Developmental Trends and Associations of Executive Functions and Oppositional Defiant Problems and Obsessive-Compulsive Problems in Preschoolers

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Presentation

This thesis focuses on the associations between executive functions and Oppositional Defiant Problems (ODP) and Obsessive-Compulsive Problems (OCP) in a sample of children from the general population that were followed up between the ages 3 to 7. The research presented in this thesis is part of a larger longitudinal project that investigates behavioral problems among preschool-aged children from ages 3 to 14 [Grant PGC2018-095239-BI00 (MICIU/FEDER)].

The purpose of this thesis is to analyze prospective associations between executive functions at age 3 and ODP, ODP dimensions, and OCP at ages 6 and 7, while also exploring the potential mediating factors that may influence these relationships. Furthermore, the thesis aims to provide insights into the factors that may contribute to the co-occurrence of these two problems.

This thesis consists of two studies. The first study aims to explore the associations between executive functions and ODP and OCP. The second study examines irritability and positive, inconsistent, and punitive parenting as potential mediators in the aforementioned relationships.

Abstract

Objectives: Deficits in executive functions are associated with neurodevelopmental disorders, behavioral problems, academic difficulties, and challenges in daily life. This research aims to explore the associations between executive functions at age 3 and two prevalent problems in the preschool population, Oppositional Defiant Problems (ODP) and Obsessive-Compulsive Problems (OCP) at ages 6 and 7, respectively. Additionally, the study examines the mediating role of irritability and parenting practices in these relationships.

Methods: The participants included preschool-aged children from the community. At age 3, teachers assessed executive functions through questionnaires. Various other variables were included in these studies, with ODP being evaluated by multiple informants in Study 1 while OCP and all variables in Study 2, irritability, parenting practices, and both problems were informed by parents. The statistical analysis includes multiple linear regressions and structural equation modeling.

Results: Specific relationships were found between executive functions and ODP, ODP dimensions, and OCP. A shared feature between ODP and OCP is the presence of challenges in Flexibility (FI). Deficits in Inhibitory Self-Control (ISCI) exhibited associations with both problems, albeit with differing directions in the relationship. Specifically, higher deficits in ISCI are related to higher ODP but lower OCP. Furthermore, increased difficulties in ISCI are associated with higher irritability and headstrong. Notably, irritability serves as a mediator between FI and both ODP and OCP.

Conclusions: The results provide insights into both the etiology and prevention of ODP and OCP, highlighting unique executive function aspects associated with each problem, as well as shared cognitive challenges linked to FI. Irritability emerges as a common mediator in the pathway from

FI to ODP and OCP and can potentially explain the co-occurrence of these problems. The findings inform interventions targeting ISCI and FI processes in early childhood that can be beneficial in mitigating later behavioral difficulties.

Chapter One: Introduction and Aims

Executive Functions: Definition and Implications in Child Development

Executive functions encompass a set of abilities necessary for directing and shaping behavior and regulating emotions (Diamond, 2013). There is evidence that these abilities represent a continuum, ranging from "cool" executive involved in emotional-neutral situations to "hot" executive functions that come into play when emotional or motivational factors are present (Zelazo, 2020). The longstanding interest in studying executive functions primarily stems from their role in the development of psychopathologies when difficulties are present (Zelazo, 2020), as well as their potential to be shaped and developed in interventions to prevent the onset of psychopathologies (Diamond & Lee, 2011).

Firstly, research indicates that the presence of difficulties in executive functions is associated with decreased academic performance, internalizing problems, Attention-Deficit/ Hyperactivity Disorder (ADHD), among others (Diamond, 2013). Secondly, intervening at certain stages when these abilities are malleable and susceptible to change, particularly during the preschool period and the transition to adolescence, can significantly enhance these abilities, serving as a protective factor and preventing the development of pathologies (Zelazo, 2020). Therefore, executive functions can serve a dual role, operating as either a risk factor in the presence of deficits or a protective factor when adequately developed.

Developmental Trends and Milestones in Executive Function during Childhood

Regarding the structure and development of executive functions, several models and theories have been proposed. In adults, Miyake et al. (2000) proposed model suggests that

executive function is an integrated process with partially independent elements, identifying three

main components: working memory, inhibition, and flexibility. Building upon this model, Garon

et al. (2008) conducted a systematic literature review on executive functions in preschoolers. The

authors provide support for an integrative framework of executive functions and suggest a

hierarchical relationship among the components of executive function (Garon et al., 2008). They

suggest that working memory, inhibition, and flexibility do not develop concurrently but rather

follow a sequential order within an existing network, wherein the attention system serves as a

fundamental component (Garon et al., 2008). Conversely, there is evidence indicating that these

components are dissociable and exhibit diverse developmental trajectories (Diamond, 2013). For

instance, in Diamond's model, the core pillars of executive function development are inhibition

and working memory. These processes develop early during the preschool period, while flexibility,

and subsequently, planning, diverge from the preceding processes at a later stage (Diamond, 2013).

While there is no consensus on a single model of executive function, authors seem to agree on

three essential components: inhibition (i.e., the ability to control, block, and modulate one's

behavior), working memory (i.e., the ability to retain basic information necessary to complete a

task) and shifting (i.e., the ability to switch between tasks and situations) (Diamond, 2013).

Executive functions are commonly evaluated through formal testing in neutral environments (i.e.,

the Go/No-Go computerized task) but their manifestation in everyday life is also captured through

measures such as questionnaires.

Executive Functions, ODD and Dimensions of ODD

According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5),

Oppositional Defiant Disorder (ODD) is characterized as a pattern of irritability, hostility towards

authority figures, and vindictiveness, observed over a duration of at least 6 months, and with a severity ranging from mild to severe when the behavior is manifested in one or more settings (at home, school, with peers) (American Psychiatric Association, 2013). The prevalence of ODD varies between 2% and 11% across different studies (Canino et al., 2010), with a notable occurrence among children of preschool age (Ezpeleta, Navarro, et al., 2019). The etiology of ODD is complex, involving genetic, cognitive, and environmental factors (Azeredo et al., 2018).

Deficits in executive functions have been associated with various outcomes and psychopathologies, including ODD and Obsessive-Compulsive Disorder (OCD). In the case of ODD, some studies address the presence of deficits in executive functions, although they often focus on comorbid conditions, particularly ADHD/ODD or ODD/Conduct Disorder (CD) (Antonini et al., 2015; Hobson et al., 2011; Schoorl et al., 2018). Some studies in preschoolers suggest deficits in inhibition and working memory are correlated with oppositional problems (Kleine Deters et al., 2020), and others observe that deficits are more significant in ODD/ADHD than in ADHD alone (Ezpeleta & Granero, 2015). Furthermore, children with ODD appear to experience deficits in emotionally laden contexts (Jiang et al., 2016), but studies measuring deficits across contexts (at home or at school) are limited. Similarly, children with ODD may face challenges when motivational factors are present, implying that their deficits are primarily associated with motivational inhibitory control (van Goozen et al., 2004). In summary, these children may encounter difficulties in regulating their behavior in response to motivational stimuli, such as rewards or punishments (Matthys et al., 2013).

The multidimensionality of ODD has generated interest in the field of developmental psychology, primarily because its constituent dimensions are considered significant indicators of psychopathology. ODD is characterized by a high comorbidity rate and diverse developmental

trajectories leading to either internalizing or externalizing problems (Boylan et al., 2007; Leadbeater & Homel, 2015). Notably, authors identify two dimensions (irritable and headstrong) (Rowe et al., 2010) or three dimensions (spiteful, in addition to irritable and headstrong) (Stringaris & Goodman, 2009). Burke et al. (2010) model also uses a 3-factor structure (negative affect, oppositional behavior, and antagonistic behavior) but with a distinct symptom distribution. The Stringaris's 3-dimensional model, also recognized by the DSM-5, is used to classify symptoms of ODD. The first dimension, Angry/Irritable Mood, encompasses symptoms such as frequent temper loss, touchiness, and anger, and is linked to emotional symptoms and internalizing difficulties (Leadbeater & Homel, 2015; Stringaris & Goodman, 2009). The second dimension, Argumentative/Defiant Behavior (or headstrong) involves symptoms like arguing, refusing to comply or blaming others and is associated with ADHD, while the third dimension includes vindictiveness and correlates with CD or criminal offenses (DSM-5; Stringaris & Goodman, 2009).

Alongside its multidimensionality, distinct classes or subtypes of ODD emerged in specific sample populations contingent upon the symptom presentation (i.e., irritable and/or headstrong) and severity (i.e., severe-ODD) (Aebi et al., 2016). As noted previously, the latest edition of DSM-5 introduces specifiers (mild, moderate, severe) denoting symptomatology's severity when observed across multiple contextual domains. Additionally, within the framework of the 11th edition of the International Classification of Diseases (ICD-11) (World Health Association, 2018), an alternative categorization delineates two subtypes of ODD, one marked by chronic irritability and one without chronic irritability. Also, the ICD-11 includes specifiers reflecting the presence of either limited prosocial emotions (LPE) (i.e., lack of remorse, callousness), or typical prosocial emotions, applicable to ODD and CD. Recent research reinforces the pivotal role of irritability

within the construct of ODD (Aebi et al., 2016; Ezpeleta et al., 2022) and children pertaining to ODD-irritable subtype may be more susceptible to severe outcomes. For example, in a sample of adolescent boys with ODD, those with the ODD-irritable subtype have been associated with suicide, aggressive criminal offenses, and affective pathologies (Aebi et al., 2016). Ezpeleta and al. (2022) also highlight two specific subtypes, Defiant-Irritability with LPE and Defiant-Irritability without LPE and no evidence for a subtype without irritability (Ezpeleta et al., 2022). Children presenting the subtypes defiant/headstrong with irritability tend to display more severe clinical traits and the LPE specifier may be an indicator for a developmental trajectory posing even a higher risk, including comorbidity with CD or peer difficulties (Ezpeleta et al., 2022). However, other studies found no difference between children with ODD-only and ODD-LPE subtype (Chrysosferidis et al., 2023), so it is plausible that the ODD severity is more linked to variability in irritability levels.

Within the context of the multidimensionality of ODD, the relationship between executive functions and ODD dimensions remains relatively unexplored. A few studies suggest potential links between working memory, attention, and inhibition and the dimension of irritability (Griffith et al., 2019). Furthermore, when a motivational aspect, such as delayed gratification, is involved, it associates with behavioral and antagonistic dimensions (Griffith et al., 2019). Similarly, Stringaris and Goodman (2009) suggest a correlation between delay aversion and the headstrong dimension, explained by the attitude of "I want it, I want it now, I won't wait" (p.221). The inability to resist immediate incentives in favor of delayed rewards or avoid punishments may account for why consequences do not exert the same modulating effect on children with ODD as suggested by Matthys et al. (2012). Therefore, understanding these specificities between executive functions

and ODD symptoms can be useful for intervention, focusing on either affective or behavioral dimensions.

Executive Functions and OCD

OCD is present in about 1-3% of the pediatric population (Brem et al., 2012) and is characterized by the presence of obsessions (i.e., fear of contamination) and/or compulsions (i.e., repetitive behaviors like washing, checking) that are time-consuming (i.e., take more than one hour daily) (APA, 2013). Like ODD, several factors, genetic, cognitive, and environmental, are involved in the etiology of OCD.

Alterations of the cortico-striato-thalamo-cortical networks have been documented in adults with OCD (Calzà et al., 2019) and cognitive processes (in particular, inhibition) have been proposed as potential endophenotypes for OCD (Chamberlain et al., 2005). Impairments in executive function, mainly in the domains of inhibition, working memory, and cognitive flexibility, have been identified in samples of adults with OCD (Abramovitch et al. 2013; Chamberlain et al., 2005; Dittrich & Johansen, 2013). According to the results of a meta-analysis, a similar neural activation pattern in the frontal-striatal circuits among pediatric cohorts with OCD supports the notion of similar neural underpinnings across different age groups with OCD (Brem et al., 2012). However, conflicting findings characterize the nature of executive function deficits in children with OCD. While some studies have identified impairments in visual memory and visual organization (Andrés et al., 2007), cognitive flexibility and planning (Ornstein et al., 2010), inhibition (Mancini et al., 2018), other studies have not found deficits in aspects of executive function (Abramovitch et al., 2015; Hybel et al., 2017). Although some cognitive deficits in children with OCD may share similarities with those observed in adults, there are differences both

in terms of cognitive profiles and symptom presentations, and comorbidity, indicating the existence of a potentially distinct OCD developmental subtype in childhood (Geller et al., 2021). It has been long believed that the onset of OCD occurs much later in adolescence. However, in the last decade, studies have increasingly focused on the preschool period, providing evidence of distressing OCD symptoms emerging as early as 18 months and the onset of OCD occurring before 3 years of age (Coskun et al., 2012). Furthermore, across multiple studies, there is evidence supporting the occurrence of OCD onset until the age of 6 (Garcia et al., 2009). Concerning age-specific characteristics, Coskun et al. (2012) have uncovered a prevailing manifestation of symptoms associated with the concepts of order, symmetry, shape, and color of clothing in individuals with early-onset OCD. Also, hoarding compulsions, as well as religious and aggressive obsessions, exhibit a higher prevalence among children and adolescents compared to adults with OCD (Brem et al., 2012). Additionally, studies suggest that commonly coexisting conditions in early childhood include ADHD, separation anxiety disorder (SAD), and ODD (Coskun et al., 2012). Finally, childhood-onset OCD is associated with increased family accommodation (Jacoby et al., 2021). Approximately 50% of cases diagnosed with OCD cases begin in childhood and persist into adulthood (Nestadt et al., 2000). A case report involving severe onset of OCD in a preschool-age child demonstrated full remission following treatment (Miyawaki et al., 2018). Therefore, examining executive functions during childhood may help comprehend the potential cognitive and emotional factors linked to early-onset OCD and facilitate early detection and intervention.

Comorbidity of ODD and OCD: Exploring Overlapping Features and Clinical Implications

As previously mentioned, early-onset OCD appears to exhibit distinct characteristics in terms of comorbidity, differing from later-onset cases where anxiety and mood disorders are more prevalent. Studies conducted in the preschool population with OCD indicate a higher comorbidity of up to 40% with disruptive behaviors, such as ADHD and ODD, and suggest that these disruptive behaviors may precede the development of OCD (Coskun et al., 2012). The study conducted by Garcia et al. (2009) indicates that the co-occurrence of ODD is linked to an earlier onset of OCD symptoms among affected children, in comparison to children without ODD. However, the underlying reasons behind this association have not been thoroughly explored, and future studies should investigate whether the dimensions of ODD can predict OCD symptomatology. The findings of a singular study, conducted on a sample consisting of children and adolescents with chronic tic disorder, revealed an association between irritability as a fundamental dimension of ODD and the presence of obsessive-compulsive behaviors (Thériault et al., 2014). Moreover, there is evidence of irritability exhibited through outbursts and temper tantrums in both ODD and OCD.

Recent investigations have specifically examined the role of irritability in children diagnosed with OCD, revealing its association with depressive symptoms, defiant behavior, and family accommodation (Guzick et al., 2021). Furthermore, another recent study exploring parental perspectives on internalizing and externalizing features in childhood OCD highlights the prevalence of externalizing problems, including oppositionality and argumentativeness specifically related to OCD issues (Guzick et al., 2019). Quite interestingly, considering this overlap in terms of irritability and defiance symptoms in childhood OCD, the clinical presentation may be misinterpreted as symptoms of ODD when individuals affected by OCD become absorbed

in their compulsive rituals and reluctant to comply with external demands or expectations. In this line, Amen and Carmichael (1997) underscore that children with ODD and OCD face challenges related to cognitive flexibility, which accounts for their persistence in saying "no" to authority figures or engaging in obsessive thoughts. Their brain imaging study suggests similar neurobiological characteristics in children with OCD and ODD, specifically involving activation in the anterior medial area of the prefrontal cortex, which is responsible for cognitive flexibility (Amen & Carmichael, 1997). The involvement of frontal circuitry and alterations in the orbitofrontal cortex, responsible for regulating behavior and emotions, are observed in both ODD and OCD. Previous research indicates that abnormalities in the prefrontal cortex and frontal-subcortical circuitry are implicated in the etiology of both ODD and OCD (Evans et al., 2004; Matthys et al., 2013). Specifically, these regions have been associated with impairments in cognitive flexibility in OCD (Vaghi et al., 2017) and response inhibition and emotional responding in ADHD with comorbid disruptive behaviors (Zhu, 2018). The high rate of comorbidity between OCD, ADHD, but also disruptive behaviors, has been explicitly linked to the developmental course of the cortico-striato-thalamo-cortical circuit (Brem et al., 2014; Zhu, 2018). This circuitry is known to be involved in various functions including cognitive flexibility, reward processing, decision-making and emotional regulation. Indeed, ODD has been consistently linked to impairments in reward processing, decision-making, and resistance to punishment cues as incentives for behavior change (Matthys et al., 2012). Similarly, altered reward and punishment sensitivity has been associated with OCD in some studies focusing on reversal learning processes reflecting the difficulty in updating their behavior following changes in rules which may indicate flexibility difficulties (Chamberlain et al., 2008). Finally, children with OCD performed poorly on the Iowa Gambling Task (IGT) indicating impaired decision-making skills (Kodaira et al., 2012).

In sum, the intricate interplay between cognition and emotion emerges as a key aspect in understanding the underlying mechanisms of these two disorders. A deeper understanding of these mechanisms holds the potential for identifying early onset markers of ODD and OCD, thus facilitating preventive interventions. Case studies exploring the simultaneous treatment of early childhood OCD and ODD provide a compelling demonstration of the significance of distinguishing between ODD and OCD symptoms and identifying contributing factors that can lead to their comorbidity. For instance, Ale and Krackow's study (2011) demonstrates how permissive parenting and accommodation of anxiety symptoms in children with OCD can precipitate aggressive behavior and the subsequent development of ODD. Overall, while not extensively explored, evidence suggests that ODD can emerge before OCD, but also parenting practices can influence the development of oppositional problems in children with OCD.

Mediating Variables between Executive Functions and Oppositional and Obsessive-Compulsive Problems

In order to better understand the relationship between executive functions and ODP and OCP, mediating variables, namely irritability and parenting practices, have been considered. The relationship between these variables and ODD and OCD, taken individually, is documented in the literature (Ezpeleta, Penelo, et al., 2019; Goli et al., 2020; Guzick et al., 2020), however, their role in the comorbidity of ODD and OCD remain to be determined.

Irritability

Irritability is an important transdiagnostic factor and a core dimension in conditions such as ODD and Disruptive Mood Dysregulation Disorder (DMDD), while also manifesting as a

symptom in other psychological disorders, including OCD. Heightened levels of irritability have been consistently linked to adverse outcomes, comorbidity, functional impairments, and treatment resistance (Boylan et al., 2007; Stringaris et al., 2012). A recent study explored executive functions in children aged 6-12 diagnosed with DMDD, ODD, and ADHD, and the associations between executive functions and irritability, employing both parents' ratings and performance-based tests (Brænden et al., 2023). Their findings suggest that elevated levels of irritability are linked to difficulties in emotional regulation and cognitive flexibility among children with DMDD and ODD when reported by parents, but no significant association emerged between irritability and neuropsychological tasks assessing executive function (Brænden et al., 2023). Therefore, children with heightened levels of irritability face increased difficulties in effectively navigating real-life situations, as reported by parents, and this is associated with impairments in executive functions pertaining to emotions. Similarly, several authors have pointed out that children with OCD exhibit executive functioning difficulties in their day-to-day experiences as reported by caregivers (Negreiros et al., 2020) and deficits in emotion regulation are linked to unfavorable treatment outcomes in children with OCD (McNamara et al., 2014).

From a neuroimaging perspective, studies provide insights into the neural mechanisms and common patterns of brain activation implicated in executive function processes and irritability. For instance, in a study involving preschoolers, a positive association was observed between cognitive flexibility and irritability at the neural level, characterized by activation in the lateral prefrontal cortex (Li et al., 2017). Similarly, another study found that higher levels of irritability, specifically the anger-frustration dimension, were associated with prefrontal cortex activation during an inhibitory control task (Fishburn et al., 2019).

Furthermore, several studies focusing on reward processing as an underlying mechanism for irritability, revealed neural dysfunction in brain regions associated with reward processing and emotion regulation, which contribute to clinically significant impairments in irritability (Brotman et al., 2017; Perlman et al., 2015). Lacombe et al. (2022) suggest that cognitive flexibility and inhibitory control are relevant to reward processing and play a role in modulating irritability. Their findings indicate that executive functions can serve as either risk or protective factors, depending on their level of development and it can impact how irritable youths adapt and react to various outcomes within reward-based situations (Kryza-Lacombe et al., 2022).

Both OCD and ODD have complex etiologies involving a combination of genetic, cognitive, and environmental factors. At the cognitive level, we have seen that they share a similar pattern of brain activation, which is also involved in executive functions such as cognitive flexibility, inhibition, but also reward processing. Considering the association between these processes and irritability, as well as the negative developmental outcomes associated with irritability, investigating irritability as a potential mediator between executive functions and the development of ODD and ODP can provide a more comprehensive understanding of the underlying mechanisms contributing to the onset of these disorders and their comorbidity.

Parenting Practices

Other potential mediators in the relationship between executive functions and ODP and OCP may involve parenting practices. The influence of parenting on executive functions is reflected in several studies and it can act as either a facilitator or a risk factor for their development. For instance, positive parenting (autonomy, support, scaffolding, stimulation) was associated with improved cognitive abilities and self-regulation (Valcan et al., 2018). On the contrary, punitive

practices were related to poor inhibitory control in children (Valcan et al., 2018). Ineffective

parenting practices, particularly those characterized by punitive and inconsistent approaches, also

play a role in the development and persistence of ODD in children (Brown et al., 2017; Derella et

al., 2020). Therefore, this explains why the modification of parenting practices is essential in the

treatment for ODD. Interventions targeting these modifications of parenting practices, like Parent

Management Training, yielded good results in children with ODD by decreasing symptomatology,

including when comorbidity was present (Costin & Chambers, 2007). In the case of OCD,

parenting style, in particular authoritarian and permissive parenting, has also been considered to

lead to OCD development and influence treatment outcomes (Goli et al., 2020). The literature on

family accommodation and the relationship with OCD is extensive and points to adjustments

families make to "accommodate" OCD symptoms (i.e., helping the child wash hands), with the

intention of alleviating the child's anxiety (Pontillo et al., 2020). However, this accommodation

has been associated with greater severity of OCD symptoms and poor response to treatment

(Jacoby et al., 2021; Pontillo et al., 2020). Hence, family accommodation has been targeted in

intervention, for example the Supportive Parenting for Anxious Childhood Emotions (SPACE)

Program, a parent-based treatment that focuses on changing the permissive behavior to a

supportive one that enables the child to tolerate anxiety and self-regulate, yielded good results and

a decrease in OCD symptoms and accommodations (Lebowitz, 2013).

Aims and Outline of this Thesis

This thesis focuses on developmental trends and associations of executive functions and

behavioral symptoms and aims to further understand the relationship between executive functions

and ODP and OCP in a Spanish community sample of preschoolers. In particular, the thesis attempts to extend prior knowledge by:

1) exploring whether executive functions at the age of 3 years are prospectively associated with ODP and their dimensions – irritability and headstrong -, and with OCP, all of them at the age of 6 years (Study 1)

2) examining prospective associations between executive functions related with inhibitory and emotional control and flexibility (at age 3) and ODP and OCP (at age 7) through irritability (at age 4) and parenting practices (at age 6) (Study 2)

The thesis consists of two studies that address the previously mentioned aims in order. The methodology used in the two studies is outlined first followed by the two studies. Finally, the integrated findings were thoroughly discussed, including clinical implications, strengths, and limitations. The reader can choose to either read the method section that presents the methodology for both studies together or the individual methodology in each study.

Chapter Two: Methodology

Participants

The thesis is part of a longitudinal study that focused on behavioral problems in a cohort of children followed from the age of 3 to adolescence (Ezpeleta et al., 2014).The sample of the two studies of the thesis is focused on ages 3 to 7. The initial sample of the longitudinal study included a total of 2,283 participants from 54 public and semi-public schools in Barcelona, selected through a random sampling method. The selection process consisted of two phases.

In the first phase, 1,341 families (58.7% of the initial sample) agreed to participate. The screening was conducted based on the study's primary focus, which was ODD. Parents were asked to complete a dimensional measure that assessed the presence of the eight symptoms of ODD as defined by the DSM-IV (American Psychiatric Association, 1994). This measure included four items of ODD (loses temper, defies rules, argues with adults, spiteful/vindictive), which were part of the conduct scale of the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997). Additionally, four symptoms (annoys people, blames others, touchy/annoyed, angry/resentful) were included to complete the DSM-IV definition of ODD.

In the second phase, two groups were identified. The screen-positive group consisted of children who met the criteria of having an SDQ score of ≥ 4 or a score of 2 "*certainly true*" in at least one of the eight DSM-IV ODD symptoms as reported by parents ($n = 417$; 49% boys). The screen-negative group consisted of a randomly selected sample of 205 children who did not meet the positive criteria. Consequently, the total sample for the follow-up assessments comprised 622 children, all of whom were 3 years old at the time of inclusion. There were no statistically

significant differences based on sex ($p = .95$), or type of school ($p = .85$) between participants. High-SES families had greater participation than low-status ones ($p < .001$).

In study 1, assessments from the longitudinal study conducted at 3 and 6 years of age were used. In study 2, assessments conducted at 3, 4, 6 and 7 years were used. Table 1 provides an overview of the participants of both studies.

Table 1

Summary of Participants in Each Study

	Study 1	Study 2
Participants	516[1]	622
Age (years)	3 - 6	3 - 7
Sex (female); %	49.1	50.0
Socioeconomic Status; %		
High	37.2	32.8
Medium- High/Medium	46.0	45.2
Medium- Low/Low	16.8	22.0
Born in Spain; %	97.3	96.9
Ethnicity; %		
Caucasian	92.8	89.1
Latino	3.8	6.4
Other	3.4	4.5

[1] Exclude participants with missing data.

Measures

a) **Executive Function**

The Behavior Rating Inventory of Executive Function preschool version (BRIEF-P; Gioia et al., 2003) is a questionnaire used to assess executive function behaviors in daily life among

preschool children aged 2-5 years. The teacher's rating form consists of 63 items rated on a 3-point ordinal scale (0: *Never*; 1: *Sometimes*; 2: *Often*) and is administered over a 6-month period to capture executive functions in a preschool environment. The BRIEF-P assesses five primary dimensions: Inhibit, Emotional Control, Shift, Working Memory, and Plan/Organize. These first-order scale scores contribute to the calculation of three second-order scale scores or indexes: 1) Inhibitory Self-Control Index (ISCI) encompassing Inhibit and Emotional Control, 2) Flexibility Index (FI) comprising Shift and Emotional Control, and 3) Emergent Metacognition Index (EMI) combining Working Memory and Plan/Organize. Additionally, a Global Executive Composite (GEC) is derived by summing the scores from all five scale scores, representing a comprehensive indicator of overall executive function difficulties in preschool children. Both studies used data collected from teachers when the children were 3 years old.

Study 1: In this study, all first-order scales except for Plan/Organize, second-order scales and total GEC scores were used as independent variables. Working Memory and Plan/Organize exhibited a high correlation coefficient of .89. Based on the ordinal alpha values, Working Memory ($\alpha = .98$) was chosen over Plan/Organize ($\alpha = .95$) due to its higher value. Internal consistency (ordinal alpha coefficient) of scale scores in the present sample ranged from .94 (Shift and Emotional Control) to .98 (Working Memory, EMI, and GEC).

Study 2: The scales considered in this study were ISCI and FI. The internal consistency, as measured by the ordinal alpha coefficient, for the scale scores in this sample were .96 for ISCI and .95 for FI.

b) Emotional and Behavioral Problems

Oppositional Defiant Problems and Dimensions

Study 1: In order to assess ODP, four items were derived from the Conduct Problems Scale of the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997) (loses temper, defies rules, argues with adults, spiteful/vindictive), along with an additional four items (annoys people, blames others, touchy/ annoyed, angry/resentful) that were included based on the symptomatology criteria outlined in DSM-IV for ODD. The SDQ is a brief screening questionnaire designed to assess emotional and behavioral difficulties in children and adolescents. The eight symptoms were coded using a 3-point Likert-type scale (0: *not true*; 1: *somewhat true*; 2: *certainly true*) and were rated by both teachers and parents when the children were 6 years of age. Furthermore, the study utilized ODD dimensions: irritability (loses temper, touchy/annoyed, angry/resentful) and headstrong (argues with adults, defies rules, annoys people, blames others, spiteful/vindictive) based on Rowe's 2-factor model (Rowe et al., 2010). These scores were obtained by summing the ratings of the corresponding items associated with each dimension.

Study 2: To evaluate ODP we used the DSM-5 oriented scale of the Child Behavior Checklist/6–18 (CBCL/6-18; Achenbach & Rescorla, 2001) that specifically targets oppositional defiant problems. This scale encompassed 6 items that assess the following behaviors: arguing, defiance, disobeying at home, disobeying at school, stubbornness, and displays of temper. Parents answered the questionnaire when children were 7 years old. The CBCL/6-18 is a widely used questionnaire answered by parents to evaluate behavioral and emotional challenges in children and adolescents. It consists of 113 items that parents rate on a 3-point Likert scale, ranging from 0 (*not true*) to 2 (*sometimes/often true*).

The irritability dimension of ODD was also used as a mediator variable. It was assessed by parents when the children reached the age of 4. The irritability dimension consisted of three items of the ODP measure.

Hyperactivity/inattention problems

The SDQ-hyperactivity/inattention scale score consists of five items rated on a 3-point scale (0 = *not true*, 1 = *somewhat true*, 2 = *certainly true*).

Study 1 and **Study 2**: The SDQ hyperactivity/inattention score, reported by parents or teachers, was used as a covariate in study 1. The SDQ hyperactivity/inattention score, reported by parents, was used as a covariate in study 2.

Obsessive-Compulsive Problems

Study 1 and **Study 2**: OCP were measured by the 2007 obsessive-compulsive problem scale (2007-OCP; Achenbach & Rescorla, 2007) of the CBCL/6-18 containing 8 items (9. Obsessions; 31. Fear doing/thinking something bad; 32. Perfectionism; 52. Feels too guilty; 66. Compulsions; 84. Strange behavior; 85. Strange ideas; 112. Worries) rated on a 3-point Likert scale (0: *not true*; 1: *sometimes true*; 2: *often true*). Parents completed the questionnaire when children were 6 years old.

c) **Parenting Practices**

Study 2: Parenting practices were assessed at age 6 using the Alabama Parenting Questionnaire for preschoolers, Spanish adaptation (APQ-PR; de la Osa et al., 2014). This is a 3-factor version of the questionnaire consisting of 24 items, rated on a 5-point format scale ranging

from 1 (*never*) to 5 (*always*). The parental dimensions were positive (12 items, e.g., friendly talk with your child, praise your child if he/she behaves well), inconsistent (7 items, e.g., threaten to punish your child and then do not punish, the punishment you give your child depends on the mood) and punitive (5 items, e.g., spank your child with hand when something wrong, yell/scream at your child when something wrong). Internal consistency (ordinal alpha coefficient) of scale scores for positive parenting, inconsistent parenting, and punitive parenting were .85, .72, and .73, respectively, in this sample.

Table 2 provides a summary of the instruments utilized in each of the studies.

Table 2

Instruments used in Each Study

Instruments	Study 1	Study 2
BRIEF-P (Gioia et al., 2003)	Inhibit, Emotional Control, Shift, Working Memory, Inhibitory Self-Control, Flexibility, Emergent Metacognition, GEC reported by teachers as independent variables	Inhibitory Self-Control and Flexibility reported by teachers as exogenous variables
The Strengths and Difficulties Questionnaire (Goodman, 1997)	ODP reported by parents and teachers as a dependent variable (4 items from the SDQ + 4 additional items) ODP dimensions: Irritability reported by parents and teachers (1 item from the SDQ + 2 additional items) as a dependent variable; Headstrong reported by parents and teachers (3 items from the SDQ + 2 additional items) as a dependent variable Hyperactivity/inattention (SDQ hyperactivity/inattention scale) reported by parents or teachers as a covariate	Irritability reported by parents as a mediator variable (1 item from the SDQ + 2 additional items) Hyperactivity/inattention (SDQ hyperactivity/inattention scale) reported by parents as a covariate
Child Behavior Checklist (Achenbach & Rescorla, 2001, 2007)	OCP reported by parents as a dependent variable (2007 obsessive-compulsive problem scale (2007-OCP) of the CBCL/6-18)	ODP (the DSM-5 oriented scale of the CBCL/6-18) reported by parents as an endogenous variable OCP (2007-OCP) reported by parents as an endogenous variable
Alabama Parenting Questionnaire Preschool Spanish adaptation (de la Osa et al., 2014)		Positive, inconsistent, and punitive parenting as mediator variables

Note. BRIEF-P: The Behavior Rating Inventory of Executive Function; GEC: Global Executive Composite; SDQ: Strengths and difficulties questionnaire; CBCL: Child Behavior Checklist; OCP: Obsessive - Compulsive Problems; ODP: Oppositional Defiant Problems.

Procedure

The project received approval from the Ethics Committee on Animal and Human Experimentation of the Autonomous University of Barcelona. The committee adheres to the ethical standards outlined in the 1964 Declaration of Helsinki and its amendments. The recruitment process took place in schools, where details regarding the project objectives were provided. Informed consent was obtained from all participants' families prior to their inclusion in the study. Parents of 3-year-old children who agreed to participate were invited to complete the SDQ at home and return it to the schools. Families who agreed and met the screening criteria were contacted via telephone and interviewed at the school. Follow-up assessments were completed on an annual basis. The interviewers had received prior training and were blind to the children's screening group.

Data Analysis

The statistical analysis was performed with Stata version 16 and Mplus8.9. Considering the multistage sampling procedure used, all the analyses were weighted by the inverse probability of selection in the second phase of sampling.

Statistical Analysis of Study 1

The independent variables were BRIEF-P scales measured at age 3 and dependent variables ODP and OCP at age 6. Specifically, and regarding BRIEF-P scores, one regression model was conducted for the first-order scales entered simultaneously. The Plan/Organize scale was excluded from the analysis due to its high correlation with Working Memory. Working Memory was

selected for inclusion in the analysis based on the higher value of the ordinal alpha. Further, one regression model for each of the three second-order scales entered separately was performed, and finally, one for GEC. Additionally, another set of multiple linear regression analyses was undertaken to explore the relationship between executive functions and each specific ODP dimension.

Each of the models was adjusted by the potential confounding variables (sex, SES, hyperactivity reported by the same informant) when necessary. Covariates were included when the difference between parameter estimates of adjusted and crude models was > 10% (Maldonado & Greenland, 1993).

Statistical Analysis of Study 2

Structural Equation Modeling (SEM) was used to determine the pathways from ISCI and FI at age 3 to ODP and OCP at age 7, via irritability at age 4 and parental practices at age 6.

The following indices were used to evaluate the goodness of fit: χ^2 test ($p > .05$), Root Mean Square Error of Approximation (RMSEA < .06), Comparative Fit Index (CFI > .90), Tucker-Lewis Index (TLI > .90), and Standardized Root Mean Squared Residual (SMSR < .08). The values in the parentheses represent the recommended thresholds for considering the model fit as satisfactory.

Chapter Three: Results

Study 1. Predictive Associations of Executive Functions and Oppositional Defiant Problems and Obsessive-Compulsive Problems in Preschoolers

Zevedei, D.E., Penelo, E., Navarro, J.B., de la Osa, N., & Ezpeleta, L (2023). *Predictive associations of executive functions and oppositional defiant problems and obsessive-compulsive problems in preschoolers* [Manuscript in preparation]**.** Departament de Psicologia Clínica i de la Salut, Universitat Autònoma de Barcelona

Main results of study 1:

- Higher inhibition, emotional control and lower shift were associated with higher ODP

- Flexibility deficits were associated with the irritability dimension of ODP

- Inhibitory Self-Control deficits were associated with both irritability and headstrong dimensions of ODP

- Flexibility deficits were related to ODP and OCP

Study 2. Irritability and Parenting Practices as Mediators between Executive Functions and Oppositional and Obsessive-Compulsive Problems in Preschool Children

Zevedei, D.E., authors (2023). *Irritability and parenting practices as mediators between executive functions and oppositional and obsessive-compulsive problems in preschool children*. [Manuscript in preparation]. Departament de Psicologia Clínica i de la Salut, Universitat Autònoma de Barcelona

Main results of study 2:

- A direct and an indirect effect via punitive parenting from ISCI to ODP

- An indirect effect from FI to ODP via irritability and/or punitive parenting

- A direct effect from ISCI to OCP

- A direct and an indirect effect from FI to OCP via irritability

Predictive Associations of Executive Functions and Oppositional Defiant Problems and Obsessive-Compulsive Problems in Preschoolers

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Abstract

Objectives: Oppositional defiant problems (ODP) and obsessive-compulsive problems (OCP) may co-occur in children, though the way they interact is not known. The aim of the study was to examine longitudinal associations between executive functions at age 3 and ODP, ODP dimensions, and OCP at age 6. **Method:** The sample consisted of 622 preschoolers (50% were boys) from the general population. Executive functions were assessed by teachers using the Behavior Rating Inventory of Executive Functioning – Preschool version questionnaire when children were 3 years old, and ODP and OCP were informed by parents and teachers at the age of 6 years. **Results:** Multiple linear regression analyses indicated that higher Inhibit and Emotional Control and lower Shift deficits were associated with higher ODP reported by teachers, while higher Shift but lower Inhibit deficits were related to higher OCP. Moreover, ODP and OCP shared difficulties on the Flexibility Index, which means that the capacity to modulate emotions and behavior according to contextual and environmental demands is compromised in both disorders. **Conclusions:** The findings inform etiology and prevention, pointing out not only the executive function specificities related to each problem, but also common cognitive challenges related to Flexibility. Young children could benefit from training and programs designed to improve executive function processes at an early age to prevent later behavioral difficulties.

Keywords: cognition, headstrong, irritability, flexibility, psychopathology, externalizing disorders

Predictive Associations of Executive Functions and Oppositional Defiant Problems and

Obsessive-Compulsive Problems in Preschoolers

Introduction

Executive function encompasses a range of interrelated cognitive processes necessary for regulating emotions and goal-driven behaviors (Miyake et al., 2000). Inhibition (i.e., the ability to control, stop, and shape one's behavior), working memory (i.e., the ability to retain basic information necessary to complete a task) and shifting (i.e., the ability to switch between tasks and situations effortlessly) are considered primary domains (Diamond, 2013). These processes are categorized as either "cold", typically measured through neuropsychological tests, or "hot", assessed in emotionally laden contexts or scenarios involving rewards (Zelazo & Carlson, 2012).

Deficiencies in executive function have been associated with a wide range of adverse outcomes, including behavioral difficulties (Schoemaker et al., 2013), suboptimal educational outcomes (Cantin et al., 2016), and diminished overall well-being among other negative impacts. The accelerated maturation of executive function during the preschool period, along with its malleable nature, make this stage an optimal timeframe for intervention (Zelazo & Carlson, 2012). Executive function performance is contingent on the development of the prefrontal cortex (Ferguson et al., 2021) and abnormalities in this area have been linked to Oppositional Defiant Disorder (ODD) (Noordermeer et al., 2016) and Obsessive-Compulsive Disorder (OCD) (Malloy, 2019).

The current study aims to explore the association between executive functions and Oppositional Defiant Problems (ODP) and Obsessive-Compulsive Problems (OCP), which to our knowledge, have not been concurrently investigated. The etiology of these problems is

multifaceted, with evidence suggesting that a combination of environmental, genetic, and biological factors contribute to their development.

Executive functions, ODD and ODD dimensions

ODD is a widespread disruptive behavior among children and adolescents and is explained as "a pattern of angry/irritable mood, argumentative/defiant behavior, or vindictiveness lasting at least 6 months" (American Psychiatric Association, 2013). ODD is further described as a multifactorial disorder (Coskun et al., 2012) caused by genetic, biological, and environmental factors (Azeredo et al., 2018).

In regards to the relationship between executive functions and ODD, there is no consensus among the researchers on their association, and most frequently, this is analyzed and explained in conjunction with other diagnoses such as Attention-Deficit/Hyperactivity Disorder (ADHD) or conduct disorder (CD) (Hobson et al., 2011; Schoorl et al., 2018). Some studies suggested that deficiencies in executive functions are not distinctive features of ODD but rather they are ADHD- specific (Granero et al., 2015), whereas others studies suggest that comorbid ADHD/ODD condition results in more severe impairments (Skogan et al., 2016; Trani et al., 2011). However, a small number of studies reported executive functions deficits in ODD, mainly in the visual working memory and inhibition domains, while accounting for hyperactivity (Kleine Deters et al., 2020; Rhodes et al., 2012).

Research on ODD emphasizes its multidimensional nature, which can provide insight into potential associations and pathways leading to problematic behaviors (Waldman et al., 2021). Prior studies have identified a 2-dimensional model including *irritable* and *headstrong* (Rowe et al., 2010) or a 3-component model where *hurtful* is included in addition to irritable and headstrong (Stringaris & Goodman 2009). Research has shown that the irritable dimension (e.g.,

symptoms of anger, tantrums, and annoyance) predicts internalizing disorders and emotional

problems, whereas headstrong (e.g., argumentative behaviors with adults, rule defiance) relates

to ADHD, and hurtful forecasts CD and aggressive symptoms (Rowe et al. 2010; Stringaris &

Goodman 2009). Hence, assessing the relationships between executive function and ODD

dimensions may elucidate potential associations between specific cognitive processes and

internalizing or externalizing problems, including OCD. The ODD irritability dimension, for

example, has previously been related to difficulties in shifting and emotional control (also FI),

and headstrong to challenges in inhibitory self-control (Ezpeleta et al., 2012).

Executive functions and OCD

Similar to ODD, OCD is a common condition in childhood and adolescence that results

from both genetic and environmental factors (Krebs & Heyman, 2015). OCD is a chronic

condition described by "recurrent intrusive thoughts/impulses and contingent ritualized

behavior" (Lewin et al., 2014, p.108).

In terms of executive functions and OCD, although impaired inhibition, set-shifting, and

working memory difficulties are admittedly present in adults (Abramovitch et al., 2015), studies

among preschoolers are scarce. Some studies report a small effect size or no evidence of

executive functions deficits among children with OCD (Hybel et al., 2017). In contrast, other

studies suggest deficits in several areas of executive functions in school-age children, such as

set-shifting (Ornstein et al., 2010), inhibition (Mancini et al., 2018), working memory (Bernardes

et al., 2020; Fakhri & Yuzbashi, 2020) and planning (Negreiros et al., 2020; Ornstein et al.,

2010). Moreover, these deficits are associated with OCD severity and suboptimal treatment

response (Fakhri & Yuzbashi, 2020; McNamara et al., 2014). Even so, the results are

inconsistent across studies, and deficits are primarily reflected in assessments based on parent or

teacher ratings rather than performance-based tests, suggesting that children with OCD may experience significant difficulties in daily executive function-related activities (Negreiros et al., 2020).

Comorbidity ODD and OCD

ODD and OCD have received limited joint research attention. Despite their potential comorbidity falling within the range of 12-40% (Ale & Krackow, 2011; Coskun et al., 2012), the underlying factors contributing to the co-occurrence of OCD and ODD are not yet fully understood. For instance, a neuroimaging study has revealed that both OCD and ODD exhibit analogous overactivation patterns in the anterior medial area of the frontal lobes with role in attention shifting (Amen & Carmichael, 1997). This similarity prompts the question of whether executive function plays a role in the relationship between the two disorders. Previous research has shown that the irritability dimension of ODD is linked to obsessive-compulsive behaviors in a sample of children with Gilles de la Tourette syndrome and chronic tic disorder (Thériault et al., 2014), and emotional control deficits in children with OCD suggest a greater probability of coexisting ODD (McKenzie et al., 2020). Overall, OCD/ODD joint consideration can provide insight into the shared and distinct executive function deficits potentially contributing to their early onset.

Therefore, this exploratory study aims to determine whether executive functions at the age of 3 years are prospectively associated with ODP and its dimensions – irritability and headstrong -, and with OCP, all of them at the age of 6 years. The results on common executive function difficulties can inform the development of more targeted treatments for children with oppositional and obsessive-compulsive problems. For example, an approach that has shown efficacy in such cases is a modified treatment protocol that employs cognitive-behavioral therapy

and parent management training (Sukhodolsky et al., 2013). Similarly, treatment can be customized to tackle executive function skills.

Method

Participants

The sample was drawn from a longitudinal study on behavioral problems that followed a cohort of children from 3 years old. A total of 2283 participants from 54 public and semi-public schools in Barcelona were randomly chosen and included in the initial sample. The selection process consisted of two phases. In the first screening phase, a total of 1,341 families (58.7%) consented to participate. The screening was based on the main study focus, which was ODD, thus a dimensional measure containing the eight symptoms of ODD according to DSM-IV (American Psychiatric Association, 1994) was answered by parents. This measure contained four items of ODD (loses temper, defies rules, argues with adults, spiteful/vindictive) included in the conduct scale of the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997) along with four additional symptoms (annoys people, blames others, touchy/ annoyed, angry/resentful) to complete the ODD definition of DSM-IV. For the second phase, two groups were further regarded. As screen positive, children who met the SDQ scores ≥ 4 criteria or obtained a score 2 "certainly true" in at least one of the eight DSM-IV ODD symptoms reported by parents were selected (a total of 417 children). And as screen negative, a random sample of 205 children who did not meet the aforementioned conditions was also included in the study sample. Therefore, the total sample to participate in the follow-ups included 622 children aged 3, of these, 311 (50%) were boys, 35.4% were of high socioeconomic status (SES), 46.3% were of middle status, and 18.3% were of low status. 97.2% were born in Spain, 2.8% were born outside Spain, and 91.1% were Caucasian. Figure 1 details the flow-chart with the screening process and the measures

administered at the two time-points. A total of 516 children remained in the follow-up at 6 years. A description of the sample followed at age 6 is shown in Table 1.

The level of nesting between children and teachers was low. A total of 91 teachers (from 54 different schools) and 100 (from 71 different schools) participated at ages 3 and 6, respectively. At age 3, the range of children per teacher was 1-13 ($Mdn = 7$) and most of the teachers (mode = 19, 20.9%) rated 7 children each. At age 6, the range of children per teacher was 1-11 ($Mdn = 5$) and most of the teachers (mode = 18, 18.0%) rated 5 children each. Given that the level of non-independence regarding teachers could therefore be considered negligible, we found it not necessary to account for this issue in the models.

Procedure

Families of 3-year-old children were recruited at the schools and written consent was obtained. Preschool education in Spain is publicly financed and 3-year-olds are enrolled in preschool education. In the screening phase, 1,341 families of 3-year-old children filled out the SDQ. The families that constituted the study sample were invited to participate in the follow-ups and on-site yearly assessments. Teachers answered the questionnaires after permission from the families was obtained. The project has been approved by the Ethical Committee at the corresponding authors' institution.

The project was approved by the Ethics Committee on Animal and Human Experimentation of the authors 'university. Families gave written consent for the assessment.

This study follows the Journal Article Reporting Standards for quantitative and longitudinal studies and the eight guidelines of the Transparency and Openness Promotion. Therefore, we inform that the data, materials, and analysis syntax of this study cannot be made

publicly available due to ethical restrictions protecting the confidentiality of the families

involved. Also, the study and the analysis plan were not preregistered.

Measures

The Behavior Rating Inventory of Executive Function – Preschool version (BRIEF-P)

(Gioia et al., 2000) is an assessment questionnaire of executive functions behaviors in daily life

for preschool children aged 2-5 years. The teachers' rating form consists of 63 items on a 3-point

ordered scale (0- *Never,* 1-*Sometimes*, 2-*Often*), and is used to measure executive functions in a

preschool environment over a 6-month period. The five dimensions measured are Inhibit,

Emotional Control, Shift, Working Memory, and Plan/Organize. These first-order scale scores

form three indexes or second-order scale scores: 1) Inhibitory Self-Control Index (ISCI)

consisting of Inhibit and Emotional Control, 2) Flexibility (FI) which includes the scores of Shift

and Emotional Control, 3) Emergent Metacognition Index (EMI) embodying Working Memory

and Plan/Organize, in addition to a total score of all five scale scores – the Global Executive

Composite (GEC), which is as a general indicator of executive functions' difficulties. For all

BRIEF-P scores, higher values indicate more deficits. The study used the data collected from

teachers when the children were 3 years old. Internal consistency (ordinal alpha coefficient) of

scale scores in the present sample ranged from .94 (Shift and Emotional Control) to .98

(Working Memory, EMI, and GEC).

Similarly, to the screening procedure, ODP was measured at the age of 6 years. The 8

symptoms were coded on a 3-point Likert-type scale (0: *not true*; 1: *somewhat true*; 2: *certainly*

true) and filled out by parents and teachers at 6 years old. ODP dimension scores based on

Rowe's 2-factor model (Rowe et al., 2010) were determined by summing the ratings of each

item: Irritability (*loses temper, touchy annoyed, angry resentful*) and Headstrong (*argues with*

adults, defies rules, annoys people, blames others, spiteful/vindictive) (Ezpeleta et al., 2012).

SDQ-hyperactivity/inattention score was used to adjust for hyperactivity and was reported by

both informants. Internal consistency (ordinal alpha coefficient) of scale scores used in the

presented sample ranged from .76 (headstrong rated by parents) to .94 (total score rated by

teachers). Higher values are indicative of more ODP and hyperactivity.

OCP was measured by the 2007-OCP CBCL/6-18 scale (Achenbach & Rescorla, 2007).

The scale contains 8 items (obsessions, fear doing/thinking something bad, perfectionism, feels

too guilty, compulsions, strange behavior, strange ideas, worries) rated on a 3-point format from

0 (*not true*) to 2 (*sometimes or often true*) that were answered only by parents when the children

were 6 years old. Higher values are indicative of more OCP. Internal consistency (ordinal alpha

coefficient) of scale score in the presented sample was .81.

Statistical Analysis

Data analyses were conducted with Stata version 16. Given the multistage sampling

procedure used, all the analyses were weighted by the inverse probability of selection in the

second phase of sampling.

All the analyses used raw scores for questionnaire measures. A correlation matrix (Table

2) was initially performed, providing insight into the magnitude of association among measures.

Two first-order BRIEF-P scale scores, Working Memory and Plan/Organize, were highly

correlated (.89). Working Memory was selected based on the ordinal alpha, which had a higher

value (.98) than Plan/Organize (.95).

In order to assess the relationship between executive functions reported by teachers at age

3 and ODP (reported by parents and teachers) and OCP (reported by parents), both at age 6,

multiple linear regressions were performed. Specifically, and regarding BRIEF-P scores, we

conducted one regression model for the first-order scales entered simultaneously as predictors,

one for each of the three considered second-order scales entered separately, and one for

GEC. Furthermore, another set of multiple linear regression analysis was undertaken to explore

the relationship between executive functions and each specific ODP dimension. Each of the

models was adjusted by the potential confounding variables (sex, SES, hyperactivity reported by

the same informant at age 3) when necessary. Covariates were included when the difference

between parameter estimates of adjusted and crude models was > 10% (Maldonado & Greenland

1993).

<div align="center">Results</div>

Predictive Associations of Executive functions and ODP

The left part of Table 3 presents executive function associations at age 3 on ODP at age 6

reported by parents, adjusted by hyperactivity when necessary. The first-order scale results did

not show any associations between executive functions and ODP reported by parents. However,

the results for the composite scales ISCI, FI, and the GEC showed that higher scores, hence

higher difficulties in ISCI, FI, and GEC at age 3, were associated with more severe ODP at age

6.

As illustrated in the central part of Table 3, based on teacher's ratings and adjusted by

hyperactivity when necessary, the first-order scale results revealed significant associations

between executive functions at age 3 and ODP at age 6, specifically, higher Inhibit and

Emotional Control problems and lower Shift scores at age 3 were associated with more severe

ODP at age 6. Also, higher difficulties on the composite ISCI at age 3 were linked to higher ODP

scores at age 6.

Predictive Associations of Executive Functions and OCP

Right part of Table 3 presents executive function associations at age 3 on OCP at age 6 reported by parents, adjusted by hyperactivity when necessary. The first-order scale results showed associations between executive functions and OCP, namely higher Shift and lower Inhibit scores at age 3 were associated with more heightened OCP at age 6. Furthermore, higher scores in the composite FI difficulties at age 3 were related to higher scores in OCP at age 6.

Predictive Associations of Executive Functions and ODP Dimensions

The results of the multiple linear regression analyzing the predictive association of executive functions reported by teachers and ODP dimensions (irritability and headstrong) reported by parents (Table 4, left), adjusted by hyperactivity when necessary, revealed that higher ISCI, FI, and GEC at age 3 were associated with higher irritability at age 6, and higher ISCI and GEC at age 3 were associated with higher headstrong at age 6. Regarding teachers as reporters (Table 4, right), higher Emotional Control problems and ISCI at age 3 and lower Shift scores were associated with higher irritability at age 6. Furthermore, higher scores in Inhibit and ISCI were associated with higher headstrong at age 6.

Discussion

The study aimed to explore the relationship between executive functions evaluated at 3 years old and ODP and OCP at 6 years old, focusing on the specificity of each problem but also the common characteristics these problems may share in relation to executive functions. In addition to showing specific associations, such as inhibition difficulties in ODP and shifting difficulties in OCP, the findings revealed a previously unknown commonality between OCP and ODP, indicating that both problems are related to FI deficits. To the author's knowledge, this is the first study to ascertain common factors that may explain the comorbidity between ODP and

OCP among preschool children. It was also determined that ODP was associated with several measures of EF, such as ISCI, FI and GEC indexes, meanwhile OCP was associated with FI.

Relations between Executive Functions and ODP and ODP Dimensions

Higher difficulties in ISCI, FI, and GEC, when reported by parents, and difficulties in Inhibit, Emotional Control, and ISCI, based on teachers' ratings, were associated with higher ODP difficulties at age 6. According to both informants, ISCI difficulties are associated with higher ODP, meaning that the ability to regulate actions, emotions, and demeanor via inhibitory control is altered in children with ODP, no matter the context (school or home). Both dimensions, irritability and headstrong, are associated with this ISCI index, which seems central in ODP, and that includes difficulties in inhibition (probably reflecting headstrong symptoms) and emotional control (probably reflecting irritability symptoms). These results may indicate that one of the deficits behind the dimensions of ODP (and of ODP) may be the difficulties in the development of EF (Ezpeleta et al., 2012).

ODP was also associated with deficits in FI (shift + emotional control) at home. When ODP was split in their dimensions, the association was due to irritability symptoms (not to headstrong). This is consistent with studies indicating that children with ODD are susceptible to negative emotions and when these are experienced, they get caught up in their emotions, unable to redirect their attention and switch from one action, emotional response, or behavior to another (Jiang et al., 2016; Kleine Deters et al., 2020). When the reporter is the teacher, only shift (a component of FI) is significantly and negatively associated to ODP (due to irritability association). In this case, higher impairments in shifting are associated with a decrease in oppositional problems at age 6. This counterintuitive result is difficult to explain and needs further research. However, it may be due to the fact that preschool children with externalizing

behavior recover some of their delays as their development of executive functions improves,

typically when they start school which may explain the reduction in these behaviors

(Schoemaker et al. 2013). Also, other environmental factors such as the school context, where

the limits are clearly established, might have a role in shaping child's behavior boosting the

development of flexibility.

Finally, the global index GEC reflects an association between executive functions

problems at age 3 and higher ODP (and irritability and headstrong) at age 6, meaning that,

developmentally, early problems in summary executive functions are predictably associated with

later behavioral difficulties related to oppositional behavior.

In sum, ODP are related with deficits in the development of EF that imply inhibition,

emotional control, and flexibility and, specifically, the irritability dimension of ODP is

associated with deficits in inhibition, emotional control and flexibility, and the headstrong

dimension with inhibition and emotional control. These findings have implications for etiological

research and for intervention.

Relations between Executive Functions and OCP

The association between higher OCP and difficulties in Shift and FI index (shift +

emotional control) aligns with prior research pointing out a link between deficits in set-shifting

and elevated levels of OCP in children aged 11-12 years (McNamara et al., 2014; Ornstein et al.,

2010). This may be an indication that shifting difficulties identified in early childhood may be an

attribute of early-onset OCD as these difficulties persist later in adolescence and continue into

adulthood (Zhang et al., 2015).

Also, higher Inhibit scores were related to lower OCP, and children who evinced higher

difficulties in inhibition at age 3 engaged in fewer obsessive-compulsive behaviors at age 6.

Although inhibition deficits are prevalent in adults with OCD (Lei et al., 2015), the results are contradictory in children with OCD. Some studies reflect the presence of inhibition deficits in relatively small samples of children (Mancini et al., 2018), but others suggest that deficits in flexibility and planning are rather associated with OCD children and that they do not experience inhibition difficulties like adults (Ornstein et al., 2010). Similar to our findings, Pietrefesa and Evans (2007) reported an inverse relationship between inhibition and compulsive-like behaviors among children over 6 years old, while a positive relationship emerged in younger children. One possible explanation is that younger children are prone to engage in compulsions (e.g. rituals around meals or bed time) as "a more involuntary yet adaptive response" (p.44) and, once performed, these have a role in reducing anxiety (Pietrefesa & Evans, 2007). The results indicate that the relationship between inhibition and compulsive behaviors could interact differently over time and that the development of inhibition entails significant changes, specifically between 3 and 6 years (Anderson & Reidy, 2012). In addition to age, OCD-specific symptoms, and their correlation to cognitive (obsessive symptoms) versus behavioral inhibition (compulsive symptoms) should be factored in for a better understanding of the relationship. If in adult samples, cognitive inhibition deficits are associated with obsessive symptoms (Glover & Moyer, 2018), these may be difficult to measure in early childhood since compulsions develop before obsessions or children may not be able to articulate intrusive thoughts (Evans et al., 2004).

Deficits in FI - The Common Point between ODP and OCP

Our findings revealed that ODP and OCP share impairment in executive functions, specifically, deficits in FI (shifting + emotional control) at age 3 reported by parents were associated with higher ODP and OCP difficulties at age 6. ODP and OCP children may share difficulties related to "hot" executive functions and their ability to shift in emotionally charged

situations may be hindered. It is important to note that FI is one of the prominent aspects of behavioral regulation, which implies the ability of the child to switch flexibly from one action to another, from one emotion to another, or from one behavior to another. If difficulties in FI are present, the capacity to regulate emotions and behaviors in response to contextual and environmental requests is compromised. The association of FI with higher ODP and OCP problems at age 6 indicates that these children face common difficulties in flexibility and emotional control when adapting their responses to contextual demands.

Consistent with previous research, children with ODP may have difficulty switching attention during emotional distress because their emotions tend to control them (Jiang et al., 2016). Similarly, children with OCP seem to exhibit shifting and emotional control deficits that are more observable in real-life environments and correlate with symptoms severity as reflected in previous research (McNamara et al., 2014). As difficulties often arise in day-to-day situations or contexts where emotional stimuli are present, future studies should examine aspects related to "hot" processes in these disorders. For instance, one study found that "affective flexibility", a hot aspect of executive function defined as "a subset of cognitive flexibility that involves the more specific ability to switch between emotion-focused and non-emotional cognitive sets" (Malooly et al., 2013, p.303) predicted emotion regulation in preschoolers (Martins et al., 2020). Finally, since FI is associated with the irritability dimension of ODP, it could be argued that irritability functions as an intermediary variable between FI and ODP. Studies have consistently acknowledged irritability as a transdiagnostic factor (Burke et al., 2014; Guzick et al., 2021), and higher irritability is indicative of a more acute clinical profile characterized by greater severity of ODD symptoms and a higher incidence of comorbidities such as anxiety or depression (Ezpeleta et al., 2016; Leadbeater & Homel, 2015), conduct problems (Leadbeater & Homel, 2015), and,

more recently, with impairments in OCD simples (Guzick et al., 2021; McNamara et al., 2014).

Interestingly, FI is specifically associated with irritability, and FI is also the common deficit in

executive functioning between ODP and OCP. Therefore, it may be that irritability is an

intermediate variable between FI and ODP and OCP. This must be tested to better understand the

etiological path between executive functioning and this different but associated symptomatology

of ODP and OCP.

The study has several strengths, including a relatively large sample of preschool children

from a general population, longitudinal assessment, multiple reporters (parents and teachers), the

developmental period under study and a focus on the specificity of ODP and OCP in relation to

executive functions. It is important to note some limitations of this study, specifically the

reliance on parent ratings alone to assess OCP at age 6 and the exclusive use of BRIEF as a

measure of executive function. Although BRIEF presents a series of advantages such as good

reliability and estimation of deficits in real-life contexts (Sherman & Brooks, 2010), it may not

provide a comprehensive measure of executive function and other regulatory abilities. The

discrepancies between informants' reports may be due to variations in the assessed environments

and informant differences. Future studies should include additional cognitive, behavioral and

performance-based measures of executive function available for use in preschool and early

school-aged children. Nevertheless, applying performance tests on a large scale may be

unfeasible if the goal is to detect early, prevent, and intervene promptly. In educational contexts,

questionnaires can inform how executive function difficulties impact daily functioning,

particularly in younger individuals. Teachers, as key observers, play a vital role in detecting

these challenges. In this context, questionnaires can serve as a viable alternative for facilitating

early identification and intervention. Of note, due to the common and dynamic changes in EF

difficulties and behavioral problems during the preschool years it can be challenging to establish

conclusive causal relationships between BRIEF results at age 3 and behavioral symptoms at age

6. Therefore, interpreting the results requires caution and future research should replicate these

findings at different ages for a more comprehensive understanding. Finally, the effect sizes based

on the reported beta weights are relatively small. And lastly, the results are generalizable only to

children from the general population.

The results have several important implications. According to parents and teachers, ISCI is

associated with both dimensions of ODP, irritability, and headstrong behavior. This indicates

that early ISCI difficulties (composed of Inhibit and Emotional Control scales) showed in

different contexts (at home and at school) are a risk factor for later higher irritability and

headstrong. The finding suggests that improving inhibition and emotional control at an early age

may be effective in mitigating the risk of developing co-occurring conditions associated with

dimensions of ODP. Additionally, the findings revealed that higher Emotional Control

difficulties at age 3 (first-order scale measured by teachers but also included in FI and in ISCI)

correspond to heightened irritability at age 6. This underscores the importance of addressing

emotional control difficulties during early childhood, as such issues are linked to an increased

vulnerability to psychopathology later in life and lead to a more severe ODP and comorbid

conditions (Ezpeleta et al., 2016). The early detection of emotional control challenges coupled

with targeted interventions, such as parent training and emotion-focused strategies, has been

associated with improvement in emotional control, resulting in decreased irritability (Leadbeater

& Homel, 2015; Leibenluft, 2017). Finally, the FI results imply that incorporating assessments of

hot aspects of executive functioning, which may be more perceptive to behavioral problems as

they unfold in real-life contexts, may provide a more comprehensive understanding of an

individual's cognitive and behavioral performance, potentially leading to more effective

treatment and better outcomes.

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Competing interest

The authors do not have any competing interest to disclose.

References

Abramovitch, A., Abramowitz, J. S., Mittelman, A., Stark, A., Ramsey, K., & Geller, D. A.
(2015). Research Review: Neuropsychological test performance in pediatric obsessive-
compulsive disorder - a meta-analysis. *Journal of Child Psychology and Psychiatry and
Allied Disciplines*, *56*(8), 837–847. https://doi.org/10.1111/jcpp.12414

Ale, C. M., & Krackow, E. (2011). Concurrent treatment of early childhood OCD and ODD: A
case illustration. *Clinical Case Studies*, *10*(4), 312–323.
https://doi.org/10.1177/1534650111420283

Amen, D. G., & Carmichael, B. (1997). Oppositional children similar to OCD on SPECT.
Journal of Neurotherapy, *2*(2), 1–6. https://doi.org/10.1300/J184v02n02_01

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental
Disorders*. American Psychiatric Association.
https://doi.org/10.1176/appi.books.9780890425596

Anderson, P. J., & Reidy, N. (2012). Assessing executive function in preschoolers.
Neuropsychology Review, *22*(4), 345–360. https://doi.org/10.1007/s11065-012-9220-3

Azeredo, A., Moreira, D., & Barbosa, F. (2018). ADHD, CD, and ODD: Systematic review of
genetic and environmental risk factors. *Research in Developmental Disabilities*,
82(February), 10–19. https://doi.org/10.1016/j.ridd.2017.12.010

Bernardes, E. T., Saraiva, L. C., E Souza, M. D. M., Hoexter, M. Q., Chacon, P., Requena, …
Batistuzzo, M. C. (2020). Cognitive performance in children and adolescents at high-risk
for obsessive-compulsive disorder. *BMC Psychiatry*, *20*(1), 1–13.
https://doi.org/10.1186/s12888-020-02751-5

Burke, J. D., Boylan, K., Rowe, R., Duku, E., Stepp, S. D., Hipwell, A. E., & Waldman, I. D.

(2014). Identifying the irritability dimension of ODD: Application of a modified bifactor

model across five large community samples of children. *Journal of Abnormal Psychology*,

123(4), 841–851. https://doi.org/10.1037/a0037898

Cantin, R. H., Gnaedinger, E. K., Gallaway, K. C., Hesson-McInnis, M. S., & Hund, A. M.

(2016). Executive functioning predicts reading, mathematics, and theory of mind during the

elementary years. *Journal of Experimental Child Psychology*, *146*, 66–78.

https://doi.org/10.1016/j.jecp.2016.01.014

Coskun, M., Zoroglu, S., & Ozturk, M. (2012). Phenomenology, psychiatric comorbidity and

family history in referred preschool children with obsessive-compulsive disorder. *Child and

Adolescent Psychiatry and Mental Health*, *6*(2005), 1–9. https://doi.org/10.1186/1753-2000-

6-36

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*, 135–168.

https://doi.org/10.1146/annurev-psych-113011-143750

Evans, D. W., Lewis, M. D., & Iobst, E. (2004). The role of the orbitofrontal cortex in normally

developing compulsive-like behaviors and obsessive-compulsive disorder. *Brain and

Cognition*, *55*(1), 220–234. https://doi.org/10.1016/S0278-2626(03)00274-4

Ezpeleta, L., Granero, R., De La Osa, N., Penelo, E., & Domènech, J. M. (2012). Dimensions of

oppositional defiant disorder in 3-year-old preschoolers. *Journal of Child Psychology and

Psychiatry and Allied Disciplines*, *53*(11), 1128–1138. https://doi.org/10.1111/j.1469-

7610.2012.02545.x

Ezpeleta, L., Granero, R., de la Osa, N., Trepat, E., & Domènech, J. M. (2016). Trajectories of

oppositional defiant disorder irritability symptoms in preschool children. *Journal of

Abnormal Child Psychology*, *44*(1), 115–128. https://doi.org/10.1007/s10802-015-9972-3

Fakhri, L. S., & Yuzbashi, M. (2020). *Comparison of the severity of obsession and working memory in children with Obsessive Compulsive Disorder and Healthy*. 8(82), 12275–12284. https://doi.org/10.22038/ijp.2020.50337.4006

Ferguson, H. J., Brunsdon, V. E. A., & Bradford, E. E. F. (2021). The developmental trajectories of executive function from adolescence to old age. *Scientific Reports*, *11*(1), 1–17. https://doi.org/10.1038/s41598-020-80866-1

Gioia, G. A., Isquith, P. K., Guy, S. C., Kenworthy, L., & Baron, I. S. (2000). Behavior rating inventory of executive function. *Child Neuropsychology*, *6*(3), 235–238. https://doi.org/10.1076/chin.6.3.235.3152

Glover, S., & Moyer, C. (2018). The examination of inhibition in Obsessive Compulsive Disorder. *Modern Psychological Studies*, *23*(2), 6.

Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. In *Journal of Child Psychology and Psychiatry and Allied Disciplines* (Vol. 38, Issue 5, pp. 581–586). https://doi.org/10.1111/j.1469-7610.1997.tb01545.x

Granero, R., Louwaars, L., & Ezpeleta, L. (2015). Socioeconomic status and oppositional defiant disorder in preschoolers: Parenting practices and executive functioning as mediating variables. *Frontiers in Psychology*, *6*(SEP), 1–12. https://doi.org/10.3389/fpsyg.2015.01412

Guzick, A. G., Geller, D. A., Small, B. J., Murphy, T. K., Wilhelm, S., & Storch, E. A. (2021). Irritability in children and adolescents with OCD. *Behavior Therapy*, *52*(4), 883–896. https://doi.org/10.1016/j.beth.2020.11.001

Hobson, C. W., Scott, S., & Rubia, K. (2011). Investigation of cool and hot executive function in ODD/CD independently of ADHD. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *52*(10), 1035–1043. https://doi.org/10.1111/j.1469-7610.2011.02454.x

Hybel, K. A., Mortensen, E. L., Lambek, R., Højgaard, D. R. M. A., & Thomsen, P. H. (2017). Executive function predicts cognitive-behavioral therapy response in childhood obsessive-compulsive disorder. *Behaviour Research and Therapy*, *99*, 11–18. https://doi.org/10.1016/j.brat.2017.08.009

Jiang, W., Li, Y., Du, Y., & Fan, J. (2016). Emotional regulation and executive function deficits in unmedicated Chinese children with oppositional defiant disorder. *Psychiatry Investigation*, *13*(3), 277–287. https://doi.org/10.4306/pi.2016.13.3.277

Kleine Deters, R., Naaijen, J., Rosa, M., Aggensteiner, P. M., Banaschewski, T., Saam, M. C., … Dietrich, A. (2020). Executive functioning and emotion recognition in youth with oppositional defiant disorder and/or conduct disorder. *World Journal of Biological Psychiatry*, *21*(7), 539–551. https://doi.org/10.1080/15622975.2020.1747114

Krebs, G., & Heyman, I. (2015). Obsessive-compulsive disorder in children and adolescents. *Archives of Disease in Childhood*, *100*(5), 495–499. https://doi.org/10.1136/archdischild-2014-306934

Leadbeater, B. J., & Homel, J. (2015). Irritable and defiant sub-dimensions of ODD: their stability and prediction of internalizing symptoms and conduct problems from adolescence to young adulthood. *Journal of Abnormal Child Psychology*, *43*(3), 407–421. https://doi.org/10.1007/s10802-014-9908-3

Lei, H., Zhu, X., Fan, J., Dong, J., Zhou, C., Zhang, X., & Zhong, M. (2015). Is impaired response inhibition independent of symptom dimensions in obsessive-compulsive disorder? Evidence from ERPs. *Scientific Reports*, *5*(April), 1–10. https://doi.org/10.1038/srep10413

Leibenluft, E. (2017). Irritability in children: what we know and what we need to learn. *World Psychiatry*, *16*(1), 100–101. https://doi.org/10.1002/wps.20397

Lewin, A. B., Larson, M. J., Park, J. M., McGuire, J. F., Murphy, T. K., & Storch, E. A. (2014). Neuropsychological functioning in youth with obsessive compulsive disorder: An examination of executive function and memory impairment. *Psychiatry Research*, *216*(1), 108–115. https://doi.org/10.1016/j.psychres.2014.01.014

Maldonado, G., & Greenland, S. (1993). Simulation study of confounder-selection strategies. *American Journal of Epidemiology*, *138*(11), 923–936. https://doi.org/10.1093/oxfordjournals.aje.a116813

Malloy, P. (2019). Frontal lobe dysfunction in obsessive-compulsive disorder. *The Frontal Lobes Revisited*, 207–223. https://doi.org/10.4324/9781315788975-11

Malooly, A. M., Genet, J. J., & Siemer, M. (2013). *Individual differences in reappraisal effectiveness : the role of affective flexibility*. *13*(2), 302–313. https://doi.org/10.1037/a0029980

Mancini, C., Cardona, F., Baglioni, V., Panunzi, S., Pantano, P., Suppa, A., & Mirabella, G. (2018). Inhibition is impaired in children with obsessive-compulsive symptoms but not in those with tics. *Movement Disorders*, *33*(6), 950–959. https://doi.org/10.1002/mds.27406

Manfei Xu, Wenqing Jiang, Yasong DU, Yan Li, J. F. (2017). *Executive Function Features in Drug-naive Children with Oppositional Defiant Disorder*. *24*(10), 228–236.

Martins, E. C., Mărcuş, O., Leal, J., & Visu-Petra, L. (2020). Assessing hot and cool executive functions in preschoolers: affective flexibility predicts emotion regulation. *Early Child Development and Care*, *190*(11), 1667–1681. https://doi.org/10.1080/03004430.2018.1545765

McKenzie, M. L., Donovan, C. L., Mathieu, S. L., Hyland, W. J., & Farrell, L. J. (2020). Variability in emotion regulation in paediatric obsessive-compulsive disorder: Associations

with symptom presentation and response to treatment. *Journal of Obsessive-Compulsive and Related Disorders*, *24*. https://doi.org/10.1016/j.jocrd.2019.100502

McNamara, J. P. H., Reid, A. M., Balkhi, A. M., Bussing, R., Storch, E. A., Murphy, T. K., … Geffken, G. R. (2014). Self-regulation and other executive functions relationship to pediatric OCD severity and treatment outcome. *Journal of Psychopathology and Behavioral Assessment*, *36*(3), 432–442. https://doi.org/10.1007/s10862-014-9408-3

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & 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

Negreiros, J., Best, J. R., Yamin, D. F., Belschner, L., Lin, S., & Stewart, S. E. (2020). Test-based versus parent ratings of executive function in pediatric Obsessive-Compulsive Disorder. *Journal of Obsessive-Compulsive and Related Disorders*, *24*(November 2019), 100495. https://doi.org/10.1016/j.jocrd.2019.100495

Noordermeer, S. D. S., Luman, M., & Oosterlaan, J. (2016). A systematic review and meta-analysis of neuroimaging in Oppositional Defiant Disorder (ODD) and Conduct Disorder (CD). Taking Attention-Deficit Hyperactivity Disorder (ADHD) into account. *Neuropsychology Review*, *26*(1), 44–72. https://doi.org/10.1007/s11065-015-9315-8

Ornstein, T. J., Arnold, P., Manassis, K., Mendlowitz, S., & Schachar, R. (2010). Neuropsychological performance in childhood OCD: A preliminary study. *Depression and Anxiety*, *27*(4), 372–380. https://doi.org/10.1002/da.20638

Pietrefesa, A. S., & Evans, D. W. (2007). Affective and neuropsychological correlates of children's rituals and compulsive-like behaviors: Continuities and discontinuities with

obsessive-compulsive disorder. *Brain and Cognition*, *65*(1), 36–46.

https://doi.org/10.1016/j.bandc.2006.02.007

Rhodes, S. M., Park, J., Seth, S., & Coghill, D. R. (2012). A comprehensive investigation of

memory impairment in attention deficit hyperactivity disorder and oppositional defiant

disorder. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *53*(2), 128–

137. https://doi.org/10.1111/j.1469-7610.2011.02436.x

Rowe, R., Costello, E. J., Angold, A., Copeland, W. E., & Maughan, B. (2010). Developmental

pathways in oppositional defiant disorder and conduct disorder. *Journal of Abnormal

Psychology*, *119*(4), 726–738. https://doi.org/10.1037/a0020798

Schoemaker, K., Mulder, H., Deković, M., & Matthys, W. (2013). Executive functions in

preschool children with externalizing behavior problems: A meta-analysis. *Journal of

Abnormal Child Psychology*, *41*(3), 457–471. https://doi.org/10.1007/s10802-012-9684-x

Schoorl, J., van Rijn, S., de Wied, M., van Goozen, S., & Swaab, H. (2018). Boys with

Oppositional Defiant Disorder/Conduct Disorder Show Impaired Adaptation During Stress:

An Executive Functioning Study. *Child Psychiatry and Human Development*, *49*(2), 298–

307. https://doi.org/10.1007/s10578-017-0749-5

Sherman, E. M. S., & Brooks, B. L. (2010). Behavior rating inventory of executive function -

Preschool version (BRIEF-P): Test review and clinical guidelines for use. *Child

Neuropsychology*, *16*(5), 503–519. https://doi.org/10.1080/09297041003679344

Skogan, A. H., Egeland, J., Zeiner, P., Øvergaard, K. R., Oerbeck, B., Reichborn-Kjennerud, T.,

& Aase, H. (2016). Factor structure of the Behavior Rating Inventory of Executive

Functions (BRIEF-P) at age three years. *Child Neuropsychology*, *22*(4), 472–492.

https://doi.org/10.1080/09297049.2014.992401

Stringaris, A., & Goodman, R. (2009). Three dimensions of oppositionality in youth. *Journal of*

    Child Psychology and Psychiatry and Allied Disciplines, *50*(3), 216–223.

    https://doi.org/10.1111/j.1469-7610.2008.01989.x

Sukhodolsky, D. G., Gorman, B. S., Scahill, L., Findley, D., & McGuire, J. (2013). Exposure and

    response prevention with or without parent management training for children with

    obsessive-compulsive disorder complicated by disruptive behavior: A multiple-baseline

    across-responses design study. *Journal of Anxiety Disorders*, *27*(3), 298–305.

    https://doi.org/10.1016/j.janxdis.2013.01.005

Thériault, M. C. G., Lespérance, P., Achim, A., Tellier, G., Diab, S., Rouleau, G. A., … Richer,

    F. (2014). ODD irritability is associated with obsessive-compulsive behavior and not

    ADHD in chronic tic disorders. *Psychiatry Research*, *220*(1–2), 447–452.

    https://doi.org/10.1016/j.psychres.2014.07.039

Trani, M. Di, Casini, M. P., Capuzzo, F., Gentile, S., Bianco, G., Menghini, D., & Vicari, S.

    (2011). Executive and intellectual functions in attention-deficit/hyperactivity disorder with

    and without comorbidity. *Brain and Development*, *33*(6), 462–469.

    https://doi.org/10.1016/j.braindev.2010.06.002

Waldman, I. D., Rowe, R., Boylan, K., & Burke, J. D. (2021). External validation of a bifactor

    model of oppositional defiant disorder. *Molecular Psychiatry*, *26*(2), 682–693.

    https://doi.org/10.1038/s41380-018-0294-z

Zelazo, P. D., & Carlson, S. M. (2012). Hot and cool executive function in childhood and

    adolescence: development and plasticity. *Child Development Perspectives*, *6*(4), 354–360.

    https://doi.org/10.1111/j.1750-8606.2012.00246.x

Zhang, J., Yang, X., & Yang, Q. (2015). Neuropsychological dysfunction in adults with early-

onset obsessive-compulsive disorder: The search for a cognitive endophenotype. *Revista*

Brasileira de Psiquiatria, *37*(2), 126–132. https://doi.org/10.1590/1516-4446-2014-1518

Table 1

Description of the Sample

		At age 6 ($N = 516$)
Age (years); M (SD)		6.8 (0.33)
Sex; %	Female	49.1
SES; %	High	37.2
	Medium-High/Medium	46.0
	Medium-low/Low	16.8
Born in Spain; %	Yes	97.3
Ethnicity; %	Caucasian	92.8
	Latino	3.8
	Other	3.4

Table 2

Means, Standard Deviations and Bivariate Pearson's Correlations

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Inhibit (BRIEF-P Teacher) at age 3	23.09	6.94	1																	
2. Shift (BRIEF-P Teacher) at age 3	13.17	3.52	**.22**	1																
3. Emotional control (BRIEF-P Teacher) at age 3	12.11	3.51	**.54**	**.52**	1															
4. Working memory (BRIEF-P Teacher) at age 3	22.56	6.77	**.62**	**.44**	**.45**	1														
5. Plan/Organize (BRIEF-P Teacher) at age 3	13.41	3.81	**.64**	**.45**	**.47**	**.89**	1													
6. ISCI (BRIEF-P Teacher) at age 3	35.20	9.28	**.95**	**.36**	**.78**	**.63**	**.65**	1												
7. FI (BRIEF-P Teacher) at age 3	25.28	6.21	**.44**	**.86**	**.88**	**.51**	**.53**	**.66**	1											
8. EMI (BRIEF-P Teacher) at age 3	35.98	10.31	**.64**	**.46**	**.47**	**.99**	**.95**	**.66**	**.53**	1										
9. GEC (BRIEF-P Teacher) at age 3	84.35	19.62	**.83**	**.58**	**.71**	**.89**	**.88**	**.89**	**.74**	**.91**	1									
10. Hyperactivity (SDQ Teacher) at age 3	3.17	2.85	**.74**	**.15**	**.34**	**.67**	**.65**	**.68**	**.29**	**.68**	**.71**	1								
11. Hyperactivity (SDQ Parent) at age 3	3.91	2.48	**.29**	-.04	.08	**.22**	**.21**	**.25**	.02	**.22**	**.23**	**.33**	1							
12. OCP (CBCL Parent) at age 6	0.84	1.34	−.07	**.12**	.05	−.02	−.02	−.03	**.09**	−.02	−.01	−.05	.09	1						
13. ODP (SDQ Parent) at age 6	3.02	2.60	**.16**	.04	**.12**	**.08**	**.12**	**.16**	**.09**	**.10**	**.14**	**.13**	**.20**	**.36**	1					
14. ODP (SDQ Teacher) at age 6	2.46	3.02	**.36**	-.01	**.22**	**.17**	**.19**	**.35**	**.12**	**.18**	**.26**	**.30**	**.22**	**.14**	**.34**	1				
15. Irritability (SDQ Parent) at age 6	1.39	1.32	**.10**	**.10**	**.12**	.08	**.10**	**.12**	**.12**	**.09**	**.12**	.06	**.15**	**.37**	**.86**	**.30**	1			
16. Irritability (SDQ Teacher) at age 6	1.07	1.38	**.26**	−.04	**.21**	**.11**	**.13**	**.27**	**.10**	**.12**	**.19**	**.22**	**.18**	**.16**	**.30**	**.90**	**.28**	1		
17. Headstrong (SDQ Parent) at age 6	1.63	1.62	**.17**	−.02	**.10**	**.07**	**.11**	**.16**	.05	**.09**	**.12**	**.16**	**.20**	**.28**	**.91**	**.30**	**.55**	**.25**	1	
18. Headstrong (SDQ Teacher) at age 6	1.39	1.84	**.38**	.01	**.20**	**.18**	**.21**	**.36**	**.12**	**.20**	**.28**	**.32**	**.22**	.10	**.33**	**.95**	**.28**	**.71**	.30	1

Note. In bold: significant correlation. BRIEF-P: Behavior Rating Inventory for Executive Function – Preschool Version; ISCI: Inhibitory Self-Control Index; FI: Flexibility Index; EMI: Emergent Metacognition Index; GEC: Global Executive Composite; SDQ: Strengths and Difficulties Questionnaire; OCP: Obsessive-compulsive problems; CBCL: Child Behavior Checklist; ODP: Oppositional Defiant Problems

Table 3

Predictive Association of Executive Functions at age 3 and Oppositional Defiant Problems and Obsessive-Compulsive Problems at age 6 (Regression analysis)

BRIEF-P Teacher (at age 3)	Oppositional defiant problems (SDQ) Parent (at age 6)			Oppositional defiant problems (SDQ) Teacher (at age 6)			Obsessive-Compulsive Problems (CBCL) Parent (at age 6)		
	B (CI 95%)	β	*p*	*B* (CI 95%)	β	*p*	*B* (95% CI)	β	*p*
First order scales[1]									
Inhibit	0.04 (−0.02; 0.09)	.10	.204	**0.10 (0.02; 0.18)**	**.23**	**.012**	**−0.03 (−0.06; −0.00)**	**−.17**	**.022**
Shift	−0.01 (−0.11; 0.09)	−.01	.879	**−0.13 (−0.24; −0.02)**	**−.14**	**.021**	**0.06 (0.00; 0.11)**	**.14**	**.040**
Emotional control	0.08 (−0.03; 0.19)	.11	.154	**0.17 (0.05; 0.29)**	**.20**	**.006**	0.03 (−0.02; 0.09)	.08	.236
Working memory	−0.01 (−0.07; 0.06)	−.02	.769	−0.06 (−0.12; 0.03)	−.11	.150	−0.01 (−0.03; 0.02)	−.03	.655
Second order scales[2]									
ISCI	**0.04 (0.02; 0.07)**	**.16**	**.003**	**0.10 (0.04; 0.14)**	**.29**	**.001**	−0.01 (−0.02; 0.01)	−.05	.323
FI	**0.05 (0.01; 0.09)**	**.12**	**.015**	0.03 (−0.01; 0.09)	.07	.167	**0.02 (0.00; 0.04)**	**.11**	**.024**
EMI	0.02 (−0.00; 0.06)	.09	.087	−0.02 (−0.06; 0.20)	−.06	.310	−0.00 (−0.02; 0.01)	−.02	.612
Total									
GEC	**0.02 (0.00; 0.03)**	**.14**	**.010**	0.02 (−0.00; 0.04)	.10	.127	−0.00 (−0.01; 0.01)	−.01	.824

[1]Adjusted by sex, SES, and hyperactivity reported by the same informant. [2]Adjusted by sex, SES, and/or hyperactivity (from the same informant) when necessary.

Note. In bold: significant parameter (*p* < .05). BRIEF-P: Behavior Rating Inventory for Executive Function- Preschool Version; ISCI: Inhibitory Self-Control Index; FI: Flexibility Index; EMI: Emergent Metacognition Index; GEC: Global Executive Composite; SDQ: Strengths and Difficulties Questionnaire; CBCL = Child Behavior Checklist

Table 4

Predictive Associations of Executive Functions at age 3 and Dimensions of Oppositional Defiant Problems at age 6 (Regression analysis)

	Oppositional Defiant Problems (SDQ)						Oppositional Defiant Problems (SDQ)					
	Parents (at age 6)						Teacher (at age 6)					
	Irritability			Headstrong			Irritability			Headstrong		
BRIEF-P Teacher (at age 3)	*B* (CI 95%)	β	*p*	*B* (CI 95%)	β	*p*	*B* (CI 95%)	β	*p*	*B* (CI 95%)	β	*p*
First order scales[1]												
Inhibit	0.00 (−0.02; 0.03)	.03	.748	0.03 (−0.00; 0.07)	.14	.070	0.02 (−0.01; 0.07)	.12	.223	**0.08 (0.03; 0.12)**	**0.29**	**.002**
Shift	0.02 (−0.03; 0.07)	.05	.423	−0.03 (−0.10; 0.03)	−.07	.268	**−0.08 (−0.01; −0.03)**	**−.19**	**.003**	−0.06 (−0.12; 0.02)	−.10	.129
Emotional control	0.04 (−0.01; 0.1)	.11	.114	0.04 (−0.02; 0.11)	.09	.203	**0.1 (0.05; 0.16)**	**.27**	**.001**	0.07 (−0.01; 0.15)	.13	.087
Working memory	−0.01 (−0.03; 0.02)	−.03	.713	−0.01 (−0.04; 0.03)	−.03	.661	−0.02 (−0.05; 0.02)	−.08	.316	−0.03 (−0.08; 0.01)	−.13	.128
Second order scales[2]												
ISCI	**0.02 (0.00; 0.03)**	**.12**	**.021**	**0.03 (0.01; 0.04)**	**.16**	**.003**	**0.04 (0.01; 0.07)**	**.25**	**.002**	**0.06 (0.03; 0.09)**	**.29**	**.001**
FI	**0.03 (0.01; 0.06)**	**.14**	**.003**	0.02 (−0.01; 0.04)	.06	.175	0.02 (−0.01; 0.04)	.07	.192	0.02 (−0.01; 0.05)	.06	.217
EMI	0.01 (−0.00; 0.02)	.08	.129	0.01 (−0.01; 0.03)	.07	.178	−0.01 (−0.03; 0.01)	−.06	.401	−0.01 (−0.03; 0.01)	−.06	.343
Total												
GEC	**0.01 (0.00; 0.01)**	**.12**	**.019**	**0.01 (0.00; 0.01)**	**.11**	**.033**	0.01 (−0.00; 0.02)	.08	.250	0.01 (−0.00; 0.02)	.11	.119

[1]Adjusted by sex, SES, and/or hyperactivity (from the same informant) when necessary. [2]Adjusted by sex and hyperactivity.
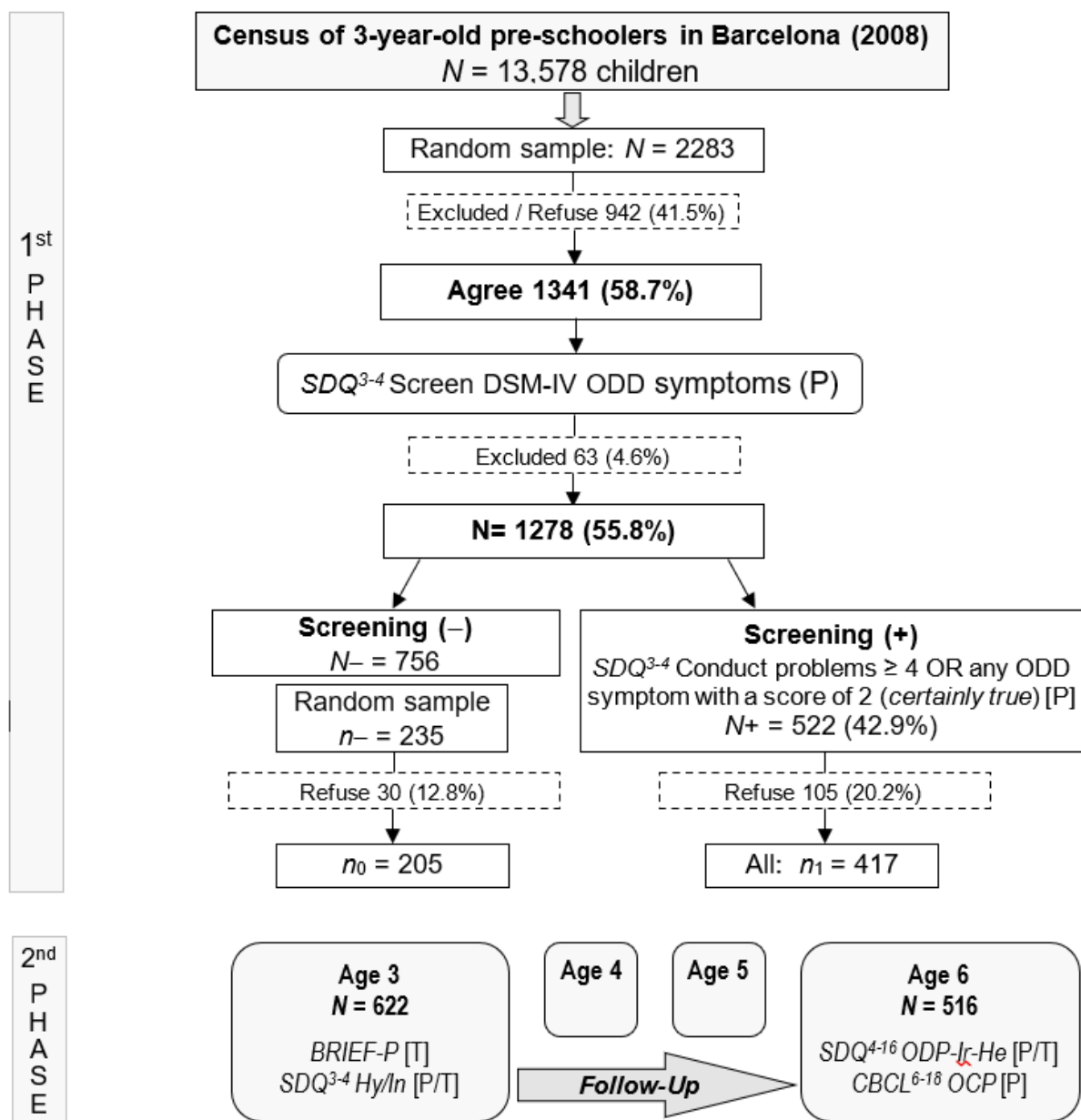
Note. In bold: significant parameter (*p* < .05). BRIEF-P: Behavior Rating Inventory for Executive Function - Preschool Version; ISCI: Inhibitory Self-Control Index; FI: Flexibility Index; EMI: Emergent Metacognition Index; GEC: Global Executive Composite; SDQ: Strengths and Difficulties Questionnaire

Figure 1.

Flow-chart with the screening process and the measures obtained at the two time-points

In italics: measure; in square brackets: informant.

Note. SDQ: Strengths and Difficulties Questionnaire; BRIEF-P: Behavior Rating Inventory of Executive Function - Preschool version; Hy/In: Hyperactivity/Inattention; ODP: Oppositional Defiant Problems; Ir: Irritability; He: Headstrong; CBCL: Child Behavior Checklist; OCP: Obsessive-Compulsive Problems; P: Parents; T: Teachers.

Irritability and Parenting Practices as Mediators between Executive Functions and Oppositional and Obsessive-Compulsive Problems in Preschool Children

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Abstract

Objective: Oppositional defiant disorder and obsessive-compulsive disorder can co-occur in some children yet the factors that contribute to this comorbidity have not been thoroughly examined. This study explored prospective patterns of associations between executive functions, namely Inhibitory Self-ControI (ISCI) and Flexibility (FI), and oppositional defiant problems (ODP) and obsessive-compulsive problems (OCP) through irritability and parenting practices.

Method: The sample included 614 preschoolers from the community. Using questionnaires, teachers evaluated children's executive functions at age 3 and parents reported about irritability at age 4, parenting practices at age 6, and ODP and OCP at age 7. Structural equation modeling (SEM) was used for statistical analysis.

Results: SEM revealed: (a) a direct and an indirect effect via punitive parenting from ISCI to ODP, (b) an indirect effect from FI to ODP via irritability and/or punitive parenting, (c) a direct effect from ISCI to OCP, and (d) a direct and an indirect effect from FI to OCP via irritability. **Conclusions:** Inhibitory control deficits are directly involved in both ODP and OCP, although the direction of the relationship differs. Deficits in FI are present in both problems, and irritability is a mediating factor between flexibility and ODP and OCP that may help to understand the comorbidity of these problems.

Irritability and Parenting Practices as Mediators between Executive Functions and

Oppositional and Obsessive-Compulsive Problems in Preschool Children

Oppositional Defiant Disorder (ODD) and Obsessive-Compulsive Disorder (OCD) can be comorbid (Coskun et al., 2012) and children with co-occurring ODD/OCD may face additional challenges. Nonetheless, little is known about shared factors that could potentially contribute to this comorbidity.

Executive Function and Irritability

Executive function, also known as cognitive control, influences later developmental outcomes and is strongly correlated with internalizing and externalizing symptoms, neurodevelopmental disorders (Yang et al., 2022), school readiness (Cantin et al., 2016), academic achievement (Pascual et al., 2019), and quality of life (Diamond, 2013). Moreover, executive functions are essential to emotional self-regulation, and recent studies emphasized two prevailing components, inhibitory control and cognitive flexibility, with a role in effective reward processing, modulating emotions, and regulating irritability and frustrations (Kryza-Lacombe et al., 2022);

Although irritability is a prominent feature of dysregulation (Brotman et al., 2017) and is associated with anxiety, mood disorders, and disruptive behaviors (Hobson et al., 2016; Stringaris et al., 2013), little is known about the neural mechanisms underpinning irritability and how it relates to cognitive aspects of self-regulation involving inhibitory control and cognitive flexibility in preschoolers. Reward processing (e.g., the ability to adapt one's behavior in response to incentives) is one potential mechanism; and alteration in this domain has been linked to increased irritability in youth (Brotman et al., 2017). According to Kryza-Lacombe et al. (2022), executive function (cognitive flexibility and inhibitory control) modulates irritability during reward processing; heightened executive function downregulates irritability, whereas deficits in executive function increase it. Additionally, neuroimaging

studies revealed common neural pathways involved in executive function processes and irritability. For example, cognitive flexibility and irritability were positively correlated at a neural level involving lateral prefrontal cortex activation in a preschool cohort (Li et al., 2017). Similarly, higher levels of irritability were associated with prefrontal cortex activation during an inhibitory control task (Fishburn et al., 2019). Further, self-regulation abilities vary significantly among children, and we can predict clinical outcomes more accurately by understanding the interaction between inhibitory control and irritability (Nili et al., 2022).

Executive Function and Parenting

The parent's role in modeling responses and behaviors is crucial during the preschool period, when cognitive functions are developing at an accelerated pace. Autonomy-supportive parenting (Bindman et al., 2015), parenting sensitivity (Blair et al., 2014), scaffolding practices (e.g. guided learning) (Hughes & Ensor, 2009; Suor et al., 2019) and, in general, positive parenting (e.g. warmth, responsiveness, encouragement, consistency) (Bindman et al., 2015; Mileva-Seitz et al., 2015; Valcan et al., 2018) are associated with better executive function development. Specifically, positive parenting and practices that foster the child's cognitive development (e.g. scaffolding, autonomy support and stimulation) contribute to higher executive functions, including increased inhibitory control, cognitive flexibility, and working memory (Valcan et al., 2018). Conversely, negative parenting (e.g., excessive control, punitive, intrusiveness) is associated with lower executive function, in particular poor inhibitory control in school-aged children (Valcan et al., 2018). Finally, the relationship between executive function and parenting appears to be bidirectional, implying that children's executive functions achievements can also affect parenting responsiveness (Blair et al., 2014).

Irritability, ODD and OCD

Both children with OCD and children with ODD have difficulty regulating their emotions (Guzick et al., 2021; Jiang et al., 2016), and as previously described, cognitive flexibility and inhibition may play a key role in modulating irritability (Kryza-Lacombe et al., 2022). In ODD, angry/irritable mood (often loses temper, touchy or easily annoyed, often angry and resentful) is a fundamental symptom dimension that holds a prevailing position within the construct of the disorder (Burke et al., 2014). Furthermore, high levels of irritability in ODD identify a subset of children more likely to suffer adverse clinical outcomes, diminished daily functioning, comorbidities, and internalizing and externalizing behaviors (Ezpeleta et al., 2016). Similarly, children with OCD may display high levels of irritability (rage, temper outbursts) if their routines are disrupted or they are unable to engage in compulsive behaviors or their obsessions interfere with daily activities (Krebs et al., 2013; Storch et al., 2012). Moreover, difficulties in emotion control were linked to OCD severity, family accommodation and the likelihood of a comorbid diagnosis of ODD (McKenzie et al., 2020). Other authors have indicated that irritability was not associated with OCD severity, but its presence required more family accommodation and was linked to depressive symptoms and defiance (Guzick et al., 2021). Despite conflicting findings regarding the link between irritability and OCD severity, it is generally agreed that irritability contributes to a more severe clinical profile and emotional regulation deficits should be targeted during OCD treatment (Guzick et al., 2021; McKenzie et al., 2020).

Irritability and Parenting

In addition to the genetic factors involved in the etiology of irritability (Stringaris et al., 2012; Vidal-Ribas et al., 2016), the environment and parenting can also influence the development and maintenance of irritability in children. In relation to irritability and internalizing symptoms, for instance, a recent twin study suggests that shared environmental

factors (e.g., familial) may exert a greater influence on the relationship between irritability and depression in children (Rappaport et al., 2020), contrasting previous literature that explained this relationship primarily through hereditary factors (Stringaris et al., 2012). Increased irritability in children with OCD can lead to higher family accommodation (Guzick et al., 2020) and it can trigger parenting inconsistency as parents eventually give in in response to challenging behavior Moreover, the association between irritability and parenting is likely bidirectional. For example, inconsistent parenting, negative control behavior and punishment in early childhood can lead to higher irritability in adolescence (Ravi et al., 2022). On the other hand, parenting interventions involving reinforcement of appropriate behavior and emotion coaching can effectively reduce irritability in children (Barlow & Parsons, 2005; Shortt et al., 2010).

Parenting, ODD and OCD

Several factors, including genetic, biological, and environmental factors, are involved in the etiology of ODD and OCD. In the case of ODD, punitive practices (Derella et al., 2020; Lin et al., 2019), parental hostility (Lavigne et al., 2016), poor monitoring and inconsistent parenting (Brown et al., 2017) have been associated with ODD. Findings also reported a reciprocal relationship and ODD symptoms may affect, in turn, parenting practices, resulting in poor monitoring, diminished parental involvement and poor parental emotion regulation (Burke et al., 2008; Chen et al., 2022; Derella et al., 2020).

Regarding OCD, a meta-analysis findings suggest that an authoritative parenting style (e.g., clear guidelines and expectations, warmth, support) tends to be associated with better outcomes and lower levels of OCD symptoms (Goli et al., 2020). In contrast, authoritarian (e.g., rigidity, harshness), permissive and neglectful parenting styles are associated with higher OCD symptoms (Goli et al., 2020). Overall, punitive parenting is associated with an increase in externalizing and internalizing behaviors in children (Zubizarreta et al., 2019).

The current study aims to examine prospective patterns of associations between executive functions (ISCI and FI) (at age 3) and Oppositional defiant problems (ODP) and Obsessive-compulsive problems (OCP) (at age 7) through irritability (at age 4) and parenting practices (at age 6). We expected irritability to be a mediational variable between flexibility and ODP and OCP and parenting practices to mediate the relationship between executive functions and ODP and OCP. The findings can provide insight into the etiologies of these disorders and inform intervention.

Method

Participants

The sample consisted of 622 participants and was part of a longitudinal project focusing on risk factors associated with problematic behaviors in preschoolers. The participants were selected in two phases. In the first phase, a sample of 2,283 families was randomly selected from 54 schools in the area of Barcelona. Out of these, 1,341 families agreed to participate and underwent screening for behavioral problems using the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997), with an additional four items to meet the ODD diagnostic symptoms according to the Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV).

In the second phase, all children who met an ODD score $\geq$ 4 criteria or presented at least one symptom of the ODD symptoms list with a score of 2 (*certainly true*) were included in the screen-positive sample ($n = 417$). In the case of children who did not meet the criteria, i.e., who screened negative, a random sample of 28% was retained ($n = 205$). Therefore, the total sample was made up of 622 3-year-old children. For the present study, assessments at ages 3, 4, 6, and 7 years were used. The socio-demographic data for the sample is illustrated in Table 1. No differences in sex ($p = .95$) or type of school ($p = .85$) were found between

participants and non-participants. High-SES families had greater participation than low-status ones ($p < .001$)

Measures

ODP and OCD problems were evaluated by parents with the Child Behavior Checklist/6–18 (CBCL; Achenbach & Rescorla, 2001) when the children were 7 years old. The CBCL consists of 113 items rated on a 3-point Likert scale ranging from 0 (*not true)* to 2 (*very/often true*). To assess ODP, we focused on oppositional defiant problems DSM5-oriented scale containing 6 items (*argues, defiant, disobey home, disobey school, stubborn* and *temper*). The internal consistency (ordinal alpha coefficient) of the ODP scale score in the present sample was .85. As for the OCP, this was measured by the 2007 obsessive-compulsive problem scale (2007-OCP) of the CBCL/6-18 containing 8 items (*mind off, fear do bad, perfect, guilty, repeats acts, strange behavior, strange ideas,* and *worries*). The internal consistency (ordinal alpha coefficient) of the OCP scale score in the sample was .80.

Executive functions were assessed by teachers at age 3 using The Behavior Rating Inventory of Executive Function – Preschool version (BRIEF-P; Gioia et al., 2000). The instrument consists of a 63-item form on a 3-point Likert scale ranging from 0 to 2 (*never, sometimes, often*) and is used to measure dimensions of executive functioning considering the child's behavior observed in real-life context over the last 6 months. It comprises five first-order scales (Inhibit, Emotional Control, Shift, Working Memory, and Plan/Organize), three second-order scales (Inhibitory Self-Control Index, ISCI; Flexibility, FI and Emergent Metacognition Index, EMI), and a total score of all five scales (Global Executive Composite, GEC). The scales of interest for this study were ISCI (consisting of Inhibit and Emotional Control scales) and FI (consisting of Shift and Emotional Control). Internal consistency (ordinal alpha coefficient) of scale scores used in this sample were .96 for ISCI and .95 for FI.

Irritability is one of the constituent dimensions of ODD and was assessed by parents at age 4. The irritability dimension included 3 items, one deriving from the conduct problems scale in the SDQ ("loses temper"), and 2, "touchy-easily annoyed" and "angry and resentful", being added to the SDQ to complete ODD symptomatology (Ezpeleta et al., 2012). Irritability items were measured through a 3-point rating scale ranging from 0 (*not true*) to 2 (*certainly true*). The ordinal alpha was .75. in the sample.

Parenting practices were measured using the Spanish adaptation of the Alabama Parenting Questionnaire for preschoolers (APQ-Pr; de la Osa et al., 2014), a 3-factor version questionnaire consisting of 24 items rated on a 5-point format scale (1 = *Never* to 5 = *Always*). The parental dimensions measured were positive (12 items, e.g., *friendly talk with your child, praise your child if he/she behaves well*), inconsistent (7 items, e.g., *threaten to punish your child and then do not punish, the punishment you give your child depends on the mood*) and punitive (5 items, e.g., *spank your child with hand when something wrong, yell/scream at your child when something wrong*). Internal consistency (ordinal alpha coefficient) of scale scores for positive parenting, inconsistent parenting, and punitive parenting were .85, .72, and .73, respectively, in this sample.

Lastly, the SDQ-hyperactivity/inattention scale score, reported by parents when children were 3 years old, was included as covariate. The scale consists of five items rated on a 3-point scale (0 = *not true*, 1 = *somewhat true*, 2 = *certainly true*). Internal consistency (ordinal alpha coefficient) of scale score in the presented sample was .78.

Procedure

The study was approved by the Ethics Commission of Animal and Human Experimentation of the authors' institution. Families of 3-year-old children were recruited at the schools and their written consent was obtained. SDQ was administered to all families of 3-year-old children in the screening phase. Participants who met screening criteria were

invited to follow-ups and on-site assessments on a yearly basis and the assessments of ages 3, 4, 6 and 7 years-old were used for this study. Families' permission was sought before teachers responded to the questionnaires.

Statistical Analysis

The statistical analyses were performed with Mplus8.9. Initially, a correlation matrix (Table 2) was obtained, which provided insight into the extent of association among the measures. Structural Equation Modeling (SEM) was used to determine the pathways from ISCI and FI to ODP and OCP, via irritability and positive, punitive, and inconsistent parenting practices, adjusted by hyperactivity. The following indices were used to evaluate the goodness of fit: χ^2 test ($p > .05$), Root Mean Square Error of Approximation (RMSEA < .06), Comparative Fit Index (CFI > .90), Tucker-Lewis Index (TLI > 0.90), and Standardized Root Mean Squared Residual (SMSR < .08).

Results

We found an excellent fit for the model we tested with values for $\chi^2 = 0.942$ df = 2 ($p = .624$), RMSEA = .000 (90% CI = .000-.064), CFI = 1.000, TLI = 1.000, and SRMR = .008. Figure 1 shows direct effects and Table 3 provides detailed information of indirect effects (standardized parameters in both cases).

Regarding ODP, the effect from ISCI to ODP was direct ($\beta = .138$; $p = .032$) and it was also mediated by punitive parenting ($\beta = .035$; $p = .049$): higher ISCI difficulties were associated directly with higher ODP, and also with higher punitive parenting and this in turn was associated with higher ODP. The effect from FI to ODP was not direct; it was mediated by irritability ($\beta = .067$; $p = .001$) and also by both irritability and punitive parenting ($\beta = .011$; $p = .014$). Higher FI was associated with higher irritability, and this in turn with higher ODP; higher punitive parenting, in addition to higher irritability, was associated with higher ODP.

In relation to OCP, the effect from ISCI to OCP was only direct: higher ISCI difficulties were associated with lower OCP ($\beta = -.130$; $p = .022$). In addition, the effect from FI to OCP was both direct ($\beta = .155$; $p = .008$) and it was also mediated by irritability ($\beta = .056$; $p = .003$). Similar to ODP, higher FI was associated with higher irritability and this in turn was associated with higher OCP. In addition, the following associations emerged. Higher FI was associated with higher positive parenting, and this was associated with lower OCP, but the indirect effect was not significant ($p = .122$).

Discussion

The study aimed to investigate the prospective associations between executive functions (ISCI and FI) and ODP and OCP through irritability and positive, punitive, and inconsistent parenting practices. We found (a) a direct and an indirect effect via punitive parenting from ISCI to ODP, (b) an indirect effect from FI to ODP via irritability and/or punitive parenting, (c) a direct effect from ISCI to OCP, and (d) a direct and a mediated effect via irritability from FI to OCP. The paths to each problem revealed both similarities and differences. Specifically, the underlying mechanisms for executive functions in ODP and OCP are different: they differ in associated executive functions (ISCI or FI), the direction of the relationship of ISCI (positive with ODP and negative with OCP), and the direct or indirect effect. However, a common path from flexibility through irritability to both problems was also found. Irritability is a common mediator that may help to explain the comorbidity between both disorders.

On the one hand, ISCI deficits appear to be more associated with oppositional problems, as indicated by the relatively higher coefficient in the case of ODP compared to OCP. Moreover, previous studies suggested a relationship between the ISCI components, inhibit and emotional control, with headstrong and anger-irritability symptom dimensions of ODD (Ezpeleta et al., 2012; Griffith et al., 2019). Specifically, inhibition deficits were

connected to the headstrong dimension, while deficits in emotional control were linked to irritability (Ezpeleta et al., 2012). Our findings suggest that difficulties in the development of ISCI may play a central role in ODP, and this after controlling for hyperactivity.

On the other hand, FI deficits appear to be more OCP-specific, as reflected by the direct effect, and aligning with prior research suggesting cognitive flexibility deficits in children with OCD (McNamara et al., 2014; Ornstein et al., 2010). However, other studies do not support executive function deficits in children with OCD (Hybel et al., 2017) and findings are inconsistent across studies. Our results on the composite scale FI (containing Emotional Control plus Shifting) suggest emotion and cognitive control are intertwined and underscore the fact that children with OCP may experience more difficulties in everyday scenarios or emotionally charged contexts (hot executive functions) as opposed to more neutral settings and measured through performance-based tests (cold executive functions). Further studies may consider examining how executive function and OCD symptoms interact across environments (home, school) and/or when emotion and motivation are factored in, to better understand the nature of these interactions.

Similar to ODP, ISCI demonstrated a significant association with OCP, albeit not in the same direction. Our findings align with those of Pietrefesa and Evans (2007), who revealed a divergent pattern of associations between inhibitory control difficulties and compulsive-like behaviors across different age groups. Specifically, they found that inhibitory control difficulties were inversely related to compulsive behaviors in children over 7 years old, whereas in younger children, these difficulties were associated with higher levels of compulsive behaviors. They explained that for younger children, engaging in these behaviors could serve as a strategy to alleviate their anxiety resulting in temporary relief. However, as children grow older, they may employ better coping strategies for managing stress and anxiety, reducing the need for compulsive behaviors (Pietrefesa & Evans, 2007). A

recent meta-analysis also found a significant relationship between age and the extent of response inhibition deficits in adults with OCD, with older patients presenting more deficits than younger ones (Mar et al., 2021). Moreover, considering the heterogeneity of OCD, individuals with this condition may exhibit a diverse range of cognitive patterns depending on their symptoms' sub-type and severity. Additional longitudinal studies are needed to better understand how inhibition control and obsessive-compulsive symptoms interact across age groups and OCD subtypes.

The common path to ODP and OCP is from flexibility through irritability. This commonality may help to explain why in approximately up to 40% of children ODD and OCD are comorbid. As mentioned earlier, we noted that cognitive flexibility and irritability are related at a neural level involving lateral orbitofrontal activation (Li et al., 2017); this area is also known to play a role in the neurobiology of OCD (Evans et al., 2004). In disruptive behavior disorders, dysfunctions of the orbitofrontal cortex have been associated with abnormalities in rewards and punishment processing leading to impaired decision-making (Matthys et al., 2013). Based on a recent meta-analysis, decision-making deficits have been consistently found in OCD adults' samples (Nisticò et al., 2021), but few studies address this in young children. To better understand their shared mechanisms, future research may consider motivational factors and decision-making in the interaction between flexibility, irritability, and ODD and OCD. Our findings suggest that irritability may contribute to co-occurring ODP/OCP, in agreement with previous studies linking irritability to defiant behavior in OCD youth (Guzick et al., 2021). Also, deficits in shift, emotional control and FI index have been previously associated with the anger-irritability dimension in ODP (Ezpeleta et al., 2012). Considering the mediated relationship between FI and ODP through irritability (but also via both irritability and punitive parenting) and the fact that children with oppositional problems are particularly sensitive to negative emotions (Jiang et al., 2016), it

can be concurred that emotional factors (anger-irritability) and environmental factors (punitive parenting) may contribute to the escalation and persistence of negative emotional experiences in these children. Consequently, these factors may hinder their ability to properly shift their attention and manage their behavior effectively.

Parenting practices mediated in the pathway from executive function to ODP but not to OCP. It is well known the implication of parenting practices in ODD, specifically punitive parenting (Derella et al., 2020). In fact, modification of parenting practices is a target in ODD treatment (Costin & Chambers, 2007). Our results of ISCI associated with higher punitive practices from parents and, in turn, with higher ODP align with existing research that underscores the link between adverse parenting characterized by punitive measures and harsh discipline and the manifestation of externalizing behaviors and poor inhibition in young children (Valcan et al., 2018; Zubizarreta et al., 2019). An example of this association is the emergence of a coercive escalation pattern between child and parental responses. This dynamic may affect the child's inhibitory capabilities over time, potentially reinforcing defiance, and oppositional behaviors. However, parenting practices were not significant in the path to OCD despite the family involvement in the rituals and the burden for the family (Guzick et al., 2020). It may be that the level of OCP in this general population sample was not as remarkable to interfere with parenting practices. Subsequent studies may explore other parenting practices and use measures of family accommodation in samples of children with OCP to better understand this relationship. Notably, permissive, and highly accommodating parenting might have a more pronounced effect on OCD and contribute to OCD/ODD co-occurrence. For example, when a parent demands a child to do something that interferes with the compulsive behavior, the child will most likely throw a tantrum, which might be reinforced by the parent ultimately giving in. Behaviorally, if repeated frequently, this would reinforce OCD and result in a presentation consistent with either ODD or comorbid

ODD/OCD. Indeed, in their ODD/OCD concurrent treatment case study, Ale and Krackow (2011) show that aggressive behavior and non-compliance/defiance in OCD are a result of permissive parenting, inconsistent limits, and failure to enforce consequences as parents were trying to accommodate their 6-year-old's OCD. Our findings also reflect a positive association between irritability and inconsistent parenting.

The study has some notable strengths, including a relatively large sample size of preschool children, longitudinal assessment, and the developmental period under investigation. Furthermore, it addresses an area that seems to have received limited attention in developmental psychopathology research, highlighting a potential link between flexibility and ODP and OCP, with irritability acting as an intermediate variable.

The study has some limitations, including relying solely on parent ratings for OCP, ODP, irritability and parenting practices, and teacher ratings only for executive functions. Moreover, the exclusive use of the BRIEF measure may not capture a broader range of cognitive processes and regulatory abilities. Future research may focus on incorporating multi-informant assessments and additional measures of executive functioning that may provide a more comprehensive understanding of these relationships.

Irritability and parenting are significant transdiagnostic factors whose interplay influences developmental trajectories and psychopathology and their role in treatment and intervention is essential. In pediatric OCD, exposure and response prevention therapy has been shown to significantly improve irritability (Guzick et al., 2021). As a result, the improvement in irritability in children with OCD could potentially lower the likelihood of concurrent manifestation of externalizing behaviors. Similarly, children with ODD can benefit from approaches that involve modification of parental practices and interventions aimed at developing emotional awareness and regulation, particularly helping them handle

negative emotions in healthier ways. A multimodal approach to intervention consisting of

emotional regulation strategies and parenting training may be considered in ODD and OCD.

References

Barlow, J., & Parsons, J. (2005). Preventing emotional and behavioural problems : the

    effectiveness of parenting programmes with children less than 3 years of age. *Stallard*

    1993, 33–43.

Bindman, S. W., Pomerantz, E. M., & Roisman, G. I. (2015). Supplemental material for do

    children's executive functions account for associations between early autonomy-

    supportive parenting and achievement through high school? *Journal of Educational*

    Psychology, *107*(3), 756–770. https://doi.org/10.1037/edu0000017.supp

Blair, C., Raver, C. C., & Berry, D. J. (2014). Two approaches to estimating the effect of

    parenting on the development of executive function in early childhood. *Developmental*

    Psychology, *50*(2), 554–565. https://doi.org/10.1037/a0033647

Brotman, M. A., Kircanski, K., Stringaris, A., Pine, D. S., & Leibenluft, E. (2017). Irritability

    in youths: A translational model. *American Journal of Psychiatry*, *174*(6), 520–532.

    https://doi.org/10.1176/appi.ajp.2016.16070839

Brown, C. A., Granero, R., & Ezpeleta, L. (2017). The reciprocal influence of callous-

    unemotional traits , Oppositional Defiant Disorder and parenting practices in

    preschoolers. *Child Psychiatry & Human Development*, *48*(2), 298–307.

    https://doi.org/10.1007/s10578-016-0641-8

Burke, J. D., Boylan, K., Rowe, R., Duku, E., Stepp, S. D., Hipwell, A. E., & Waldman, I. D.

    (2014). Identifying the irritability dimension of ODD: Application of a modified bifactor

    model across five large community samples of children. *Journal of Abnormal*

    Psychology, *123*(4), 841–851. https://doi.org/10.1037/a0037898

Burke, J. D., Pardini, D. A., & Loeber, R. (2008). Reciprocal relationships between parenting

    behavior and disruptive psychopathology from childhood through adolescence. *Journal*

    of Abnormal Child Psychology, *36*(5), 679–692. https://doi.org/10.1007/s10802-008-

9219-7.Reciprocal

Cantin, R. H., Gnaedinger, E. K., Gallaway, K. C., Hesson-McInnis, M. S., & Hund, A. M. (2016). Executive functioning predicts reading, mathematics, and theory of mind during the elementary years. *Journal of Experimental Child Psychology*, *146*, 66–78. https://doi.org/10.1016/j.jecp.2016.01.014

Chen, H., He, T., Xu, M., Zhao, J., Li, L., & Lin, X. (2022). Children's oppositional defiant disorder symptoms make parents difficult to be nice: Longitudinal association among parent emotion regulation, child emotion regulation and children's oppositional defiant disorder symptoms in Chinese children with oppositi. *Clinical Child Psychology and Psychiatry*, *27(4)*, 1155–1169. https://doi.org/10.1177/13591045211055822

Coskun, M., Zoroglu, S., & Ozturk, M. (2012). Phenomenology, psychiatric comorbidity and family history in referred preschool children with obsessive-compulsive disorder. *Child and Adolescent Psychiatry and Mental Health*, *6*(2005), 1–9. https://doi.org/10.1186/1753-2000-6-36

Costin, J., & Chambers, S. M. (2007). Parent management training as a treatment for children with oppositional defiant disorder referred to a mental health clinic. *Clinical Child Psychology and Psychiatry*, *12*(4), 511–524. https://doi.org/10.1177/1359104507080979

de la Osa, N., Granero, R., Penelo, E., Domènech, J. M., & Ezpeleta, L. (2014). Psychometric properties of the Alabama Parenting Questionnaire-Preschool Revision (APQ-Pr) in 3 year-old Spanish preschoolers. *Journal of Child and Family Studies*, *23*(5), 776–784. https://doi.org/10.1007/s10826-013-9730-5

Derella, O. J., Burke, J. D., Stepp, S. D., & Hipwell, A. E. (2020). *Reciprocity in undesirable parent – child behavior? Verbal aggression, corporal punishment , and girls' oppositional defiant symptoms*. *49*(3), 420–433.

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*, 135–168.

https://doi.org/10.1146/annurev-psych-113011-143750

Evans, D. W., Lewis, M. D., & Iobst, E. (2004). The role of the orbitofrontal cortex in

normally developing compulsive-like behaviors and obsessive-compulsive disorder.

Brain and Cognition, *55*(1), 220–234. https://doi.org/10.1016/S0278-2626(03)00274-4

Ezpeleta, L., Granero, R., De La Osa, N., Penelo, E., & Domènech, J. M. (2012). Dimensions

of oppositional defiant disorder in 3-year-old preschoolers. *Journal of Child Psychology*

and Psychiatry and Allied Disciplines, *53*(11), 1128–1138.

https://doi.org/10.1111/j.1469-7610.2012.02545.x

Ezpeleta, L., Granero, R., de la Osa, N., Trepat, E., & Domènech, J. M. (2016). Trajectories

of Oppositional Defiant Disorder irritability symptoms in preschool children. *Journal of*

Abnormal Child Psychology, *44*(1), 115–128. https://doi.org/10.1007/s10802-015-9972-

3

Fishburn, F. A., Hlutkowsky, C. O., Bemis, L. M., Huppert, T. J., Wakschlag, L. S., &

Perlman, S. B. (2019). Irritability uniquely predicts prefrontal cortex activation during

preschool inhibitory control among all temperament domains: A LASSO approach.

NeuroImage, *184*(August 2018), 68–77.

https://doi.org/10.1016/j.neuroimage.2018.09.023

Gioia, G. A., Isquith, P. K., Guy, S. C., Kenworthy, L., & Baron, I. S. (2000). Behavior rating

inventory of executive function. *Child Neuropsychology*, *6*(3), 235–238.

https://doi.org/10.1076/chin.6.3.235.3152

Goli, E., Abdekhodaie, M. S., Mashhadi, A., & Bigdeli, I. (2020). The role of parent-child

interaction patterns in the development of obsessive-compulsive disorder: A literature

review study. *Journal of Fundamentals of Mental Health*, *22*(1), 5–20

Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. In *Journal*

of Child Psychology and Psychiatry and Allied Disciplines (Vol. 38, Issue 5, pp. 581–

586). https://doi.org/10.1111/j.1469-7610.1997.tb01545.x

Granero, R., Louwaars, L., & Ezpeleta, L. (2015). Socioeconomic status and oppositional

defiant disorder in preschoolers: Parenting practices and executive functioning as

mediating variables. *Frontiers in Psychology*, *6*(SEP), 1–12.

https://doi.org/10.3389/fpsyg.2015.01412

Griffith, S. F., Arnold, D. H., Rolon-Arroyo, B., & Harvey, E. A. (2019). Neuropsychological

predictors of ODD symptom dimensions in young children. *Journal of Clinical Child

and Adolescent Psychology*, *48*(1), 80–92.

https://doi.org/10.1080/15374416.2016.1266643

Guzick, A. G., Geller, D. A., Small, B. J., Murphy, T. K., Wilhelm, S., & Storch, E. A.

(2020). Irritability in children and adolescents with OCD. *Behavior Therapy*.

https://doi.org/10.1016/j.beth.2020.11.001

Guzick, A. G., Geller, D. A., Small, B. J., Murphy, T. K., Wilhelm, S., & Storch, E. A.

(2021). Irritability in children and adolescents with OCD. *Behavior Therapy*, *52*(4),

883–896. https://doi.org/10.1016/j.beth.2020.11.001

Hobson, C. W., Scott, S., & Rubia, K. (2016). Investigation of cool and hot executive

function in ODD/CD independently of ADHD. *Journal of Abnormal Child Psychology*,

44(1), 539–551. https://doi.org/10.1111/j.1469-7610.2011.02454.x

Hughes, C. H., & Ensor, R. A. (2009). How do families help or hinder the emergence of early

executive function? *New Directions for Child and Adolescent Development*, *2009*(123),

35–50. https://doi.org/10.1002/cd.234

Hybel, K. A., Mortensen, E. L., Lambek, R., Thastum, M., & Thomsen, P. H. (2017). Cool

and hot aspects of executive function in childhood Obsessive-Compulsive Disorder.

Journal of Abnormal Child Psychology, *45*(6), 1195–1205.

https://doi.org/10.1007/s10802-016-0229-6

Jiang, W., Li, Y., Du, Y., & Fan, J. (2016). Emotional regulation and executive function

deficits in unmedicated Chinese children with oppositional defiant disorder. *Psychiatry

Investigation*, *13*(3), 277–287. https://doi.org/10.4306/pi.2016.13.3.277

Krebs, G., Bolhuis, K., Heyman, I., Mataix-Cols, D., Turner, C., & Stringaris, A. (2013).

Temper outbursts in paediatric obsessive-compulsive disorder and their association with

depressed mood and treatment outcome. *Journal of Child Psychology and Psychiatry

and Allied Disciplines*, *54*(3), 313–322. https://doi.org/10.1111/j.1469-

7610.2012.02605.x

Kryza-Lacombe, M., Palumbo, D., Wakschlag, L. S., Dougherty, L. R., & Wiggins, J. L.

(2022). Executive functioning moderates neural mechanisms of irritability during reward

processing in youth. *Psychiatry Research - Neuroimaging*, *323*(March), 111483.

https://doi.org/10.1016/j.pscychresns.2022.111483

Lavigne, J. V, Gouze, K. R., Hopkins, J., & Bryant, F. B. (2016). *A multidomain cascade

model of early childhood risk factors associated with oppositional defiant disorder

symptoms in a community sample of 6-year-olds*. *28*, 1547–1562.

https://doi.org/10.1017/S0954579415001194

Li, Y., Grabell, A. S., Wakschlag, L. S., Huppert, T. J., & Perlman, S. B. (2017). The neural

substrates of cognitive flexibility are related to individual differences in preschool

irritability: A fNIRS investigation. *Developmental Cognitive Neuroscience*, *25*, 138–

144. https://doi.org/10.1016/j.dcn.2016.07.002

Lin, X., Li, Y., Xu, S., Ding, W., Zhou, Q., Du, H., & Chi, P. (2019). Family risk factors

associated with oppositional defiant disorder symptoms, depressive symptoms, and

aggressive behaviors among chinese children with oppositional defiant disorder.

Frontiers in Psychology, *10*(SEP), 1–12. https://doi.org/10.3389/fpsyg.2019.02062

Mar, K., Townes, P., Pechlivanoglou, P., Arnold, P., & Schachar, R. (2021). Obsessive

Compulsive Disorder and response inhibition: Meta-Analysis of the Stop-Signal Task. In *Journal of Abnormal Psychology*. https://doi.org/10.1037/abn0000732

Matthys, W., Vanderschuren, L. J. M. J., & Schutter, D. J. L. G. (2013). The neurobiology of oppositional defiant disorder and conduct disorder: Altered functioning in three mental domains. *Development and Psychopathology*, *25*(1), 193–207. https://doi.org/10.1017/S0954579412000272

McKenzie, M. L., Donovan, C. L., Zimmer-Gembeck, M. J., Waters, A. M., Mathieu, S. L., & Farrell, L. J. (2020). Examining parent-report of Children's emotion regulation in paediatric OCD: Associations with symptom severity, externalising behaviour and family accommodation. *Journal of Obsessive-Compulsive and Related Disorders*, *25*(September 2019), 100508. https://doi.org/10.1016/j.jocrd.2020.100508

McNamara, J. P. H., Reid, A. M., Balkhi, A. M., Bussing, R., Storch, E. A., Murphy, T. K., Graziano, P. A., Guzick, A. G., & Geffken, G. R. (2014). Self-regulation and other executive functions relationship to pediatric OCD severity and treatment outcome. *Journal of Psychopathology and Behavioral Assessment*, *36*(3), 432–442. https://doi.org/10.1007/s10862-014-9408-3

Mileva-Seitz, V. R., Ghassabian, A., Bakermans-Kranenburg, M. J., van den Brink, J. D., Linting, M., Jaddoe, V. W. V., Hofman, A., Verhulst, F. C., Tiemeier, H., & van IJzendoorn, M. H. (2015). Are boys more sensitive to sensitivity? Parenting and executive function in preschoolers. *Journal of Experimental Child Psychology*, *130*, 193–208. https://doi.org/10.1016/j.jecp.2014.08.008

Nili, A. N., Krogh-Jespersen, S., Perlman, S. B., Estabrook, R., Petitclerc, A., Briggs-Gowan, M. J., Sherlock, P. R., Norton, E. S., & Wakschlag, L. S. (2022). Joint consideration of inhibitory control and irritability in young children: contributions to emergent psychopathology. *Research on Child and Adolescent Psychopathology*, *50*(11), 1415–

1427. https://doi.org/10.1007/s10802-022-00945-x

Nisticò, V., De Angelis, A., Erro, R., Demartini, B., & Ricciardi, L. (2021). Obsessive-compulsive disorder and decision making under ambiguity: A systematic review with meta-analysis. *Brain Sciences*, *11*(2), 1–23. https://doi.org/10.3390/brainsci11020143

Ornstein, T. J., Arnold, P., Manassis, K., Mendlowitz, S., & Schachar, R. (2010). Neuropsychological performance in childhood OCD: A preliminary study. *Depression and Anxiety*, *27*(4), 372–380. https://doi.org/10.1002/da.20638

Pascual, A. C., Moyano, N., & Robres, A. Q. (2019). The relationship between executive functions and academic performance in primary education: Review and meta-analysis. *Frontiers in Psychology*, *10*(JULY). https://doi.org/10.3389/fpsyg.2019.01582

Pietrefesa, A. S., & Evans, D. W. (2007). Affective and neuropsychological correlates of children's rituals and compulsive-like behaviors: Continuities and discontinuities with obsessive-compulsive disorder. *Brain and Cognition*, *65*(1), 36–46. https://doi.org/10.1016/j.bandc.2006.02.007

Rappaport, L. M., Carney, D. M., Brotman, M. A., Leibenluft, E., Roberson-Nay, R., & Hettema, J. M. (2020). HHS Public Access. *J Clin Child Adolesc Psychol*, *49*(4), 524–534. https://doi.org/10.1080/15374416.2018.1514612

Ravi, S., Havewala, M., Kircanski, K., Brotman, M. A., Schneider, L., Degnan, K., Almas, A., Fox, N., Pine, D. S., Leibenluft, E., & Filippi, C. (2022). *Parenting and childhood irritability : Negative emotion socialization and parental control moderate the development of irritability*. 1–10. https://doi.org/10.1017/S0954579421001346

Shortt, J. W., Stoolmiller, M., Smith-Shine, J. N., Eddy, J. M., & Sheeber, L. (2010). Maternal emotion coaching, adolescent anger regulation, and siblings' externalizing symptoms. *The Journal of Child Psychology and Psychiatry*, *51*(7), 799–808. https://doi.org/10.1111/j.1469-7610.2009.02207.x

Storch, E. A., Jones, A. M., Lack, C. W., Ale, C. M., Sulkowski, M. L., Lewin, A. B., De

Nadai, A. S., & Murphy, T. K. (2012). Rage attacks in pediatric obsessive-compulsive

disorder: Phenomenology and clinical correlates. *Journal of the American Academy of

Child and Adolescent Psychiatry*, *51*(6), 582–592.

https://doi.org/10.1016/j.jaac.2012.02.016

Stringaris, A., Maughan, B., Copeland, W. S., Costello, E. J., & Angold, A. (2013). Irritable

mood as a symptom of depression in youth: Prevalence, developmental, and clinical

correlates in the Great Smoky Mountains study. *Journal of the American Academy of

Child and Adolescent Psychiatry*, *52*(8), 831–840.

https://doi.org/10.1016/j.jaac.2013.05.017

Stringaris, A., Zavos, H., Leibenluft, E., Maughan, B., & Eley, T. (2012). Adolescent

irritability : phenotypic associations and genetic links with depressed mood. *American

Journal of Epidemiology*, *169*(1), 47–54.

https://doi.org/10.1176/appi.ajp.2011.10101549

Suor, J. H., Sturge-Apple, M. L., Davies, P. T., & Jones-Gordils, H. R. (2019). The interplay

between parenting and temperament in associations with children's executive function.

Journal of Family Psychology, *33*(7), 841–850. https://doi.org/10.1037/fam0000558

Valcan, D. S., Davis, H., & Pino-Pasternak, D. (2018). Parental behaviours predicting early

childhood executive functions: a meta-analysis. *Educational Psychology Review*, *30*(3),

607–649. https://doi.org/10.1007/s10648-017-9411-9

Vidal-Ribas, P., Brotman, M. A., Valdivieso, I., Leibenluft, E., & Stringaris, A. (2016). The

status of irritability in psychiatry: a conceptual and quantitative review. *Journal of the

American Academy of Child and Adolescent Psychiatry*, *55*(7), 556–570.

https://doi.org/10.1016/j.jaac.2016.04.014

Yang, Y., Shields, G. S., Zhang, Y., Wu, H., Chen, H., & Romer, A. L. (2022). Child

executive function and future externalizing and internalizing problems: A meta-analysis

of prospective longitudinal studies. *Clinical Psychology Review*, *97* (November 2021),

102194. https://doi.org/10.1016/j.cpr.2022.102194

Zubizarreta, A., Calvete, E., & Hankin, B. L. (2019). Punitive parenting style and

psychological problems in childhood: The moderating role of warmth and temperament.

Journal of Child and Family Studies, *28*(1), 233–244. https://doi.org/10.1007/s10826-

018-1258-2

Table 1 *Description of the sample*

		At age 3 ($N = 622$)
Sex; %	Female	50.0
Socioeconomic status; %	High	32.8
	Medium-High/Medium	45.2
	Medium-low/Low	22.0
School type; %	Public	64.0
	Semi-Public	36.0
Ethnicity; %	Caucasian	89.1
	Hispanic (South America)	6.4
	Other	4.5

Table 2

Means, Standard Deviations and Bivariate Pearson's Correlations

Measure (minimum-maximum scale score)	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. ISCI (BRIEF-P Teacher) at age 3 (0-52)	35.20	9.28	1								
2. FI (BRIEF-P Teacher) at age 3 (0-40)	25.28	6.21	**.66**	1							
3. Irritability (SDQ Parent) at age 4 (0-6)	1.39	1.21	**.12**	**.19**	1						
4. Punitive (APQ-Pr Parent) at age 6 (0-15)	3.38	1.93	**.10**	.02	**.18**	1					
5. Inconsistent (APQ-Pr Parent) at age 6 (0-21)	6.81	3.28	−.02	−.01	**.13**	**.32**	1				
6. Positive (APQ-Pr Parent) at age 6 (0-60)	40.97	4.07	.08	**.13**	.00	**−.20**	**−.24**	1			
7. ODP (CBCL Parent) at age 7 (0-12)	1.94	1.97	**.18**	**.11**	**.35**	**.35**	**.24**	−.07	1		
8. OCP (CBCL Parent) at age 7 (0-16)	0.84	1.28	−.01	**.09**	**.27**	.09	**.17**	**−.12**	**.31**	1	
9. Hyperactivity/Inattention (SDQ Parent) at age 3 (0-10)	3.91	2.48	**.26**	.01	**.11**	**.13**	.03	−.01	**.18**	.03	1

Note. In bold: significant correlations; BRIEF-P: Behavior Rating Inventory for Executive Function – Preschool Version; ISCI: Inhibitory Self-Control Index; FI: Flexibility Index; SDQ: Strengths and Difficulties Questionnaire; APQ-Pr: Alabama Parenting Questionnaire for preschoolers OCP: Obsessive-compulsive problems; CBCL: Child Behavior Checklist; ODP: Oppositional Defiant Problems

Table 3

Standardized indirect effects from ISCI and FI to ODP and OCP

X-variable	Y-variable	Mediator	Standardized parameter	p-value
ISCI_3	ODP_7	SDQ_Irritability_4	−.020	.271
ISCI_3	ODP_7	APQ-Pr_Positive_6	.000	.988
ISCI_3	ODP_7	APQ-Pr_ Punitive_6	**.035**	**.049**
ISCI_3	ODP_7	APQ-Pr_Positive_6; SDQ_Irritability_4	.000	.989
ISCI_3	ODP_7	APQ-Pr_ Inconsistent_6; SDQ_Irritability_4	−.001	.363
ISCI_3	ODP_7	APQ-Pr_ Punitive_6; SDQ_Irritability_4	−.003	.273
FI_3	ODP_7	SDQ_Irritability_4	**.067**	**.001**
FI_3	ODP_7	APQ-Pr_Positive_6	.000	.989
FI_3	ODP_7	APQ-Pr_ Punitive_6	−.025	.147
FI_3	ODP_7	APQ-Pr_Positive_6; SDQ_Irritability_4	.000	.989
FI_3	ODP_7	APQ-Pr_ Inconsistent_6; SDQ_Irritability_4	.003	.168
FI_3	ODP_7	APQ-Pr_ Punitive_6; SDQ_Irritability_4	**.011**	**.014**
ISCI_3	OCP_7	SDQ_Irritability_4	−.017	.280
ISCI_3	OCP_7	APQ-Pr_Positive_6	.002	.829
ISCI_3	OCP_7	APQ-Pr_ Punitive_6	.002	.788
ISCI_3	OCP_7	APQ-Pr_Positive_6; SDQ_Irritability_4	.000	.649
ISCI_3	OCP_7	APQ-Pr_ Inconsistent_6; SDQ_Irritability_4	−.001	.345
ISCI_3	OCP_7	APQ-Pr_ Punitive_6; SDQ_Irritability_4	.000	.792
FI_3	OCP_7	SDQ_Irritability_4	**.056**	**.003**
FI_3	OCP_7	APQ-Pr_Positive_6	−.014	.123
FI_3	OCP_7	APQ-Pr_ Punitive_6	−.001	.785
FI_3	OCP_7	APQ-Pr_Positive_6; SDQ_Irritability_4	.000	.641
FI_3	OCP_7	APQ-Pr_ Inconsistent_6; SDQ_Irritability_4	.003	.140
FI_3	OCP_7	APQ-Pr_ Punitive_6; SDQ_Irritability_4	.001	.786

Note. In bold: statistically significant effects. ISCI: Inhibitory Self-Control Index; FI: Flexibility Index; APQ-Pr: Alabama Parenting Questionnaire-Preschool; CBCL: Child Behavior Checklist; SDQ: Strengths and difficulties questionnaire; OCP: Obsessive Compulsive Problems; ODP: Oppositional Defiant Problems. The number at the end of each measure corresponds to the age at which it was assessed.
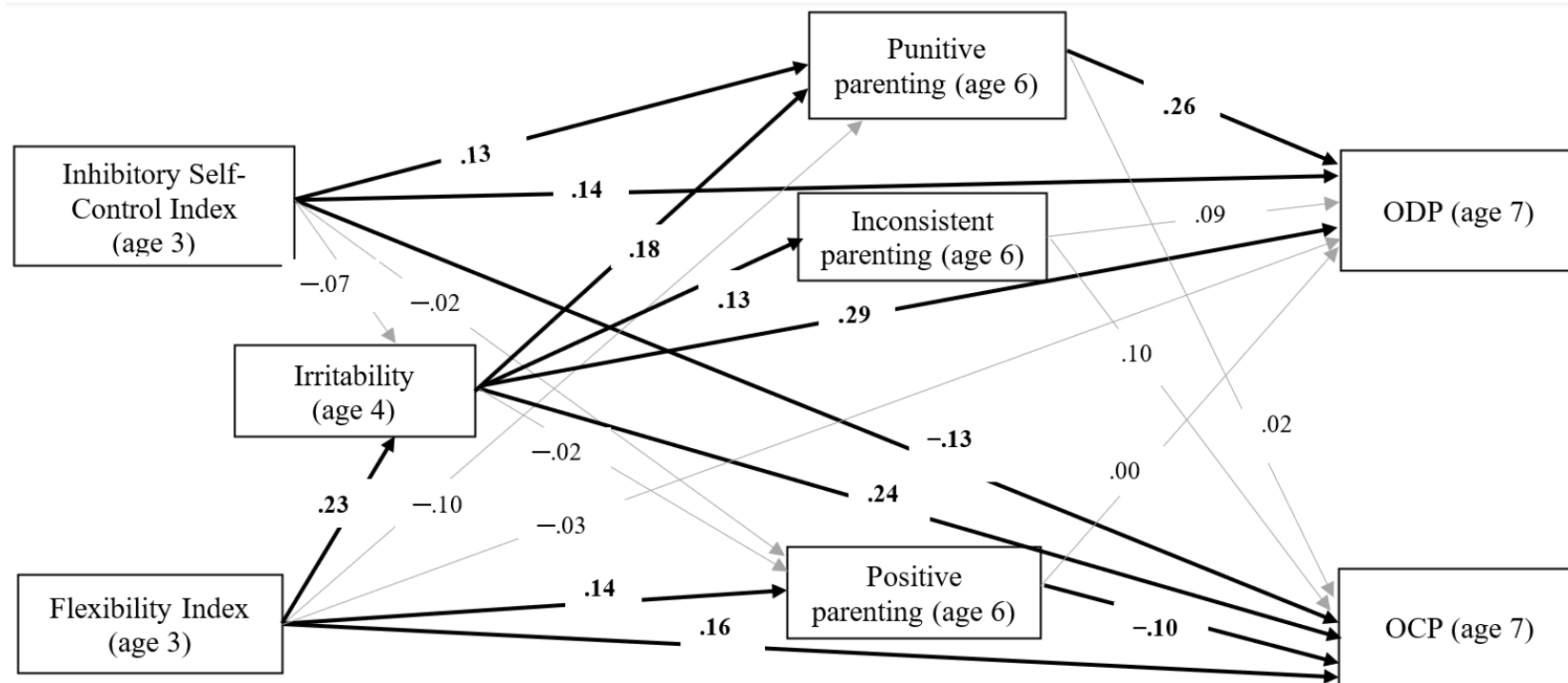
Figure 1

Hypothesized model and paths involved in statistically significant direct effects for ODP and OCP controlling for hyperactivity

Note. In bold: statistically significant direct effects; in gray: non-significant direct effects; covariances among concurrent measures and adjustment by hyperactivity are not shown; ODP: Oppositional Defiant Problems; OCP: Obsessive-Compulsive Problems.

Chapter Four: Discussion

Integration of Findings

This thesis comprises two studies that investigate the prospective relationships between executive functions and behavioral symptoms, ODP and OCP. The primary objective of these studies is to gain insight into the specificity of these associations for each problem while also exploring commonalities and potential factors that may contribute to both problems. Study 1 aimed to explore the longitudinal associations between executive functions assessed at age 3 and the development of ODP, their dimensions, and OCP at age 6. The findings revealed specific associations unique to each problem, while also indicating that deficits in flexibility were linked to both ODP and OCP. Study 2 examined prospective associations between executive functions (ISCI and FI) (at age 3) and ODP and OCP (at age 7) through irritability (at age 4) and parenting practices (at age 6) and the results showed that irritability acts as a mediator in the relationship from flexibility to both problems.

Specific Associations between Executive Functions and ODP

Firstly, the findings revealed distinctive patterns of associations between executive functions and each specific problem. Study 1 highlighted that ODP is associated with deficits in executive functions, particularly involving inhibition, emotional control, and flexibility. Notably, the irritability dimension is linked to deficits in emotional control, ISCI, and FI, while the headstrong dimension is associated with deficits in inhibition and ISCI. Study 2 further substantiated these findings, revealing a direct pathway between ISCI and ODP, but also partially mediated by negative parenting. The results align with prior research, indicating that children with ODP exhibit altered inhibitory control (Kleine Deters et al., 2020; Rhodes et al.,

2012), impacting their regulation of actions, emotions, and demeanor in everyday life. Importantly, these findings are significant after controlling for hyperactivity, suggesting that these deficits in inhibitory control may be specific to ODP and not solely attributed to comorbidity with ADHD. Moreover, taking into account that challenges in ISCI were linked to both dimensions of ODD, specifically higher levels of irritability and headstrong behavior, this could potentially act as a risk factor for the emergence of full ODD as supported by previous research (Ezpeleta, Navarro, et al., 2019).

In sum, it appears that impairments in ISCI play a central role in ODP. ISCI relates to both dimensions of ODP, *headstrong* and *irritability*, as reported by both parents and teachers, so observed in multiple contexts (home, school). Specifically, the subscales within ISCI, namely *Inhibit* and *Emotional Control* are associated with headstrong and irritability, respectively. These results contribute to the existing research confirming a bi-factor developmental model of ODD, and a relationship between ODD symptom dimensions and distinct developmental outcomes (Ezpeleta et al., 2022; Waldman et al., 2021). According to Waldman et al. (2021), irritability in ODD is linked to depression and Generalized Anxiety Disorder (GAD), while headstrong is associated with ADHD and CD. Therefore, difficulties in ISCI may inform different clinical outcomes and/or comorbidity and underscore the importance of training inhibitory abilities at early ages.

Finally, parenting practices mediated between executive functions and ODP but not OCP. Specifically, the observed deficits in inhibitory self-control are partially explained by the influence of punitive parenting practices, supporting the notion of a coercive escalation dynamic between parents and children affected by ODD (Smith et al., 2014). This coercive process may adversely impact the development of inhibitory capacities over time, thereby potentially reinforcing the manifestation of oppositional behaviors. The findings are consistent

with previous research highlighting the association between punitive parenting and compromised inhibitory control (Valcan et al., 2018).

Specific Associations between Executive Functions and OCP

Study 1 highlighted that difficulties in shifting and FI are associated with OCP at age 6. Study 2 provided additional support for these findings, showing a direct pathway from FI to OCP at age 7, but also partially mediated by irritability. Based on these findings, flexibility issues seem to be specific to OCP, in line with previous research reflecting flexibility deficits in a sample of children with OCD (Ornstein et al., 2010) and showing consistency with deficits observed in adults with OCD. Flexibility difficulties may serve as a potential indicator of early-onset OCD, however further longitudinal studies are needed to assess the persistence of OCD symptoms. These studies may track the development of flexibility beyond the preschool period, ideally extending their observations until the age of 10 when flexibility typically reaches maturity (Dick, 2014).

Another specificity is related to inhibition (Study 1) and ISCI (Study 2) being involved in OCP at age 6 and 7, respectively. Contrary to our expectations, deficits in executive function involving inhibition were related to lower OCP. Even though developmental, environmental, and individual factors may account for this, another possible avenue to the understanding of this association is considering the role of anxiety in OCP. The findings may reflect some intersecting features between inhibition, anxiety and OCP in younger children. For example, young children can engage in compulsive behaviors to reduce distress, and this has been normally noted in contexts related to routines (i.e., meals or bedtime) (Evans et al., 2004; Pietrefesa & Evans, 2007). However, as these children mature, they develop compensatory mechanisms and the engagement in compulsion is no longer necessary reflecting the reduction in obsessive-compulsive behaviors (Pietrefesa & Evans, 2007). Of note, compulsive-like

behaviors observed in early childhood may be often misdiagnosed SAD (Miyawaki et al., 2018). Distinguishing between these two conditions may pose a challenge during early years, primarily due to children's limited ability to articulate intrusive thoughts and fears (Miyawaki et al., 2018). Nevertheless, early identification of this distinction could prove essential, as it has the potential to hinder treatment outcomes. Also, most cases of preschool OCD can be effectively treated when identified early (Miyawaki et al., 2018). In sum, variability in inhibition across different ages in samples with OCD may be a neuropsychological indicator of different developmental trajectories and it may be of interest to be addressed in subsequent studies and jointly considered with GAD or SAD.

Prospective Contributing Factors from Executive Function to ODP and OCP

When considered jointly, these two studies yield significant insights into the etiological factors associated with the development of ODP and OCP. Moreover, it offers valuable perspectives on the risk factors that potentially contribute to the understudied comorbidity between ODP and OCP. The findings unveiled a common pattern of association, wherein ODP and OCP exhibited shared deficits in FI (shifting + emotional control). Study 1 suggested that higher flexibility difficulties at age 3 were linked to increased ODP and OCP difficulties at age 6, meaning that children with ODP and OCP may encounter similar challenges in adapting their responses to contextual demands in everyday life. Moreover, study 1 revealed an association between flexibility and the irritability dimension of ODP, leading us to posit that irritability may serve as an intermediary variable between flexibility and both problems. Indeed, the results from study 2 revealed a common pathway from flexibility through irritability to both ODP and OCP at age 7. These findings provide insights into one potential underlying mechanism that may contribute to OCD/ODD comorbidity. While deficits in flexibility are observed in both disorders, they may be specific to OCP. We may interpret this

given that between FI and OCP, there is both a direct effect and an indirect effect through irritability.

Conversely, in ODP, the pathway is not direct but only mediated by irritability, and by both irritability and negative parenting. This result aligns with the existing literature, which establishes a connection between irritability in OCD and symptoms of oppositional/defiance (Guzick et al., 2020). Similarly, Storch et al. (2012) indicate that the presence of anger outbursts in pediatric OCD suggests a higher probability of comorbidity with disruptive behavior disorders (ODD and CD) compared to cases of OCD without such anger outbursts. In the context of ODD, it has been suggested that the regulation of negative emotions is compromised (Jiang et al., 2016), and this impairment may be linked to difficulties in recognizing and processing anger, as proposed by Deters et al. (2020). It is plausible to assume that manifestations of anger, but also punitive measures, may interfere with their capacity to adapt and regulate emotions and behavior effectively, thereby contributing to higher oppositional symptoms. A parallel association between flexibility and irritability has been observed on a neural level as evidenced by the activation of the dorsolateral prefrontal cortex in both contexts (Li et al., 2017).

Overall, our findings are consistent with prior research concerning executive functions in children with ODD and OCD, as well as the cross-diagnostic significance of irritability. Nevertheless, the novelty of this thesis lies in the joint consideration of ODP and OCP in relation to executive function and provides insights into potential mechanisms, involving impairment in flexibility mediated by irritability as a common pathway leading to these problems.

Strengths and Limitations

The thesis has several notable strengths, including a relatively large sample size of preschool children and longitudinal assessment. Oppositional problems were reported by parents and teachers, which contributes to a more thorough understanding of behavioral manifestations across distinct environments (i.e., home and school). A key strength of this thesis is its focus on a critical developmental period. Despite the recent increase in studies investigating how executive function affects behavioral symptoms, there is still much we do not understand about these connections in early development. Specifically, there is a lack of research that follows children through this highly active phase of executive function development. A better understanding of these relations in an early phase of development opens for treatment in a particularly active period where intervention potentially can result in change. Finally, the originality of the thesis consists of jointly considering ODP and OCP and suggesting potential contributing factors to their co-occurrence with implications for etiology and intervention strategies.

However, certain limitations warrant consideration. In Study 1 (OCP) and Study 2 (OCP, ODP, irritability, and parenting practices), the reliance solely on parent ratings for these variables may introduce potential bias. Similarly, using teacher ratings only for assessing executive functions in both studies might limit the scope of cognitive processes and regulatory abilities considered. Incorporating multi-informant assessments of executive functions, irritability, and other relevant study variables would have provided a more comprehensive understanding of the relationship between cognitive control and ODP/OCP. Additionally, the studies do not use performance-based assessments of executive function, which could be a limitation, given that existing literature shows differences between questionnaire-based assessments and neuropsychological testing. Nonetheless, questionnaires, especially when

dealing with younger individuals, offer insights into how executive function difficulties manifest in everyday situations, particularly in educational settings where educators frequently identify such challenges. Another limitation is that some variables used in the studies had internal consistency values lower than .80, potentially resulting in weakened associations with other measures. Finally, the variables used in the thesis may not predict OCP/ODP comorbidity but provide insights into shared aspects that could potentially lead to comorbidity.

Clinical Implications

First, the results suggesting a relationship between executive functions at 3 years of age and ODP and OCP at 6 and 7 years of age underscore the importance of studying behavioral symptoms in early childhood to enable timely interventions and target the cognitive functions associated with the early onset of these problems.

Second, given the specific and common relationships between executive functions and each individual problem, it becomes evident that early training in inhibitory self-control and cognitive flexibility may prevent the development of behavioral symptoms such as ODP and OCP. In the case of ODP, this thesis supports the understanding that punitive practices need to be targeted in ODD treatment while also suggesting a connection between inhibition deficits and the coercive process that perpetuates the negative cycle leading to worsened ODP. Furthermore, considering that inhibitory self-control is related to both headstrong behaviors and irritability, it may suggest the importance of training inhibitory self-control to reduce the early onset of ODD. Regarding OCD, given the direct effect of flexibility on OCD symptoms, training cognitive flexibility may reduce the likelihood of developing symptoms related to OCD. Moreover, inhibitory self-control and cognitive flexibility play a role in emotional regulation and previous research highlights their significance in moderating irritability (Kryza-Lacombe et al., 2022). The thesis findings reflect that both children with OCD and ODD

experience emotional regulation difficulties and struggle to adjust emotions and behaviors to contextual demands. Therefore, training cognitive flexibility during a malleable developmental period, such as preschool years, may have a positive impact on irritability. Studies have shown that better levels of flexibility and inhibitory control are associated with a decrease in irritability (Kryza-Lacombe et al., 2022), which could potentially reduce behavioral symptoms such as ODP and OCP.

Third, the findings can inform caregivers and health professionals regarding the co-existence of these problems and the presence of irritability as an indicator that may lead to comorbidity. Furthermore, as demonstrated in previous studies, irritability is a transdiagnostic factor that may be part of OCD symptomatology, and it can manifest in contexts where rituals are interrupted (Guzick et al., 2019), resembling the reaction of children with ODD who cannot handle parental refusals and exhibit tantrums. Irritability in OCD is commonly linked to increased family accommodation (Guzick et al., 2021) characterized by permissive parenting and occasional assistance with rituals to alleviate anxiety. With sufficient repetition, this pattern of family accommodation may lead to the development of noncompliant behavior in the affected child, even in situations unrelated to anxiety (Ale & Krackow, 2011). Thus, differentiating irritability-anxiety related OCD symptoms from oppositional defiant behavior is crucial for treatment, as reflected in studies employing concurrent treatment of ODD/OCD (Ale & Krackow, 2011). Similarly, in successive treatment of these problems, appropriate protocols should be implemented. For instance, when OCD emerges before ODD, Parent Management Training has been proposed before Cognitive-Behavioral Therapy, resulting in positive outcomes (Lehmkuhl et al., 2009). Additionally, another study utilized Exposure and Response Prevention Therapy to treat irritability in children with OCD, leading to significant reduction of irritability (Guzick et al., 2021).

Future Directions

The thesis attempted to address specific aspects related to the relationship between executive functions and ODP and OCP, while also considering the potential mediating role of irritability and punitive, positive, and inconsistent parenting practices. However, some questions remain unanswered and warrant consideration in future research.

Existing literature reveals a discrepancy between outcomes from the BRIEF questionnaire and performance tests, which may contribute to inconsistent findings regarding deficits in children with ODD and OCD. Deficits in these disorders appear less frequently in neutral contexts (cold executive functions) but are more evident in daily life situations involving emotional and motivational factors (hot executive functions). Future research may adopt a comprehensive approach, using both questionnaires and neuropsychological testing, to better understand the interactions between cognition and emotions in these disorders.

Additionally, further investigations are needed to explore the common deficits in cognitive flexibility and the role of irritability as an intermediate variable leading to both problems across multiple time points throughout childhood and adolescence. The use of the BRIEF at age 3 and ODP and OCP at ages 6 and 7 might limit the ability to draw conclusions about developmental changes in EF and the persistence of behavioral problems. By examining executive functions and ODP and OCP at various time points, researchers can gain a better understanding of the developmental trajectories and potential long-term impact of executive functions on behavioral outcomes. This approach will enhance the reliability and validity of any conclusions drawn regarding causal relations or interactions between EF and ODP/OCP. Also, future research might consider motivational factors, including reward and punishment processing, when investigating the underlying mechanisms of flexibility and irritability, in relation to ODP and OCP. Finally, affective symptoms such as anxiety, which is likely to play

an important part in the development of OCD, may be further considered, in particular in the relationship between inhibition and obsessive-compulsive behaviors in early childhood.

Conclusions

- ODP is associated with various measures of executive functions, including Inhibitory Self-Control, Flexibility and Global Executive Composite indexes, while OCP showed an association with Flexibility.

- Inhibitory Self-Control difficulties reported by teachers at age 3 are a risk factor for later increased irritability and headstrong behavior.

- Both ODP and OCP exhibited shared difficulties in the Flexibility Index, indicating compromised capacity to modulate emotions and behavior based on contextual and environmental demands.

- Irritability serves as a mediating factor between flexibility and ODP and OCP and it may help to understand the comorbidity of these problems.

- Punitive parenting mediated in the relation of executive function on ODP but not on OCP.

References

Note: The reference list does not contain the references from Study 1 and Study 2 since they have already been included at the end of each study.

Abramovitch, A., Abramowitz, J. S., Mittelman, A., Stark, A., Ramsey, K., & Geller, D. A. (2015). Research Review: Neuropsychological test performance in pediatric obsessive-compulsive disorder - a meta-analysis. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *56*(8), 837–847. https://doi.org/10.1111/jcpp.12414

Achenbach, T. M., & Rescorla, L. A. (2001). Manual for the ASEBA school- age forms & Profiles, Burlington, VT: University of Vermont, Research Center for Children, Youth & Families

Achenbach, T. M., & Rescorla, L. A. (2007). Multicultural supplement to the Manual for the ASEBA school-age forms & profiles. University of Vermont, Research Center for Children, Youth & Families.

Aebi, M., Barra, S., Bessler, C., Steinhausen, H. C., Walitza, S., & Plattner, B. (2016). Oppositional defiant disorder dimensions and subtypes among detained male adolescent offenders. *Journal of child psychology and psychiatry, and allied disciplines, 57*(6), 729–736. https://doi.org/10.1111/jcpp.12473

Ale, C. M., & Krackow, E. (2011). Concurrent treatment of early childhood OCD and ODD: A case illustration. *Clinical Case Studies*, *10*(4), 312–323.

https://doi.org/10.1177/1534650111420283

Amen, D. G., & Carmichael, B. (1997). Oppositional children similar to OCD on SPECT. *Journal of Neurotherapy*, *2*(2), 1–6. https://doi.org/10.1300/J184v02n02_01

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders*. American Psychiatric Association. https://doi.org/10.1176/appi.books.9780890425596

Andrés, S., Boget, T., Lázaro, L., Penadés, R., Morer, A., Salamero, M., & Castro-Fornieles, J. (2007). Neuropsychological performance in children and adolescents with Obsessive-Compulsive Disorder and influence of clinical variables. *Biological Psychiatry*, *61*(8), 946–951. https://doi.org/10.1016/j.biopsych.2006.07.027

Antonini, T. N., Becker, S. P., Tamm, L., & Epstein, J. N. (2015). Hot and cool executive functions in children with Attention-Deficit/Hyperactivity Disorder and comorbid Oppositional Defiant Disorder. *Journal of the International Neuropsychological Society*, *21*(8), 584–595. https://doi.org/10.1017/S1355617715000752

Azeredo, A., Moreira, D., & Barbosa, F. (2018). ADHD, CD, and ODD: Systematic review of genetic and environmental risk factors. *Research in Developmental Disabilities*, *82*(December 2017), 10–19. https://doi.org/10.1016/j.ridd.2017.12.010

Boylan, K., Vaillancourt, T., Boyle, M., & Szatmari, P. (2007). Comorbidity of internalizing disorders in children with oppositional defiant disorder. *European Child and Adolescent Psychiatry*, *16*(8), 484–494. https://doi.org/10.1007/s00787-007-0624-1

Brænden, A., Coldevin, M., Zeiner, P., Stubberud, J., & Melinder, A. (2023). *Executive function in children with disruptive mood dysregulation disorder compared to attention - deficit / hyperactivity disorder and oppositional defiant disorder, and in children with different irritability levels*. *0123456789*.

Brem, S., Grünblatt, E., Drechsler, R., Riederer, P., & Walitza, S. (2014). The neurobiological link between OCD and ADHD. *ADHD Attention Deficit and Hyperactivity Disorders*, *6*(3), 175–202. https://doi.org/10.1007/s12402-014-0146-x

Brem, S., Hauser, T. U., Iannaccone, R., & Walitza, S. (2012). *Neuroimaging of cognitive brain*

function in paediatric obsessive compulsive disorder: a review of literature and preliminary meta-analysis. 1425–1448. https://doi.org/10.1007/s00702-012-0813-z

Brotman, M. A., Kircanski, K., Stringaris, A., Pine, D. S., & Leibenluft, E. (2017). Irritability in youths: A translational model. *American Journal of Psychiatry*, *174*(6), 520–532. https://doi.org/10.1176/appi.ajp.2016.16070839

Brown, C. A., Granero, R., & Ezpeleta, L. (2017). The reciprocal influence of callous-unemotional traits, Oppositional Defiant Disorder and parenting practices in preschoolers. Child Psychiatry & Human Development, 48(2), 298–307. https://doi.org/10.1007/s10578-016-0641-8

Calzà, J., Gürsel, D. A., Schmitz-koep, B., Bremer, B., Reinholz, L., Berberich, G., & Koch, K. (2019). *Altered Cortico – Striatal Functional Connectivity During Resting State in Obsessive-Compulsive Disorder*. *10*(May), 1–8. https://doi.org/10.3389/fpsyt.2019.00319

Canino, G., Polanczyk, G., Bauermeister, J. J., Rohde, L. A., & Frick, P. J. (2010). Does the prevalence of CD and ODD vary across cultures? *Social Psychiatry and Psychiatric Epidemiology*, *45*(7), 695–704. https://doi.org/10.1007/s00127-010-0242-y

Chamberlain, S. R., Blackwell, A. D., Fineberg, N. A., Robbins, T. W., & Sahakian, B. J. (2005). The neuropsychology of obsessive compulsive disorder: The importance of failures in cognitive and behavioural inhibition as candidate endophenotypic markers. *Neuroscience and Biobehavioral Reviews*, *29*(3), 399–419.

 https://doi.org/10.1016/j.neubiorev.2004.11.006

Chamberlain, S. R., Menzies, L., Hampshire, A., Suckling, J., Fineberg, N. A., del Campo, N., Aitken, M., Craig, K., Owen, A. M., Bullmore, E. T., Robbins, T. W., & Sahakian, B. J. (2008). Orbitofrontal dysfunction in patients with obsessive-compulsive disorder and their unaffected relatives. *Science (New York, N.Y.), 321*(5887), 421–422.

https://doi.org/10.1126/science.1154433

Chrysosferidis, J. R., Burns, G. L., Becker, S. P., Beauchaine, T. P., & Servera, M. (2023). Oppositional Defiant Disorder in the DSM-5: Does the limited prosocial emotions specifier portend a more severe clinical presentation? *Research on Child and Adolescent Psychopathology*, *51*(7), 1037–1050. https://doi.org/10.1007/s10802-023-01052-1

Coskun, M., Zoroglu, S., & Ozturk, M. (2012). Phenomenology, psychiatric comorbidity and family history in referred preschool children with obsessive-compulsive disorder. *Child and Adolescent Psychiatry and Mental Health*, *6*(2005), 1–9.

https://doi.org/10.1186/1753-2000-6-36

Costin, J., & Chambers, S. M. (2007). Parent management training as a treatment for children with oppositional defiant disorder referred to a mental health clinic. *Clinical Child Psychology and Psychiatry*, *12*(4), 511–524. https://doi.org/10.1177/1359104507080979

Derella, O. J., Burke, J. D., Stepp, S. D., & Hipwell, A. E. (2020). *Reciprocity in undesirable parent – child behavior? Verbal aggression, corporal punishment, and girls' oppositional defiant symptoms*. *49*(3), 420–433.

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*, 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, *333*(6045), 959–964.

https://doi.org/10.1126/science.1204529

Dick, A. S. (2014). The development of cognitive flexibility beyond the preschool period: An investigation using a modified Flexible Item Selection Task. *Journal of Experimental Child Psychology*, *125*(1), 13–34. https://doi.org/10.1016/j.jecp.2014.01.021

Dittrich, W. H., & Johansen, T. (2013). Cognitive deficits of executive functions and decision-making in obsessive-compulsive disorder. *Scandinavian Journal of Psychology*, *54*(5), 393–400. https://doi.org/10.1111/sjop.12066

Evans, D. W., Lewis, M. D., & Iobst, E. (2004). The role of the orbitofrontal cortex in normally developing compulsive-like behaviors and obsessive-compulsive disorder. *Brain and Cognition*, *55*(1), 220–234. https://doi.org/10.1016/S0278-2626(03)00274-4

Ezpeleta, L., De La Osa, N., & Doménech, J. M. (2014). Prevalence of DSM-IV disorders, comorbidity and impairment in 3-year-old Spanish preschoolers. *Social Psychiatry and Psychiatric Epidemiology*, *49*(1), 145–155. https://doi.org/10.1007/s00127-013-0683-1

Ezpeleta, L., & Granero, R. (2015). Executive functions in preschoolers with ADHD, ODD, and comorbid ADHD-ODD: Evidence from ecological and performance-based measures. *Journal of Neuropsychology*, *9*(2), 258–270. https://doi.org/10.1111/jnp.12049

Ezpeleta, L., Navarro, J. B., De La Osa, N., Penelo, E., & Domènech, J. M. (2019). First incidence, age of onset outcomes and risk factors of onset of DSM-5 oppositional defiant disorder: A cohort study of Spanish children from ages 3 to 9. *BMJ Open*, *9*(3). https://doi.org/10.1136/bmjopen-2018-022493

Ezpeleta, L., Penelo, E., de la Osa, N., Navarro, J. B., & Trepat, E. (2019). Irritability and parenting practices as mediational variables between temperament and affective, anxiety, and oppositional defiant problems. *Aggressive Behavior*, *45*(5), 550–560. https://doi.org/10.1002/ab.21850

Ezpeleta, L., Penelo, E., Navarro, J. B., de la Osa, N., & Trepat, E. (2022). Co-developmental trajectories of defiant/headstrong, irritability, and prosocial emotions from preschool age to early adolescence. *Child Psychiatry and Human Development*, *53*(5), 908–918. https://doi.org/10.1007/s10578-021-01180-z

Fishburn, F. A., Hlutkowsky, C. O., Bemis, L. M., Huppert, T. J., Wakschlag, L. S., & Perlman, S. B. (2019). Irritability uniquely predicts prefrontal cortex activation during preschool inhibitory control among all temperament domains: A LASSO approach. *NeuroImage, 184* (August 2018), 68–77.

Garcia, A. M., Freeman, J. B., Himle, M. B., Berman, N. C., Ogata, A. K., Ng, J., Choate-Summers, M. L., & Leonard, H. (2009). Phenomenology of Early Childhood Onset Obsessive Compulsive Disorder. *Journal of psychopathology and behavioral assessment, 31*(2), 104–111. https://doi.org/10.1007/s10862-008-9094-0

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive Function in Preschoolers: A Review Using an Integrative Framework. *Psychological Bulletin*, *134*(1), 31–60. https://doi.org/10.1037/0033-2909.134.1.31

Geller, D. A., Homayoun, S., & Johnson, G. (2021). Developmental considerations in Obsessive Compulsive Disorder: Comparing pediatric and adult-onset cases. *Frontiers in Psychiatry*, *12*(June), 1–15. https://doi.org/10.3389/fpsyt.2021.678538

Gioia, G. A., Espy, K. A., & Isquith, P. K. (2003). *Behavior Rating Inventory of Executive Function - Preschool version.* Lutz, FL: Psychological Assessment Resources

Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. In *Journal of Child Psychology and Psychiatry and Allied Disciplines* (Vol. 38, Issue 5, pp. 581–586). https://doi.org/10.1111/j.1469-7610.1997.tb01545.x

Goli, E., Abdekhodaie, M. S., Mashhadi, A., & Bigdeli, I. (2020). The role of parent-child interaction patterns in the development of obsessive-compulsive disorder: A literature review study. *Journal of Fundamentals of Mental Health*, *22*(1), 5–20. https://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=143206805&site=ehost-live

Griffith, S. F., Arnold, D. H., Rolon-Arroyo, B., & Harvey, E. A. (2019). Neuropsychological predictors of ODD symptom dimensions in young children. *Journal of Clinical Child and Adolescent Psychology*, *48*(1), 80–92. https://doi.org/10.1080/15374416.2016.1266643

Guzick, A. G., Cooke, D. L., Mcnamara, J. P. H., Reid, A. M., Graziano, P. A., Lewin, A. B., Murphy, T. K., Goodman, W. K., Storch, E. A., Geffken, G. R., & Reid, A. M. (2019). Parents ' perceptions of internalizing and externalizing features in childhood OCD. *Child Psychiatry & Human Development*, *50*(4), 692–701. https://doi.org/10.1007/s10578-019-00873-w

Guzick, A. G., Geller, D. A., Small, B. J., Murphy, T. K., Wilhelm, S., & Storch, E. A. (2020). Irritability in children and adolescents with OCD. *Behavior Therapy*. https://doi.org/10.1016/j.beth.2020.11.001

Guzick, A. G., Geller, D. A., Small, B. J., Murphy, T. K., Wilhelm, S., & Storch, E. A. (2021). Irritability in Children and Adolescents With OCD. *Behavior Therapy*, *52*(4), 883–896. https://doi.org/10.1016/j.beth.2020.11.001

Hobson, C. W., Scott, S., & Rubia, K. (2011). Investigation of cool and hot executive function in ODD/CD independently of ADHD. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *52*(10), 1035–1043. https://doi.org/10.1111/j.1469-7610.2011.02454.x

Hybel, K. A., Mortensen, E. L., Lambek, R., Thastum, M., & Thomsen, P. H. (2017). Cool and hot aspects of executive function in childhood Obsessive-Compulsive Disorder. *Journal of Abnormal Child Psychology*, *45*(6), 1195–1205. https://doi.org/10.1007/s10802-016-0229-6

Jacoby, R. J., Smilansky, H., Shin, J., Wu, M. S., Small, B. J., Wilhelm, S., Storch, E. A., & Geller, D. A. (2021). Longitudinal trajectory and predictors of change in family accommodation during exposure therapy for pediatric OCD. *Journal of Anxiety*

Disorders, *83*(June), 102463. https://doi.org/10.1016/j.janxdis.2021.102463

Jiang, W., Li, Y., Du, Y., & Fan, J. (2016). Emotional regulation and executive function deficits in unmedicated Chinese children with oppositional defiant disorder. *Psychiatry Investigation*, *13*(3), 277–287. https://doi.org/10.4306/pi.2016.13.3.277

Kleine Deters, R., Naaijen, J., Rosa, M., Aggensteiner, P. M., Banaschewski, T., Saam, M. C., Schulze, U. M. E., Sethi, A., Craig, M. C., Sagar-Ouriaghli, I., Santosh, P., Castro-Fornieles, J., Penzol, M. J., Arango, C., Werhahn, J. E., Brandeis, D., Franke, B., Glennon, J., Buitelaar, J. K., … Dietrich, A. (2020). Executive functioning and emotion recognition in youth with oppositional defiant disorder and/or conduct disorder. *World Journal of Biological Psychiatry*, *21*(7), 539–551. https://doi.org/10.1080/15622975.2020.1747114

Kodaira, M., Iwadare, Y., Ushijima, H., Oiji, A., Kato, M., Sugiyama, N., Sasayama, D., Usami, M., Watanabe, K., & Saito, K. (2012). Poor performance on the Iowa gambling task in children with obsessive-compulsive disorder. *Annals of General Psychiatry*, *11*(1), 1. https://doi.org/10.1186/1744-859X-11-25

Kryza-Lacombe, M., Palumbo, D., Wakschlag, L. S., Dougherty, L. R., & Wiggins, J. L. (2022). Executive functioning moderates neural mechanisms of irritability during reward processing in youth. *Psychiatry Research - Neuroimaging*, *323*(March), 111483. https://doi.org/10.1016/j.pscychresns.2022.111483

Leadbeater, B. J., & Homel, J. (2015). Irritable and defiant sub-dimensions of ODD: their stability and prediction of internalizing symptoms and conduct problems from adolescence to young adulthood. *Journal of Abnormal Child Psychology*, *43*(3), 407–421. https://doi.org/10.1007/s10802-014-9908-3

Lebowitz, E. R. (2013). Parent-based treatment for childhood and adolescent OCD. *Journal of Obsessive-Compulsive and Related Disorders*, *2*(4), 425–431.

https://doi.org/10.1016/j.jocrd.2013.08.004

Lehmkuhl, H. D., Storch, E. A., Rahman, O., Freeman, J., Geffken, G. R., & Murphy, T. K. (2009). Just say no: sequential Parent Management Training and Cognitive-Behavioral Therapy for a child with comorbid disruptive behavior and obsessive compulsive disorder. *Clinical Case Studies, 8*(1), 48–58. https://doi.org/10.1177/1534650108326786

Li, Y., Grabell, A. S., Wakschlag, L. S., Huppert, T. J., & Perlman, S. B. (2017). The neural substrates of cognitive flexibility are related to individual differences in preschool irritability: A fNIRS investigation. *Developmental Cognitive Neuroscience*, *25*, 138–144. https://doi.org/10.1016/j.dcn.2016.07.002

Maldonado, G., & Greenland, S. (1993). Simulation study of confounder-selection strategies. *American Journal of Epidemiology*, *138*(11), 923–936.

   https://doi.org/10.1093/oxfordjournals.aje.a116813

Mancini, C., Cardona, F., Baglioni, V., Panunzi, S., Pantano, P., Suppa, A., & Mirabella, G. (2018). Inhibition is impaired in children with obsessive-compulsive symptoms but not in those with tics. *Movement Disorders*, *33*(6), 950–959. https://doi.org/10.1002/mds.27406

Matthys, W., Vanderschuren, L. J. M. J., & Schutter, D. J. L. G. (2013). The neurobiology of oppositional defiant disorder and conduct disorder: Altered functioning in three mental domains. *Development and Psychopathology*, *25*(1), 193–207. https://doi.org/10.1017/S0954579412000272

Matthys, W., Vanderschuren, L. J. M. J., Schutter, D. J. L. G., & Lochman, J. E. (2012). Impaired neurocognitive functions affect social learning processes in Oppositional Defiant Disorder and Conduct Disorder: implications for interventions. *Clinical Child and Family Psychology Review*, *15*(3), 234–246. https://doi.org/10.1007/s10567-012-0118-7

McNamara, J. P. H., Reid, A. M., Balkhi, A. M., Bussing, R., Storch, E. A., Murphy, T. K.,

Graziano, P. A., Guzick, A. G., & Geffken, G. R. (2014). Self-regulation and other executive functions relationship to pediatric OCD severity and treatment outcome. *Journal of Psychopathology and Behavioral Assessment*, *36*(3), 432–442. https://doi.org/10.1007/s10862-014-9408-3

Miyawaki, D., Goto, A., Iwakura, Y., Hirai, K., Miki, Y., Asada, N., Terakawa, H., & Inoue, K. (2018). Preschool-onset obsessive-compulsive disorder with complete remission. *Neuropsychiatric Disease and Treatment*, *14*, 1747–1753. https://doi.org/10.2147/NDT.S169797

Negreiros, J., Best, J. R., Yamin, D. F., Belschner, L., Lin, S., & Stewart, S. E. (2020). Test-based versus parent ratings of executive function in pediatric Obsessive-Compulsive Disorder. *Journal of Obsessive-Compulsive and Related Disorders*, *24*(November 2019), 100495. https://doi.org/10.1016/j.jocrd.2019.100495

Nestadt, G., Samuels, J., Riddle, M., Bienvenu, O. J., Liang, K.-Y., LaBuda, M., Walkup, J., Grados, M., & Hoehn-Saric, R. (2000). A Family study of Obsessive-compulsive Disorder. *Archives of General Psychiatry*, *57*(4), 358. https://doi.org/10.1001/archpsyc.57.4.358

Ornstein, T. J., Arnold, P., Manassis, K., Mendlowitz, S., & Schachar, R. (2010). Neuropsychological performance in childhood OCD: A preliminary study. *Depression and Anxiety*, *27*(4), 372–380. https://doi.org/10.1002/da.20638

Perlman, S. B., Jones, B. M., Wakschlag, L. S., Axelson, D., Birmaher, B., & Phillips, M. L. (2015). *Developmental Cognitive Neuroscience Neural substrates of child irritability in typically developing and psychiatric populations*. *14*, 71–80.

Pietrefesa, A. S., & Evans, D. W. (2007). Affective and neuropsychological correlates of children's rituals and compulsive-like behaviors: Continuities and discontinuities with

obsessive-compulsive disorder. *Brain and Cognition*, *65*(1), 36–46. https://doi.org/10.1016/j.bandc.2006.02.007

Pontillo, M., Demaria, F., Tata, M. C., Averna, R., Gargiullo, P., Pucciarini, M. L., Santonastaso, O., Boldrini, T., Tozzi, A. E., & Vicari, S. (2020). *Clinical significance of family accommodation and parental psychological distress in a sample of children and adolescents with obsessive-compulsive disorder aged 8-17 years old*. 1–10.

Rhodes, S. M., Park, J., Seth, S., & Coghill, D. R. (2012). A comprehensive investigation of memory impairment in attention deficit hyperactivity disorder and oppositional defiant disorder. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *53*(2), 128–137. https://doi.org/10.1111/j.1469-7610.2011.02436.x

Rowe, R., Costello, E. J., Angold, A., Copeland, W. E., & Maughan, B. (2010). Developmental pathways in oppositional defiant disorder and conduct disorder. *Journal of Abnormal Psychology*, *119*(4), 726–738. https://doi.org/10.1037/a0020798

Schoorl, J., van Rijn, S., de Wied, M., van Goozen, S., & Swaab, H. (2018). Boys with Oppositional Defiant Disorder/Conduct Disorder show impaired adaptation during stress: an executive functioning study. *Child Psychiatry and Human Development*, *49*(2), 298–307. https://doi.org/10.1007/s10578-017-0749-5

Smith, J. D., Dishion, T. J., Shaw, D. S., Wilson, M. N., & Patterson, G. R. (2014). *NIH Public Access*. *26*, 917–932. https://doi.org/10.1017/S0954579414000169.Coercive

Stringaris, A., & Goodman, R. (2009). Three dimensions of oppositionality in youth. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *50*(3), 216–223. https://doi.org/10.1111/j.1469-7610.2008.01989.x

Stringaris, A., Zavos, H., Leibenluft, E., Maughan, B., & Eley, T. (2012). Adolescent irritability : phenotypic associations and genetic links with depressed mood. *American*

Journal of Epidemiology, *169*(1), 47–54. https://doi.org/10.1176/appi.ajp.2011.10101549

Thériault, M. C. G., Lespérance, P., Achim, A., Tellier, G., Diab, S., Rouleau, G. A., Chouinard, S., & Richer, F. (2014). ODD irritability is associated with obsessive-compulsive behavior and not ADHD in chronic tic disorders. *Psychiatry Research*, *220*(1–2), 447–452. https://doi.org/10.1016/j.psychres.2014.07.039

Vaghi, M. M., Vértes, P. E., Kitzbichler, M. G., Apergis-Schoute, A. M., van der Flier, F. E., Fineberg, N. A., Sule, A., Zaman, R., Voon, V., Kundu, P., Bullmore, E. T., & Robbins, T. W. (2017). Specific frontostriatal circuits for impaired cognitive flexibility and goal-directed planning in Obsessive-Compulsive Disorder: evidence from resting-state functional connectivity. *Biological Psychiatry*, *81*(8), 708–717. https://doi.org/10.1016/j.biopsych.2016.08.009

Valcan, D. S., Davis, H., & Pino-Pasternak, D. (2018). Parental behaviours predicting early childhood executive functions: a meta-analysis. *Educational Psychology Review*, *30*(3), 607–649. https://doi.org/10.1007/s10648-017-9411-9

van Goozen, S. H. M., Cohen-Kettenis, P. T., Snoek, H., Matthys, W., Swaab-Barneveld, H., & van Engeland, H. (2004). Executive functioning in children: A comparison of hospitalised ODD and ODD/ADHD children and normal controls. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *45*(2), 284–292. https://doi.org/10.1111/j.1469-7610.2004.00220.x

Waldman, I. D., Rowe, R., Boylan, K., & Burke, J. D. (2021). External validation of a bifactor model of oppositional defiant disorder. *Molecular Psychiatry*, *26*(2), 682–693. https://doi.org/10.1038/s41380-018-0294-z

World Health Organization (2019) The ICD-11 classification of mental and behavioural disorders. https://icd.who.int/en

Zelazo, P. D. (2020). Executive function and psychopathology: a neurodevelopmental perspective. *Annual Review of Clinical Psychology*, *16*, 431–454. https://doi.org/10.1146/annurev-clinpsy-072319-024242

Zhu, Y. (2018). The mechanism of cortico-striato-thalamo-cortical neurocircuitry in response inhibition and emotional responding in Attention Deficit Hyperactivity Disorder with comorbid Disruptive Behavior Disorder. *Neuroscience Bulletin*, *34*(3), 566–572. https://doi.org/10.1007/s12264-018-0214-x