). Effortful control is defined as the ability to suppress a dominant response and/or enact a subdominant response. Effortful control is evident by the second half of the first year and develops into a longitudinally stable and coherent personality characteristic through the early school years (Kochanska & Knaack, 2003; Valiente, Eisenberg, Smith, Reiser, Fabes, Losoya, Guthrie, & Murphy, 2003). The term "effortful control" must be treated with caution, however. The conceptualization of the term apparently echoes that of the inhibitory control. In fact, the battery used to measure effortful control in the studies of Kochanska and her colleagues consisted of tasks which corresponds to delay inhibition and conflict inhibition tasks used in the research reviewed previously. On the other hand, effortful control is also measured in the reviewed literature through parent and teacher rated questionnaires appropriate for the age group under investigation (CBQ-Childhood Behavior Questionnaire; Rothbart, Ahadi, Hershey & Fisher, 2001) which include temperamental characteristics such as perceptual sensitivity, low-intensity pleasure, cuddliness. In this sense, inhibitory control and effortful control refer to differing subcomponents as well as overlapping components.

Effortful control conceptualized as the regulatory aspect of temperament, is differentiated from the reactive aspects of temperament (Ahadi & Rothbart, 1994, as cited in Aksan & Kochanska, 2004). Reactive processes include children's fearfulness, shyness and/or inhibition of action in response to the novelty while regulatory processes include voluntary/effortful control of attention and actions in a goal-directed manner. Despite the distinction between reactive and regulatory processes, effortful control is found to relate to the extent to which children are prone to positive or negative emotions and inhibited to the unfamiliar objects/people around (Kochanska & Knaack, 2003). In fact, it was found that individual differences in reactive inhibition to the novelty during the first year of life influences the individual differences in regulatory inhibition through the end of the second year (Aksan & Kochanska, 2004). Moreover, there was substantial convergence between effortful control as children demonstrate through performance-based measures and temperament characteristics as rated by their parents/teachers (Kochanska et al., 1996; Kochanska & Knaack, 2003; Valiente et al., 2003). Comparing observed and parent-rated performances revealed that children high in effortful control tend to exhibit less negative affect, social fear and joy, and they are more competent in inhibitory control.

In this regard, children's ability to suppress their prepotent response tendencies appears to be related to their temperament in both reactive and regulatory aspects. Thus, the present study also questions whether different types of inhibitory control relate to reactive and regulatory temperament differentially.

Integrating the Cognitive and Temperamental Aspects of Executive Function

The reviewed literature above implies that "inhibitory control" as investigated in cognitive neuroscience and "effortful control" as investigated in socio-emotional development areas has some common characteristics (Zhou et al., 2011). First of all, the term "effortful control" has the same connotations as "inhibitory control" in that it designates the ability to suppress a dominant response tendency and/or activate a subdominant response (Rueda et al., 2005). Moreover, effortful control is argued to have two types; "delay of gratification" and "executive control" resembling the distinction between delay and conflict inhibition (Li-Grinning, 2007; Carlson & Moses, 2001). The characterization of these two constructs implies that effortful control as a temperamental construct, and inhibition as a cognitive control mechanism might have some overlapping nature. However, there are also some differences between the two constructs especially with regard to the context in which they are studied. Effortful control has generally been studied within the emotion-laden contexts, particularly in terms of its relationship and contributions to social-emotional development such as externalizing and internalizing behaviors, and personality development (e.g., Kochanska & Knaack, 2003; Valiente et al., 2003). Executive functions on the other hand, have been mostly studied in relation to problem-solving and higher-order cognition contexts, presumably devoid of affective states.

Concerning the fact that cognitive factors as well as socio-emotional factors play crucial role in children's increasing competency in self-regulation, goal-directed behavior and adaption to their social environment (Bodrova & Leong, 2006; as cited in Liebermann et al., 2007), the present study highlights the need for studying executive functions within an integrative framework, focusing on the dynamic relationships among cognitive processes and temperament. Fox and Calkins (2003) argue that temperamental characteristics and cognitive processes interact in controlling the duration, the manner and the intensity of emotion expressed. According to their perspective, cognitive control processes themselves are influenced by temperament such that the emotional reactivity of the children determines to what extent children can control their attention and inhibit certain behaviors. The interrelation between emotional and cognitive control processes can be further supported by brain studies. As Anderson (2002) stated, higher-order functioning is suggested to require the integration of different parts of the brain. Despite the fact that executive processes are known to be localized to the prefrontal cortex (PFC), this area is interconnected with the limbic system and brain stem, and they function in a reciprocal interaction (Blair, Zelazo, & Greenberg, 2005). The Executive Attention System and the anterior cingulated cortex (ACC) which goes through an initial developmental change by 10 months are thought to be responsible for the inter-communication between prefrontal and limbic areas of the brain. Thus, attentional control is suggested to serve as a latent variable underlying the relation between executive function and self-regulation. Through the second year of life to preschool years, the attentional control follows a rapid development such that children gradually become more competent in using volitional control over their thoughts and emotions (Bell & Deater- Deckard, 2001).

The Present Study

Relying on the fact that the basic abilities in early years of life are not achieved independently from each other, the present study attempted to integrate certain aspects of early cognitive and socio-emotional development in order to investigate their relative roles in children's increasing ability to control their perceptions, thoughts, motivations and behaviors for goal-directed behavior in novel environments. In terms of cognitive control, executive functions appear to play an important role and the reviewed literature suggested that working memory and inhibition are the two fundamental executive functions enabling goal-directed behavior in toddlerhood. On the other hand, the self-regulation literature reviewed above emphasizes the role of effortful control and its close association with temperament. The present study proposed that executive function and effortful control, though studied in distinct research areas and in relation to different processes have some commonalities such that they refer to the voluntary control over behaviors in the face of a distractor or an interfering stimuli to achieve a specified goal. In fact, effortful control can be equated with inhibition with regard to its conceptualization and measurement.

Although both inhibition and effortful control is mostly measured by a set of various tasks, recent research argued that there might be two types of inhibition requirements in these tasks. One of them can be called simple behavioral or delay inhibition requiring mere suppression of/slowing down a dominant response. The other can be called conflict or complex cognitive inhibition which requires suppression of a dominant response as well as activating a conflicting subdominant response. On the basis of the reviewed empirical data, this latter type of inhibition is thought to relate to working memory beyond the former type of inhibition due to the fact that conflict inhibition puts a higher demand on the controlled attention mechanism. On the other hand, regarding the indirect role of reactive and direct role of regulatory temperament in self-regulation, together with the fact that effortful control incorporates temperamental characteristics distinct from inhibition, delay inhibition was thought to relate to these temperamental characteristics over and above working memory.

The aim of the present study therefore was to explore different types of inhibition would relate to cognitive and temperamental processes differentially. Specifically, it was hypothesized that conflict inhibition will relate to working memory over and above temperament whereas delay inhibition will relate to parent-rated temperament over and above working memory. Conflict inhibition and delay inhibition were measured by a total of six tasks designed and commonly used for children of 24-36 months. Working memory was measured through Imitation Sorting Task (Alp, 1994) which is a well-established working memory capacity measure for children of 18-36 months. Temperament was measured through ECBQ-Early Childhood Behavior Questionnaire developed for measuring negative affectivity, surgency and effortful control aspects of temperament through parent-ratings (Putnam et al., 2006). Therefore, effortful control was measured by both performance-based measures (conflict and delay inhibition tasks) and parent reporting. The

There is hardly any study on executive processes in toddlerhood due to methodological problems such as lack of age-appropriate tasks and the limited attention span of young children (Hughes & Ensor, 2007). Thus, the present study tried to provide with a better understanding the inner dynamics of executive functioning in children as young as 2 year-olds. Moreover, the study attempted to unite two separate research areas by exploring the relationships between different aspects of cognitive and emotional control in an integrative framework. In this sense, it is argued here that the study would provide a unique contribution by highlighting the relationships among working memory, inhibition and temperament in the third year of life, using age-appropriate and separate measures.

CHAPTER 2

METHOD

Participants

A total of 36 toddlers were recruited by convinence sampling from the day-care centers around Istanbul, including the one in Bogazici University. One of the children was solicited by personal contact with her parent. Children were chosen from the middle-to-high SES families. For the purposes of the study, the target range of age was between 24 to 36 months. Due to the fact that there are few children in day-care centers at this age range, the sample did not involve any 24 months old child. Two children were already turned three-years-old; one of them were a 38-months girl and the other 37-months boy (*M*= 30.92, *SD* =3.76; range = 25-38).

The participants included 19 males and 17 females. There were minimum 2 children of each months of age .None of the children had a diagnosed attention or learning disability, major medical or psychiatric illness, or mental retardation. The demographic information is presented in the Table 1 (Apppendix A).

Procedure

The children were tested individually in a separate room (library, sports activity room or play room) of the day-care centers where the measurements could be carried on without any distraction. The child who was recruited by personal contact was invited with her mother to the day-care center of Bogazici University and was measured in the same room as other children of that day-care center. In order to lessen the anxiety of children against a stranger coming and inviting them to play with, all sessions began with a small meeting phase in the classes. Children who seemed ready to play with were individually invited to the testing room together with their day care teacher or the trainee teachers. Each task was introduced as a game. The games started with warm-up trials. After the measurement was completed, the children were thanked, presented with stickers and accompanied to their class.

Due to the limited attention capacity of this age, the study was composed of two separate sessions for each child. Each session lasted for about half an hour to an hour. Considering the fact that in early childhood, even one month is a substantial period for rapid changes to take place in any developmental aspect, the second sessions of the measurements were arranged within three weeks interval.

Measures

A total of seven measures were employed. Half of the children took the working memory measure (Imitation Sorting Task) in the first session and half of them the inhibitory control battery including conflict inhibition tasks (Shape Stroop, Multilocation Search, and Reverse Categorization) and delay inhibition tasks (Walk-a-line slowly, Snack Delay and Gift Wrap). The administration of the Shape Stroop, Walk-a-line Slowly, Snack Delay, Gif Delay Tasks was fixed roughly in the same order as in the study by Kochanska et al. (2000). The two additional conflict inhibition tasks- Reverse Categorization and Multilocation Search Tasks- were incorporated into the established order of Kochanska et al. (2000) considering that none of the two conflict/delay type of inhibition tasks were administered consecutively. Therefore, the order of the tasks was fixed for all participants in the following order: Shape Stroop, Walk-a-line Slowly, Reverse Categorization, Snack Delay, Multilocation Search Task, Gift Delay. The performance in inhibition tasks were videotaped and watched by a trained coder. The interrater reliability was established on 35% of the cases. Kappas for responses in all tasks were 1.00 and Cronbach's alphas for the latency scores were at least .966.

Apart from these tasks, the mothers were given a 36 items temperament scale (Early Childhood Behavior Questionnaire-Very Short Form; Putnam, Garstein, & Rothbart, 2006).

Working Memory Measure

Working memory was measured by Imitation Sorting Task (IST) (Alp, 1994). The task required children to imitate the experimenter as he/she sorts small toys into two separate canisters. There were eight levels of difficulty in the IST. Each level included five sets of different toys. The first level began with a warm-up trial during which the experimenter demonstrated the sorting with only one toy in the presence of one canister. This level was administered in order to make sure that the children could imitate dropping a toy into a canister. In the second level, there were two canisters and two toys to be sorted, each going to one of the two canisters. The task was organized into levels of increasing difficulty, with each succeeding level containing one more number of toys to be sorted. Thus, the eighth level contained eight toys to be sorted four by four into the canisters.

Every trial began with the specific number of toys put in front of the child so that when the child seemed to attend to each toy in the set, the experimenter gathered them and demonstrated the sorting in prescribed order one toy at a time. The child who could sort the toys the same way as the experimenter did pass the criterion for imitation. It was not required for children to drop the sorted toys exactly in the same canisters as the experimenter. Rather the pass criterion was achieved when the child could imitate sorting the toys into the same groups of two. In order to pass a level, the child needed to correctly sort two correct trials out of the first three sets of toys, if not/or three correct trials out of five sets of toys in each level. If the child failed to pass a certain level, the following level was administered anyway to check whether there was an attention loss or some other factors about that level. After two consecutive unsuccessful levels, the game was finished and the last successfully completed level was coded as the score for this task.

Conflict Inhibition Measures

There were three tasks to measure conflict inhibition. Despite differences in the contents and instructions of the tasks, all were introduced as a game and required children to inhibit a dominant response and to enact a subdominant response.

Shape Stroop Task (Kochanska et al., 2000)

The experimenter showed a total of six cards. Three of them depicted pictures of an apple, an orange and a banana, in large size and the other three depicted the same fruits in much smaller size. The small fruits were taken away, and the child was asked to show apple, orange and banana in turn as the baseline condition. On the test trial, the child was presented three other cards, on which small fruits were depicted inside a different large fruit (eg. a small banana inside a large apple). The child was asked to point to the little fruits (eg. "Show me the little banana"). The performance of the child was coded ranging from 1 *(points to the large fruit)* to 2 *(points to the large fruit but self-corrects),* to 3 *(points to the little fruit)* for each fruit. Total score of the task was calculated by averaging the scores in three trials.

<u>Reverse Categorization Task (Carlson, Mandell, & Williams, 2004)</u>

The child was introduced mommy and baby animals to play a sorting game. The experimenter demonstrated using verbal instructions that little animals must be dropped into baby bucket and mommy animals into mommy bucket. If the child successfully sorted in 83% of the six trials, the experimenter introduced a new game, "a silly game" in which the sorting was reversed so that baby animals were dropped into mommy bucket and mommy animals into baby bucket. Two scores were calculated for this task; the proportion of correct sorting in the first six trials as the pre-switch score and the proportion of correct sorting after the sorting was reversed as post-switch score.

<u>Multistep Multilocation Search Task (Zelazo, Reznick, & Spinazolla, 1998)</u>

The child was presented a wooden box with a moveable front door and top. The front door was either closed by transparent plexiglass or opaque door. On the base of the box, there was a sliding tray on which five cardboard symbols of $2cm^2$ size were aligned on a Velcro fastener and each attached to five plastic bags with 45cm strings. The experimenter hid a sticker in one of the plastic bags as the child watched through the transparent plexiglass and showed that the plastic bag was attached to the corresponding cardboard symbol. The experimenter then lowered the opaque door and put a foam barrier in front of the box. The child was required to complete four-steps; take away the foam barrier, pull the sliding tray, choose the cardboard symbol to which the plastic bag with sticker was attached and pull the string. The child was trained to accomplish four-steps her/himself with one symbol in the center of the tray and then tested with a total of five symbols. If the child could retrieve the sticker in the same place in three consecutive trials, the experimenter visibly hid the sticker into a different plastic bag with a different symbol attached. Three trials were administered after switching to a different plastic bag. Two scores were calculated for this task; the percentage of correct pre-switch and post-switch trials.

Delay Inhibition Measures

Delay inhibition was measured with three tasks utilized from the effortful control battery developed by *Kochanska et al. (2000).* These tasks required slowing down motor activity, suppressing a dominant response and/or delaying a temptation.

Walk-a-line Slowly

The task required the child to walk on a straight ribbon of 183 cm length without going out of borders of the ribbon. Following the baseline trial during which the child received no instruction except walking straight, the experimenter asked the child both to walk within borders and very slowly. There were two slows trials. For all trials the scores were coded as the durations and errors. Due to many errors children as young as two-year-old made during walking, the errors did not contributed to the final scores. Durations for the two slow trials were averaged to generate a total score for this task.

Snack Delay

In this task, the child was shown a candy hidden under a transparent cup on a table, and asked to wait while keeping his/her hands on the table. The child was allowed to retrieve the candy only after the experimenter rang the bell. There were six trials, with 5sec, 10sec, 0sec, 20sec, 0sec, and 40sec durations respectively. The behavior of the child during waiting were coded as following: 0 = eats the candy before the bell; 1 = attempts to grab the candy, but the trial ends; 2 = doesn’t eat the candy, but touches the coverage or the plate before the bell; 3 = waits for the bell, but doesn’t keep hands in required position; 4 = waits for the bell as demanded. In addition to these scores, latency to fidgeting such as talking aloud about the situation, asking for the experimenter to ring the bell, acting restlessly were coded. Waiting scores that correlated with each other averaged to generate a total response score. Latencies to fidgeting in six trials were averaged to generate a total latency score. The total response score and the total latency score were converted to z-scores and averaged to generate a total delay score for this task.

Gift Delay

This task consisted of two phases; wrapping phase and waiting for the bow phase. In the first phase, the child was required to sit facing back and not to peek while the experimenter wrapped the gift brought for the child. This phase lasted for 60 seconds. In the second phase of the task, the experimenter asked the child not to stand up and touch the gift. The experimenter left the gift within reach of the child and leaved the room to get a bow. The child was required to wait 180 seconds in this phase. Two scores were coded, one for waiting for wrapping and one for waiting for bow. Waiting for wrapping score consisted of whether the child peeked/stand up combined with the latency to peek/stand up and the latency to fidgeting. Waiting for the bow scores consisted of a seat score, a touch score as well as latency score for fidgeting, standing up and touching. Peeking, seat, touch and latency scores for two phases were averaged and standardized to generate Wrapping and Bow total scores. These two scores were averaged to generate a total score for the Gift Wrap.

Temperament Measure

Temperament was measured through parent-reported questionnaire. The Early Childhood Behavior Questionnaire Very Short Form consisted of thirty-six items was used (Putnam et al., 2006). Children were rated in a 7-point Likert scale ranging from “never” to “always”, based on the frequency of specific behaviors which they demonstrated within the daily contexts. The original questionnaire was translated to Turkish by a graduate student from the department of Foreign Language Education in Bogazici University and back translated by a faculty member. The Turkish version can be found in Appendix F. The questionnaire consisted of three subscales; Negative affectivity, Surgency and Effortful Control. The scale, negative affectivity attempts to measure individual differences in children's discomfort, fear, sadness, frustration, and soothability. Surgency subscale measures individual differences in children's impulsivity, activity level, high-intensity pleasure, sociability, and positive anticipation. The last subscale, effortful control measures individual differences in children's inhibitory control, attention shifting, low-intensity pleasure, cuddliness, and attention focusing. Three total scores for each subscale were calculated by averaging the related item scores (item numbers 1, 2, 10, 16, 17, 19, 22, 23, 26, 32, 33, 34(reversed) constituting the Negative Affectivity subscale; item numbers 3, 4, 6, 9, 11, 13, 18, 20, 24, 25, 30, 36 constituting the Surgency subscale; item numbers 5, 7, 8, 12(reversed), 14(reversed), 15, 21, 27, 28, 29, 31, 35 constituting the Effortful Control subscale). The Cronbach's alphas were .77 for Negative Affectivity subscale, .47 for Surgency subscale and .65 for Effortful Control subscale.

CHAPTER 3

RESULTS

Descriptive Statistics of the Study Variables

Descriptive statistics for the demographic variables of the study is presented in Table 1 in Appendix A. A summary of the descriptive statistics for the study variables is presented in Table 2 in Appendix B. Prior to the hypothesis testing, study variables were examined in terms of normality. The sample was found to represent a normal distribution in terms of all study variables (*SE* of skewness > .05; *SE* of kurtosis >.05). Table 3 in Appendix C presents the intercorrelations among the age and the individual tasks employed in the study. No relation was found between sex of the child and any of the individual task scores (all ps > .05). Age was treated as a continuous variable and found to correlate with the percentage of correct trials in Reverse Categorization Task and Multilocation Search Task.

In order to test the main hypotheses of the study, a total of four scores were generated. All four scores were standardized and converted to Z-scores. The score obtained from the Imitation Sorting Task was included in the analysis as the working memory score. For temperament, three separate scores were obtained by averaging the ratings in the relevant subscales; Negative Affectivity score, Surgency score, Effortful Control score. Consistent with the previous research (Putnam et al., 2006) there was a significant and negative correlation between Negative Affectivity and Effortful Control, $r\ (31) = -.53\ p < .01$, yet Surgency did not relate the former two subscales. Relying on this relationship, total scores on Negative Affectivity (reversed) and Effortful Control subscales were standardized and averaged into a composite score for temperament. Cronbach's alpha was .62 for the temperament composite score.

For conflict and delay inhibition each, two composite scores were generated. The scores in Shape Stroop, Reverse Categorization and Multilocation Search Tasks were standardized and averaged into a conflict inhibition composite score. Due to a high rate of failure (only 18 out of 34 children could pass) in passing to postswitch phase of Reverse Categorization Task, only the percentage of correct preswitch trials were included in the composite score. There was a similar problem with Multilocation Search Task, but in this task 77 % of the children could pass to the postswitch trial, and the percentage of correct postswitch trials were also included in the composite score. For the ones who could not pass to the postswitch, the composite score was calculated by taking their postswitch percentage of correct trials as zero. Cronbach's alpha was .75 for the conflict inhibition composite score.

The scores obtained from Walk-a-line Slowly, Snack Delay and Gift Delay Tasks were standardized and averaged into a delay inhibition score. Cronbach's alpha was .33 for the delay inhibition composite score.

Neither of the study variables showed difference due to the sex of the child. Age was associated with working memory and conflict inhibition but not with delay inhibition and temperament. There was a significant and positive relationship between IST scores and the age of children in months, r (33) = .45, $p < .01$. Moreover, the conflict inhibition composite score was almost significantly and positively correlated with age, r (32) = .34, $p = .06$. However, no relationship was found between age and either delay inhibition composite score or the temperament composite score ($ps > .05$). Due to the fact that age is a significant correlate of both working memory and conflict inhibition, the intercorrelations between the study variables were analyzed by controlling for age and age was included in the further analysis as the control variable. The partial correlations among the study variables (Table 4, Appendix D) showed that when controlled for age, there was still a significant and positive correlation between IST and conflict inhibition composite scores, r (28) = .58, $p < .01$. IST scores were also found to have a significant and positive relationship with delay inhibition composite scores though with a lower correlation coefficient, r (30) = .40, $p < .05$. Moreover, delay and conflict inhibition composite scores were found to be significantly related, r (29) = .42, $p < .05$. However, neither temperament composite score nor separate total scores for negative affectivity, surgency and effortful control showed a significant relation to the other study variables. Due to this lack of relationship, the second hypothesis of the study was not supported and temperament was not included in the following analyses.

Prediction of Conflict Inhibition from Age, Delay Inhibition and Working Memory

In order to test what predicts conflict inhibition differentially among the correlated study variables, a hierarchical regression analyses was conducted. In the analysis, the effects of age, delay inhibition and working memory in predicting conflict inhibition was tested. The model included age in months, delay inhibition composite score and the IST score, respectively, as the predictors of conflict inhibition composite score.

As presented in Table 5 in Appendix E, the overall regression model was significant in explaining 50% of the variance in conflict inhibition scores, F (3, 27) =

9.141, $p < .01$. Age was entered in the first step in order to control its effects on the dependent variable. Age explained 16 % of the variance in conflict inhibition, F (1, 29) = 5.417, $p < .05$. Age significantly predicted conflict inhibition, β = .40, t (29) = 2.328, $p < .05$. In the following step, delay inhibition composite score was entered. Delay inhibition explained an additional 20% of the variance in conflict inhibition, R^2 change = .20, F change (1, 28) = 8.821, $p < .01$. After delay inhibition was entered, both age and delay inhibition significantly predicted conflict inhibition, β = .38, t (29) = 2.529, $p < .05$; β = .45, t (28) = 2.970, $p < .01$, respectively. In the last step, IST was entered. IST contributed an additional 15 % of the variance in conflict inhibition, R^2 change = .15, F change (1, 27) = 7.871, $p < .01$. However, after IST was entered, the overall model showed that the coefficients of both age and delay inhibition turned to be nonsignificant while IST was still a significant predictor of conflict inhibition, β = .47, t (27) = 2.860, $p < .01$.

Therefore, the first hypothesis was supported by the hierarchical regression which revealed that despite a moderate association of conflict inhibition with age and delay inhibition, working memory capacity was found to be the only variable predicting conflict inhibition over and above the other two variables.

CHAPTER 4

DISCUSSION

The results of the present study revealed that working memory capacity and conflict inhibition performance increase from 24 months to 36 months while there was no age-related increase in children's delay inhibition performance or temperament rated by their parents. With regard to sex, there was no significant difference between children in terms of any of the latent variables.

When the relationships among the study variables were examined, conflict inhibition performance, delay inhibition, and working memory capacity were found to be interrelated constructs while temperament did not relate to the others. Therefore, the second hypothesis of the study which proposed that delay inhibition performance would be predicted by temperament beyond other study variables was not validated. On the other hand, confirming the first hypothesis, conflict inhibition performance was predicted by working memory capacity beyond age and delay inhibition. In fact, the results showed that the association between conflict inhibition and both age and delay inhibition disappeared once working memory capacity was counted in.

Working Memory as a Predictor of Conflict Inhibition

Based on the first hypothesis, a positive relationship was expected between working memory capacity and total performance in conflict inhibition tasks. The findings showed that the strength of the relationship was .58 indicating a moderate effect size.

Furthermore, the analysis to better understand this high association between working memory and conflict inhibition showed that working memory capacity accounted for 15 % of the variance in conflict inhibition apart from the influences of age and delay inhibition.

That is to say, children with higher levels of working memory capacity could not only suppress their dominant response tendency more efficiently but also could activate a subdominant response where the response to be activated was in conflict with the one to be suppressed. This finding is consistent with the previous research which found a significant relationship between working memory and inhibition efficiency of children of 6-to-8 years (Roncandin, Pascaul-Leone, Rich & Dennis, 2007). It is well-established that working memory as a limited-capacity mental resource is not only responsible for storage of information rather operates in deployment of activation, suppression and strategic resources to enable efficient processing (Roncandin et al., 2007; Engle et al, 1999). The present findings provide further evidence for the association between working memory and inhibitory control in goal-directed behavior in complex situations with multiple competing alternatives.

Congruent with the previous research, age was found to be positively and significantly associated with working memory capacity, implying that as children get older, there is an improvement in the amount of information they can hold in mind and manipulate (Alp, 1994; Roncandin et al., 2007). The study by Alp (1994) revealed that working memory capacity increased linearly from 12 months to 36 months of age. In addition, the study focusing on the first year of life showed that between the ages 8 months to 12 months, children's capacity for spanning longer delays and searching in multiple locations improved (Pelphrey et al., 2004).

Although the age range in the present study was restricted to one year and the sample size was relatively small, the relationship between working memory and age proved to be robust.

In addition, age was related to the total performance in conflict inhibition tasks; older children were better at dealing with their dominant response tendencies in conflict situations and choosing the alternative competing responses. This relationship is consistent with the previous findings that performance in executive tasks that impose conflict is subjected to age-related increase throughout the preschool years (Hongwanishkul et al., 2005; Carslon & Moses, 2001).

Despite the non-negligible effect of age on the mentioned cognitive capabilities, the strength of the relationship remained still significant when age-related improvement in working memory and conflict inhibition was eliminated. This finding implies that the relationship between working memory and conflict inhibition performance was beyond the general improvement in processing efficiency due to aging. In fact, among the other study variables, working memory capacity predicted conflict inhibition performance differentially; explaining a significant portion of the variance in conflict inhibition beyond age and delay inhibition.

Lack of a Relation between Delay Inhibition and Temperament

It was hypothesized that delay inhibition performance of the children would relate to their certain temperamental characteristics; negative affectivity, surgency and effortful control. Contrary to the hypothesis, there were no significant associations between delay inhibition and either total temperament score or any of the temperamental characteristics in question. Nor there was any age-related improvement in either temperament or delay inhibition performance.

Research on temperament offers us mixed results about the convergence of behavioral and parent-reported data. There is substantial research which revealed significant association between laboratory measures of inhibitory control and parental ratings of effortful control. In one of them, Kochanska et al. (2000) found that the performance of children of 33 months at effortful control battery converged with their parents' concurrent ratings. The same study showed that the performance of children of 22 months converged with their parents' ratings 11 months later. Another study found that parents' ratings of their children's temperament when they are 22 months highly correlated with children's performances in effortful control tasks at 33 months of age (Kochanska & Knaack, 2003). However, in both studies, there is no evidence for the contemporaneous correspondence between parent reports and behavioral data at when children were 22 months year old. Moreover, another longitudinal study found that children's performance-based effortful control across 4 years was in high association with parent and/or teacher-reported effortful control (Valiente et al., 2003).

A few study failed to find convergence between these measures. Hongwanishkul et al. (2005) found that despite a moderate association between cool executive function and parent ratings in children between ages 3-6, performance of children in hot executive function tasks did not show any association with parent ratings. Moreover, the Behavior Rating Inventory for Executive Function (BRIEF) which was utilized to measure effortful control in preschool children failed to overlap with the behavioral data loading on a single-distinct factor (Bodnar et al., 2007; Liebermann et al., 2007).

One possible explanation for the lack of any relationship might be that temperamental characteristics were measured through parental ratings of children's behavior tendencies during everyday activities whereas laboratory measures of delay inhibition tasks were highly structured and required specified concrete responses (Baker, Friedman & Leslie, 2010). In everyday life, mothers often have a chance to observe their children's behaviors in terms of general rules. Therefore, to be in line with parents observations the questionnaire requires them to rate their children on behaviors such as "When asked to wait for a desirable item (such as ice cream), how often did your child wait patiently?" (Putnam et al., 2000). However, for example in the gift delay task we asked the children not to peek over shoulder or stand up while we were wrapping the surprise gift for them, and to sit still and not to touch the wrapped gift while we went out of the room to the bow. Although the questionnaire focuses on specific concrete situations, parents might nevertheless focus on the general impressions about their children's behavior causing the discrepancy with the performance-based measures which restrain and segment children's behaviors in order to reveal a specific process of executive function (Liebermann et al., 2007). In this regard, the lack of association might imply a problem with ecological validity that performance-based measures and parental ratings might tap different aspects of inhibitory control, the former assessing more general impressions of executive functioning in everyday contexts whereas the latter assess specific aspects of executive functioning (Reck & Hund, 2011). Another possible explanation might be the fact that children' performance in delay inhibition tasks showed a relatively low coherence (Cronbach'a alpha = .33) to converge with highly cohered ratings from negative affectivity and effortful control subscales of ECBQ (Cronbach'a alpha =.65). Previous findings suggest that the performance of children in different inhibition tasks increasingly cohered as children age (Kochanska et al., 2000).

Furthermore, the lack of association might result from a conceptual confusion about the underlying mechanisms of the processes and characteristics in question. As Rothbart et al. (2000) suggested, temperament encompasses regulative as well as reactive processes (Rothbart, Ahadi & Evans, 2000). The processes we investigated through the performances of children in inhibitory control tasks tap voluntary control of behaviors to reach a specified goal. In this regard, the performance in these tasks seems to rely more on the regulative aspects of temperament. On the other hand, it is probably hard to totally eliminate reactive processes from regulative ones in such tasks. We can interpret poor performance on a delay task as a result of poor effortful control yet it can as well be the impulsivity or negative affectivity of a child that despite his/her effortful control, he/she cannot delay (Spinrad, Eisenberg & Gaertner, 2007). Thus, it is hard to differentiate the degree to which a child is impulsive and the degree to which he/she lacks effortful control. In addition, the temperament of the child might modulate his/her behavioral tendencies in reaction to environmental factors such that the experimenter or the novel situation might itself lead to fear or syhness and this might reflect to the performance in the task as more inhibition/effortful control.

In the present study for example, we cannot ensure that children who walk slowly on the line could better inhibit their prepotent tendency to run to the end of the line. It is as well possible that they found the task difficult and disturbing as we can interpret from their incapability of walking without stepping out of the line. The performance of children on this task might be affected by their reactive control rather than regulative control. To sum up, the novelty of the experimenter and the task might confound the performance and make it difficult for us to attribute the performance to impulsivity or lack of inhibition.

Still another possible cause of a lack of any relationship might be the low internal consistency between component scores of delay inhibition. Walk-a-line slowly task did not significantly correlated to the other two delay inhibition tasks. When it was excluded from the composite score, the low internal consistency increased from .33 to .53 yet this did not change the reported relations between delay inhibition and other study variables.

With regard to age and sex differences in terms of delay inhibition performance and temperament, the present findings failed to replicate previous studies. Kochanska et al. (2000) found that the performance of children increased significantly from the ages 22 months to 33 months. Moreover, they found sex differences in both 22 months and 33 months children. According to their findings, at 22 months girls showed better performance compared to boys in Shape Stroop, Snack Delay, Gift Delay tasks and at 33 months girls outperformed boys in the same tasks; and also in Walk-a-line slowly. The discrepancy between the findings of the previous study and the present study cannot be explained, it needs further investigation.

Lack of a Relation between Conflict Inhibition Tasks and Temperament

Consistent with our expectations, we could not find any significant relationship between conflict inhibition performances and any of the temperamental characteristics. The results are again mixed in the literature. The study by Hongwanishkul et al. (2005) found a moderate association of parent-ratings to cool executive function while there is evidence supporting the correspondence between parent-reported effortful control and performance-based inhibitory control. Rothbart et al. (2003) found that children who were rated as higher in effortful control and children who were rated as less prone to negative affect experienced less accuracy interference in Spatial Conflict Task (Rothbart, Ellis, Rueda & Posner, 2003). The same study showed that children at 30 months with less negative affect completed the task with less number of trials. In another study, children who were rated by their parents as high in effortful control showed higher attentional control in the Spatial Conflict Task, and children who were more prone to anger made more perseverative errors and had lower delay scores (Gerardi-Caulton, 2000). Both studies utilized the Spatial Conflict Task in order to measure attentional control which is a highly specific process within the umbrella of executive functions. Yet in the present study, three different tasks were administered for conflict inhibition and delay inhibition each, and the composite scores for each type of inhibition were compared to the parental ratings separately. The lack of a relationship between conflict inhibition performance and parent ratings of temperament in our study might be due to specific requirements of the tasks used and calls for a deeper analysis into the nature of inhibitory control tasks.

The Relation between Conflict and Delay Inhibition

The strength of the relationship between conflict and delay inhibition was .42 after age was controlled, indicating that these two different types of inhibitory control have a substantial amount of shared variance. Although recent research differentiated between conflict and delay inhibition, present finding is consistent with the previous findings in terms of a common process underlying both types of inhibition (Carlson & Moses, 2001). The hypothesis that these two types of inhibition relate to other cognitive and socio-emotional capabilities differentially does not mean that these two are totally independent from each other. They tap the same underlying process in that both require suppression of a dominant response tendency. However, conflict inhibition imposes a higher cognitive demand for it requires activating a subdominant or new learned response instead of the dominant response especially in situations where the subdominant response conflicts the dominant response. To better understand the overlapping as well as differentiating processes underlying the two types of inhibition and their relations to working memory and temperament, future studies should recruit bigger samples and conduct more advanced statistical techniques such as Structural Equation Model (SEM).

Conclusion

The present study was an attempt to explore the interrelations among working memory, different types of inhibitory control and temperamental characteristics of children over the third year of life when children gradually gain more control over their thoughts, emotions, motivations and behaviors. The findings suggest that conflict inhibition was predicted only by working memory capacity far beyond age, and delay inhibition, and not related to any temperamental characteristics. On the other hand, the study failed to find any relationship between delay inhibition and temperament.

Working memory explained a significant portion of the variance in conflict inhibition after any contribution of age and delay inhibition was eliminated. Consistent with the previous research on the dichotomy of conflict and delay inhibition, the present findings implied that conflict inhibition which is defined as the inhibition of prepotent response to activate a competing response impose a higher cognitive load and thus more susceptible to individual differences in working memory compared to delay inhibition which relies on mere inhibition of prepotent response. Apart from the differential cognitive load the two types of inhibition impose on children, as reviewed in the literature, these inhibition tasks are used in different contexts, which results from the difference between research traditions focusing on cognitive and socio-emotional aspects of executive function. Although it is hard to utilize pure measures, conflict inhibition or cool executive tasks as called by some researchers (e.g., Hongwanishkul et al., 2005) are argued to tap more cognitive capacity in the contexts devoid of emotional factors whereas delay inhibition or hot executive tasks rely on children's regulation of their emotions or motivations in order to delay or slow their urge to reach a desirable treat or outcome. However, the present findings concerning the relationship between delay and conflict inhibition highlight the interaction between cognitive and emotional aspects of control. As previous research suggested, the interaction between cognition and emotion begins in the first four years of life, as evident by the concurrent improvements in self-regulation and higher order cognition (Wolfe & Bell, 2007). The brain imaging studies revealed that the relationship between these socio-emotional and cognitive control mechanisms is supposed to be the function of effortful/controlled attention executed by the Anterior Attention System which operates across the common neural structures and circuitry in the frontal lobe (Rueda et al., 2005). In other words, the attentional and regulatory mechanisms which emerge in the first year of life underlie the protracted developments in higher order cognitive processes and socio-emotional development (Bell & Deater-Deckard, 2001).

Limitations and Future Directions

It is inevitable that the present study had limitations. First of all, the sample was recruited from middle-to-high class families which eventually restrict generalization of the findings. Secondly, the sample size was quite small to provide substantial variability for all study variables. The total number of children tested was 36 yet due to the young age it was not possible to gather data from all children in all tasks. In some of the tasks, total number of subjects decreased to 25 (e.g. walk-a-line slowly). For this reason, the hypothesis testing was conducted through a correlational design which statistically restricted us to the interrelations among the study variables instead of detecting causal relationships. Moreover, the limited age range restricted monitoring of age-related changes in terms of measured processes more apparently.

Although it was an advantage of the present study that it utilized a total of six separate inhibition measures, working memory capacity was measured by a single measure. To our knowledge, there is no alternative measure for working memory capacity in toddlers that could be administered as a complementary to the Imitation Sorting Task. Most of the working memory tasks in the literature for young children are generally based on span tasks measuring how long children can hold information in their minds rather than how much information they can actively process. On the other hand, Imitation Sorting Task was developed to measure children's capacity for actively maintaining information in mind and manipulating this information in a context-appropriate fashion. Therefore, the relationships reported in the present study should be interpreted within the framework of working memory as the limited capacity for the amount of information maintained and manipulated. Moreover, due to the fact that a complete account of working memory capacity incorporates the amount of information maintained as well as the span of time that it can be maintained in an active state (Reznick, 2009); future studies should include a supplementary measure to IST which will assess the duration.

In addition, temperament was also measured by a single questionnaire, ECBQ. This questionnaire is based on parents' judgments about how frequent their children demonstrate specific concrete behaviors in everyday contexts. Although it is not based on general judgments, comparison with other children, or memory on past events and has well-established reliability and validity, a supplementary temperament measure would provide responses assessed in terms of threshold, intensity and time course (Rothbart & Derryberry, 1981; cited in Putnam & Stifter, 2008).

Recently, there has been a great interest in investigating the neurological underpinnings of executive functioning. The main question of the present study concerning the differentiation between conflict and delay inhibition in terms of their relations to cognitive and emotional processes could be investigated in future studies by integrating physiological measures.

APPENDICES

APPENDIX A: Child Characteristics

Table 1 Child Characteristics (N = 36)

	M	SD	Min.	Max.
Child age (months)	30.92	3.76	25	38

Child gender by age period

	25-29 months	30-38 months	Total
Male	8	11	19
Female	6	11	17
Total	14	22	36

APPENDIX B: Descriptive Statistics of the Study Variables

Table 2 Descriptive Statistics of the Study Variables

Variable	N	Mean	SD	Min.	Max.
IST	35	4.57	2.36	1.00	8.00
ECBQ					
Negative Affectivity	33	3.01	0.90	1.50	5.30
Surgency	33	5.37	0.53	4.17	6.83
Effortful Control	33	4.95	0.63	3.70	6.00
Shape Stroop Task	35	2.29	0.63	1.00	3.00
Reverse Categorization Task					
Preswitch phase	34	0.74	0.24	0.33	1.00
Postswitch phase	18	0.60	0.37	0.00	1.00
Multistep Multilocation Search Task					
Preswitch phase	31	0.68	0.37	0.00	1.00
Postswitch phase	31	0.66	0.43	0.00	1.00
Walk-a-line Slowly Task					
Total score with baseline	28	-0.21	1.49	3.50	3.50
Total score without baseline	30	4.72	2.33	1.00	11.50
Snack Delay Task (Z-score)	34	0.00	0.79	-1.51	1.85
Gift Delay Task					
Wrapping phase (Z-score)	30	0.32	0.64	-0.57	2.09
Bow phase (Z-score)	28	0.42	0.58	-0.75	1.13

IST= Imitation Sorting Task
ECBQ= Early Childhood Behavior Questionnaire

APPENDIX C: Zero-order Intercorrelations between Child Age, IST, ECBQ Subscales, and Individual Conflict Inhibition and Delay Inhibition Tasks

Table 3 Zero-order Intercorrelations between Child Age, IST, ECBQ Subscales, and Individual Conflict Inhibition and Delay Inhibition Tasks

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Child age	-	.45**	-.27	-.01	-.02	.07	.37*	.41	.23	.40*	.27	-.35	-.01	.31	-.11	.13
2. IST		-	-.19	-.17	.11	.30	.64**	.33	.48**	.61**	.50	.23	.25	.34	.40*	.44*
3. ECBQ- Negative affectivity			-	.08	-.50**	-.36*	-.37*	.19	-.07	-.16	.21	.13	-.26	-.11	-.07	-.16
4. ECBQ- Surgency				-	-.21	.34	-.11	.49	.01	.08	-.06	-.06	.01	-.19	.01	-.16
5. ECBQ- Effortful control					-	.18	.14	-.34	-.13	-.03	-.47*	-.34	.11	-.21	.20	-.04
6. Shape Stroop						-	.63**	.21	.23	.38*	-.29	.16	-.07	.18	.16	.19
7. Reverse Cat.-preswitch							-	.37	.53**	.70**	.09	.27	.18	.27	.26	.33
8. Reverse Cat.-postswitch								-	-.07	.06	.26	.44	.21	.44	.32	.41
9. M. Multi. Search-preswitch									-	.82**	.53*	.57*	.34	.34	.20	.35
10. M. Multi. Search-postswitch										-	.29	.38	.24	.25	.26	.31
11. Walk-a-line slowly- baseline											-	.79**	.18	.29	-.14	.13
12. Walk-a-line slowly- w/o baseline												-	.07	.43*	-.13	.23
13. Snack Delay													-	.17	.45*	.40*
14. Gift Delay- wrapping														-	.17	.80**
15. Gift Delay- bow															-	.73**
16. Gift Delay-composite																-

$^{*}p < .05$
$^{**}p < .01$
IST = Imitation Sorting Task
ECBQ = Early Childhood Behavior Questionnaire

APPENDIX D: Partial Correlations Among the Main Study Variables Controlled for Age

Table 4 Partial Correlations Among the Main Study Variables Controlled for Age

	1	2	3	4
1. IST	-	.58**	.40*	0.16
2. Conflict Inhibition		-	.42*	0.18
3. Delay Inhibition			-	-.07
4. Temperament				-

* $p < .05$
** $p < .01$

IST = Imitation Sorting Task

APPENDIX E: Summary of the Results of the Hierarchical Regression Analysis of Conflict Inhibition

Table 5 Summary of the Results of the Hierarchical Regression Analysis of Conflict Inhibition

Dependent Variable: CI- Conflict Inhibition. Overall, F (3, 27) = 7.595, p = .001

Step	Predictors	ΔR^2	ΔF	p	β	p
1.		.157	5.417	.027		
	Age				.397	.027
2.		.202	8.821	.006		
	Age				.383	.017
	DI				.450	.006
3.		.145	7.871	.009		
	Age				.182	.246
	DI				.279	.071
	IST				.465	.009

DI = Delay Inhibition
IST = Imitation Sorting Task

APPENDIX F: The Turkish Form for ECBQ-Early Childhood Behavior Questionnaire-Very Short Form

ERKEN ÇOCUKLUK DÖNEMİ DAVRANIŞ ANKETİ-KISA FORM

Çocuğun ismi: ____________________ Çocuğun doğum tarihi: Ay: ___Gün: ___ Yıl: ______

Formun doldurulduğu tarih: Ay: ___Gün: ___Yıl: _____ Çocuğun Yaşı:____Yıl, ____Ay

Çocuğa yakınlık derecesi: ________________ Çocuğun cinsiyeti (birini işaretleyiniz): E K

YÖNERGE: Lütfen formu doldurmadan önce bu yönergeyi dikkatlice okuyunuz.
Aşağıda birtakım davranış tanımları verilmiştir. Lütfen bu davranış tanımlarını okuyunuz ve geçen iki hafta boyunca çocuğun bu davranışları hangi sıklıkta göstermiş olduğunu sağ sütundaki rakamlardan birini işaretleyerek belirtiniz. Bu rakamlar, tanımlanan davranışları geçen iki hafta boyunca hangi sıklıkta gözlemlediğinizi göstermektedir.

Hiç	Nadiren	Yarı yarıyadan az	Yarı yarıya	Yarı yarıyadan çok	Hemen hemen her zaman	Her zaman	Durum gözlenmedi
1	2	3	4	5	6	7	DG

Eğer son iki hafta boyunca, çocuğu tanımlanan durum içerisinde görmediyseniz "DG" seçeneğini işaretleyiniz. Örneğin, eğer çocuğun doktora gittiği bir durum tanımlanıyorsa, fakat çocuk son iki hafta içinde doktora gitmediyse "DG" seçeneğini işaretleyiniz. "DG" seçeneği "HİÇ" (1) seçeneğinden farklıdır. "Hiç" seçeneği, son iki haftalık süreçte çocuğun tanımlanan durum içerisinde bulunduğu ancak belirtilen davranışı sergilemediği takdirde işaretlenmelidir. Lütfen bütün maddeler için uygun olan rakam ya da DG seçeneklerinden birini işaretlediğinizden emin olunuz.

<u>Halka açık bir alanda (örneğin bir markette) yabancı bir kişi yanına yaklaştığında çocuğunuz hangi sıklıkta</u>

1. anne ya da babasının eteğine yapıştı? 1 2 3 4 5 6 7 DG

<u>Bir etkinliği bitirmekte sorun yaşadığı zaman (örn. Legolarla oynarken, resim çizerken, kıyafet giyinirken) çocuğunuz hangi sıklıkta</u>

2. hemen hırçınlaştı? 1 2 3 4 5 6 7 DG

<u>Tanıdığı bir çocuk evinize geldiğinde çocuğunuz hangi sıklıkta</u>

3. onunla arkadaşlık kurmaya çalıştı? 1 2 3 4 5 6 7 DG

Kendisine birden fazla seçenek sunulduğunda çocuğunuz hangi sıklıkta

4.	ne yapmak istediğine hemen karar verip o aktiviteyi tamamladı?	1	2	3	4	5	6	7 DG

Gündüz veya akşam saatlerinde çocuğunuzla otururken çocuğunuz hangi sıklıkta

5.	ona şarkı söylemenizi sakince dinlemekten keyif aldı?	1	2	3	4	5	6	7 DG

Dışarıda oynarken çocuğunuz hangi sıklıkta

6.	onu eğlendirip heyecanlandıracak yeni bir şeyler yapmayı denedi?	1	2	3	4	5	6	7 DG

En sevdiği oyuncağıyla oynarken çocuğunuz hangi sıklıkta

7.	10 dakikadan daha uzun bir süre oynadı?	1	2	3	4	5	6	7 DG
8.	aynı anda sizin sözlerinize ya da sorularınıza cevap vererek oynamaya devam etti?	1	2	3	4	5	6	7 DG

Sevdiği yetişkinlerin ziyarete geleceğini söylendiğinde çocuğunuz hangi sıklıkta

9.	çok heyecanlandı?	1	2	3	4	5	6	7 DG

Ona bir hikaye okuduğunuzdaki gibi sakin bir ortamda çocuğunuz hangi sıklıkta

10.	saçıyla, üzerindeki kıyafetleriyle vs. oynadı (çekiştirdi)?	1	2	3	4	5	6	7 DG

Kapalı bir mekanda oynarken çocuğunuz hangi sıklıkta

11.	itişmeli kakışmalı oyunlar oynamaktan keyif aldı?	1	2	3	4	5	6	7 DG

Ona şefkatle sarıldığınızda veya kucağınızda salladığınızda çocuğunuzun hangi sıklıkta

12.	kurtulmaya çalışır gibi davrandığını hissettiniz?	1	2	3	4	5	6	7 DG

Daha önce tanımadığı yeni bir oyunla (ortamla) karşılaştığında çocuğunuz hangi sıklıkta

13.	anında o oyuna dahil oldu?	1	2	3	4	5	6	7 DG

Legolarla oynamak gibi dikkat isteyen bir oyundan çocuğunuz hangi sıklıkta

14.	çabucak sıkıldı?	1	2	3	4	5	6	7 DG

Gün içi etkinlikler sırasında çocuğunuz hangi sıklıkta

15.	ona seslendiğinizde derhal dikkatini size çevirdi?	1	2	3	4	5	6	7 DG
16.	kıyafetlerindeki etiketlerden rahatsız olmuş gibi göründü?	1	2	3	4	5	6	7 DG
17.	gürültülü ortamlardayken etraftaki seslerden rahatsız oldu?	1	2	3	4	5	6	7 DG

18. akşamları bile enerji doluymuş gibi göründü?	1	2	3	4	5	6	7	DG

<u>Halka açık bir alanda çocuğunuz hangi sıklıkta</u>

19. büyük ve gürültülü araçlardan korkmuş gibi göründü?	1	2	3	4	5	6	7	DG

<u>Dışarıda diğer çocuklarla oynarken, çocuğunuz hangi sıklıkta</u>

20. en hareketli çocuklardan biriymiş gibi göründü?	1	2	3	4	5	6	7	DG

<u>Kendisine 'Hayır' denildiği zaman çocuğunuz hangi sıklıkta</u>

21. yasaklanan şeyi yapmayı bıraktı?	1	2	3	4	5	6	7	DG
22. ağlamaklı oldu?	1	2	3	4	5	6	7	DG

<u>Heyecan verici bir etkinlik ya da olayın ardından çocuğunuz hangi sıklıkta</u>

23. sanki mutsuz veya hüzünlenmiş gibi göründü?	1	2	3	4	5	6	7	DG

<u>Evde oynarken çocuğunuz hangi sıklıkta</u>

24. evin içinde koşuşturdu?	1	2	3	4	5	6	7	DG

<u>Heyecan verici bir olaydan önce (yeni bir oyuncak almak gibi) çocuğunuz hangi sıklıkta</u>

25. onu almak için sabırsızlandı?	1	2	3	4	5	6	7	DG

<u>Çocuğunuz sizden birşey istediğinde ve siz ona 'hayır' dediğinizde çocuğunuz hangi sıklıkta</u>

26. kontrolsüz bir şekilde öfkelendi?	1	2	3	4	5	6	7	DG

<u>Çok istediği bir şey için (örneğin dondurma) beklemesini istendiğinizde çocuğunuz hangi sıklıkta</u>

27. sabırlı bir şekilde bekledi?	1	2	3	4	5	6	7	DG

<u>Hafif bir şekilde kucağınızda sallandığında çocuğunuz hangi sıklıkta</u>

28. gülümsedi?	1	2	3	4	5	6	7	DG

<u>Çocuğunuzu kucağınızda tutarken çocuğunuz hangi sıklıkta</u>

29. kendini rahatça bıraktı?	1	2	3	4	5	6	7	DG

<u>Tanıdık bir yetişkin, bir akraba ya da arkadaş, evinize geldiğinde çocuğunuz hangi sıklıkta</u>

30. onunla konuşmak/oynamak istedi?	1	2	3	4	5	6	7	DG

<u>Kırılabilecek bir eşyaya karşı dikkatli olmasını istediğinizde çocuğunuz hangi sıklıkta</u>

31. gerçekten dikkatli davranabildi?	1	2	3	4	5	6	7	DG

<u>Yeni bir yere gittiğinizde çocuğunuz hangi sıklıkta</u>

32. içeri girmek istemedi?	1	2	3	4	5	6	7	DG

<u>Bir şeye canı sıkıldığında veya sinirlendiğinde çocuğunuz hangi sıklıkta</u>

33. yatıştırmaya çalıştığınızda bile 3 dakikadan fazla ağladı?	1	2	3	4	5	6	7	DG
34. kolayca yatıştı?	1	2	3	4	5	6	7	DG

<u>Siz meşgulken çocuğunuza kendisine yapacak başka bir şey bulmasını söylediğinizde çocuğunuz hangi sıklıkta</u>

35. bunu başardı?	1	2	3	4	5	6	7	DG

<u>Tanıdığı yetişkinler veya çocuklardan oluşan kalabalık ortamlarda çocuğunuz hangi sıklıkta</u>

36. farklı kişilerle oynamaktan zevk aldı?	1	2	3	4	5	6	7	DG

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