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Comparison of Executive Functions in Offenders and Non-Offenders: A Meta-Analysis

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Abstract

Executive function is one of the structures that explain aggressive and violent behavior. However, the existing literature has inconsistencies regarding criminal behavior due to the division of executive functions into three constructs: inhibition, monitoring, and task shifting. Therefore, the main aim of this study is to assess the effect of executive functions on criminal behavior and the second aim is to examine the impact of executive functions on different crime types. The research is based on a meta-analysis of 17 studies which were selected upon the inclusion and exclusion criteria. The meta-analysis involved calculating individual effect sizes for each study and then the overall effect size was calculated by using the random effects model. Then subgroup analyses were conducted to evaluate the differences due to crime types and psychological assessment tools. The results revealed that offenders made more errors in tasks involving executive functions than non-offenders and the findings were consistent with the literature. Additionally, no publication bias was found in the study. It is expected that this study will lay the groundwork for future studies.

Keywords: *Executive Function, Criminality, Metaanalysis, Impulsivity, Cognition*

Öz

Yönetici işlevler, saldırgan ve şiddet içeren davranışları açıklayan yapılardan biridir. Ancak mevcut literatür, yönetici işlevlerin ketleme, izleme ve görev değiştirme olmak üzere üç yapıya ayrılması nedeniyle suç davranışı konusunda tutarsızlıklara sahiptir. Bu çalışmada yönetici işlevlerin suçluluk üzerindeki etkisinin ortaya konması amaçlanmıştır. Bununla birlikte, bu çalışmanın ikinci amacı da önceki çalışmalara ek olarak yönetici işlevlerin suç davranışlarına olan etkisini suç türlerine göre kategorize ederek incelemektir. Çalışmada meta-analiz için gerekli verilerin toplanması amacıyla öncelikle uygun anahtar kelimeler kullanılarak literatür taraması yapılmıştır. Dışlama ve dahil etme kriterlerine göre 17 çalışmaya ulaşılmıştır. Daha sonra 17 ayrı çalışmadan elde edilen verilerin etki büyüklükleri hesaplanmıştır. Sonrasında rastgele etkiler modeline göre genel etki büyüklüğü hesaplanmıştır. Son olarak, suç türleri ve psikolojik değerlendirme araçlarındaki farklılıklara göre alt grup analizleri yapılmıştır. Bulgular, suçlu bireylerin kontrol gruplarına göre yönetici işlevler içeren görevlerde daha fazla hata yaptıklarına işaret etmektedir. Ayrıca çalışmada yayın yanlılığına rastlanmamıştır. Çalışma, suçlu grubunun yönetici işlevlerde kontrol grubuna göre daha düşük performans gösterdiği sonucuna varmıştır. Elde edilen bulguların literatürle uyumlu olduğu görülmektedir. Bu çalışmanın gelecek çalışmalara zemin hazırlaması beklenmektedir.

Anahtar Kelimeler: *Yönetici İşlevler, Suçun Önlenmesi, Metaanaliz, Dürtüsellik, Biliş*

Introduction

Human behavior depends on many biopsychosocial factors. Depending on these factors, individuals exhibit different behavioral patterns. Likewise, the concept of criminal behavior consists of specific patterns and is affected by biological, psychological, cognitive, and sociological factors (Polat, 2004; Marsh, 2006; Özaşçılar, 2016). In recent years, the expanding literature draws attention to the importance of neuropsychological structure in the emergence of criminal behavior (Joyal et al., 2013). By focusing on neuropsychological factors, researchers aim to provide a different perspective that increases the explanatory power of criminal behavior.

Social norms, the informal rules that govern behavior in groups and societies, are very important because they provide order in a society by guiding appropriate behavior. And following social norms is important for individuals because violating them often leads to negative consequences (Gross & Vorontsov, 2022). To maintain their behaviors in harmony with the community, individuals need some cognitive mechanisms, such as behavioral suppression/inhibition, impulse control, emotional self-control, and reviewing behaviors (Barkley, 2012; Çarkıt & Yalçın, 2023). In other words, the individual's ability to adapt to appropriate behaviors depends on the functionality of the self-regulation mechanism. Self-regulation components include working memory, regulation of emotions, problem-solving, analysis, and synthesis of new behavioral goals (Barkley, 2012; Goldstein & Naglieri, 2014). From this perspective, when an individual regresses in these functions, the individual's behaviors tend to deviate from the expected social behaviors.

Executive functions refer to a neuropsychological structure that controls cognitive processes that have an impact on regulating social behaviors (Barkley, 2012). These functions involve complex cognitive structures and can be seen as an umbrella term for various putative cognitive processes, including planning and working memory. These processes are performed mainly by the prefrontal areas and extend to subcortical areas in the brain (Goldstein & Naglieri, 2014; Yalçın & Yılmaz, 2023). Miyake et al. (2000), in their Unity and Diversity of Executive Functions Model, consider the executive functions as a three-factor structure: inhibiting, monitoring, and shifting. The inhibition function can be defined as the ability to suppress dominant behavior, in other words, voluntarily inhibiting dominant responses (Miyake et al., 2000). When the inhibition function is considered, impulsive behaviors emerge in cases of impaired activity. Shifting can be defined as enabling adaptation to a changing situation or a task and provides flexibility between cognitive tasks (Zakzanis et al., 2005). The shifting function affects the problem-solving and strategy-making abilities of an individual. Any deterioration in this function causes the individual to behave violently due to regressions in his prosocial skills (Cruz et al., 2020). Finally, monitoring information is related to an individual's active use of the working memory. Working memory provides temporary storage and reshaping of the information. Since it plays an active role in the process of analyzing information, it also affects the outputs of compatible and incompatible behaviors (Karakaş et al., 2003). Although executive functions have different functions, the essential function can be seen as inhibition since the functions of protecting, monitoring, and shifting information are closely related to cognitive inhibition skills (Miyake et al., 2000). Considering this information, it can be predicted that when executive functions cannot fulfill their functions as a complex structure, there are going to be regressions in many cognitive skills and an increase in impulsive behaviors. In other words, deterioration in executive functions leads to important deficits such as reduced self-regulating behaviors (Barkley, 2012), impulsivity (Ogilvie et al., 2011), and behavioral problems in individuals (Cruz, 2020).

Executive functions include self-regulatory functions that organize social behaviors. Hayes et al. (1996), in their Behavioral Analytical Model, focus on the behavioral dimension of executive functions. In this model, executive functions come into play when previously learned behavioral regulation resources conflict with the rules that were previously set by the rule maker. Executive functions try to facilitate the generation of new

rules by considering society's reactions to the individual's behaviors. By the help of executive functions, individual can suppress his/her behavior to comply with the social expectations or make some behavioral adjustments in accordance with these rules (Hayes et al., 1996). Thereby, executive function is a functional ability of rule-managed behavior (Barkley, 2012; Kılıç, 2002). Barkley's (2012) Extended Phenotype Model for Executive Functions (2012), another model that refers to the social function of executive functions, also states that individuals need certain cognitive mechanisms to adapt to social rules. Executive functions cognitively provide these skills to individuals, contributing to the individual's adaptation within the group. In this model, executive functions form the basis of the individual's self-regulation mechanism and take part in the analysis and maintenance of behavior. Problem solving, behavior inhibition and emotion regulation skills provided by executive functions enable the individual to carry out harmonious behavior within the group (Barkley, 2012; Goldstein & Naglieri, 2014). Since executive functions contain self-regulation components, they may lead to inappropriate or antisocial behaviors in the case of dysexecutive functions (Cruz et al., 2020; Moffitt, 1993).

Another important function related to executive functions is self-control. While self-control is thought to develop through the environment, new insights have indicated that biological factors are also effective (Beaver et al., 2007). Executive functions hosted by the prefrontal cortex regulates people's impulsivity and self-control (Glenn & Raine, 2018; Glenn & Raine, 2014). There are three neural regions mainly related to executive functions. These are dorsolateral prefrontal cortex, orbitofrontal cortex, and medial prefrontal cortex (Ongur et al., 2003). The dorsolateral prefrontal cortex (DLPFC) is responsible for working memory, cognitive control, behavioral suppression, and information processing skills. In contrast, the orbitofrontal cortex is located just above the eye and communicates with other brain regions. It regulates emotions, complex decision-making processes, and goal-directed behavior. On the other hand, the medial prefrontal cortex acts at many points in the brain (amygdala, hypothalamus, DLPFC) to perform tasks that require attention. These regions in the brain perform essential tasks in terms of executive functions, and when any dysfunction occurs in these regions, many behavioral and cognitive disorders may appear (Cruz, 2020). Brain imaging studies support the relationship between impulsive behaviors and executive functions.

The relationship between executive functions and antisocial behavior patterns has attracted attention in researchers. A meta-analysis conducted by Morgan and Lilienfeld (2000), the relationship between antisocial behaviors and executive functions was investigated by considering studies with many different experimental designs and revealed that there was a significant relationship between executive functions and antisocial behaviors. According to the study, when the group exhibiting antisocial behavior was compared with the control group, deficits in executive functions were observed in the antisocial group. Another meta-analysis, including 126 studies conducted by Ogilvie et al. (2011), has demonstrated significant effect sizes between executive functions and criminal behaviors (d =.61), psychopathy (d =.42), and conduct/defiant disorder (d =.54). In addition, in a previous meta-analysis, the frontal lobe was evaluated as an executive function. However, evaluating the frontal lobe as an executive function remains erroneous (Miyake et al., 2000) because recent studies have shown that, in addition to the anterior and posterior regions of the cerebral cortex, some subcortical areas are also associated with executive functions (Chung et al., 2014). In summary, although there are some research and analysis on this subject, it is thought that new research and meta-analysis, including experimental design studies that address methodological problems (Ogilvie et al., 2011), would indicate more promising results in understanding the nature of crime and executive functions relationship. Therefore, a meta-analytic review in which three dimensions of executive functions (inhibiting, monitoring, and shifting) are discussed would be better to explain the relationship between criminal behavior and executive functions.

Many studies indicate that impairments in executive functions often lead to problems in

cognitive mechanisms, such as impulsive behaviors, planning ability, suppression of impulses, and difficulty in concentrating. A study about juvenile crime revealed that juvenile offenders have a higher number of omission errors in the Stroop Test than juveniles in the control group (Şenses et al., 2014). Another study examined the individuals who started committing crimes at an early age. According to this study, the likelihood of an individual for reoffending is related to their neuropsychological functioning during childhood and adolescence (Enns et al., 2007). In addition, many other studies have indicated that recidivism in crime is closely related to dysexecutive functions (Moffitt, 1993; Moffitt et al., 2002; Moffitt & Henry, 1991; Piquero & White, 2003). Another study by Bergeron and Valliant (2001) examined the personality patterns and executive functions of delinquent and non-delinquent adolescents. Findings indicated that personality traits and dysexecutive functions were effective in the maladaptive behaviors of delinquent adolescents. Similarly, studies conducted by Seruca and Silva (2016) and Yalçın et. al. (2018), examined the executive functions in relation to the types of crime and found that there was a significant difference in executive functions between the offenders who committed violent crimes and those who committed non-violent crimes (e.g., white-collar crime). Offenders performed worse than non-offenders on their mental flexibility and planning measures, and offenders against property had poorer performance on mental flexibility measures, while violent offenders performed worse on planning ability (Seruca & Silva, 2016). Considering these findings, it can be argued that while there are differences in executive functions between criminals and non-criminals, there are also differences in executive functions depending on the type of crime (Baker, 2007; Barbosa & Monteiro, 2008; Brito et al., 2013). Along with these, there are also studies that do not find any significant relationship between these two factors (Ross & Hoaken, 2011; Morgan & Lilientfield, 2001; Syngelaki, 2009). Youngs (2004) suggests that these inconsistent results might be due to the differences in criminal behaviors. For example, since white-collar crime is characterized by more manipulative behaviors, they are expected to have high cognitive flexibility and inhibition skills, that is, their executive functions are expected to be better, whereas interpersonal violent criminals are expected to have more impairment in their executive functions because they are characterized by more impulsive behaviors (Raine et al., 2012). Moreover, another review of the effectiveness of executive functions on criminal behaviors stated that each executive function domain is differentiated in effect according to crime or aggression type (Cruz, 2020). Considering all these findings, it can be suggested that although executive functions might be related to criminal behaviors, it remains controversial that which executive functions are related with criminality and to what extent. This difference raises the question of which of the executive functions dimensions is effective in the emergence of antisocial behavior. Thus, there is a need for a meta-analysis on studies of executive functions using more comprehensive variables and this study has been an attempt to clarify these debates.

Additionally, as stated before, while most studies focus on the psycho-social aspects of criminality (Boduszek et al., 2013; Eryılmaz, 2018a; Eryılmaz, 2018b; Galinari & Bazon, 2021; Molinedo-Quilez, 2020), this study focuses more on cognitive processes. Furthermore, the meta-analyses previously performed as part of the current investigation were seen to include different research designs (e.g. correlational, experimental) and no study could be found that included only experimental or quasi-experimental designs. Therefore, this study aimed to conduct a meta-analysis that only includes studies with an experimental or quasi-experimental design. The main purpose behind all of these is to contribute to the prevention of crime and rehabilitation of criminals by revealing the effect of cognitive processes on criminal behavior. Since studies revealed that deficiencies in executive functions are related to problems like emotion regulation, crime, violence and reckless behavior (Broidy et al., 2003; Denson, Pederson, Friese, Hahm, & Roberts, 2011; Moffitt et al., 2011; Saarni, 1999; Winstok, 2009), it can be argued that improvement in these functions would be useful for both prevention and rehabilitation of criminal behavior.

Consistent with these purposes, this meta-analysis has one hypothesis and two research questions. First, based on previous studies, the executive functions of criminal groups are expected to be weaker than the community sample group (Seruca & Silva, 2016; Ogilvie et al., 2011). This is why we tested the hypothesis that offenders perform significantly more errors in tests of executive functions than non-offenders do. In addition, although executive function factors are interrelated, as stated previously they may have varying degrees of impact on criminal behavior (Cruz, 2016; Burgess, 2020). However, most previous studies have considered executive functions as a single system. Therefore, to examine the effect of three systems of executive functions on criminal behavior, the answer to the following research question was answered: "When offenders are compared to non-offenders, which executive functions (inhibition, monitoring, and updating) are more related to offending?". Finally, executive functions may have different effects on different criminal groups, as Youngs (2004) stated, previous studies generally have focused on violent crimes. In this study, we categorized the crime groups and investigated their relationship with executive functions and aimed to answer the question, "When the offenders were clustered into different crime groups, do the levels of executive functions differ significantly between these groups?"

Method

This paper presents results from a meta-analysis examining existing patterns of relationships between executive functions and criminality. The meta-analysis method is the gathering and interpretation of the findings of previous quantitative studies using statistical methods (Glass, 1976). For this study, the independent variable was criminality, and the dependent variable was executive functions. To enhance the explanatory power of our meta-analysis, rather than correctional studies, we just focused on quasi-experimental studies. A protocol called "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" was followed in the meta-analysis (Moher et al., 2009). A coding table was created using Microsoft Excel while collecting the studies. The coding table included the titles of the studies, authors' names, year of study, character of the sample (clinic, population, prison), number of samples, and research designs of the studies.

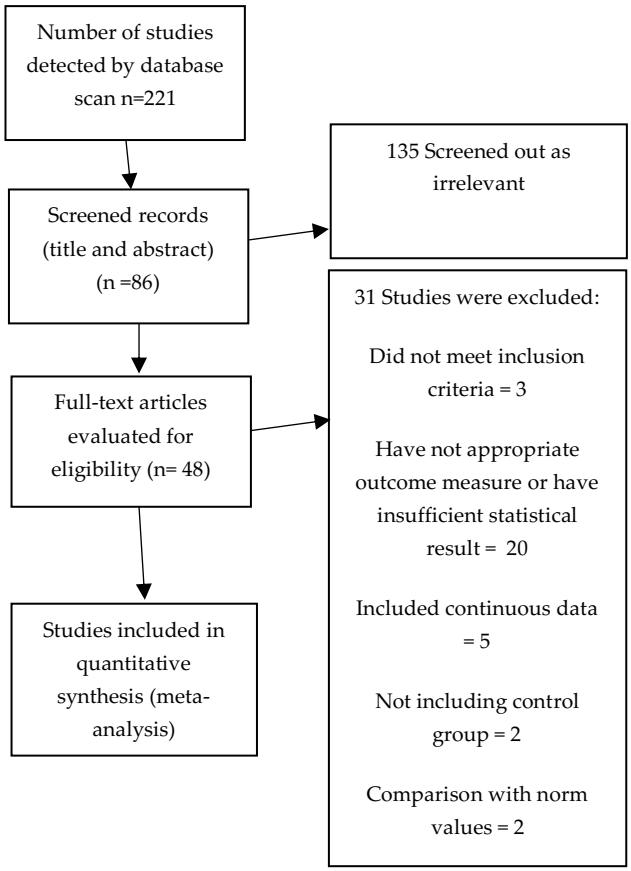


Figure 1: The Process of Inclusion of Individual Studies as a Result of Literature Search in Meta-analysis

A literature search was conducted on Scopus, Web of Science and PubMed with all possible keyword combinations such as "executive function" OR "inhibition" OR "working memory" AND "criminality" OR "violence" OR "offender" OR "aggression" and all articles published between 2007 and 2021 were covered. As a result of the search in the databases using keywords, 221 study titles were obtained. Eighty-six studies were selected according to the inclusion and exclusion criteria. After reading the abstracts of the 86 studies, 48 studies were found to be appropriate to our criteria. When full papers are read, some studies were seen to be analyzed over continues variables, therefore we did not include these studies in the meta-analysis (Hancock et al., 2010;

Tonnaer et al., 2016; Hancock, 2014; Haberle, 2011; Miura & Fuchigami, 2017). Some other studies were observed that they did not meet the inclusion criteria (Pietrzak et al., 2008; Ross & Hoaken, 2010; Langevin & Curnoe, 2010). Some others did not have a control group (Bromhall, 2005; Marsh & Martinovich, 2006). And in two studies, group difference analysis was performed with the norms of the scales instead of the control group; therefore, they were not included in the study (Syngelaki et al., 2009; Enns et al., 2008).

Inclusion and Exclusion Criteria

Existing studies were eliminated or included in the analysis for inclusion and exclusion criteria. We included studies that at least have two groups as offenders and non-offenders to focus on experimental studies and, have at least one measurement for executive function variables. To calculate the effect sizes, the data in the studies must be understandable; the mean, standard deviation and number of participants must be indicated, and the group differences must be revealed through statistical analysis. Since the protocol date of our meta-analysis study is 2021, the studies conducted before 2021 were considered, but no specific start date was determined.

Studies that did not meet the inclusion criteria were excluded from the study by stating their reasons. Then, the experimental studies which consisted of more than two levels such as low, medium, and high violence groups and whose extreme values can be calculated, these studies were included in the meta-analysis. Whereas in cases where extreme values could not be calculated due to the characteristics of the variable such as the personality variables, these studies were not included in the meta-analysis.

The effect size of each study was calculated using data provided by the inclusion and exclusion criteria. Since different measurement methods were used to obtain the executive functions, the studies were combined with the random effects model. First, the effect size of each study was calculated to standardize the different score types in the studies and determine their weights. The web-based Campbell Collaboration (Wilson, 2020) was used to calculate effect sizes and variances in the studies. After calculating the effect size and variance of each study, the grand effect size was calculated using the random effects model. So, the grand effect size was revealed by combining the effect sizes of the studies. Then the significance of the differences between the two groups was tested. Subgroup analyzes were conducted using the Comprehensive Meta Analysis (CMA) program (Dinçer 2020). Analog ANOVA method was used for subgroup analyses. Subgroup analyses measured types of crime and types of executive functions. In addition, publication bias analysis was conducted to control publication bias in the studies accessed. Publication bias in meta-analysis studies is not only important in terms of the validity of the study, but also reveals whether the studies can reflect the cumulative result (Borenstein et al., 2019; Normand, 1999). First, a "funnel plot analysis'', a visual demonstration for publication bias, was introduced. Funnel plot analysis means that there is no publication bias if the studies are distributed relatively equally to the right and left of the cutoff point (Normand, 1999). The second technique we used for publication bias is ''Duval and Tweedie's Trim and Fill Technique''. It is a method for both detecting and correcting the publication bias. In the technique, studies that cause publication bias are identified on the funnel chart, and the program fills in similar studies by producing them until the analysis is unbiased. By producing similar studies, this technique enables us to see the effect size when the bias disappears (Borenstein, 2019:275). Finally, "Rosenthal's FailSafe-N Technique'' helps to control publication bias by determining how many additional studies are needed to reverse the result that has been found. If more studies are needed to reverse the study result than the number of studies used, it means that there is no publication bias (Borenstein et al., 2019).

The effect sizes and variances of the studies were calculated to determine the overall effect size. Web-based Campbell Collaboration (2020) was used to calculate the studies' effect sizes and variances. As the materials and scores used to measure the executive functions vary, the effect size was calculated by taking more than one measurement score from the measures used in the

studies. For example, in the Stroop Test, time and error scores were included in the study as two different effect sizes. Thus, a total of 53 effect sizes and variances were calculated from the 17 studies. The calculated effect sizes were entered into the JAMOVI program and the overall effect values (*d*) were obtained (Table 1.4). The model selection used for calculating the overall effect was determined using the random effects model before the analysis. The random effect model is preferred if there are differences between studies, such as methodological differences like measurement tools and techniques or population. In this case, studies are included in the meta-analysis by calculating their weights (Borenstein et al., 2007). Similarly, Şen (2018) argues that it is more appropriate to use random effects models in social sciences. This is because different scales or research designs are often used in studies in social sciences.

Results

17 individual studies were included in the meta-analysis. These 17 studies included 21 different scales, tests, or batteries and measurements created 53 different effect sizes. There were a total of 1033 participants in the studies included in the meta-analysis.

Descriptive Analysis of Studies

The studies included in the meta-analysis measured dependent variables using different measurement materials. When we look at the assessment materials of executive functions, it was found that the Wisconsin Card Sorting Test was used in 14.54% of the 17 studies; 10.8% of the studies used Trail Making Test, Stroop Color Word Test and, Go/NoGo Task; 8.1% of the studies used Porteus Maze Task; 5.4% of the studies used Barratt Impulsivity Scale; the other 15 measurements were found to constitute the 40.5% of the studies.

Measurement materials other than the Barratt Impulsivity Scale are all behavioral performance assessments. Barratt Impulsivity Scale (BIS-11) is one of the most frequently used self-report scales in both normal and clinical samples in the assessment of impulsivity structure. It is a scale consisting of thirty items and using 4-point likert scoring (Patton et al., 1995).

Wisconsin Card Sorting Test (WCST) is a test created by Grant & Berg (1993) to evaluate executive functions and measure the skills of planning, strategy, and maintaining the setup against external stimuli, which are the contexts of executive functions. The test includes 4 stimulus cards, 63 response cards and 6 categories. When the subject makes the correct match 10 times, they move on to the next category. In Wisconsin Test 16 score types are calculated by using the number of successes and errors in these matching tasks. Stroop Color-Word Test is another test used to evaluate executive functions. Stroop (1935) demonstrated through his studies that when the color used and the word representing the color are different (for example, the word yellow written using blue), it is pronounced later than if the color and the word representing the color are the same and this effect is defined as the Stroop Disruption Effect in the literature. Along with the Stroop Effect, the Stroop Test began to be included as a neuropsychological test used to evaluate frontal lobe functioning (Stroop, 1935). To overcome the Stroop Disruption Effect, individuals must adapt to changing demands, in other words, they must change their habitual behavioral patterns. In the Stroop task, the participant is asked to make fewer mistakes and finish the task in the optimal time. Similarly, in the Go/noGo task, the participant is expected to reveal the correct response by suppressing the incorrect response. Higher number of incorrect responses indicates higher impulsivity (Schiffer & Vonlaufen, 2011). In the last test, the Porteus Maze task, participants must actively use their problem solving, cognitive inhibition and cognitive flexibility skills by making the appropriate response to exit the maze (Greenfield & Valliant, 2007). It's a test which has similar properties with Trail Making Test (Schiffer & Vonlaufen, 2011).

The individual studies included in the meta-analysis were conducted over different years. 29.4% of the studies included in the meta-analysis were conducted in 2007, 17.6% in 2011, 11.8% in 2008, 11.8% in 2016, 11.8% in 2014, 6.9% in 2012, 6.9% in 2013 and 6.9% in 2020.

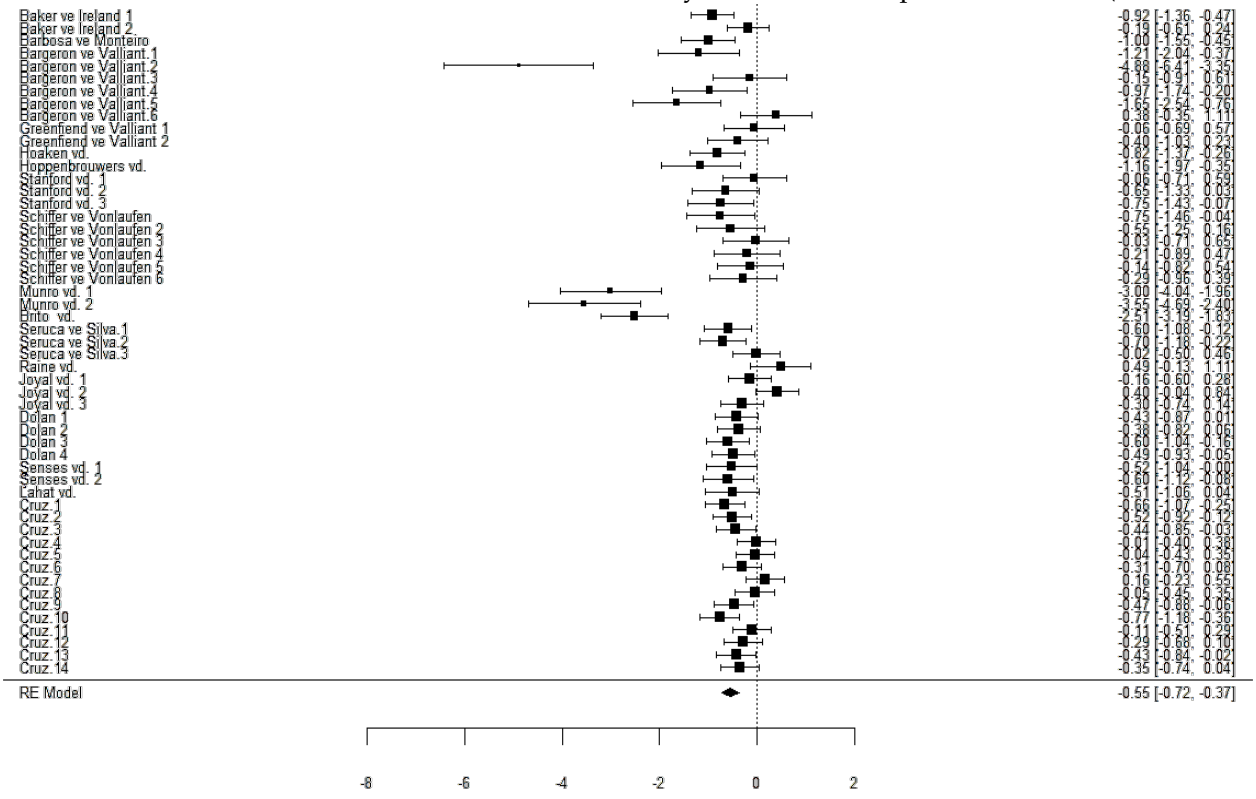
Effect Size and Heterogeneity Analysis

Based on the random effects model, the meta-analysis output revealed at 95% confidence interval values, the lower limit was -0.73, the upper limit was -0.37, and the grand mean effect size was calculated as *d*= -0.55 at 0.09 standard error value. Significant differences existed between the offender and non-offender groups in executive function tasks. Since the effect size found was between 0.50 and 0.80 values, it has a moderate effect, according to Cohen (1977).

Table 2: Results of Meta-analysis Results by Fixed Effects Model and Random Effects Model

Model	N	Effect Size	Z	*SE*	%95 Confidence Interval		*sd*	*Q*	*p*	I^2
					Lower	Upper				
Fixed effects model	53	-0.42	-11.8	0.04	-0.49	-0.35				
Random effects model	53	-0.55	-6.04	0.09	-0.73	-0.37	52	218.00	0.00	83.72

Table 3: Forest Plot of Effect Size

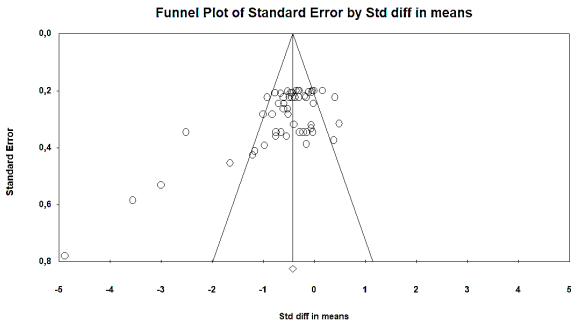


Moreover, in the heterogeneity tests performed, a $p < 0.01$ value was observed at a $Q = 218.00$ value according to the Cochrane Q test. Since the Q value is 69.83 in the X^2 critical value table for 52 degrees of freedom (*df*) and 95% significance level, it is seen that the studies are heterogeneously distributed. In other words, the null hypothesis that the variance was not significantly distributed among studies was rejected. According to the results of the I^2 test, which shows the power of heterogeneity, heterogeneity of 83.72% was observed among the studies.

Publication Bias

According to the funnel plot, the studies are relatively symmetrically distributed. This indicated that there is no publication bias. According to Rosenthal's Failsafe-*N* approach, it is seen that 2464 studies at $p > 0.05$ level are required to reverse the p significance level of the results. Since the number of 2464 studies is higher than the 53 effect size studies calculated in the meta-analysis, it shows no publication bias (Borenstein, 2019; Orwin, 1983). On the other hand, Duval and Tweedie's Trim and Fill method is based on the principle of generating new studies until the p-value reverses neutral. According to Duval and Tweedie's Trimming and Filling method, no additional studies were produced due to the absence of biased studies. Thus, it is seen that there is no publication bias in the studies included in this study.

Figure 2: Funnel Plot of Studies in Meta-analysis



Subgroup Analysis

An analog ANOVA was performed to analyze the crime type. The result indicated that crime types were found to be significant at the p<0.01 level, as the critical X^2=11.071 value was smaller than the Q=25.416 value. Thus, crime types explain the heterogeneity between studies. When the subgroups clustered into crime types were examined, it was seen that the mixed crime group, labeled as the mixed group because the studies in this group did not explain the characteristics of their offender sample, had the highest effect size (d=-0.79).

study was excluded from the subgroup analysis because it reported standardized z-scores of Concrete Subject-Ordered Working Memory, Conditioned Non-spatial- Association Test, and Abstract Subject-Ordered Working Memory Test measurements used to measure executive functions. When the subgroups were examined, it was seen that the Benton Word Fluency Test, Behavioral Assessment of Dysexecutive Syndrome, Letter-Number Sorting Test, Stopping Task Test, and Passive Avoidance Learning Task measurements were used in one study. In effect size, with the inclusion of these measures, the offender group made more errors than the control group. Two studies used the Barratt Impulsivity Test, Paragraph Completion Test, London Tower Test, Stockings of Cambridge Task, and Rule Shift Cards. Similarly, in studies using these measures, it was seen that the offender groups got worse scores than the control groups.

Go/noGo measurements were the most applied measurement tools and were used in 9 effect-size calculations. For this type of measurement, it was seen that the offender groups had more errors than the non-offender groups with d = 0.75 effect size

Table 4: Analogue ANOVA for Crime Type

Variables		N	Effect Size	SE	%95 CI		*sd*	0.05 confidence level X^2	Q_B	*p*
					Lower	Upper				
Crime Type	Mixed	28	-0,79	0.13	-1.05	-0.54				
	Violence	9	-0.27	0.09	-0.46	-0.09				
	Psychopathy	5	-0.52	0.11	-0.73	-0.31				
	Sexual	8	-0.14	0.12	-0.37	0.10				
	White-Collar	1	0.49	0.32	--0.13	1.11				
	Property-related									
	Total	2	-0.56	0.19	-0.93	-0.19				
		53	-0.39	0.05	-0.49	-0.29	5	11.071	25.416	0.000

Note: mixed group represent crime type is not understood by individual studies

Furthermore, offenders with property-related (d=-0.56), psychopathic (d=-0.52), and violent (d=-0.27) criminal types showed executive function deficit than controls. However, offenders with sexual (d=-0.14) and white-collar (d=0.49) crimes have performed a close error rate in executive function tasks compared to non-offenders.

According to the Analogue ANOVA findings, measurement material was found to be significant at the p<0.01 level, as the critical value of X^2=27.86 was smaller than the value of Q=91.094. According to this result, the material types explain the heterogeneity between studies. Hoaken's (2007) (95% *CI* [0.00, 3.27], p<0.05). The Wisconsin Card Matching Test (WCST) was the second most applied measurement tool compared to other studies included in 8 effect-size calculations. For this type of measurement, the effect size was 0.18 (95% *CI* [-0.25, 1.15]) and there was a non-significant effect at the critical value of p>0.5.

The Porteus Maze Test was used for 6 effect size calculations. In studies using this measure, the overall effect size was d = -0.71 points, indicating that offenders had more errors in the Porteus Maze task than in the control group (95% *CI* [0.00, 3.80], p<0.05).

Trail Making Test and Stroop Color-Word Test measurements were used in 5 effect size calculations. Similarly, in studies using these measures, it was observed that the offender groups had more errors than the control group (see in Table 5).

Especially during adolescence, the individual adapts to the changes in himself and his social environment by means of executive functions. Therefore, deficiencies in executive functions in the adolescence might cause antisocial behaviors in early adulthood (Moffitt et al., 2002).

Table 5: Analogue ANOVA for Measurements

Variables	N	Effect Size	SE	%95 CI		*sd*	0.05 confidence level X^2	Q_B	*p*
				Lower	Upper				
BWFT	1	-0.918	0.224	-4.10	0.00				
BIT	2	-0.366	0.21	-1.78	0.00				
BADS	1	-1.00	0.28	-3.54	0.00				
PCM	2	-2.98	1.84	-1.63	0.10				
WCST	8	-0.18	1.60	-1.15	0.25				
PM	6	-0.71	0.19	-3.80	0.00				
LNS	1	-1.16	0.41	-2.81	0.01				
TMT	5	-0.58	0.11	-5.14	0.00				
Go/NoGo Task	9	-0.75	0.23	-3.27	0.00				
LTT	2	-0.21	0.24	-0.87	0.39				
Stroop WCST	5	-0.46	0.11	-4.17	0.00				
CLGT	1	0.40	0.23	1.80	0.07				
Stop-it Task	1	-0.30	0.23	-1.35	0.18				
SOC	2	-0.55	0.16	-3.45	0.00				
Simon Task	2	-0.18	0.14	-1.24	0..22				
WIT	2	0.06	0.14	0.40	0.69				
RSC	2	-0.20	0.14	-1.41	0.16				
PALT	1	-2.51	0.35	-7.25	0.00				
Total	50	-0.41	0.04	-9.80	0.00	17	27.86	91.094	0.000

Note: BWFT = Benton Word Fluency Test, BIT = Barratt Impulsivity Scale, BADS = Behavioral Assessment of the Dysexecutive Syndrome, PCM = Paragraph Completion Task, WCST = Wisconsin Card Sorting Task, PM = Porteus Maze, LNS = Letter Number Sequencing Task, TMT = Trail Making Task, LTT = London Tower Test, CLGT = Computerized Lowa Gambling Task, SOC = Stockings of Cambridge Task, WIT = Williams Inhibition Task, RSC = Rule Shifting Cards, PALT = Passive Avoidance Learning Test

Discussion

Prior studies have noted the importance of the impact of neuropsychological farctors on criminal behavior (Moffitt, 1993; Moffitt et al., 2002; Moffitt & Henry, 1991; Piquero & White, 2003; Seruca & Silva, 2016). This study accepted the hypothesis that offenders perform significantly worse in tests on executive functions than non-offenders and the findings of the study confirm our hypothesis. Hayes's (1996) Behavioral Analytical Model confirms the results of our study. Due to the dysfunction of executive functions, the decreased ability of individuals to self-regulate, plan, and give appropriate answers to the problems might lead to aggression and criminal behaviors, and the decrease in these skills might led to the deterioration of rule-oriented behaviors. While one reason for the impairment of executive functions is traumatic experiences in childhood (DeBellis, 2001; Deniz, 2017; Menard, 2002), another important reason is the negative effects of substance addiction, which is common in criminals, on cognitive processes (Borckett et al., 2018; Eryılmaz, 2018; Fernandez-Serrano et al., 2009).

One unexpected finding was that the offenders against property had worse performance on executive function tasks or tests than violent offenders. While it was expected that the functions of planning, organizing, and self-regulation would be impaired in violent behaviors, a similar result was obtained for property-related criminal behavior as well. A possible explanation might be that different measurement tools were used in different studies. Using different measurement materials for different crime types might have affected the effect sizes as they changed the sensitivity of the measurements. Another explanation might be that while the result related to violent behavior was affected by nine effect sizes, the result related to property crimes was obtained from only two effect sizes. This means

that the meta-analysis has not included sufficient data from property related crimes. The difference in the variance between the two groups might have affected the effect size, as Borenstein et al. (2019) stated that the variance would affect the effect size.

Among the effect sizes included in the meta-analysis, the Go/No-Go measurements were seen to have a high effect size. The Go/No-Go task measures individuals' ability to inhibit executive functions as seen in the Barratt Impulsivity Scale and Stroop Color-Word Test, which measure cognitive and motor inhibition ability. In these measurements, the offender group performed more errors on the Stroop Color-Word Test and Go/NoGo Task and had more impulsive scores on the Barratt Impulsivity Scale than the non-offender group. Thus, it can be concluded that the impulsive behaviors of the offenders are more than those of non-offenders because of inadequacies or deterioration in the inhibition abilities controlled by executive functions, and these impairments might lead to criminal behaviors. These findings are consistent with the results of much previous research that the offenders are characterized with increased impulsive behaviors (Hecht & Laztman, 2017; O'Toole et al., 2016; Zhu et al., 2019).

Similarly, The BADS, London Tower Test, Computerized Iowa Gambling Test, and Cambridge Socks Task are the materials created to measure the strategy-enactment and problem-solving abilities of executive functions. As expected, in the studies that used these materials, it was seen that the offenders performed worse than the non-offender group on the BADS and Cambridge Stockings Task measurements (Barbosa & Monteiro, 2008; Dolan, 2011). The problems experienced as the result of their decision-making mechanisms during the tasks might have increased their impulsive or aggressive behaviors by causing frustration.

Another contradictory finding is that there were no significant differences between offenders and non-offenders in the Wisconsin Card Sorting Test (WCST). The Wisconsin Card Sorting Test is a classical measure of individuals' ability to adapt to changing rules (set-shifting), mental flexibility, thinking in a logical framework, and problem-solving. A possible reason for this result may be that some crimes are committed in a highly impulsive manner (such as wounding and sexual assault), while others require a high level of cognitive abilities and planning (such as white-collar crimes). Therefore, the nature of the crime behavior might have acted as a confounding variable. Contrary to impulsive crime behaviors, cognitive skills are expected to be reasonably used in planned crimes. The fact that the measures were collected from both planned and impulsive crime groups may have caused the results to be meaningless. This finding is consistent with the study of Cruz (2016), who reported that, while there was no significant difference between offenders and non-offenders in terms of set-shifting, there was a significant difference in the context of inhibition.

In addition to these results, some inconsistencies were found between tests that measure similar neuropsychological structures. For set-shifting measures, while there was no significant difference between the groups in the rule-shifting cards and the WCST, there was a significant difference in the Trail Making Test. Similarly, Burgess (2020) indicated that although mental flexibility and set shifting are associated with violent behaviors, inconsistent results come out from studies using the WCST and the Trail Making Test. Our study, consistent with the Burgess' study, encountered the same measurement problem that gave raise to failure in finding any association.

Finally, it seems that executive functions play a critical role in impulsive criminal behavior. Therefore, it is possible to reduce antisocial behaviors of individuals in rehabilitation services, especially with interventions for executive functions. For example, a rehabilitation program that modified by Dawson and Guare (2004) for executive functions focus on to improve EF that increase attention span to set self-regulation of emotion, planning ability and decrease impulsivity. Thus, it can be aimed at reducing aggressive behaviors of individuals and increasing problem solving abilities, interpersonal relationship.

It seems that traumatic experiences in childhood affect cognitive abilities (DeBellis, 2001; Taft, Creech & Murphy, 2016; Eryılmaz, 2018). Preventive actions should be taken in this regard.

Providing psychoeducation to families about childhood trauma may increase their awareness. At this point, it may be useful to explain the legal consequences of maltreatment as well as its possible effects on the future psychological development of children in the education model developed. Finally, we can add the protective factor for childhood traumas to the responsibility of professionals working on the subject. In fact, the deficiency in executive functions can be understood by attention deficit and impulsive behaviors in children. Professionals should question the situation of children with these behaviors at home. Because both child maltreatment can lead to EF deficit and EF deficit might prepare the ground for the child to become child maltreatment. As a result, recognizing executive dysfunction at an early age may be valuable in crime prevention studies.

Conclusion

This research sought to gain an understanding of criminal behavior from a neuropsychological standpoint. In general, the findings support the overall study hypothesis that there is a relationship between deficits in executive functions and criminal behavior and this result is also consistent with the previous research findings (Cruz, de Castro-Rodrigues & Barbosa, 2020; Ostrosky & Diaz, 2019; Ross & Hoaken, 2011). The findings also partly support that there is a difference between executive functions with respect to the type of crime (Barker et al., 2007; Hancock, Tapscott, & Hoaken, 2010; Seruca & Silva, 2016). The findings show that although there is a significant difference between the groups in terms of executive functions in mixed, violent, psychopathic, property related crimes, there is no significant difference between offenders and non-offenders in white-collar and sexual crimes.

The results in this meta-analysis also indicate that the use of different measurement materials in different studies leads to inconsistencies in terms of study findings. Therefore, for the future studies, it can be suggested that it would be beneficial to use research designs in which different materials measuring executive functions are used in the same study.

When the results of the study are considered in terms of application; since there is a relationship between deficits in executive functions and criminal behavior, to prevent recidivism it might be useful to develop rehabilitation programs for incarcerated offenders and the ones who are subjected to probation with poor executive functions. In addition, since executive functions are differently associated with distinct types of offenses, it can be recommended that the intervention programs should be developed based on the specific needs of criminal typologies indicated in this study. When it comes to crime prevention, the findings also point to the importance of detecting and intervening with executive dysfunctions as early as possible to prevent overall crime, as Raine (2002) also stated. Well-designed intervention methods would be useful to prevent the development of antisocial behaviors and future criminality in children and adolescents.

Limitation

This study had some limitations. The major limitation of this study is that there is no gold standard measurement material for executive functions. Although different measurements or tests could be evaluated in the meta-analysis, including different measurement materials would affect the validity of the study.

Second limitation is that the criminal behavior varies across offensive styles. The individual studies included in this research cover different offense types. For this reason, a subgroup analysis was performed in the meta-analysis, and the studies were evaluated according to crime types. In this situation, as Youngs (2004) stated, despite the overestimation of executive functions in some types of crime, the lack of sufficient studies in some other types could prevent reaching an objective result.

Third limitation is that although some individual studies in different languages were accessed during the screening process, the data could not be obtained due to language limitations. Although it is thought that the inclusion of the studies from different cultures in the meta-analysis would contribute to obtain more objective results,

inability to include these studies in this research limited the scope of this study. Cultural differences can create fundamental differences in crime research because individuals are affected by the societies in which they grow up. It should be taken into consideration that cultural differences, especially in socialization processes, may have an impact on the individual's cognitive system. Poor family environments or ineffective parenting skills during childhood may cause children to have weak social bonds and therefore, inefficiency in self-control. (Marsh et al., 2007). To overcome this problem, the research owners tried to reach out the data set from these researchers directly via e-mail, but no response was provided.

References

Baker, S. F., & Ireland, J. L. (2007). The link between dyslexic traits, executive functioning, impulsivity, and social self-esteem among an offender and non-offender sample. *International Journal of Law and Psychiatry, 30*(6), 492–503. https://doi.org/10.1016/j.ijlp.2007.09.010.

Barker, E. D., Seguin, J. R., White, H. R., Bates, M. E., Lacourse, E., Carbonneau, R., & Tremblay, R. E. (2007). Developmental trajectories of male physical violence and theft: Relations to neurocognitive performance. *Archives of General Psychiatry, 64*(5), 592–599.

Barbosa, M., & Monteiro, L. (2008). Recurrent Criminal Behavior and Executive Dysfunction. *The Spanish Journal of Psychology, 11*(1), 259-265. https://doi.org/10.1017/S1138741600004297.

Barkley, R. A. (2012). Executive functions: What they are, how they work, and why they evolved. Guilford Press.

Beaver, K. M., Wright, J. P., & DeLisi, M. (2007). Self-control as an executive function: Reformulating Gottfredson and Hirschi's parental socialization thesis. *Criminal Justice and Behavior, 34*(10), 1345–1361. https://doi.org/10.1177/0093854807302049.

Bergeron, T. K., & Valliant, P. M. (2001). Executive function and personality in adolescent and adult offenders vs. non-offenders. *Journal of Offender Rehabilitation, 33*(3), 27-45. https://doi.org/10.1300/J076v33n03_02.

Boduszek, D., Hyland, P.; Bourke, A.; Shevlin, M. & Gary Adamson (2013). Assessment of psycho-social factors predicting recidivistic violent offenses within a sample of male prisoners. *The Irish Journal of Psychology*, 1-11. http://dx.doi.org/10.1080/03033910.2012.754324

Borenstein, M., Hedges, L.V.., Higgins, J. P. & Rothstein, H. R., (2019). *Introduction to meta-analysis*. John Wiley & Sons.

Broidy L M.; Nagin, D. S.; Tremblay, R. E.; Brame, B.; Dodge, K. A. & Fergusson, D. E. (2003). Developmental trajectories of childhood disruptive behaviors and adolescent delinquency: a six-site cross-national study. *Developmental Psychology, 30*, 222–245.

Broomhall, L. (2005). Acquired sociopathy: A neuropsychological study of executive dysfunction in violent offenders. *Psychiatry, Psychology and Law, 12*(2), 367-387. https://doi.org/10.1375/pplt.12.2.367.

Chung, H. J.; Weyandt, L. L. & Swentosky A., (2014), The Physiology of Executive Functioning. S. Goldstein and J. A. Naglieri (eds.), *Handbook of Executive Functioning*. Springer.

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences.* Academic Press.

Cruz, A. R., de Castro-Rodrigues, A., & Barbosa, F. (2020). Executive dysfunction, violence, and aggression. *Aggression and Violent Behavior, 51*, 101380. https://doi.org/10.1016/j.avb.2020.101380

Cruz, A.R.P., (2016). *Executive dysfunction, ımpulsivity, and violent criminal behavior.* (Unpublished Doctore Thesis). Portuguese: Porto University.

Çarkıt, E. & Yalçın, S. B. (2018). Üniversite öğrencilerinin düşünce hataları ve duyguları ifade etmelerinin mükemmeliyetçilik tutumlarını yordaması . *Sakarya University Journal of Education, 8*(1), 195-210. https://doi.org/10.19126/suje.367429

Dawson, P., Guare, R. (2014). Interventions to Promote Executive Development in Children and Adolescents. In: Goldstein, S., Naglieri, J. (eds) *Handbook of Executive Functioning*. Springer, New York, NY. https://doi.org/10.1007/978-1-4614-8106-5_24

De Bellis, M. D. (2001). Developmental traumatology: The psychobiological development of maltreated children and its implications for

research, treatment, and policy. *Development and psychopathology*, *13*(3), 539-564. https://doi.org/10.1017/S0954579401003078.

D. (2017). Suç işleyen bireylerde çocukluk çağı travmaları ve dissosiyatif yaşantıların sıklığı. *Türkiye Klinikleri, 14*(2), 34-47. https://doi.org/10.5336/forensic.2017-56847

Denson, T. F.; Pederson, W. C.; Friese, M.; Hahm, A. & Roberts, L. (2011). Understanding impulsive aggression: Angry rumination and reduced self-control capacity are mechanisms underlying the provocation-aggression relationship. *Personality and Social Psychology Bulletin, 37*(6), 850–862.

Dinçer, Serkan (2020). *Eğitim bilimlerinde uygulamalı meta-analiz.* Pegem Yayıncılık.

Dolan, M. (2012). The neuropsychology of prefrontal function in antisocial personality disordered offenders with varying degrees of psychopathy. *Psychological Medicine*, *42*(8), 1715-1725. https://doi.org/10.1017/S0033291711002686.

Enns, R. A., Reddon, J. R., Das, J. P., & Boukos, H. (2007). Measuring executive function deficits in male delinquents using the cognitive assessment system. *Journal of Offender Rehabilitation*, *44*(4), 43-63. https://doi.org/10.1300/J076v44n04_04

Eryılmaz, A. (2018). Comparison of offender and non-offender young men to setting goals for life and attributing meaning to life. *Journal Of Religion and Health*, 57, 1350-1362. https://doi.org/10.1007/s10943-017-0478-x

Eryilmaz, A. (2018). Self-Perceptions of Young Males who were Offenders and Non-offenders: Positive and Pathological Self-Images. *Bartin University Journal of Faculty of Education*, *7*(2), 479-506. https://doi.org/:10.14686/buefad.380384

Fernandez-Serrano, M. J., Pérez-García, M., Schmidt Río-Valle, J., & Verdejo-Garcia, A. (2010). Neuropsychological consequences of alcohol and drug abuse on different components of executive functions. *Journal of Psychopharmacology*, *24*(9), 1317-1332. https://doi.org/10.1177/0269881109349841

Galinari, L. S., & Bazon, M. R. (2021). Criminal Behavior and Psychosocial Risk Factors in Brazilian Adolescent Offenders: An Exploratory Latent Class Analysis. *International Journal of Environmental Research and Public Health, 18*(19), 10509. https://doi.org/10.3390/ijerph181910509

Glenn, A. L., & Raine, A. (2014). *Psychopathy: An introduction to biological findings and their implications.* New York University Press.

Goldstein, S. & J. A. Naglieri, (2014). *Handbook of executive functioning.* Springer Press.

Grant, D. A. & Berg, E. A., (1993). Wisconsin Card Sorting Test (WCST). Psychology Assessment Resources

Greenfield, R., & Valliant, P. M. (2007). Moral reasoning, executive function, and personality in violent and nonviolent adult offenders. *Psychological Reports*, *101*(1), 323-333. https://doi.org/10.2466/pr0.101.1.323-33

Gros, J. & Vostroknutov, A. (2022). Why do people follow social norms? *Current Opinion in Psychology, 44*, 1-6.

Haberle, S. K. (2011). *The role of the prefrontal cortex in the expression of impulsive and premeditated-aggression.* (Unpublished Doctoral Thesis), Tazmania: Tazmania University.

Hancock, M., Tapscott, J. L., & Hoaken, P. N. (2010). Role of executive dysfunction in predicting frequency and severity of violence. *Aggressive Behavior*, *36*(5), 338–349. https://doi.org/10.1002/ab.20353

Hayes, S. C., Gifford, E. V., & Ruckstuhl Jr, L. E., (1996). Relational frame theory and executive function: A behavioral approach. Lyon and Krasnegor (Eds.), In *Attention, memory, and executive function* (pp. 279-305), Baltimore: Brookes.

Joyal, C. C., Tardif, M., & Spearson-Goulet, J. A. (2020). Executive functions and social cognition in juveniles who have sexually offended. *Sexual Abuse*, *32*(2), 179-202. https://doi.org/10.1177/1079063218807487

Karakaş, S., Irak, M. & Bekçi, B., (2003). Sağlıklı insanda bilgi işleme süreçleri: biliş ve üst-biliş. S. Karakaş, C. İrkeç and N. Yüksel (eds.), *Beyin ve Nöropsikoloji*, Cizgi Press: Ankara.

Kılıç, B. G. (2002). Yönetici işlevler ve dikkat süreçlerine ilişkin kuramsal modeller ve nöroanatomi. *Klinik Psikiyatri Dergisi*, *5*(2), 105-110.

Langevin, R., & Curnoe, S. (2010). A comparison of psychopathy, attention deficit hyperactivity disorder, and brain dysfunction among sex

offenders. *Journal of Forensic Psychology Practice*, *10*(3), 177-200. https://doi.org/10.1080/15228930903550624

Marsh, I., Melville, G., Morgan, K., Norris, G., & Walkington, Z. (2007). *Theories of crime*. Routledge.

Marsh, N. V., & Martinovich, W. M. (2006). Executive dysfunction and domestic violence. *Brain Injury*, *20*(1), 61-66. https://doi.org/10.1080/02699050500110645

Menard, S. (2002). Short-and Long-Term Consequences of Adolescent Victimization. *OJJDP Youth Violence Research Bulletin*, 1-15.

Miura, H., & Fuchigami, Y. (2017). Impaired executive function in 14-to 16-year-old boys with conduct disorder is related to recidivism: A prospective longitudinal study. *Criminal Behaviour and Mental Health, 27*(2), 136-145. https://doi.org/10.1002/cbm.1993

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., and Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734

Moffitt, T. E., & Henry, B. (1991). Neuropsychological studies of juvenile delinquency and juvenile violence. *Neuropsychology of Aggression*, 67–91.

Moffitt, T. E., Caspi, A., Harrington, H., & Milne, B. J. (2002). Males on the life-course-persistent and adolescence-limited antisocial pathways: Follow-up at age 26 years. *Development and Psychopathology*, *14*(1), 179–207. https://doi.org/10.1017/S0954579402001104

Moffitt, T. E.; Arseneault, L; Belsky, D.; Dickson, N.; Hancox, R. J.; Harrington, H. & Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences, USA. 108*, 2693–2698.

Moffitt, T. E. (2017). *Adolescence-limited and life-course-persistent antisocial behavior: A developmental taxonomy* (pp. 69-96). Routledge.

Molinedo-Quílez, M. P. (2020). Psychosocial risk factors in young offenders. *Revista Espanola de Sanidad Penitenciaria,*, *22*(3), 104-111. https://doi.org/10.18176/resp.00019

Morgan, A. B., & Lilienfeld, S. O. (2000). A meta-analytic review of the relation between antisocial behavior and neuropsychological measures of executive function. *Clinical Psychology Review*, *20*(1), 113–136. https://doi.org/10.1016/S0272-7358(98)00096-8

Normand, S. L. T. (1999). Meta-analysis: formulating, evaluating, combining, and reporting. *Statistics in Medicine*, *18*(3), 321-359. https://doi.org/10.1002/(SICI)1097-0258(19990215)18:3<321::AID-SIM28>3.0.CO;2-P

Ogilvie, J. M., Stewart, A. L., Chan, R. C., & Shum, D. H. (2011). Neuropsychological measures of executive function and antisocial behavior: A meta-analysis. *Criminology*, *49*(4), 1063-1107. https://doi.org/10.1111/j.1745-9125.2011.00252.x

Orwin, R. G. (1983). A fail-safe N for effect size in meta-analysis. *Journal of Educational Statistics*, *8*(2), 157–159. https://doi.org/10.3102/10769986008002157

Ostrosky, S. F. & Diaz, K. (2019). Executive dysfunction in violent and criminal behavior. In: Ardila, A., Fatima, S., Rosselli, M. (eds) Dysexecutive Syndromes. Springer, Cham. https://doi.org/10.1007/978-3-030-25077-5_10

Öngür, D., Ferry, A. T., & Price, J. L. (2003). Architectonic subdivision of the human orbital and medial prefrontal cortex. *Journal of Comparative Neurology*, *460*(3), 425-449. https://doi.org/10.1002/cne.10609

Özaşçılar, M. (2016). Şiddet davranışının nedenlerini açıklamada biyolojik temelli kuramların rolü. *Türk Psikoloji Yazıları*, *19*, 16-28.

Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt impulsiveness scale. *Journal of Clinical Psychology*, *51*(6), 768-774. https://doi.org/10.1002/1097-4679(199511)51:6<768::AID-JCLP2270510607>3.0.CO;2-1

Pietrzak, R. H., Sprague, A., & Snyder, P. J. (2008). Trait impulsiveness and executive function in healthy young adults. *Journal of Research in Personality*, *42*(5), 1347-1351. https://doi.org/10.1016/j.jrp.2008.03.004.

Piquero, A. R., & White, N. A. (2003). On the relationship between cognitive abilities and life-course-persistent offending among a sample of African Americans: A longitudinal

test of Moffitt's hypothesis. *Journal of Criminal Justice*, *31*(5), 399-409. https://doi.org/10.1016/S0047-2352(03)00046-1

Polat, O. (2004), *Kriminoloji ve kriminalistik üzerine notlar*. Seçkin Yayıncılık.

Raine, A. (2002). Biosocial studies of antisocial and violent behavior in children and adults: A review. *Journal of Abnormal Child Psychology*, *30*, 311-326. https://doi.org/10.1023/A:1015754122318

Raine, A., Laufer, W. S., Yang, Y., Narr, K. L., Thompson, P., & Toga, A. W. (2012). Increased executive functioning, attention, and cortical thickness in white-collar criminals. *Human Brain Mapping*, *33*(12), 2932 2940. https://doi.org/10.1002/hbm.21415

Reddy, K. J., Menon, K. R., & Hunjan, U. G. (2018). Neurobiological aspects of violent and criminal behavior: deficits in frontal lobe function and neurotransmitters. *International Journal of Criminal Justice Sciences*, *13*(1), 44. https://doi.org/10.5281/zenodo.1403384

Ross, E. H., & Hoaken, P. N. (2011). Executive cognitive functioning abilities of male first time and return Canadian federal inmates. *Canadian Journal of Criminology and Criminal Justice*, *53*(4), 377–403. https://doi.org/10.3138/cjccj.53.4.377

Schiffer, B., & Vonlaufen, C. (2011). Executive dysfunctions in pedophilic and nonpedophilic child molesters. *The Journal of Sexual Medicine*, *8*(7), 1975-1984. https://doi.org/10.1111/j.1743-6109.2010.02140.x

Seruca, T., & Silva, C. F. (2016). Executive functioning in criminal behavior: Differentiating between types of crime and exploring the relation between shifting, inhibition, and anger. *International Journal of Forensic Mental Health, 15*(3), 235-246. https://doi.org/10.1080/14999013.2016.1158755

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*(6), 643–662. https://doi.org/10.1037/h0054651

Sullivan, T. P., Cavanaugh, C. E., Buckner, J. D., & Edmondson, D. (2009). Testing posttraumatic stress as a mediator of physical, sexual, and psychological intimate partner violence and substance problems among women. *Journal of Traumatic Stress: Official Publication of The International Society for Traumatic Stress Studies*, *22*(6), 575-584.

Syngelaki, E. M., Moore, S. C., Savage, J. C., Fairchild, G., & Van Goozen, S. H. (2009). Executive functioning and risky decision making in young male offenders. *Criminal Justice and Behavior*, *36*(11), 1213–1227. https://doi.org/10.1177/0093854809343095

Şen, S. (2017, November 27). Meta analiz. *Eğitim Araştırmalarında Metot ve Analiz Sempozyumu*. https://sedatsen.com/2017/11/27/meta-analizsunumu-egitim-arastirmalarinda-metot-veanaliz-sempozyumu-maku/

Şenses, A., Akbaş, S., Baykal, S., & Karakurt, M. N. (2014). Hırsızlık suçuna sürüklenmiş erkek ergenlerin psikiyatrik tanı dağılımları ve nöropsikolojik özellikleri. *Adli Tıp Dergisi*, *28*(3), 223-233.

Tonnaer, F., Cima, M., & Arntz, A. (2016). Executive (dys) functioning and impulsivity as possible vulnerability factors for aggression in forensic patients. *The Journal of Nervous and Mental Disease, 204*(4), 280-286. https://doi.org/10.1097/NMD.0000000000000485

Wilson, D. B. (2020). Practical meta-analysis effect size calculator (Version 2020.11.27). https://www.campbellcollaboration.org/escalc/html/EffectSizeCalculator-Home.php

Winstok, Z. (2009). From self-control capabilities and the need to control others to proactive and reactive aggression among adolescents. *Journal of Adolescence, 32*(3):455–466.

Yalçın, S. B. & Yılmaz, E. (2023). A Study on the Predictability of Students' Grit by their Growth Mindset. *Participatory Educational Research*, *10*(5), 184-199. https://doi.org/10.17275/per.23.81.10.5.

Yalçın, S. B., Mehmet, A. K., Kavaklı, M., & Kesici, Ş. (2018). The obstacle to happiness: early maladaptive schemas. *Journal of Cognitive-Behavioral Psychotherapy and Research*, *7*(1), 7-7. https://doi.org/10.5455/JCBPR.270828

Yang, Y., & Raine, A. (2009). Prefrontal structural and functional brain imaging findings in antisocial, violent, and psychopathic individuals: a meta-analysis. *Psychiatry Research: Neuroimaging*, *174*(2), 81-88.

https://doi.org/10.1016/j.pscychresns.2009.03.012

Zakzanis, K. K., Mraz, R., & Graham, S. J. (2005). An fMRI study of the trail-making test. *Neuropsychologia*, *43*(13), 1878-1886. https://doi.org/10.1016/j.neuropsychologia.2005.03.013