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Executive Function Difficulties among Preschool-Aged Children

Examining Their Everyday Manifestations and the Potential of a Play-Based Intervention

UNIVERSITY OF JYVÄSKYLÄ

FACULTY OF EDUCATION AND
PSYCHOLOGY

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JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

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ABSTRACT

The aim of this dissertation was to investigate the everyday manifestations of executive function (EF) difficulties among preschool-aged children and to study the potential of a play-based intervention for improving related behavioral outcomes and parental functioning. In Study I, we examined the heterogeneity of everyday EF skills in a mixed clinical sample through a variable-oriented approach, entailing comparisons of different symptom-based groups, as well as through a person-oriented approach using latent profile analysis. In Study II, we examined the effectiveness of a play-based EF intervention (ENGAGE) in reducing EF-related behavior problems among preschool children with elevated inattentive and/or hyperactive/impulsive problems. In Study III, we examined the effectiveness of ENGAGE in reducing parenting stress directly and indirectly through changes in children's behavior. Three distinct datasets were used in the studies: Study I utilized a clinical sample ($N = 171$) gathered from child psychiatric outpatient clinics as well as a normative sample ($N = 667$) gathered from early childhood education (ECE) units; Studies II and III utilized a dataset ($N = 95$) gathered as a part of the *Leikitään ja keskitytään* project (2017–2019). The person-oriented results of Study I, obtained using latent profile analysis, showed that the everyday EF of children with emotional and behavioral problems are captured by five distinct profiles. Compared to the variable-oriented comparisons of clinical groups based on internalizing and externalizing symptoms, the person-oriented profiles brought out more nuanced information concerning the heterogeneity of everyday EF skills. The results of Study II and III showed that the ENGAGE intervention was effective in reducing children's EF-related behavior problems according to parent ratings but not according to ECE teacher ratings, and that the relieving effect of the intervention on parenting stress operated fully through reductions in child aggressive and oppositional behavior. The results highlight the need for individual assessment of a child's everyday EF profile regardless of their level and type of internalizing and externalizing symptoms, and support the potential of the ENGAGE intervention as an effective way to reduce children's EF-related behavior problems in the Finnish health care context. Furthermore, the results highlight the importance of addressing child aggressive and oppositional behavior in order to improve parental outcomes.

Keywords: executive function, preschool-age, play-based intervention

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Tämän väitöskirjatutkimuksen tavoitteena oli selvittää alle kouluikäisillä lapsilla arkielämässä ilmenevien toiminnanohjauksen (TO) vaikeuksien luonnetta sekä tutkia mahdollisuutta tukea lapsia ja heidän vanhempiaan leikkiperustaisen intervention avulla. Ensimmäisessä osatutkimuksessa pyrittiin selvittämään, minkälaisia arjen TO-vaikeuksia on eri tavoin psyykkisesti oireilevilla lapsilla. Kysymystä lähestyttiin muuttujakeskeisesti, eli vertailemalla eri tavoin oireilevien lasten ryhmiä toisiinsa ja tyypillisesti kehittyviin lapsiin, sekä henkilökeskeisesti, eli selvittämällä TO:n yksilölliseen vaihteluun perustuvia profiileja koko kliinisessä aineistossa. Toisessa osatutkimuksessa selvitettiin leikkiperustaisen ENGAGE-intervention vaikutusta lasten käyttäytymiseen perheissä, joissa vanhemmilla oli huolta lastensa tarkkaamattomuudesta ja/tai ylivilkkaudesta ja impulsiivisuudesta. Kolmannessa osatutkimuksessa selvitettiin ENGAGE-intervention vaikutusta vanhempien kokemaan vanhemmuuden stressiin suoraan sekä lasten käyttäytymisessä tapahtuvien muutosten välittämänä. Kaikki tutkimuksen aineisto oli kyselylomakemuotoista ja perustui vanhempien ja varhaiskasvatuksen lasta koskeviin arvioihin. Ensimmäisen osatutkimuksen kliininen aineisto (*N*=171) kerättiin pienten lasten psykiatrisiin yksilöihin ohjautuneilta perheiltä ja normatiivinen aineisto (*N*=667) kerättiin päiväkodeista. Toisessa ja kolmannessa osatutkimuksessa käytetty aineisto (*N*=95) kerättiin osana Niilo Mäki Instituutin Leikitään ja keskitytään -hanketta (2017-2019). Tulokset osoittivat, että psyykkisesti oireilevien lasten arjen TO:sta voidaan kuvata viiden profiilin kautta. Henkilökeskeiset profiilit tavoittivat eri TO:n osa-alueilla ilmenevää vaihtelua muuttujakeskeisiä oireryhmävertailuja tarkemmin. Toiseksi tulokset osoittivat, että ENGAGE oli tehokas tapa vähentää lasten TO:een liittyviä käyttäytymisen ongelmia vanhempien, mutta ei varhaiskasvatuksen, arvioihin perustuen. Kolmanneksi tulokset osoittivat, että intervention vanhemmuuden stressiä vähentävä vaikutus välittyi täysin lasten aggressiivisen ja uhmakkaan käyttäytymisen vähenemisen myötä. Kaikkiaan väitöstutkimuksen tulokset korostavat lapsen arjen TO-vaikeuksien yksilöllisen arvioinnin tärkeyttä riippumatta lapsen ulos- ja sisäänpäin kääntyvien oireiden tyypistä ja määrästä. Tulokset myös tukevat ENGAGE-intervention toimivuutta varhaisena tukitoimena alle kouluikäisille lapsille. Aggressiivisen ja uhmakkaan käyttäytymisen vähenemiseen intervention myötä on tärkeä kiinnittää erityistä huomiota, sillä se on tärkeää koko perheen hyvinvoinnin kannalta.

Avainsanat: toiminnanohjaus, leikki-ikä, interventio

Author   Teivaanmäki Sini
                    Department of Psychology
                    University of Jyväskylä
                    sini.teivaanmaki@gmail.com
                    https://orcid.org/0000-0002-0575-7964

Supervisors   Professor Noona Kiuru
                    Department of Psychology
                    University of Jyväskylä

                    PhD Liisa Klenberg
                    Niilo Mäki Institute

                    Senior Researcher Vesa Närhi
                    Department of Education
                    University of Jyväskylä

Reviewers   Senior Research Fellow, Docent Anneli Kylliäinen
                    Welfare Sciences/Psychology
                    Faculty of Social Sciences
                    University of Tampere

                    Professor Riikka Korja
                    Department of Psychology and Speech-Language
                    Pathology
                    University of Turku

Opponent   Senior Research Fellow, Docent Anneli Kylliäinen
                    Welfare Sciences/Psychology
                    University of Tampere

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FIGURE

TABLE

LIST OF ORIGINAL PUBLICATIONS

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The author of this thesis participated in planning the research and collecting the data for Studies II and III, as well as conducted the analyses and wrote the reports for all three articles with the help of co-author's comments and instructions.

*Study II was first-authored together with L. Klenberg, the principal investigator of the Finnish ENGAGE study, who had the main responsibility in the intervention research process as a whole. The author of this thesis made a significant contribution to the introduction and discussion sections, as well as had the main responsibility in collecting and analyzing the data and writing the methods and results sections for the article.

CONTENTS

1 INTRODUCTION

Preschool-aged children, approximately 3 to 6 years of age, are heavily dependent on their caregivers and other adults in regulating their behavior, cognition and emotion appropriately and adaptively. Despite this known fact, young children possess a variety of emerging regulatory skills that grant them simple forms of control and that form the foundation for further development, culminating in the ability to autonomously manage the complexities of life in adulthood. This group of cognitive skills, underlying all goal-directed behavior and deliberate, "top-down" responses to situational demands, is referred to as executive function (EF; Hofmann et al., 2012; Nigg, 2017). EF is needed in situations that are typically novel and complex and in which well-learned and automatic responses do not suffice. For preschool-aged children, such situations include, for instance, persisting in play and tasks despite distractions, staying still and quiet when needed, and focusing on and following parental instructions.

By virtue of being domain-general skills that contribute to the purposeful use of all other cognitive processes, EF skills can be considered foundational for development and learning. Empirical research supports this notion. Whether measured cognitively or behaviorally, EF in the preschool age has repeatedly been shown to predict a multitude of important outcomes concurrently and later on, including psychosocial well-being (Fleming et al., 2020; Morgan et al., 2019; Quistberg & Mueller, 2020; Yang et al., 2022), social functioning, including theory of mind (Holmes et al., 2016; Hughes & Ensor, 2007; Marcovitch et al., 2015; Riggs et al., 2006), and academic achievement (Ahmed et al., 2021; Kegel & Bus, 2014; McClelland et al., 2014; Morgan et al., 2019). In their seminal study, Moffitt et al. (2011) showed that a composite measure of self-control, measured at multiple time points during the first decade of life, predicted physical health, personal finances and criminal offending outcomes at the age of 32.

The far-reaching impact of EF on important life outcomes may operate directly or indirectly through a process of cascading effects. With respect to the latter option, Ahmed et al. (2021) showed that EF skills at 4 years of age predict educational attainment two decades later above and beyond the effects of EF measured during childhood and adolescence and a variety of potential

confounders. This highlights the importance of the preschool age in terms of EF development. Early EF difficulties may hinder the development of other skills and capacities, such as social and academic skills, which can set forth negative cycles that eventually operate at least partly independent of the EF-related dysfunction that initiated the process in the first place. Therefore, understanding the nature of early EF difficulties and designing and evaluating interventions suitable for the young age group is of the utmost importance to prevent widespread adversities and reduce social disparities in health and well-being later on (Diamond, 2016). In an effort to address this demand, this study aimed to provide knowledge about the nature of EF difficulties among preschool-aged children with developmental vulnerabilities, as present in the form of elevated emotional and behavioral problems, as well as to study the potential of a novel play-based intervention in providing support for both children and their parents.

Difficulties in EF are a common feature in many forms of psychopathology often categorized as either externalizing or internalizing (Snyder et al., 2015; Yang et al., 2022; Zelazo, 2020). As such, difficulties in EF have been suggested as an important intervention target for many forms of psychopathology, and preschool age has been postulated as an optimal time point for such interventions (Shephard et al., 2022; Zelazo, 2020). However, more understanding is needed about the more specific areas of EF where preschool-aged children with externalizing and internalizing symptoms may struggle. Previously, externalizing symptoms have repeatedly been related to difficulties in all core EF skills, i.e. inhibition, working memory and cognitive flexibility (Pauli-Pott & Becker, 2011; Schoemaker et al., 2023) as well as to broad difficulties in the use of EF skills in everyday contexts (Ezpeleta & Granero, 2015; Graziano et al., 2022; Mahone & Hoffman, 2007). Findings concerning children with internalizing symptoms are more mixed in terms of the core EF skills (Bloemen et al., 2018; Vilgis et al., 2015; Wagner et al., 2015), and there is a paucity of studies examining the difficulties that children with internalizing symptoms face when using these skills in their everyday lives. Furthermore, the majority of studies have examined these relationships from a variable-oriented perspective, assuming similarity between all children exhibiting certain kinds of symptoms. Hence, the aim of Study I was to examine the everyday manifestations of EF difficulties in a heterogeneous group of preschool-aged children with emotional and behavioral problems using two complementary approaches. The first approach (variable-oriented) focused on mean comparisons between different symptom-based groups and typically developing children, and the second approach (person-oriented) focused on individual-level variability in EF skills to identify typical EF profiles and then to examine their relations to key background variables, including internalizing and externalizing symptoms.

Currently, the recommended psychosocial interventions for children exhibiting behavior problems, such as those with attention-deficit hyperactivity disorder (ADHD), are ones based on behavioral techniques, including behavioral parent training (ADHD: Current Care Guidelines Abstract, 2017). Another intervention approach gaining increasing interest is one focusing on the core

cognitive skills that underlie adaptive behavior regulation—that is, EF skills (Halperin & Healey, 2011). Many kinds of EF-targeting interventions have been found to improve children's EF skills (Diamond & Lee, 2011; Pauli-Pott et al., 2021; Scionti et al., 2020; Takacs & Kassai, 2019). However, little is known about what kinds of EF interventions are the most suitable for "at-risk" preschoolers with elevated levels of EF-related behavior problems, including inattentive and hyperactive/impulsive behavior problems. There is, nevertheless, promising evidence for play-based EF interventions that aim to provide EF-related practice for children through guided play between parents and children (Halperin et al., 2020; Healey & Healey, 2019; Tamm et al., 2019). These interventions have been found to be at least as effective as other psychosocial interventions (Halperin et al. 2020; Tamm et al., 2019), including behavioral parent training (Healey & Healey, 2019), in reducing children's behavior problems. The aim of Study II was to examine the effectiveness of one such play-based EF intervention, ENGAGE, in reducing EF-related behavior problems among 4- to 5-year-old Finnish children with elevated inattentive and/or hyperactive/impulsive problems. Studies conducted in New Zealand have found ENGAGE to be a promising way to reduce such problems (Healey & Halperin, 2015; Healey & Healey, 2019); however, the generalizability of the results to other cultural contexts and societies is not yet known.

Child development is a transactional process where the child's characteristics and contexts shape one another over time (Sameroff, 2019). One contextual factor closely tied to child behavior and problems related to it is the stress that parents feel in their parent role, that is, parenting stress (Deater-Deckard, 2004; Deater-Deckard, 1998). Parenting stress can be understood as stemming from different sources, with some factors related more directly to the parent (e.g., social isolation, depression), some related to the child's characteristics (e.g., adaptability and demandingness), and some related to dysfunctional parent–child relationship (e.g., the degree that the parent feels the child meets their standards) (Abidin, 2012). Parenting stress and child behavior problems have been found to contribute to one another over time in a transactional way (Mackler et al., 2015; Neece et al., 2012), meaning that problems easily accumulate and escalate in the family. It is therefore pertinent that interventions aiming to support children's behavior are also effective in reducing parenting stress. Although it has been shown that parenting stress can be reduced (Colalillo & Johnston, 2016; Theule et al., 2018), very little is known about whether play-based EF interventions can reduce parenting stress and through which mechanisms such an effect might operate. The aim of Study III was therefore to examine the effect of the ENGAGE intervention on different aspects of parenting stress and whether changes in children's behavior mediate this relationship.

1.1   On the concept of executive function

Using the term "executive" to describe the functions of the prefrontal cortex first took place in the scientific literature in the 1970s (Pribram, 1973). However, the idea of control functions had been a topic of interest much longer, largely stemming from studies of patients having suffered frontal lobe damage (Goldstein et al., 2014). Such studies revealed that, despite intact basic processes, such as memory and language, patients with frontal lobe damage displayed marked deficits in their ability to use those basic processes in a strategic and controlled way (Robbins et al., 1996). Since the 1970s, theoretical accounts and empirical investigations concerning EF have emerged at a fast rate. EF, or similar concepts (e.g., effortful control, self-regulation, cognitive control), have been approached from various scientific traditions in somewhat independent lines of research. This has contributed to increased understanding of the construct(s) but also to confusion in terms of terminology and methodology—or "conceptual clutter and measurement mayhem", as described by Morrison and Gramer (2016).

Although EF is nowadays understood as a multi-componential construct, the earliest theoretical accounts of EF emphasized EF more as a unitary control function (Baddeley, 1983; Carver & Scheier, 1982). At the turn of the millennium, the factor analytic study of Miyake et al. (2000) laid the ground for the widely influential account of EF, according to which EF is a set of dissociable yet interrelated cognitive processes, displaying both "unity" and "diversity". The three processes of updating (of working memory contents), inhibition and shifting (or cognitive flexibility) all tap a common underlying factor, often attributed to holding goal-relevant information in mind (Miyake & Friedman, 2012), as well as updating- and shifting-specific factors (Friedman et al., 2008). Notably, no inhibition-specific variance is left when common EF is accounted for, suggesting that inhibition is identical to what common EF represents (Friedman et al., 2008). Since then, many latent variable studies with adult, adolescent and older child populations have supported this factor structure (Karr et al., 2018). Although much current research on EF relies on this widely established EF structure, it should be noted that these three processes are by no means elemental or exhaustive—that is, there can be other EF skills, especially when examined at differing levels of complexity (Friedman & Miyake, 2017). Indeed, WM, inhibition, and shifting are often considered to be important building blocks for more complex EF skills, including planning and organizing (Diamond, 2013a).

Inhibition refers to the skill of suppressing inappropriate reactions and impulses, whether prepotent (dominant through learning), automatic, or highly tempting (Diamond, 2013a; Miyake et al., 2000). Among preschool-aged children, inhibition becomes visible, for instance, in situations that necessitate resisting the urge to blurt out an answer before raising one's hand or to act aggressively despite not getting one's way, or when waiting for ones' own turn in a game or in line. Inhibition is, in itself, an umbrella concept that can be divided into the interrelated components of response inhibition (inhibition of prepotent motor

responses) and inference control (attentional resistance to distractors), as well as a separate cognitive inhibition component (suppressing unwanted or irrelevant thoughts) (Friedman & Miyake, 2004).

Working memory (WM) refers to the ability to maintain information in mind while working with it, therefore including both maintenance (also known as short-term memory) and manipulation components (Diamond, 2013a). WM is critical in anything that unfolds over time, e.g. language or problem solving, as it bridges earlier elements to later ones. Small children need WM, for instance, when memorizing parents' instructions and following them or when carrying out their own plans. Some accounts, often concerning adults, highlight the updating functions of WM which, based on the experiments of Ecker et al. (2014), can be isolated as the removal of outdated material from WM. In this dissertation, I use the term WM instead of updating as it refers to both the maintenance and manipulation functions more generally. In addition, updating develops later than simple maintenance and is therefore not, age-wise, so relevant to young preschoolers (Garon et al., 2008). WM is closely linked to the concept of selective attention—the selecting and prioritizing of information that is relevant to ongoing behavior at any given moment—which forms the foundation for internal WM representations and assists in its operations (Van Ede & Nobre, 2022). Moreover, from a developmental perspective, selective attention has been considered the foundation of WM and other EF skills (Garon et al., 2008), with WM building upon the basic abilities to select a target and focus on it.

Shifting or cognitive flexibility means shifting one's attention to different aspects of a stimulus or a situation and switching flexibly between tasks (Diamond, 2013a). Shifting is a key element in adaptive behavior: when a certain way of doing things is not working one has to flexibly find another way. This often requires looking at things from different perspectives and angles. As discussed in the following section concerning the development of EF skills, shifting builds upon WM and inhibition and is thus the latest of EF skills to develop (Akshoomoff et al., 2018; Best & Miller, 2010; Garon et al., 2008; Karr et al., 2022).

The concept of EF emerged from a tradition that mainly considered and measured the construct in emotionally and motivationally "cool" contexts, aligning with the general cognitive focus in the field of psychology in the latter half of the twentieth century (Goldstein et al., 2014). However, in everyday life, such a neutral stance seems somewhat uncommon since people usually engage in goal pursuits that they actually care about and that involve consequences with personal significance. Especially among young children, whose emotional development is still in its early stages, challenges related to EF are often mingled with emotional aspects such as learning to deal with disappointment and frustration. Despite such an apparent union, interest in the intersection of cognitive control and emotion only arose after the formative research conducted by Miyake et al. (2000), and even more so from the 2010s onwards.

To address the gap in literature that existed for the role of emotions and motivation in relation to EF, a conceptual distinction between "hot" and "cool"

aspects of EF emerged (Zelazo & Carlson, 2012). Whereas cool EF concerns control in emotionally neutral situations and in decontextualized and abstract tasks, hot EF highlights the reprocessing of affective and motivational significance of stimuli according to context, especially manifest in decision-making situations (Zelazo, 2007; Zelazo & Carlson, 2012). Despite being dissociable on the conceptual and neural levels, hot and cool forms of control are best thought to exist on a continuum and are both often present in real-world situations to differing degrees (Zelazo, 2007). On the one hand, motivational and emotional salience in situations can undermine cool EF and make it more difficult, and on the other hand, positive stimuli may facilitate cool EF (Zelazo, 2010). Cool EF has also been shown to support performance in hot EF tasks (Carlson et al., 2005; Zelazo, 2010), and it plays an integral part in effortful forms of emotion regulation, such as in reappraisal (Schmeichel & Tang, 2014). For instance, a recent study showed that better cool EF can contribute to more flexible use of different ER strategies in different situations (Toh & Yang, 2023).

The other approach to integrating the EF concept with emotion and motivation has been forming conceptual frameworks that incorporate EF as the cognitive components of a larger regulatory whole, often termed self-regulation (e.g. Bailey & Jones, 2019; Blair & Ku, 2022; Hofmann et al., 2012; Nigg, 2017). Self-regulation as a concept has typically been used in broader ways compared to EF, concerning emotion and motivation as much as cognition (Inzlicht et al., 2021; Nigg, 2017). In the present dissertation, I limit the use of concepts mainly to that of EF for the purpose of simplicity. I will use the term *executive function skills* (EF skills) when the aim is to highlight the plurality and distinctiveness of the cognitive subcomponents, and by *executive function* (EF) I refer to the overall skill that the sub-skills form since they typically work together to allow cognitive control. I will use the "hot" and "cool" prefixes when wanting to highlight the emotional and motivational aspects of EF or lack thereof. Furthermore, as will be elaborated in section 1.3 concerning measurement, EF can be measured in different ways, which produces information concerning somewhat different aspects of the construct. I will use the term *everyday EF* when referring to the behavioral manifestations of EF in everyday contexts, typically measured using rating scales, to make a distinction with EF as a neurocognitive concept, typically measured in structured environments using different neuropsychological tasks. Finally, when referring to the use of EF in the context of modifying one's own emotional state, I use the term *emotion regulation*, thus focusing on its effortful side. Due to comprising a highly specific context for EF, emotion regulation is singled out as an important skill to practice in the intervention studied in the present dissertation.

1.2 The development of executive function

The development of EF is a relatively lengthy process, continuing over the first two decades of life. The time course parallels the protracted development of the

prefrontal cortex that supports EF in concert with associated brain regions (Fiske & Holmboe, 2019). Genetic contribution to EF development is notable, as demonstrated by twin studies showing that the latent common EF factor (capturing unity in EF) is highly heritable in children and in young adults (Engelhardt et al., 2015; Friedman et al., 2008). Both unique genetic as well as small environmental effects have been found for the distinct components (Engelhardt et al., 2015; Friedman & Miyake, 2004). High heritability does not mean immutability or genetic determinism, however, despite being commonly misunderstood as such (Harden, 2020). Indeed, the long developmental course of the prefrontal cortex and EF means a long period of sensibility to environmental effects, both in good and in bad (Miguel et al., 2023). Examples of environmental factors that have turned out to be important predictors of EF are adverse events prenatally or during birth, such as preterm birth or low birth weight (van Houdt et al., 2019), exposure to early deprivation and threat (Johnson et al., 2021), SES (Lawson et al., 2018), and parenting styles/behaviors, such as parental warmth and scaffolding (Koşkulu-Sancar et al., 2023).

Although the exact developmental course of EF is unique to each child, empirical investigations have revealed some general trends and patterns. First, EF development seems to follow a pattern of hierarchical integration where EF builds upon simpler skills in an integrative fashion (Garon et al., 2008). The development of basic attentional processes sets the stage for the development of simple WM and inhibition which then, during the preschool years, integrate, allowing inhibition to operate on the basis of more and more complex WM representations (Garon et al., 2008; Zelazo, 2015). Cognitive flexibility seems to be one result of such an integration, as it requires both WM and inhibition and becomes more central during later childhood (Karr et al., 2018). The core components of WM, inhibition and cognitive flexibility then further allow the development of the even more complex and integrative forms of EF, such as planning and organizing, that characterize adult EF (Diamond, 2013a).

A second developmental trend that might seem somewhat paradoxical to integration is differentiation of EF subcomponents along with age. Contrary to the three-factor structure of EF that has been identified among adults and adolescents, and sometimes with school-age children (Karr et al., 2018), a single-factor solution has often provided the best fit in preschool samples, most consistently in 3-year-olds (Wiebe et al., 2008, 2011; Willoughby et al., 2010). Thus, it seems that there is a shift from a relatively undifferentiated executive *function* to multiple *functions* with development. This gradual differentiation seems to reflect a general trend of increased functional specialization of cortical areas (Fiske & Holmboe, 2019; McKenna et al., 2017). A third trend characterizing EF development is a shift from more reactive forms of control (external cues determine which goals to pursue and how) to proactive forms of control, driven by internal factors (Frick & Chevalier, 2022). Preschool-aged children often exercise EF in situations that arise in the here and now and need reminders to do so, whereas adult EF is more characterized by autonomously formulated plans and forethought.

During the preschool years, EF develops particularly rapidly (Montroy et al., 2016; Reilly et al., 2022), with somewhat differing developmental trajectories for the core components (Garon et al., 2008). Development of attention allows children to stay in a state of focused attention for longer periods of time (Ruff & Capozzoli, 2003). Attention continues to develop across later childhood (Klenberg et al., 2001). Furthermore, rapid improvements in complex inhibition tasks have been documented during the preschool period (Best & Miller, 2010; Garon et al., 2008), signaling a growing ability to inhibit prepotent responses and produce alternative responses on the basis of a rule held in mind. Of the EF components, inhibition development seems to level off earliest, with mature levels documented by early school years (Best & Miller, 2010; Klenberg et al., 2001); however, subtle changes in accuracy and reaction times can continue even further (Best & Miller, 2010). WM memory capacity also develops during the preschool period and the development continues steadily into adolescence (Ahmed et al., 2022; Lee et al., 2013). What develops is both the number of items that can be stored in WM (Cowan et al., 2011; Simmering, 2012), as well as the accuracy of those representations (Burnett Heyes et al., 2012; Guillory et al., 2018). Shifting begins to develop in the preschool age (Doebel & Zelazo, 2015), and develops more slowly during childhood until early adulthood (Cepeda et al., 2001; Davidson et al., 2006).

1.3   Measuring executive function

EF in children have typically been measured using either performance-based measures or rating scales. Performance-based measures are used to obtain structured, standardized and objective information concerning EF, and they are either adaptations of adult measures or designed specifically for children. Fortunately, many EF tasks suitable for preschool children exist nowadays (Carlson, 2005). An example of a popular measure of inhibition is the Day-Night Stroop test (Gerstadt et al., 1994), an adaptation of the original Stroop test (Stroop, 1935), requiring children to say "night" when shown pictures of the sun and "day" when shown pictures of the moon and stars. Rating scales, on the other hand, are used to obtain information about everyday behavior and functional abilities related to EF—that is, everyday EF. In the case of preschool children, ratings are typically filled by a parent or some other relevant caregiver, often an early childhood education (ECE) teacher. Probably the most widely used rating scale measure of everyday EF for preschool children is the Behavior Rating Inventory of Executive Function, Preschool Version (BRIEF-P; Isquith et al., 2005) which is meant for children between ages 2 to 5 and involves items tapping inhibition, shifting, working memory, planning and organizing, and emotion regulation.

Although often referred to as objective measures of EF—and therefore considered optimal—many problems related to performance-based measures have been recognized, with perhaps the most fundamental ones being poor ecological validity (Burgess et al., 2006; Isquith et al., 2013) and the task impurity

problem (Miyake, 2000; Miyake & Friedman, 2012). Ecological validity is typically considered to consist of two aspects: representativeness (the degree to which the form and context of assessment matches that of natural contexts) and generalizability (the degree to which performance on a measure can predict performance in natural contexts) (Burgess et al., 2006; Pinto et al., 2023). With performance-based measures, the examiner provides an important part of executive control in the situation: structure, planning, organization, monitoring etc., leaving the test subject with a relatively simple and de-contextualized task that may not correspond well with the complex and dynamic EF situations of everyday life (Isquith et al., 2013). With rating scale measures, however, the measurement context *is* the natural context; therefore, the strength of rating scales lies in their high ecological validity and the resultant relevance and utility for clinical judgement. Recently, more ecologically valid performance-based measures of EF have also been created. For example, in EPELI, participants navigate a virtual apartment and perform chores (Seesjärvi et al., 2022). The task impurity problem, on the other hand, arises from the fact that EF skills in use are always embedded in a certain task context and activate other EF and non-EF processes in addition to the target EF skills, including perceptual, motor, and linguistic processes. This makes it hard to get clean measures of the EF skill of interest. The use of latent variables has been an important way of alleviating the task-impurity problem, allowing the attainment of relatively pure measures of EF skills (Friedman & Miyake, 2017).

Although the task-impurity issue has mainly been discussed in relation to performance-based measures, the impurity problem also concerns rating scale measures, even to a wider degree, since EF skills are embedded in even more complex networks of contextual factors in everyday situations than in highly controlled test situations. As Hofmann et al. (2012) suggested, successful self-regulation requires at least three things: a direction, motivation and capacity. The traditional view of EF links EF mainly with the capacity aspect, but simply lacking a clear enough goal in mind (direction) or not wanting to comply with it and perhaps preferring to do something else instead (motivation) can equally well manifest as behavior that could be reported as poor EF in rating scale measures. On one hand, it may be appropriate to question the very position of viewing all context-related factors as hindrances to the measuring of EF. EF skills never operate in a vacuum, and contextual factors can also be seen as an integral part of EF—as is done in some recently formulated views (Doebel, 2020; Perone et al., 2021).

Other core limitations related to rating scale measures stem from the lack of control that the examiner has over different environmental factors affecting ratings and the inherent subjectivity of such ratings. Rating scales are known to be highly affected by source effects (Podsakoff et al., 2012), with ratings obtained from the same persons being more highly correlated over time than the ratings obtained from different persons. Many factors can contribute to source effects, such as consistency motif (the tendency of respondents to try to maintain consistency in their responses), social desirability (the tendency of respondents

to present themselves in a favorable light to gain social approval and acceptance), or mood states of the respondent that can be more stable characteristics (the tendency to see things in a negative/positive light) or more transient ones, induced by recent events (Podsakoff et al., 2003). In addition to source effects, bias may also arise from factors such as the way the items on a questionnaire are worded and the context in which each item is placed (Podsakoff et al., 2003).

Both performance-based measures and rating scale measures have been used to obtain information of the same construct, EF. However, studies have elicited important questions about what they actually measure since the correlations between them tend to be low at best (Toplak et al., 2013). Toplak et al. (2013) suggested that performance-based and rating scale measures of EF measure two different aspects of cognitive processing: performance-based measures tap the algorithmic level, concerning the efficiency of EF processes, whereas rating scales tap the reflective level, concerning issues of rational goal pursuit and incorporating aspects such as the goals of a person and beliefs related to those goals. This distinction can also be seen as a distinction between optimal/maximal performance and typical performance. As Toplak et al. (2013) conclude, both kinds of measures provide important information about an individual's goal pursuit and are therefore best seen as complementary rather than alternative ways of measuring EF. Holochwost et al. (2023) argued that performance-based measures often capture mostly state-like performance related to EF. Due to relying on one relatively short incident of data gathering, contextual variables such as the child's task persistence (which in itself can be affected by many situation-specific factors), task length, the child's perception of the task as hot or cool, nutrition and sleep status, noise and disruptions can all produce intra-individual variability to task performance. Rating scales, on the other hand, are better at capturing trait-like EF by referencing broader periods of time and a wider range of contexts (Holochwost et al., 2023). The ability of rating scale measures to capture typical and trait-like behavior makes them highly useful when EF-related functional ability in everyday life is of particular interest in a study.

1.4 Executive function and children's emotional and behavioral problems

The connection between weaknesses in EF and psychopathology is widely established. The link has been found for most forms of developmental and psychiatric disorders affecting children and adults, e.g. ADHD, autism spectrum disorder (ASD), depression, schizophrenia, bipolar disorders, obsessive compulsive disorder, post-traumatic stress disorder, and substance use disorders (Snyder et al., 2015; Yang et al., 2022; Zelazo, 2020). In fact, EF is implicated in psychopathology so widely that it has been considered a trans-diagnostic indicator of atypical development overall (Zelazo, 2020). In some disorders, such

as in ADHD, an EF dysfunction has even been postulated as the core deficit (Barkley, 1997), or one potential core deficit (Sonuga-Barke, 2005). Despite a clear connection, more questions than answers surround the issue of cause and effect; that is, whether EF difficulties contribute to psychopathology or vice versa, or weather both are true. A recent study found bi-directional prospective relations between the general psychopathology factor ('p') and EF, suggesting that EF dysfunction is both a risk factor and a consequence of general psychopathology (Romer & Pizzagalli, 2021).

The relationship between children's emotional and behavioral problems and EF has typically been measured on the level of different diagnostic groups. However, approaching these questions on the level of distinct disorders may not be ideal since comorbidity between disorders is more a rule than an exception (Eaton, 2010), suggesting that the different disorders may share etiologies and risk factors, such as EF difficulties. In such a case, a disorder-specific approach can hinder the uncovering of more broad, trans-diagnostic relations. Different statistical techniques, including latent variable approaches, have allowed the investigation of the structure of psychopathology in a way where comorbidity is not seen as a hindrance but rather a phenomenon that can shed light on the most fundamental structures of psychopathology.

Latent variable studies have constantly identified two fundamental dimensions of psychiatric symptoms or disorders: internalizing and externalizing. In his pioneering work examining the comorbidity of children's emotional and behavioral problems, Achenbach (1966) found that different syndromes were subsumed under more fundamental internalizing and externalizing latent factors. Later, the same structure, termed in the same way, has consistently been found in adult samples, with the internalizing factor consisting of anxiety and mood disorders, and externalizing factor entailing anti-social and substance-use disorders (Caspi et al., 2014; Eaton et al., 2013; Kessler et al., 2011; Krueger et al., 2003). In addition, many studies have identified a general psychopathology factor, 'p' — much like the 'g' in intelligence research and the common factor in EF research — capturing the comorbidity between any forms of psychopathology (Lahey et al., 2017; Martel et al., 2017). In this dissertation, I rely on Achenbach and Rescorla's (2000) categorization of internalizing and externalizing symptoms, according to which internalizing symptoms among preschoolers include anxiety and depression, somatic complaints without known medical cause, and social withdrawal (Achenbach & Rescorla, 2000). Externalizing symptoms, in turn, include aggressive behavior and ADHD-related problems (Achenbach & Rescorla, 2000).

1.4.1 Executive function and externalizing symptoms

Earlier studies examining the relationship between EF and externalizing symptoms mainly stem from a cross-sectional tradition where the focus has been on children with (symptoms of) a specific disorder. Many of such studies compare children with a certain diagnosis, such as ADHD, to typically developing controls. Measures of EF include performance-based measures and

rating scales. There are more studies addressing school-aged children than preschool-aged children; however, results obtained from both age groups paint a similar picture of broad difficulties related to EF.

Disorder-specific studies examining school-aged children and using performance-based measures have consistently found deficits in inhibition, WM, and flexibility among children with ADHD (Martinussen et al., 2005; Willcutt et al., 2005). Similarly, when examined using performance-based measures, preschool children with ADHD (symptoms) have been found to have deficits in all core EF skills (Pauli-Pott & Becker, 2011; Schoemaker et al., 2013), although effect sizes have been medium to large only for inhibition and delay aversion and small for WM and flexibility. Parent and teacher ratings have also revealed wide-ranging everyday EF difficulties among both school-aged (Klenberg et al., 2017; Sullivan & Riccio, 2007; Tan et al., 2018) and preschool-aged children (Ezpeleta & Granero, 2015; Graziano et al., 2022; Mahone & Hoffman, 2007) with externalizing symptoms.

There is some evidence to suggest that different externalizing disorders may be somewhat differentially related to EF difficulties. Namely, ADHD has consistently been related to cool EF difficulties (Pauli-Pott & Becker, 2011; Willcutt et al., 2005), whereas oppositional/defiant disorder (ODD) and conduct disorder (CD) have been more consistently related to weaknesses in hot EF (Hobson et al., 2011; Schoorl et al., 2018; Woltering et al., 2016). On the other hand, there is evidence suggesting that even within more narrow diagnostic categories, such as within ADHD, different causal pathways are likely to exist (Sonuga-Barke, 2005). For example, Pauli-Pott et al. (2019) examined the prospective relationship between cool and hot forms of control and ADHD symptoms in a community sample of preschoolers and found that both cool inhibitory control and hot reward-related control independently contributed to subsequent ADHD symptoms. This aligns with the finding that cool EF difficulties are only present among a subgroup of children with ADHD (Nigg et al., 2005). In conclusion, when hot EF is considered in addition to cool EF, a broader group of children with externalizing symptoms can be considered as having problems with EF. Rating scales probably identify both cool and hot EF more comprehensively and may therefore show more robust and wide-ranging links to externalizing symptoms than performance-based measures.

A wealth of more recent studies with improved designs and statistical techniques corroborate these findings of an overall association between EF weaknesses and externalizing symptoms. A meta-analysis of prospective longitudinal studies showed that EF in childhood predicts subsequent externalizing symptoms, and that this appears to be more the case for younger children than for older ones (Lynch et al., 2021; Yang et al., 2022). Studies using latent variable approaches to form empirical models of psychopathology have also found connections between externalizing symptoms and EF (Lynch et al., 2021). However, many latent variable studies suggest that much of this association is accounted for by the general psychopathology factor rather than externalizing symptoms specifically, pointing towards EF weakness as risk factor

for overall psychopathology (Martel et al., 2017; Shields et al., 2019; Snyder et al., 2019). In all these cases, however, the results relied on measures of performance-based cool EF. Similar latent variable studies, including rating scale measures of EF, have found a link between EF and externalizing symptoms, specifically (Hankin et al., 2017; Loin et al., 2014; Shields et al., 2019).

1.4.2 Executive function and internalizing symptoms

The relationship between internalizing symptoms and EF is generally less studied than the relationship between externalizing symptoms and EF, possibly because no internalizing disorder has been conceptualized as an "EF disorder" to the degree that ADHD has. Overall, the work that has been done to uncover this relationship reveals a relatively incoherent pattern of findings.

Similar to externalizing symptoms, earlier studies examining the link between internalizing symptoms and EF weaknesses tended to focus on specific internalizing disorders, such as major depressive disorder (MDD) or generalized anxiety disorder (GAD). In a meta-analysis examining depressed children and adolescents, deficits in interference control, planning, WM, flexibility, and phonemic and semantic verbal fluency were found (Wagner et al., 2015). However, in a systematic review concerning EF and attention deficits in children and adolescents with depressive disorders, Vilgis et al., (2015) concluded that, across all domains, results are mixed with a leaning towards null results. According to them, notable methodological heterogeneity within studies, including in sample selection, inclusion criteria and EF tasks used, makes the interpretation of findings difficult. A meta-analysis of longitudinal studies revealed a significant relationship between childhood EF and subsequent internalizing symptoms, although the effect was small in size (Yang et al., 2022). Children of varying ages were included in the meta-analysis; however, since age did not emerge as a significant moderator, it seems that the findings also applied to younger children.

The link between EF and internalizing symptoms is even less studied among preschoolers and on the level of everyday EF. Eisenberg et al. (2001) used both performance-based and rating scale measures with multiple informants in studying executive control in 4- to 8-year-old children. They found that the children with internalizing symptoms were rated as less impulsive and lower in attentional control than control children, but similar in terms of inhibition. Skogan et al. (2015) found that preschool-aged children with an anxiety disorder showed more problems on all scales of the BRIEF-P (Inhibit, Shift, Emotional Control, Working Memory, Plan/Organize) than control children. Compared to children with ADHD, the children with anxiety had a lower score on the Inhibit and Working Memory subscales (Skogan et al., 2015).

Similar to externalizing symptoms, it seems unclear whether the relationship between internalizing symptoms and EF difficulties is specific to internalizing symptoms or whether it reflects a more general relationship between general psychopathology and EF. Some studies suggest the latter option to be the case (Martel et al., 2017; Shields et al., 2019). However, other studies

suggest especially cognitive flexibility to have a special relationship with internalizing symptoms (Bloemen et al., 2018; Kasabian et al., 2014; Patwardhan et al., 2021). Poor cognitive flexibility can predispose a person for ruminative thinking (Yang et al., 2017), which has been theorized and empirically shown to be a risk factor for both general psychopathology and internalizing symptoms (Joormann & Quinn, 2014; Nolen-Hoeksema & Watkins, 2011; Yang et al., 2017).

Although the relationship between EF weaknesses and externalizing symptoms is relatively well-studied and apparent, it remains unclear whether children with primarily internalizing symptoms tend to show EF weaknesses, particularly in everyday life, and of what sort those might be. It is also unclear whether the co-occurrence of internalizing and externalizing symptoms or the level of symptoms affect the pattern of everyday EF. Consequently, one aim of the dissertation was to examine the kinds of everyday EF difficulties that children with mainly externalizing, mainly internalizing, both externalizing and internalizing, and mild symptoms have when compared to typically developing children, and how children with different kinds of symptoms differ from one another.

1.4.3   A person-oriented approach to executive function skills

A variable-oriented approach, focusing on individual variables and their relations, has long dominated in psychology (Bergman & Andersson, 2010). Despite the approach's clear benefit of providing precision of measurement, it possesses notable limitations. First, an underlying assumption is that populations are homogeneous, and, statistically speaking, individual differences are typically regarded as "noise" or "error." However, in case populations are not homogeneous and different subpopulations exist, the aggregate statements may not describe any of the individuals well (Von Eye & Bergman, 2003; Von Eye & Bogat, 2006). In such a case, the studying of heterogeneity within the population is meaningful in its own right. Moreover, when the focus is on single variables and their relations, the total picture, which is more than the sum of its parts, can easily get lost.

Due to the limitations, attempts have been made during the last few decades to formulate concrete and unified principles that characterize a person-oriented approach, with the aim of "bringing the person back into scientific psychology" (Molenaar, 2004). In the person-oriented approach, the focus is on an individual rather than on a group and on a pattern of information rather than a single variable representing a certain construct (Bergman & Andersson, 2010). The theoretical and philosophical background assumptions behind the person-oriented approach can be traced back to the holistic-interactionist paradigm formulated by David Magnusson (Magnusson, 1988; Magnusson & Törestad, 1993), which highlights a person as an organized whole, with different elements operating together and in interaction with one another to produce a functioning system. Therefore, a key assumption in the person-oriented approach is that the value of single variables comes from them being a part of an indivisible pattern or profile; in isolation they have no meaning (Bergman & Andersson, 2010).

Although each person is unique, it is assumed that there is certain lawfulness to development and often only a small number of patterns is enough to describe the individual variability on a more global level adequately (Bergman & Magnusson, 1997).

Within the person-oriented approach, two aspects often get blurred and are therefore important to distinguish here: theory and methodology (Bergman & Andersson, 2010; Sterba & Bauer, 2010). All methods often considered as person-oriented are not created equal and differ in terms of which of the person-oriented theoretical principles they can empirically test (Sterba & Bauer, 2010). Von Eye and Bogat (2006) stated three criteria for person-oriented research: (1) the sample is analyzed under the assumption that it was drawn from more than one population, (2) the external validity of subpopulations is examined, and (3) the interpretation of groups is based on theory. The choice of methodology in Study I, using latent profile analysis (LPA), meets these criteria.

The relationship between children's emotional and behavioral problems and EF has primarily been studied from the variable-oriented perspective (see the previous sections summarizing this research). However, it could be meaningful to study EF from the person-oriented perspective because the concept of EF is multi-faceted (Friedman & Miyake, 2017), meaning that children can have unique strengths related to some aspects of EF but weaknesses related to others. When studying children with externalizing and internalizing symptoms, EF weaknesses, or "deficits," have typically been considered in isolation and clinical implications are based on that information alone. However, the investigation of entire EF profiles, based on unique configurations of information, has the benefit of providing information about EF weaknesses *in relation to* areas of relative strengths and thus provide a more holistic basis for clinical assessment and intervention.

Only a handful of studies has examined the heterogeneity of EF skills in children using a person-oriented approach, with only one, to my knowledge, considering preschool-aged children. Litkowski et al. (2020) used both teacher ratings of everyday EF (attentional control and inhibition) and performance-based measures (cognitive flexibility and WM) to examine the heterogeneity of EF skills in a sample of 10,770 U.S. children. Using latent profile analysis (LPA), they found five profiles, with three of them showing level differences ("high," "average," and "vulnerable") but no unique strengths and weaknesses. The two additional profiles showed a clear discordance between teacher ratings and performance-based measures (Litkowski et al., 2020). In other words, their study highlighted that there may be subgroups of children that struggle with EF in their everyday lives yet show good efficiency of EF processes in highly structured tasks—and vice versa.

Dajani et al. (2016) examined the heterogeneity of everyday EF skills in a sample consisting of school-age children diagnosed with ASD or ADHD using LPA. They found three EF profiles: above average, average, and impaired, concluding that the nature of EF is dimensional among children with neurodevelopmental disorders. Similarly, Cumming et al. (2023), found three

everyday EF profiles showing mild, moderate and clinical levels of difficulties among school-age children at risk for internalizing and externalizing symptoms. As expected, the children with moderate and clinical profiles exhibited more problematic behaviors, poorer social competence, and greater language difficulties than did the children in the mild group (Cumming et al., 2023).

These studies suggest that EF subgroups found among children tend to show differences only in their overall level, and no unique patterns of strengths and weaknesses exist. However, none of the above-mentioned studies used a heterogeneous clinical sample that may best enable the detecting of nuanced EF profiles among children with emotional and behavioral problems. One study that used a similar sample as in Study I of the present dissertation, consisting of a highly heterogeneous group of children referred to an evaluation for a psychiatric inpatient program, albeit including older children (6 to 12 years old), did find unique strengths and weaknesses in children's neurocognitive abilities (Kavanaugh et al., 2016). Using cluster analysis, they identified four subgroups: intact, global dysfunction, organization/planning dysfunction, and inhibition-memory dysfunction.

All in all, the variability of everyday EF skills in a truly heterogeneous clinical sample of preschool-aged children has not previously been studied using a person-oriented approach. It is therefore not known whether unique strengths and weaknesses or merely dimensional differences could be found in this population characterized by rapid EF maturation but also atypical development. Therefore, one aim of this dissertation was to examine the EF profiles of young children visiting a psychiatric outpatient clinic, and to test the external validity of those profiles by linking them with background variables and internalizing and/or externalizing symptoms.

1.5 Children's behavior problems and parenting stress

In the transactional model of development, children's development is seen as the result of constant and dynamic interplay between children's characteristics and contextual factors (Sameroff, 2019). A highly important and immediate contextual factor for children's development is family and, within family, a parent or parents. Transactional relationships between children and their parents can be demonstrated using numerous psychological constructs—however, in this dissertation, the choice of construct used to operationalize parental functioning, affecting children and being affected by children, is parenting stress.

Sources of stress in human life are countless, and although stresses in all areas of life share something in common, including the core psychophysiology of the stress response, they also differ from one another in important ways. The stress experienced in the parent role can have particular consequences for parenting and child functioning, including increased negative parenting behaviors and child emotional and problem behaviors (Anthony et al., 2005; Crnic et al., 2005; Deater-Deckard, 1998; Mackler et al., 2015; Tsotsi et al., 2019),

more so than stress experienced in other areas of life, e.g. occupational stress. (Deater-Deckard, 2004). This notion has been an important motivator for the formulation of the concept of parenting stress. Parenting stress can be defined as an experience of distress or discomfort that arises from the demands of the parent role (Deater-Deckard, 2004). Importantly, central to most theories of parenting stress is the balance between demands and the parent's resources in meeting those demands (Deater-Deckard, 2004). Demands are highly time and culture specific, and they can include aspects such as the need to provide nutrition, shelter, structure, and emotional support for the child; and resources can include aspects such as knowledge, financial resources, and instrumental and emotional support from others, such as professionals, friends, and relatives.

Different models of parenting stress have been developed (Abidin, 1992; Belsky, 1984; Crnic & Greenberg, 1990; Webster-Stratton, 1990). In this dissertation, I rely on Abidin's model of parenting stress, one of the most endorsed models that has also generated a widely used measure: Parenting Stress Index (PSI; Abidin, 2012). The concept of parenting stress, as understood in Abidin's model, relies on previous formulations on the psychobiology of the stress response. Some important assumptions behind the theory are that the sources of stress are additive (Selye, 1956), and that stress arises from the interaction between stressors, interpretation of them, and coping (Lazarus, 1999). In the model, parenting stress is seen as multifactorial, consisting of different domains or sources of stress (Abidin, 2012). These domains are the Parent Domain, consisting of factors directly related to the parent or the family context, such as depression, role restriction, social support, and spousal relationship; and Child Domain, consisting of factors related to the child and their characteristics, such as adaptability, demandingness, and distractibility/hyperactivity. Furthermore, a situational/demographic domain is included that considers issues outside of the parent-child relationship, such as parental separation, loss of income and problems at work.

The structure of the parenting stress construct used in the present dissertation comes from the shortened version of the PSI measure (Parenting Stress Index-Short Form; PSI-SF; Abidin, 2012). In the short form, parenting stress is comprised of three domains: parent domain (PD), child domain (CD), and parent–child dysfunctional interaction domain (P-CDI). The P-CDI domain concerns the extent to which the parent perceives the child as meeting their expectations and the extent to which the parent finds the interactions with the child as reinforcing (Abidin, 2012).

When considering children's behavior, parenting stress is a highly relevant concept. Empirical studies have consistently linked children's emotional and behavioral problems to heightened parenting stress (Anthony et al., 2005; Baker et al., 2003; Barroso et al., 2018; Crnic et al., 2005; Neece et al., 2012; Tsotsi et al., 2019), also above and beyond parental psychopathology (Costa et al., 2006). Many studies have examined the parents of children with ADHD, specifically, and found that they experience pronounced parenting stress compared to the parents of typically developing children (Theule et al., 2013), and this also applies

to the parents of preschool-aged hyperactive children (Mash & Johnston, 1983). The relationship between child behavior problems and parenting stress has been shown to be transactional, meaning that parenting stress tends to increase child behavior problems over time and child behavior problems tend to increase parenting stress over time (Mackler et al., 2015; Neece et al., 2012). Such transactionality can easily cause accumulation of problems within families and it is therefore an important aspect to consider in interventions that aim to foster behavioral outcomes among children. Thus, one aim of this dissertation was to examine the effect of the Finnish ENGAGE intervention, which aims to improve children's EF-related behavioral outcomes, on parenting stress — directly and as mediated through changes in children's behavior.

1.6 Supporting preschool children with behavior problems and their families

The most thoroughly studied approach and also the current gold-standard treatment for young children with behavior problems is behavioral parent training, encompassing programs such as Incredible Years (Murray et al., 2017) and Triple P Positive Parenting Program (Bor, Sanders & Markie-Dadds, 2002). These interventions are based on teaching parents more effective strategies for the management of their children's behavior, including positive reinforcement, ignoring inappropriate behavior, as well as clear and consistent consequences for undesirable behavior. Studies have shown them to be effective in reducing ADHD symptoms and conduct problems, as well as in improving parental outcomes (Charach et al., 2013, Halperin et al., 2019; Rimestad et al., 2019), although their ability to mitigate core ADHD symptoms has also been questioned (Daley et al., 2014). Despite their effectiveness, they can be quite lengthy (up to 5 months) and costly, and often require an extensive training for the interventionists, which may limit their feasibility for families with milder problems or where concern over the child has just started to arise. The existence of more "light" and easy-to-approach interventions would diversify options and perhaps allow addressing problems in even earlier stages and with a lower threshold than what is currently taking place.

Due to the centrality of EF for adaptation and well-being in life, EF can be seen as an important route and target of intervention for preschool-aged children at risk for developmental disorders, such as ADHD (Zelazo, 2020). Studies have shown that EF can be improved using many different kinds of interventional approaches, such as computerized and noncomputerized training, different kinds of school curricula and mindfulness interventions (Diamond & Lee, 2011; Takacs & Kassai, 2019). However, some interventions are likely to be more effective than others for particular groups of children. For instance, based on a meta-analysis conducted by Tacaks and Kassai (2019), typically developing children may benefit more from explicit training and atypically developing

children more from strategy learning. At this point, relatively little is known about what kinds of EF interventions are most effective for preschool-aged children showing elevated levels of behavior problems and who are, consequently, at an increased risk for the accumulation of impairment.

Recent meta-analyses have highlighted different aspects that seem to be important for EF interventions to be effective. These include targeting children with EF difficulties, targeting multiple EF skills at once, delivering the intervention in a group format, and including strategy learning and scaffolding in addition to skill training (Pauli-Pott et al., 2021; Scionti et al., 2020; Takacs & Kassai, 2019). In addition, many environmental factors (e.g. stress, loneliness, poor physical health) can compromise EF in addition to a primary deficiency or weakness in the core skills, due to which comprehensive interventions, considering social, emotional, and physical aspects of health all at once, may have a better chance of producing wider and more long-lasting benefits (Diamond, 2013). Due to the transactional relationship between child behavior problems and parenting stress, comprehensiveness within interventions would ideally extend to supporting parents' well-being, including the reduction of parenting stress.

In the following sections, I will review literature dealing with the questions of what kinds of interventions have the potential to improve children's EF and reduce parenting stress. Finally, I will turn to the potential of play-based interventions and ENGAGE.

1.6.1 Interventions supporting children's EF development

A wide variety of different kinds of interventions have been developed to support children's EF and many have also shown promise in being effective (Diamond & Lee, 2011; Takacs & Kassai, 2019). Different approaches that all have been shown to be successful in improving children's EF in at least some studies include (1) explicit training of EF skills, either in a computerized or non-computerized way; (2) teaching children strategies to regulate themselves, such as through meditation; (3) physical activity interventions; (4) school/ECE curricula where EF-enhancing activities are built into the daily schedule; as well as (5) art activities, such as drama or music training (Takacs & Kassai, 2019). Many interventions do not fall neatly into the aforementioned categories, however, but include aspects from many categories, which brings a challenge to grouping interventions for the sake of conducting meta-analyses and reviews. Hence, the categories discussed below are not necessarily definitive and mutually exclusive.

One much studied approach to improving children's EF is computerized training. The most used and studied computerized training program for children is CogMed, which has been mostly used for WM training. Computerized training has been shown to improve all core EF skills, with the strongest effects for WM (Takacs & Kassai, 2019); however, the effect does not seem to transfer to untrained domains (Aksayli et al., 2019; Diamond & Lee, 2011; Diamond & Ling, 2016; Kassai et al., 2019; Melby-Lervåg et al., 2016; Thorell et al., 2009), for example, WM training does not affect inhibitory skills (Melby-Lervåg & Hulme,

2013). Aksayli et al. (2019) conclude that "transfer appears to be a function of the degree of overlap between trained tasks and outcome tasks." Thus, it seems that EF needs to be practiced in "real-world" contexts and situations in order to truly provide benefit in those situations. The benefits of computerized training also appear to be relatively short-lasting (Melby-Lervåg & Hulme, 2013).

In addition to computerized training, different kinds of non-computerized training interventions have been used to improve children's EF. A meta-analysis by Takacs and Kassai (2019) showed that noncomputerized training, which mainly consisted of interventions executed in ECE, including a variety of different activities such as group games and shared book reading, yielded a small but significant effect on all core EF skills. Similarly, a recent meta-analysis including only preschool children (3 to 6 years old) showed that cognitive training (including both computerized and non-computerized training) was effective in improving children's EF, with a medium-sized overall effect (Scionti et al., 2020). The two meta-analyses produced differing results in terms of what subgroup of children benefits the most, however. Takacs and Kassai (2019) showed that the effect of computerized and non-computerized training in combination was more effective for typically developing children than for atypically developing children, whereas Scionti et al. (2020) showed that cognitive training was more effective for the children with ADHD symptoms than for typically developing children.

One approach to improving children's EF is through teaching them strategies for self-regulation. Perhaps the most-studied and popular form of such interventions are mindfulness-based interventions (MBIs). Mindfulness refers to the act of paying purposeful attention to the present moment in a non-judgmental way, and gently directing attention to the target of focus in case it wonders away. With children, MBIs have included activities that, for example, cultivate awareness of breathing and the senses as well as mindful movement and body practices, including yoga (Vekety et al., 2022). For the most part, MBIs for children have been executed at schools and in ECE. In general, these interventions have shown promise in being effective in improving children's EF (Diamond & Lee, 2011; Takacs & Kassai, 2019), although some recent reviews concerning preschool-aged children have provided more mixed results (Bockmann & Yu, 2023; Sun et al., 2021). Other strategy-teaching interventions such as teaching children how to apply strategies during academic tasks and biofeedback-enhanced relaxation have yielded encouraging results (Takacs & Kassai, 2019).

Another group of interventions that has shown promise in improving children's EF are ones based on physical activity with varying cognitive elements. Activities such as running, jump rope, team games like basketball or tennis, and martial arts have been included (Takacs & Kassai, 2019). There is evidence that physical activity can improve children's EF (Álvarez-Bueno et al., 2017; Best, 2010; Diamond & Lee, 2011; Li et al., 2020; Verburgh et al., 2014), and that this might be particularly true for cognitively engaging physical activity (Best, 2010; Diamond & Lee, 2011). After all, many forms of exercise require notable cognitive

engagement, such as team sports. According to the meta-analysis by Takacs and Kassai (2019), physical activity had a small effect on EF and it was significant only for atypically developing children (e.g., children with ADHD or ASD). This applied for both aerobic exercise without cognitive stimulation and cognitively engaging aerobic exercise. Therefore, studies suggest that, overall, physical activity can have small beneficial effects on EF; however, it remains unclear which kind of physical activity is most beneficial and to whom.

One line of interventions that has provided rather mixed results is EF-enhancing school curricula, such as Tools of the Mind and Montessori (Takacs & Kassai, 2019). In these interventions, practicing EF is integrated into everyday activities in school or ECE, which may be particularly helpful in enabling the generalization of learned skills into multiple contexts. These interventions include aspects from strategy teaching as well as explicit training of EF skills, but due to being so complex, Takacs and Kassai (2019) included them as a separate category in their meta-analysis. Diamond and Lee (2011) highlighted their efficacy; however, Takacs & Kassai (2019) found only a marginally significant and very small effect for complex curricula. These interventions can be long in duration (up to two years) and require extensive training for the school/ECE staff. Therefore, they may not be particularly easy to apply in the ECE setting.

Behind the immense interest in improving children's EF is the will to improve children's everyday lives in the present as well as in the long run. Improvements in everyday life can manifest as reduced internalizing and externalizing symptoms and improved social relationships and academic outcomes, for instance. However, often these ultimate end-goals are not directly measured. The meta-analyses by Pauli-Pott et al. (2021) and Scionti (2020) suggest that EF interventions have little effect on outcomes such as behavior problems and academic skills. However, their meta-analyses included only a few studies that had measured such further outcomes and even fewer had done so in groups of children that need such improvements the most: those showing elevated behavior problems at a young age and that are thus at risk for accumulated problems. Hence, more research is needed about the effect of EF interventions on EF-related behavioral outcomes among at-risk children. Furthermore, the majority of the interventions examined in the previously mentioned meta-analyses were conducted in ECE. However, the people most intensively present in children's lives are usually their parents, and more studies are needed that explore the potential of parents as mediators of EF interventions to their children.

1.6.2   Play-based EF interventions

1.6.2.1   The theoretical rationale

For such a common and recognizable phenomenon, play has been surprisingly hard to define (Burghardt, 2011). Many have developed lists of aspects that need to take place for an activity to pass the definition of play, with some of the most commonly recognized ones being that it is something done for its own sake and is characterized by means rather than ends, it is flexible (new combinations of

objects are formed and roles are switched and acted out in new ways), and it is related to positive affect or joy (Smith & Pellegrini, 2013). Often these definitions easily include activities commonly considered as free play and exclude activities such as games and play for educational or developmental purposes. However, the important role of play for children's development and its wide potential for different educational and rehabilitative purposes has been widely acknowledged (Chu & Schulz, 2020; Halperin & Healey, 2011; Nilsson et al., 2018; Shaheen, 2014).

Zosh et al. (2018) suggested play be viewed as a spectrum ranging from free play, initiated and fully directed by children, to playful direct instruction, with guided play and games falling in between. Zosh et al. (2018) also hypothesized that guided play, where an adult helps to structure an activity that centers around a learning goal, yet the child retains some kind of agency in directing the activity, may be the optimal way to cultivate learning, especially for academic skills. Play, especially guided play, has also been suggested to be important and useful for the development of EF in different ways (Halperin & Healey, 2011; Shaheen, 2014). Guided play could particularly benefit those children that tend to be highly active, impulsive and distractible in their behavior, and that also tend to exhibit those tendencies in their free play and thus get fewer opportunities to practice persistence and control on their own.

During the past decade, a group of play-based EF interventions have been developed that center around the idea of using parent-guided play and games as a tool for supporting children's EF development. The target group for these interventions has been preschool-aged children (3 to 5 years old) with elevated levels of behavior problems, particularly ADHD related, or with a diagnosis of ADHD. Basic principles that they share are (1) regular engagement in guided play in the everyday life between a parent or parents and a child (with other people such as family members also potentially joining) that offer opportunities for the child to practice EF skills; (2) the parent using a technique often termed as "scaffolding" to support the child's skill development; in other words, pulling back or increasing their support according to the child's mastery of the activity at hand; and (3) group sessions for both parents and children, with the specific functions of the group sessions varying slightly depending on the intervention, but the main goal being to offer professional and peer support for the playing that takes place at home and to provide education. Therefore, in theses interventions, the children are the main target of the intervention, and the parents are operating "in between," both as the recipients of the intervention, who are learning ways to support their children, and as interventionists.

In comparison to behavioral interventions that focus on sculpting the child's problematic behavior to increased adaptability through the use of effective parenting practices, the theoretical focus of play-based EF interventions is on the neural and cognitive underpinnings of such behavior and related effects of environmental enrichment, with a particular focus on ADHD-related dysfunction (Halperin & Healey, 2011). While ADHD is known to have many etiological routes, and EF dysfunction is not enough to explain the entirety of the disorder, the strengthening of the prefrontally-mediated EF skills as well as other

cortical functions may be a key pathway for compensation for the primary deficits and alleviation of symptoms over time (Halperin & Healey, 2011).

Another key theoretical underpinning of the play-based EF interventions is that EF is something that is primarily developed within the social context (Halperin & Healey, 2011; Vygotsky, 1978). Parents are ideal deliverers of an intervention as they are key figures present in children's everyday lives, with the opportunity to intervene in everyday contexts and with a high intensity. Guided play offers the possibility for the parents to provide scaffolding, which has been shown to be highly beneficial for children's EF development (Koşkulu-Sancar et al., 2023). Furthermore, the social nature of playing and games can improve many social skills and allow for the practicing of EF skills in social contexts, thus promoting the generalization of improved EF skills to social behaviors such as turn-taking, compromising, co-operating, and negotiating. This is particularly relevant for children at risk for or with ADHD, as social relationships are an area of notable impairment for these children (Gardner & Gerdes, 2015; Hoza et al., 2005).

1.6.2.2   Empirical evidence

TEAMS (Halperin et al., 2013, 2020) is one play-based EF intervention, closely resembling the ENGAGE intervention studied in this dissertation. The participants of the TEAMS intervention studies have been preschool-aged children with an ADHD diagnosis. In TEAMS, weekly group sessions are organized for parents and children for 5 consecutive weeks, with a booster session 1 month later. Parents are directed to play the EF-targeting games each day for 30 minutes with their child. In a proof-of-concept study, Halperin et al. (2013) demonstrated that participating in TEAMS was accompanied with significant decreases in ADHD symptoms among 4- to 5-year-old children with an ADHD diagnosis, and that the gains lasted until a 3-month follow-up. Later, Halperin et al. (2020) conducted an RCT comparing TEAMS to an active control group that included ADHD-related psychoeducation for parents and play group sessions for children, but without introducing the games to parents and directing them to play at home. They found that, in both the TEAMS and control groups, the children's ADHD-symptoms decreased following the intervention based on teacher and clinician ratings, and that no group differences concerning the children were found in rating scale or performance-based measures. Halperin et al. (2020) concluded that TEAMS and other psychosocial interventions appear to provide similar benefit.

GAIM (Tamm et al., 2014, 2019) is another play-based EF intervention offered to families. It includes eight weekly group sessions lasting 1 hour each (except for the first and last sessions lasting for 2 hours). In GAIM, metacognitive strategies are emphasized to promote generalization of learned skills. Parents are asked to practice at least one of the EF-targeting play activities three or more times a week at home. After promising results from an open trial (Tamm et al., 2012), Tamm et al. (2015) conducted an RCT where they compared GAIM to a waitlist control group. They found that the GAIM participants demonstrated

significantly greater reduction in parent-rated problems of cognitive flexibility and emotion regulation as well as blinded clinical ratings of inattention compared to the controls. Further, a medium-to-large non-significant effect was found for an array of other outcomes, implying relatively large benefits. In 2019 Tamm et al. (2019) compared GAIM to an active control condition that included psychoeducation concerning topics such as self-esteem or school readiness, avoiding topics potentially overlapping with the focus of the GAIM intervention. Statistically significant differences between the groups were found in favor of the GAIM group for parent-rated functional ability in home situations. Moreover, non-significant effects in the size of .02 or greater were found in favor of the GAIM group for parent ratings of ADHD symptoms, emotion regulation and overall impairment, as well as teacher and clinical ratings of functional ability and overall impairment. Performance-based measures of EF did not reveal positive intervention effects. Intervention gains were maintained for parent ratings of functional ability at home and clinical ratings of overall impairment at a 3-month follow-up.

Two studies, conducted in New Zealand, have previously examined the effectiveness of ENGAGE (Healey & Healey, 2019; Healey & Halperin, 2015)—the intervention studied in the present dissertation. In addition, an ECE adaptation of the intervention has been studied (Healey et al., 2022). The preliminary study concerning ENGAGE included 25 families participating in the intervention. In this study, the intervention lasted 5 weeks with weekly parent and child group sessions and daily playing for 30 minutes. Parent ratings of elevated hyperactivity (at or above the 92nd percentile) was an inclusion criterion for the study. Based on the analyses with no control group comparison, significant improvements with large effects in parent ratings of hyperactivity, attention problems, and aggression were found following the intervention (Healey & Halperin, 2015). Results also suggested intervention gains were maintained for up to 12 months post-intervention. Significant improvements in WM and visuomotor precision were also found using performance-based measures. When the change in problem behaviors in the ENGAGE group at the 12-month follow-up was compared to change in an age- and gender-matched no-treatment comparison group of hyperactive preschoolers drawn from another study, significant effects favoring the ENGAGE group were found for parent ratings of hyperactivity and aggression as well as a neurocognitive measure of WM. In the second study (Healey & Healey, 2019), 60 families were randomized to ENGAGE (*n*=29) or to an evidence-based behavioral parent training intervention, Triple P (*n*=31). In this study, the intervention lasted eight weeks altogether, with two weeks for individual phone calls to families and one week for a final booster session added to the five-week package. The children were 3-4 years of age and had elevated levels of hyperactivity as reported by parents. The results showed that ENGAGE was as effective as Triple P in reducing parent-rated hyperactivity, attention problems, and aggression, with gains maintained up to 1-year post-intervention (Healey & Healey, 2019). No reliable intervention effects were found according to teacher ratings or performance-based measures.

Notable for the play-based EF interventions is the high acceptability and palatability ratings from parents (Halperin et al., 2013; Tamm et al., 2014; Tamm et al., 2019). Attendance on group sessions as well as playing at home has also been on a high level, approaching maximum (Halperin et al., 2013; Healey & Halperin, 2012; Healey & Healey, 2019; Tamm et al., 2012; Tamm et al., 2019). For comparison, previous studies concerning behavioral parent training have reported an average homework completion rate of 48% (Chacko et al., 2016). Therefore, it seems that play-based EF interventions are generally liked by parents and that a good portion of them are motivated and capable of engaging in them to the degree that is expected—something without which overall effectiveness would be rather meaningless.

Overall, the empirical data concerning play-based EF interventions suggest that the interventions are as effective as other psychosocial interventions in improving EF-related behavioral outcomes among preschoolers with inattentive and hyperactive/impulsive problems. However, although play is a universal phenomenon, the forms it takes, especially when talking about parent–child play, and the meanings parents attach to it, vary culturally (Roopnarine & Davidson, 2015). To strengthen the evidence from previous studies and to understand the universality of play-based interventions, RCTs in different populations and cultural contexts are needed. Therefore, one aim of this dissertation was to examine the effectiveness of the ENGAGE intervention among Finnish families with preschool-aged children showing elevated levels of inattentive and hyperactive/impulsive problems.

1.6.3 Interventions relieving parenting stress

According to Abidin's model, parenting stress stems from many factors related to the parent, the child, and the interaction between them (Abidin, 2012). A logical consequence is that altering any of these contributing factors could result in changes in parenting stress. Accordingly, empirical studies have shown that focusing on parenting stress directly is not necessary for an intervention to yield positive effects on parenting stress. A meta-analysis by Theule et al. (2018) examined the effect of child ADHD interventions on parenting stress. The majority of included interventions were psychosocial (72%), such as behavioral parent training or MBIs, and the rest were either pharmacological or a combination of both. The majority of these studies reported only within-group results for parenting stress, and only nine studies included comparisons between the intervention and control groups. Both the within- and between-group comparisons yielded significant reductions in parenting stress with a moderate effect size (Theule et al., 2018), suggesting that interventions directed at child ADHD symptoms can also reduce parenting stress. Child age was not a significant moderator, implying that the results apply to younger children as well. A literature review by Colalillo and Johnston (2016) examined parental affective and cognition outcomes following behavioral parent training. Including only studies using an experimental design, they found that there is consistent evidence showing that behavioral parent training can improve parental

outcomes that are closely intertwined with parenting: parenting stress and perceived parenting competence. More distal outcomes, such as general stress and depression, were not as consistently affected. Therefore, there is convincing evidence to show that behavioral parent training interventions can reduce parenting stress. However, more novel intervention approaches for young children, such as play-based EF interventions, have rarely been studied in relation to parenting stress.

The only study to my knowledge that has studied the effect of a play-based EF intervention on parenting stress was conducted by Halperin et al. (2020). They found that there was a significant decrease in parent domain parenting stress irrespective of whether the family belonged to the intervention (TEAMS) or active control group. They also found that the two groups differed from one another in terms of child domain parenting stress, with greater decreases found in the TEAMS group than in the control group. Since there was no differential change in any other domain of parenting stress besides the child domain nor in any other child- or parent-related outcomes (except one neuropsychological measure, in favor of the control group) in the wide array of measures included, they concluded that the few significant findings could represent a type I error due to the large number of analyses conducted. Therefore, further studies are needed to clarify the effect of these play-based interventions on parenting stress.

Another important question concerns the mechanisms of change. Since play-based interventions focus heavily on the child's skills and behavior, and children's behavioral outcomes have been shown to be affected through them, it seems plausible that decreases in children's behavior problems could be an important mediator of their positive impact on parenting stress. Another option is that play-based interventions could reduce parenting stress more directly through affecting parental cognition, such as attributions concerning the child's behavior or the sense of competence related to parenting, or affective factors. The parent's group sessions, providing peer and professional support as well as educational content, could certainly produce such effects. These mechanisms have not previously been studied in relation to play-based EF interventions.

A few studies concerning behavioral parent training interventions have addressed the mechanisms related to changes in parenting stress. Heath et al. (2015) found that the parents of children that showed clinically significant reductions in ADHD symptoms following the intervention had greater decreases in parenting stress than the parents of children with continued impairment. They found that it was the clinical significance rather than magnitude of change in child symptoms that mattered for parenting stress. However, they did not test mediation specifically. Van der Stoep et al. (2017) compared two service delivery models as interventions for children with ADHD. Relevant to the considerations here, they found that children's oppositional/defiant symptoms, but not hyperactive or inattentive symptoms, mediated the effect of the better-performing service delivery model on parenting stress. These studies suggest that improvements in child behavior do reduce the level of parenting stress experienced by parents. Nevertheless, neither study differentiated between the

different aspects of parenting stress. It may very well be that the child-mediated effects only alleviate child domain parenting stress but not parent domain parenting stress. Most importantly, these questions have not been studied in relation to play-based EF interventions. Hence, one aim of this dissertation was to investigate the effect of ENGAGE on the different domains of parenting stress—overall and as mediated by changes in children's inattentive, hyperactive/impulsive, and aggressive/oppositional problems.

1.7   Aims of the empirical studies

The overall aim of the dissertation was to examine the nature and variability of everyday EF difficulties and the potential to reduce EF-related behavior problems through a play-based intervention among preschool-aged children at varying risks of poor developmental outcomes. The main aim of Study I was to examine the nature and heterogeneity of everyday EF difficulties among 4- to 7-year-old children with clinical levels of emotional and behavioral problems. This was done using two approaches: a variable-oriented approach and a person-oriented approach. The first sub-aim, utilizing the variable-oriented approach, included the comparison of children with different types and levels of internalizing/externalizing symptoms to one another as well as to typically developing children. The second sub-aim was to use the person-oriented approach to identify the latent profiles of everyday EF from the clinical sample as a whole. The external validity of the identified profiles was also examined by studying their associations with different background variables.

The aim of Study II was to examine the effectiveness of the ENGAGE intervention in reducing EF-related behavior problems, more specifically inattentive, hyperactive/impulsive, and aggressive/oppositional problems, among 4- to 5-year-old Finnish children with elevated levels of inattentive and hyperactive-impulsive problems. Both the immediate effects of the intervention as well as the maintenance of intervention gains until a 3-month follow-up point were examined.

The main aim of Study III was to examine the effect of the ENGAGE on parenting stress within the same sample of children as in Study II. The first sub-aim was to examine the overall immediate and lagged (evident at the 3-month follow-up) effects of the intervention. The second sub-aim was to examine whether changes in children's EF-related behavior problems mediated the effects of the intervention on different indices of parenting stress.

2 METHOD

2.1 Participants and procedure

The data used in the present dissertation comes from three distinct samples. Study I included two samples: normative and clinical. Studies II and III utilized a third, "at-risk," sample, gathered based on parental concern regarding their child's inattentive and hyperactive/impulsive problems. Ethical approval was granted for Study I by the Helsinki University Central Hospital Ethics Committee for Pediatrics, Adolescent Medicine and Psychiatry; and for Study II and III by the Human Sciences Ethics Committee of the University of Jyväskylä. Due to the young age of the children taking part in the studies, written consent was obtained from their parents for all of the studies. A summary of the methodological aspects of the three studies is provided in Table 1.

TABLE 1   Summary of Studies I–III

Study	Aims	Design	Participants	Measurement points	Outcome variables	Statistical analyses
Study I	To investigate heterogeneity in everyday EF difficulties among clinically referred 4- to 7-year-old children via variable-oriented and person-oriented approaches	Cross-sectional	Clinical sample: 171 4- to 7-year-old children recruited from psychiatric outpatient clinics Reference sample: 667 4- to 7-year-old children recruited from Finnish ECE centers	1 measurement point	- Child everyday EF (AT-TEX-P, ECE-teacher reports) - Child internalizing and externalizing symptoms (CBCL, parent reports)	- ANCOVAs comparing the different symptom groups (variable-oriented approach) - Latent profile analysis (person-oriented approach)
Study II	To investigate the efficacy of the Finnish ENGAGE intervention in reducing EF-related behavior problems of preschool-aged children	Randomized controlled trial	95 4- to 5-year-old children with elevated hyperactive/impulsive and inattentive problems, randomized to intervention (n = 55) and waitlist control (n = 40) groups	T1, T2, T3	- Child EF-related behavior problems (5–15R questionnaire, parent reports) - Child everyday EF (AT-TEX-P, ECE-teacher reports) - Functional ability in home and ECE situations related to attention (HSQ and SSQ, parent and ECE teacher reports) - Intervention fidelity (parent and intervention provider reports) - Intervention acceptability (AARP, parent and intervention provider reports)	- Mixed modeling for repeated measures

Table 1 continues

Study	Aims	Design	Participants	Measurement points	Outcome variables	Statistical analyses
Study III	To investigate the efficacy of the Finnish ENGAGE intervention in reducing parenting stress and the mediational role of change in children's behavior problems	Randomized controlled trial	The parents of 95 4- to 5-year-old children with elevated hyperactive-impulsive/inattentive problems, randomized to intervention (n = 55) and waitlist control (n = 40) groups	T1, T2, T3	- Parenting stress (PSI-SF , self-report) - Child EF-related behavior problems (5–15R questionnaire; parent reports)	- Mixed modeling for repeated measures - Multiple mediation modeling using latent difference scores and bootstrap confidence intervals

2.1.1 Study I

The clinical sample (*n* = 171) included children attending psychiatric outpatient clinics at the Helsinki University Hospital's Child Psychiatry Unit between the years 2015 and 2017. Children were included based on the following criteria: (1) age between 4 and 7 years, (2) Finnish-speaking parents, and (3) child attends ECE. Out of the 315 children visiting the clinics during data collection, 252 met the inclusion criteria and their parents were given the questionnaires. Questionnaires concerning 171 children were returned. The mean age of the children in the clinical sample was 5.7 years (*SD* = 0.7), and the majority (71.3%) were boys. Of the children, 53.8% had mothers with either no further education besides basic education or vocational education, which was categorized as low. A degree from a higher education institution (university, university of applied sciences, or the old post-secondary level institutions) was held by 46.2% of the children's mothers, which was categorized as high. Finnish was the native language for 96.5% of the children. The children had varying diagnoses, including ADHD, conduct disorder, oppositional defiant disorder, autism spectrum disorder, learning and speech disorders, and motor system disorders. Many unspecified neurodevelopmental diagnoses were also present due to the fact that the diagnostic process was still ongoing for many children.

The normative sample (*n* = 667), forming the reference group in Study I, was collected as a part of the ATTEX-P (see "Measures" for a description) standardization study during the years 2014 and 2015 (Klenberg et al., 2017). Families were approached through 28 ECE units in the city of Lahti and asked to participate. Similar to the clinical sample, children had to be between 4 and 7 years of age, have Finnish-speaking parents and attend ECE in order to participate. Questionnaires concerning 709 children were returned. The final sample consisted of 667 children, as the children with missing values on the ATTEX-P questionnaire or in the mother's education level variable (*n* = 42) were omitted from the analyses. The mean age of children in the final reference group was 6.0 years (*SD* = 0.7), and a majority of them were boys (51.1%). Of the children's mothers, 40.9% had an education level categorized as low (see the previous paragraph for a description of the categories) and 59.1% of the children's mothers had an education level categorized as high. Finnish was the native language for 96.3% of the reference children.

2.1.2 Studies II and III

The third sample ($n_{randomized}$ = 95), utilized in Studies II and III, was collected as a part of the *Leikitään ja keskitytään* project (2017–2019) at the Niilo Mäki Institute. Families were recruited in three urban locations (Jyväskylä, Helsinki and Rovaniemi) via basic-level health services, ECE, and media on the grounds of having a 4-to 5-year-old child whose hyperactivity and/or inattention-related problems were a concern for the parents. The inclusion criteria were as follows: (1) suitability of the group form for the child based on parental evaluation, (2)

parent-rated elevations in EF-related behavior problems, evident as a score at or above the 65th percentile on the Attention Deficit/Hyperactivity Problems scale of the Child Behavior Checklist (CBCL), (3) child age between 4 and 5, (4) child attending ECE, (5) no other interventions targeting EF or self-regulation during the assessment period, and (6) parents having sufficient Finnish skills to participate in the group sessions. Although the ADHD Problems scale of CBCL is a measure of the core symptoms of a clinical disorder rather than executive function skills per se, on a behavioral level these two overlap. Of the 111 families participating in screening, 95 passed the inclusion criteria. Once five to 10 families had been recruited, they were randomly allocated to the intervention (n = 51) and waitlist control (n = 35) groups. More participants were allocated to the intervention group to ensure enough participants (at least three, preferably four) in the parents' group sessions even when recruitment was slow. After randomization, parents received the pre-intervention questionnaires via mail and delivered the ECE questionnaires to the ECE staff. Measurements took place at three time points: pre-intervention measurement (T1), post-measurement two months after the beginning of the intervention (T2), and a follow-up measurement five months after the beginning of the intervention (T3). The families in the control group received the intervention after the assessment period was completed.
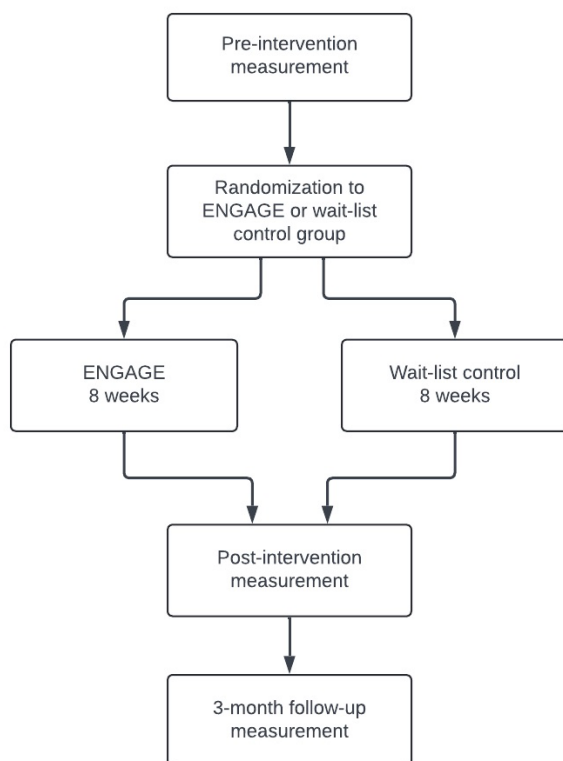
FIGURE 1   Progression of Studies II and II

2.2   Description of the ENGAGE intervention (Studies II and III)

ENGAGE (Healey & Halperin, 2015; Healey & Healey, 2019) is an 8-week intervention centering around adult-guided play and games, intended to provide opportunities for children to practice EF in a fun and enjoyable way. ENGAGE was developed in New Zealand and carried out for the present purposes according to the original manual, translated into Finnish. In totality, it consisted of six group sessions for parents and children, two phone calls to each family, and parents and children playing pre-selected EF-challenging games every day for 30 minutes. During the first five weeks, the parents' weekly group sessions consisted of introducing a new set of games to be played at home, sharing experiences about playing so far, receiving guidance in how to adjust the games to match the child's developing abilities, and discussing pre-selected topics related to EF in everyday life and playing at home. At the same time in an adjacent room, children played the new games. During the 6th and 7th weeks, playing at home continued but the group sessions were replaced with phone calls to each family, providing an opportunity for the parents to receive more individualized guidance. A final group session was held in the 8th week, with a focus on how to keep the positive development going in the future.

The games were mainly common and familiar ones, such as jigsaw puzzles, blocks, ball games, and Simon Says. They targeted one or more of the following EF subcomponents or related skills: inhibition, working memory, sustaining attention, and emotion regulation. The full set of games has previously been described by Healey and Healey (2019). The simplicity of the games enabled parents to focus on the child's EF skill use during play rather than learning new rules. Some of the games, such as hopscotch, required EF use in the context of physical activity, whereas others, such as object sorting and stringing beads, required children to stay still and focus. The repertoire also included relaxation exercises, intended to assist children in learning the fundamentals of emotion regulation. Parents were encouraged to try all games but to focus especially on the ones that were challenging for their child. In addition to the games themselves, of special importance was the parent's "dual role" of engaging in playing with the child but also monitoring and guiding the child's use of EF skills during play. In the group discussions, the parents were assisted in balancing between keeping the games at an easy enough level to offer the child experiences of joy and mastery but also providing enough challenge to push the child's development further.

Participation in group sessions was made flexible for parents. Both parents were welcome to participate in the group sessions; however, some parents (mainly mothers) attended the group sessions alone, some parents always arrived together and some alternated between which parent participated. The intended group size was five families (five children and five to ten parents, depending on whether one or both parents participated). The parents' groups were led mainly by licensed psychologists (nine psychologists and one social

worker). The children's groups were led by mainly ECE teachers (seven ECE teachers, two special education teachers, two psychologists, and 1 psychology student). The group leaders received a 1-day training.

2.3 Measures

Child outcomes. The Attention and Executive Function Rating Inventory—Preschool (ATTEX-P; Klenberg et al., 2017) was used to measure children's everyday EF in the ECE context in Studies I and II. In ATTEX-P, ECE teachers rate the frequency of a child's problems related to multiple facets of attention and EF. There are 44 items overall, rated on a three-point scale (0 = not a problem, 1 = sometimes a problem, and 2 = often a problem). A total score and the following nine subscale scores can be obtained: distractibility (5 items), impulsivity (10 items), motor hyperactivity (5 items), directing attention (5 items), sustaining attention (4 items), shifting attention (4 items), initiative (3 items), planning (3 items), and execution of action (5 items). Good internal consistency (ranging between 0.73 and 0.94), test-retest reliability (ranging between 0.81 and 0.94), and convergent validity have been found for the questionnaire (Klenberg et al., 2017). Total and scale scores at or above the 90th percentile are considered as indicators of clinically relevant problems.

The Child Behavior Checklist (CBCL) questionnaire, belonging to the Achenbach System of Empirically Based Assessment (ASEBA) family, was used to measure children's internalizing and externalizing symptoms in Study I and as an inclusion criteria measure in Studies II and III. The CBCL is a parent-report form and consists of 99 problem items, rated on a three-point scale (0 = not true, 1 = somewhat or sometimes true, 2 = very true or often true). In Study I, the Externalizing symptoms and Internalizing symptoms scales of the CBCL were used to categorize children into the clinical subgroups for comparisons. The Externalizing symptoms scale consists of the following empirically-derived symptom scales: Attention Problems (5 items) and Aggressive Behavior (19 items), while the Internalizing symptoms scale consists of the following symptom scales: Emotionally Reactive (9 items), Anxious/Depressed (8 items), and Somatic Complaints (11 items). The Attention Deficit/Hyperactivity Problems scale of the CBCL was used as the inclusion criteria measure in Studies II and III. Overall, the psychometric properties of the CBCL have been widely tested and found strong, both in terms of reliability and validity (Achenbach & Rescorla, 2000).

The Home Situations Questionnaire—Revised and School Situations Questionnaire—Revised (HSQ-R and SSQ-R; DuPaul & Barkley, 1992) were used to obtain parents' and ECE teachers' reports of the severity of children's problems in attending and concentrating in various situations in the home and ECE contexts in Studies II and III. Including questions about a child's behavior in specific situations, the measures captures the child's everyday functional ability better than the symptom-focused questionnaires (CBCL and 5-15R) which

provide more abstract information about the child's behavioral tendencies across various situations. The HSQ-R includes 14 typical home situations (e.g. when having dinner or getting dressed), whereas the SSQ-R includes eight ECE situations (e.g. during small-group activities or special assemblies). In terms of each situation, the parent or ECE teacher answers whether the child has attention-related difficulties in it and rates the severity of such problems on a 9-point scale (1 = mild, 9 = severe). The wordings of one item in the HSQ-R and two items in the SSQ-R were slightly modified to make them suit the young age group and Finnish culture. The outcome measure used in the analyses was the mean severity score of problems across all situations, with the highest possible score being 9. One item (During movies, filmstrips) was left out of the SSQ-R mean severity score due to high number of missing information, probably due to not being a regular part of the ECE program. Both the HSQ-R and SSQ-R have demonstrated good reliability (DuPaul & Barkley, 1992).

The Five-To-Fifteen—Revised (5–15R; Labek & Trillingsgaard, 2015) questionnaire was used to measure children's EF-related behavior problems in Studies II and III. The following subdomains were used: Attention and Concentration (9 items), Overactivity and Impulsivity (9 items), and Acting Out (13 items). The Acting Out subdomain measures both aggressive and oppositional behavior. The items are rated on a three-point scale (0 = Does not apply, 1 = Applies sometimes or to some extent, 2 = Definitely applies). The questionnaire has demonstrated good psychometric properties (Kadesjö et al., 2004). In Studies II and III, mean scores of the subdomain items were used in the analyses, with the highest possible score being 2 per domain.

Parent outcomes. The Parenting Stress Index–Short Form 4 (PSI-SF-4; Abidin, 2012) was used as a measure of parenting stress in Study III. The self-report questionnaire includes 36 items concerning different aspects of parenting stress, answered on a 5-point scale. The items group into three subscales: Parental Distress (PD), Parent–Child Dysfunctional Interaction (P-CDI), and Difficult Child (DC). The PD scale concerns PS due to factors related to the parent, such as sense of competence, relationship with the spouse, and social support. The P-CDI scale concerns the degree to which the parents feel that the child meets their expectations and the degree to which they feel interaction with the child as reinforcing. The DC scale concerns parenting stress due to child temperamental factors, such as adaptability, mood, and distractibility/hyperactivity. The questionnaire also yields a total score, combining all the items and reflecting the overall level of PS. The Cronbach's alphas of the PS-SF subscales has been found to range between .90 and .95 (Abidin, 2012), reflecting a high reliability.

Intervention fidelity. Fidelity was measured in Study II using checklists filled out by group leaders as well as daily play diaries filled out by parents. The checklists included information concerning whether each component of the group sessions was carried out and which parents participated. The play diaries were used to gather information concerning adherence, that is, whether parents played each day and for how long.

Intervention acceptability. Parents' and intervention providers' experience of intervention acceptability was measured in Study II using the Abbreviated Acceptability Rating Profile (AARP; Tarnowski & Simonian, 1992). The AARP includes eight items that load onto a single latent factor capturing overall intervention acceptability. The scale of possible answers ranges from 1 ("strongly disagree") to 6 ("strongly agree"). The internal consistency of the measure has been reported to be good to excellent (Tarnowski & Simonian, 1992).

Background information. Information concerning children's age, gender, and parents' education level was gathered using a background questionnaire. Education level was measured on a five-point scale, ranging from no further education degree (beyond basic education) to licentiate/doctoral degree. Only mother's education level was used in the analyses due to more missing information on father's education level. In addition, the variable was made categorical for the analyses, with low mother's education level including the options 1 = no further education and 2 = vocational education and high mother's education level including the options 3 = post-secondary education, 4 = lower university (of applied sciences) degree, 5 = higher university (of applied sciences) degree, and 5 = licentiate/doctorate degree.

2.4 Analysis strategy

In Study I, the first set of analyses followed a variable-centered approach, examining differences between different clinical groups and typically developing children in terms of ECE teachers' ratings of everyday EF. The clinical groups were formed based on parent's ratings of children's externalizing and internalizing symptoms on the CBCL questionnaire. T scores > 63, signifying clinically significant impairment, were used as threshold to categorize whether children would be placed into the internalizing, externalizing, combined or mild groups. Comparisons of the groups in terms of the ATTEX-P scores were conducted using ANCOVAs along with pairwise group comparisons using the Bonferroni correction. Mother's education level, child's age, and child's gender were used as covariates in all analyses. Furthermore, latent profile analysis (LPA), conducted using Mplus (Muthén & Muthén, 1998–2017), was used to investigate the profiles of everyday EF within the whole clinical sample following a person-oriented approach. Models with different numbers of profiles were fitted and the best solution was chosen based on different model fit indices as well as theoretical interpretation of the profiles. To examine the relationship between the profiles and a set of categorical background variables, cross tabulation and χ^2 tests were used. Adjusted residuals with an absolute value over 1.96 were considered to indicate a statistically significant relationship.

In Study II, a mixed model for repeated measures (MMRM) approach, using restricted maximum likelihood (REML) estimation and an unstructured covariance pattern for within-subject errors, was used to examine the intervention effects. The analyses were implemented in the SPSS Linear Mixed

Models (MLL) procedure. The benefit of this approach is that it utilizes all available data and produces unbiased estimates in case data is missing completely at random (MCAR) or at random (MAR). Fixed categorical effects included time (pre-intervention and post-intervention) and group (intervention and control) and the interaction between the two. To examine the stability of the intervention effects, similar models with the post-intervention and 3-month follow-up time points included were ran. Time between assessments, child's age, and father's education level were used as covariates in all analyses due to significant differences between the intervention and control groups and/or theoretical assumptions concerning their relationship with the outcomes.

In Study III, a similar MMRM approach was used as in Study II to investigate the overall effect of the ENGAGE intervention on parenting stress. Fixed effects included time (pre-intervention and post-intervention for immediate effects and pre-intervention and follow-up for lagged effects) and group (intervention and control) and the interaction between the two. To investigate the potential mediation of intervention effects, a set of multiple mediation models were conducted on Mplus. In these models, the outcome variables were different indices of parenting stress (total/parent domain/child domain/parent-child interaction domain). The mediating variables concerning children's inattentive, hyperactive/impulsive, and aggressive/oppositional problems were all included simultaneously to test their unique contribution to each outcome. Both the mediating and outcome variables were latent change scores capturing pre-to-post intervention changes. Of particular interest were the indirect paths, assessing the effects of the intervention on parenting stress through changes in children's behavior. Bias-corrected bootstrap confidence intervals with 1000 repetitions were used to estimate the indirect paths. All change scores of the outcome and mediating variables were controlled for by their respective pre-intervention scores. Further, in some models, model fit was improved by controlling for one or two additional paths going either from the pre-intervention score of a mediator to the change of an outcome or vice versa. All of the analyses conducted in Study III included time between assessment point, father's education level and child's age as covariates.

3 OVERVIEW OF THE ORIGINAL STUDIES

3.1 Study I: Heterogeneity of executive functions among preschool children with psychiatric symptoms

The overall aim of Study I was to examine everyday EF difficulties among preschool-aged children with emotional and behavioral problems from two different perspectives: a variable-oriented perspective and a person-oriented perspective. First, we aimed to compare children with internalizing, externalizing, combined (both internalizing and externalizing) and mild (below-clinical levels of both internalizing and externalizing) symptoms to one another as well as to typically developing children in terms of everyday EF. We hypothesized that the children with mainly externalizing symptoms and combined symptoms would show more EF difficulties across all domains as compared to typically developing children. Furthermore, we expected the children with internalizing symptoms to show more difficulties than typically developing children in, at the least, shifting attention. Between the symptom groups, we expected the externalizing group to show more difficulties than the internalizing group in, at the least, impulsivity and motor hyperactivity. The second sub-aim (person-oriented) was to uncover underlying EF profiles, based on individual variability, within the clinical sample and to examine their external validity by studying their associations with different background variables, including symptom group status. For this aim, we maintained a more exploratory approach with no specific hypotheses.

Concerning the first sub-aim and the variable-oriented perspective, we found that all symptom groups had more total EF difficulties and difficulties in almost all the separate domains than did the typically developing children. The only exception to this was that the children with mainly internalizing symptoms did not have more difficulties related to motor hyperactivity than typically developing children did. In terms of the symptom group comparisons, the

children with externalizing symptoms had the most severe problems, especially when compared to the children with internalizing symptoms. These two groups differed from one another significantly in terms of impulsivity and motor hyperactivity, and although not statistically significant, substantial effect sizes were also found for the differences in total EF difficulties, distractibility, execution of action, and sustaining attention. The children with externalizing symptoms also showed significantly more impulsivity and motor hyperactivity than the children with combined symptoms and more impulsivity than did the children with mild symptoms.

Concerning the second aim and the person-oriented perspective, we identified five EF profiles, with some showing unique combinations of strengths and weaknesses and associations with background variables within the clinical sample. The "average" profile (*n*=29, 17%) had everyday EF skills comparable to typically developing children across all domains. Within this group, female gender, mild externalizing and internalizing symptoms, as well as high mother's education level, were overrepresented. The second profile, "weak average," (*n*=37, 22%) did not have clinically significant impairment in any EF domain; however, their EF scores were slightly below average across all domains, and they had a mild elevation (indicating more difficulties) in terms of initiating action. Within this group, female gender, high internalizing symptoms, and high mother's education level were overrepresented. The third group was named "attentional problems" (*n*=25, 15%) due to showing clinically significant difficulties in all domains except in motor hyperactivity, with particular weaknesses in attention-related areas. This group was not associated with any background variables specifically. The fourth group, named "inhibitory problems," (*n*=42, 25%) had particularly severe difficulties in motor hyperactivity, impulsivity, and distractibility, but close to average scores in directing and shifting attention as well as in initiating behavior. Within this group, male gender, high externalizing symptoms, and low mother's education level were overrepresented. The fifth group, "overall problems," (*n*=38, 22%) had clinically significant and severe difficulties across all EF domains. This group was not related to background variables.

To summarize the results across different approaches, the results showed that the person-oriented approach provided more fine-grained information concerning children's everyday EF skills when compared to the symptom group comparisons, which mainly revealed the overall difficulties that were present in all groups and the gross inhibition-related differences between the internalizing and externalizing groups. Variability in some everyday EF skills, specifically in different aspects of attention, planning and acting on one's initiative, were not captured by the type and level of internalizing and externalizing symptoms and required more individual-level examination to become apparent. Furthermore, the person-oriented approach revealed the heterogeneity of everyday EF *within* the symptoms groups by demonstrating that, despite increased difficulties in the symptom groups overall, approximately two thirds of children with internalizing and one third of children with mild and combined symptoms showed no

clinically relevant EF difficulties in the ECE environment. The children with mainly externalizing symptoms tended to be more homogeneous in having severe difficulties, but they also exhibited varying patterns of EF difficulties.

3.2 Study II: Effectiveness of ENGAGE in reducing difficulties in everyday executive functions among Finnish preschoolers: A randomized controlled trial

The aim of Study II was to examine the effectiveness of the ENGAGE intervention in reducing behavior problems related to EF among 4- to 5-year-old Finnish children with elevated levels of hyperactive/impulsive and inattentive problems. Both the immediate effects of the intervention as well as the maintenance of intervention gains until a 3-month follow-up point were examined. Due to previous findings suggesting so (Healey & Halperin, 2012; Healey & Healey, 2019), we expected the intervention to be effective in reducing problems in all areas of behavior that were assessed, that is, inattentive, hyperactive/impulsive, and aggressive/oppositional. We also expected ENGAGE to be effective in increasing functional ability as evidenced by reduced attention-related problems in everyday situations at home. Further, we expected the gains to be maintained until the 3-month follow-up. The effects were anticipated to be stronger for parent ratings than for ECE teacher ratings.

The results showed that the children in the ENGAGE group did show significantly greater reductions in parent-rated inattentive, hyperactive/impulsive, and aggressive/oppositional behavior as well as greater improvements in parent-rated functional ability in home situations than the children in the waitlist control group. The effect sizes were all in the moderate category. As expected, the gains were maintained until the 3-month follow-up. The ECE teacher ratings mainly did not reveal significant intervention effects. The only group difference found within ECE teacher ratings (concerning impulsivity) could have been due to Type I error due to a relatively high number of analyses conducted and could therefore not be reliably interpreted as an intervention effect. Both parents and interventionists reported high levels of acceptability ($M_{parents}$ = 5.3, $M_{interventionists}$ = 5.5, when the maximum was 6). On average, parents attended 84% of the group sessions, engaged in playing the games with their child at home for 69% of the potential days, and played for 94% of the targeted 30 minutes each day when engaging in play.

3.3 Decreases in child aggressive and oppositional behavior mediate the effects of the ENGAGE intervention on parenting stress

The main aim of Study III was to examine the effect of the ENGAGE intervention on parenting stress. The overall intervention effect as well as a mediated effect, passing through changes in children's inattentive, hyperactive/impulsive, and aggressive/oppositional behavior problems were examined. We expected the ENGAGE intervention to reduce parenting stress at least in the child domain. Furthermore, we expected pre-to-post intervention changes in children's behavior to mediate the effect of ENGAGE on pre-to-post changes in parenting stress. The mediated path was examined using multiple mediation analysis, with all the potential mediators included in the model simultaneously in order to test for their unique contribution.

The results showed that ENGAGE did not have an overall effect on parenting stress in any domain. This was the case for both immediate and lagged (evident at the 3-month follow-up) effects. However, parents in the ENGAGE group did show significant immediate and lagged reductions in total and child domain parenting stress, as well as marginally significant reductions in the interaction-related parenting stress, whereas the parents in the control group did not, potentially indicating a trend in the hypothesized direction. Furthermore, the mediation analyses revealed that the only significant mediator was changes in children's aggressive/oppositional behavior. The significant mediation effects emerged for total, child, and interaction domains of parenting stress. The direct paths were not significant in any model, suggesting that, in these models, reductions in children's aggressive/oppositional behavior were fully explained by the mitigating effect of the intervention on parenting stress. In order to get some temporal separation between the mediating and outcome variables, we replaced the pre-to-post change scores of parenting stress with pre-to-follow-up change scores of the same variables, while keeping the mediating variable (change in children's aggressive/oppositional problems) as a pre-to-post change score. In these analyses, the results remained the same, with significant indirect paths and insignificant direct paths, thus further supporting the hypothesized temporal order of events (changes in children's behavior preceded changes in parenting stress).

4 DISCUSSION

The aim of this dissertation was to provide further knowledge concerning everyday EF difficulties among preschool children as well as to provide information concerning the potential of a novel intervention in improving children's EF-related behavioral outcomes and in supporting parents. The focus was on children in a developmentally vulnerable position due to heightened emotional and/or behavioral problems. The results provide novel information concerning the assessment and intervention of children's EF-related difficulties early in development and offer tangible means to reduce or avoid the accumulation of problems among at-risk children.

Specifically, the first aim of the dissertation (Study I) was to examine the variability of everyday EF skills in a heterogeneous sample of children attending psychiatric outpatient clinics through a variable-oriented and a person-oriented route. The variable-oriented route consisted of comparisons of groups of children, formed based on type and level of internalizing and externalizing symptoms, in terms of everyday EF. The person-oriented route focused on children's individual-level variability in EF skills and consisted of the identification of typical EF profiles within the clinical sample as well as the examination of their relationship to different background variables. The second aim of the dissertation (Study II) was to examine the effectiveness of a play-based EF intervention, ENGAGE, in reducing children's EF-related behavior problems in a sample of children showing elevated levels of inattentive and hyperactive/impulsive problems. The third aim of the dissertation (Study III) was to examine the effectiveness of ENGAGE in reducing parenting stress and whether reductions in children's behavior problems mediate this effect.

4.1 Heterogeneity of everyday executive function skills among preschool children with emotional and behavioral problems

EF difficulties, measured both cognitively and behaviorally, have consistently been linked to various forms of emotional and behavioral problems that children face (Yang et al., 2022; Zelazo, 2020), and children attending psychiatric outpatient clinics are known to show heightened levels of EF difficulties in their everyday lives (Huhdanpää et al., 2019; Pollastri et al., 2022). However, many questions regarding these relationships remain elusive and person-oriented approaches have been utilized only little to increase understanding. The aim of Study I was to explore the nature of everyday EF difficulties among children with emotional and behavioral problems from two perspectives: variable-oriented and person-oriented. The results of the variable-oriented analyses showed that all the symptom groups (clinical levels of internalizing, externalizing, and both symptoms, as well as those with below-clinical symptoms) had higher levels of everyday EF difficulties than typically developing children in almost all EF domains, including overall EF. These results align with previous findings having shown wide-spread everyday EF difficulties among children with mainly externalizing and both externalizing and internalizing symptoms (Eisenberg et al., 2001; Ezpeleta & Granero, 2015; Mahone & Hoffman, 2007; Skogan et al., 2015). Fewer studies have examined multiple everyday EF domains among preschool children with internalizing symptoms. In one such study, Skogan et al. (2015) found broad everyday EF difficulties among children with an anxiety disorder. Their results together with ours suggest that, despite some studies having identified more specific EF difficulties using performance-based measures (e.g., Bloemen et al., 2018), in everyday situations the EF difficulties of children with internalizing symptoms present widely. The results also highlight that children with perhaps more "silent" symptoms (internalizing or mild) may need screening of everyday EF difficulties in as much as the children whose symptoms are mainly expressed as disruptive behavior.

Results from the variable-oriented analyses further showed that the different groups of children, formed on the basis of their type and level of symptoms, differed from one another mainly in terms of inhibition-related everyday EF, with the externalizing group showing more impulsivity in the ECE context than the internalizing group, combined and mild groups and more hyperactivity than the combined and mild groups. These results were anticipated, considering the consistency with which externalizing symptoms have been associated with inhibitory problems (e.g., Ezpeleta & Granero, 2015; Pauli-Pott & Becker, 2011; Schoemaker et al., 2013). The largest differences were found between the externalizing and internalizing groups, with some of the insignificant differences (in distractibility, execution of action, and sustaining attention) reaching a substantial effect size. The pronounced difficulties of the externalizing group in distractibility and sustaining attention can reflect inhibitory problems on the attentional level, more specifically inference control

(Friedman & Miyake, 2004). Inhibitory problems can then radiate to the overall ability to execute and complete everyday tasks.

In addition to the variable-oriented mean group comparisons, the variability in EF skills and the relationship between EF difficulties and internalizing/externalizing symptoms was examined from a person-oriented standpoint. To the best of my knowledge, this was the first study to adopt a person-oriented approach in studying everyday EF in a clinical sample of preschool children. The examination of typical EF patterns within the clinical sample yielded five distinct profiles, with three of them ("average," "weak average," and "overall problems") showing mainly different levels of problems, and two profiles ("attentional problems" and "inhibitory problems") showing clearly distinct and somewhat "mirroring" patterns of everyday EF skills. Three of the five profiles showed significant relations to background variables: The average profile was related to female gender, high maternal education, and mild symptoms; the weak average profile was related to female gender, high maternal education, and internalizing symptoms; and the inhibitory problems profile was related to male gender, low maternal education, and externalizing symptoms.

Our results show that many children differ from one another mainly in terms of the level of EF difficulties, in accordance to some previous findings (Cumming et al., 2023; Dajani et al., 2016; Litkowski et al., 2020). However, our results also show that some children with emotional and behavioral problems do show varying strengths and weaknesses in EF, in line with the findings of Kavanaugh et al. (2016). The two subgroups identified by Kavanaugh et al. (2016) bear resemblance to our inhibitory and attentional problem groups, with the other one showing difficulties in inhibition and delayed memory and the other one showing difficulties in organization and planning. However, the exact correspondence is made difficult by the use of highly different measures (global measures of neurocognitive functioning vs. rating scale measures of EF). Similar to our study, they included a heterogeneous sample of children drawn from psychiatric care, indicating that a heterogeneous sample of clinically referred children may be needed to detect more nuanced patterns of EF.

Further, although poorer child EF skills are known to be related to lower parental education level (Ardila et al., 2005; Klenberg et al., 2010; Sherman & Brooks, 2010), the results of our study show that low maternal education is pronounced among those children showing more specific inhibitory problems rather than among those showing the highest overall levels of impairment. Overall, the inhibitory problems group stands out as the group of children among whom risk factors, including cognitive-emotional and environmental ones, tend to accumulate. The attentional and overall problems profiles were not related to any background variables due to which the "identity" of these profiles remains elusive. These children may be characterized mostly by neuropsychiatric symptoms, such as inattentive symptoms or social and communicative symptoms, which may not be well captured by the internalizing and externalizing factors of psychopathology (Noordhof et al., 2015). Furthermore, the children showing high overall EF difficulties may be characterized more by

high severity and/or chronicity of psychiatric symptoms overall, something that the general factor of psychopathology, "p," captures, rather than any specific symptom type per se (Bloemen et al., 2018).

Overall, the individual-level examination completed the variable-oriented analyses by revealing heterogeneity both *within* the symptom groups as well as *beyond* the symptom groups. For instance, although all the symptom groups were found to have significantly more difficulties than typically developing children on average, the individual-level analysis showed that many children within these groups had EF difficulties below the clinically significant threshold across all domains (66.7% of children in the internalizing group; 39.4% in the mild group; 33.4% in the combined group; 19.0% of children in the externalizing group). In addition, approximately every fourth child in the internalizing and mild groups had all everyday EF domains on a comparable level with typically developing children. Further, the individual-based EF profiles showed significant variability in EF domains that seemed undifferentiated based on clinical group comparisons, such as in attentional domains, initiating activity and planning. Our results suggest that these domains of everyday EF are poorly captured by the externalizing/internalizing distinction, or the severity of such symptoms, and that differences within these domains may be related to some other factors not identified in this study. Hence, the results show that the child's type or level of internalizing/externalizing symptoms is not a particularly reliable indicator of their everyday EF profile and thus highlight the importance of an individual and comprehensive assessment of each child with potential EF difficulties.

4.2 Effectiveness of ENGAGE in reducing children's behavior problems related to executive function

One aim of this dissertation, addressed in Study II, was to examine the effectiveness of a play-based EF intervention, ENGAGE, in reducing EF-related behavior problems in a sample of 4- to 5-year-old Finnish preschoolers with parental concern over their child's inattentive and/or hyperactive/impulsive problems. This is the first study to suggest that this novel approach, based on parent-guided play, could be a viable tool in the Finnish health care context. In the study, the ENGAGE group was compared to a wait-list control group in an RCT design. We expected ENGAGE to be effective in reducing children's behavior problems, and the effects were expected to be larger for parent ratings than for ECE teacher ratings. The results showed that ENGAGE was effective in reducing parent-rated inattentive, hyperactive/impulsive, and aggressive/oppositional problems, as well as in improving attention-related functional ability across frequently encountered everyday situations at home. All effect sizes were in the moderate range. Furthermore, these gains were found to be maintained until the follow-up measurement point occurring 3 months after

the ending of the intervention. ECE teacher ratings, however, did not show significant intervention effects.

Overall, the obtained results are in line with previous findings concerning ENGAGE (Healey & Healey, 2019; Healey & Halperin, 2015) as well as other play-based EF interventions having demonstrated significant behavioral improvements comparable to those obtained using other psychosocial interventions (Halperin et al., 2020; Tamm et al., 2019). These findings jointly strengthen the idea that a child's behavior problems can be reduced using many approaches, with ENGAGE being one of them. Specifically, our study shows that the findings apply to the Finnish cultural context, and that ENGAGE can be a viable low-threshold intervention option for families where parents' concern over their young child's behavior problems, particularly inattention and hyperactivity/impulsivity problems, has just started to arise and where problems can be milder.

The high acceptability ratings obtained from parent and interventionists further speak for the applicability of ENGAGE in the Finnish health care context. Engagement at home, which is a key part of the intervention, was also excellent in terms of the time spent playing when engaging in play (94% of the goal of 30 minutes per day). The amount of days parents engaged in playing at home was also satisfactory (69%), although not quite as high as the maximal average engagement found previously for ENGAGE and TEAMS (Halperin et al., 2013; Healey & Halperin, 2015). Nevertheless, the numbers for engagement at home were notably better than what has previously been found for behavioral parent training (mean homework completion rate of 48%; Chacko et al., 2016). Similarly, average attendance on group sessions (84%) was somewhat lower than the 100% attendance found for ENGAGE and TEAMS before (Halperin et al., 2013; Healey & Halperin, 2015), yet higher than what has generally been found for behavioral parent training (72%; Chacko et al., 2016).

Despite optimistic results concerning the parent-rated outcomes, the lack of significant intervention effects in ECE teacher ratings raises questions concerning the transfer of intervention effects to different contexts and potential bias in parent ratings. A significant intervention effect did emerge in teacher-rated impulsivity; however, as this was the only significant teacher effect out of 11 effects analyzed, it could have been due to Type I error. Overall, the lack of intervention effects on ADHD symptoms beyond non-blinded ratings by people most proximal to intervention delivery (often parents) is a common phenomenon in behavioral parent training interventions (Rimestad, 2019; Daley, 2013; Sonuga-Barke, 2013) as well as in cognitive training (Cortese, 2015). One explanation for such results is that more distant and potentially blinded raters are less sensitive to intervention-induced change because they do not expect it. In addition, especially when practice and implementation of new strategies takes places mainly at home, the gains obtained at home may not transfer to other environments that pose somewhat different demands on the child's EF—at least in the same magnitude. In ECE, children are often in large groups with other children, increasing distractibility and necessitating the use of EF skills in socially

more challenging situations than at home. Moreover, in ECE, children may receive less individualized guidance and support than what they would receive at home—in general and/or especially during the intervention period. Different results concerning parent and teacher ratings could also reflect bias related to the source of ratings (Podsakoff et al., 2003). Particularly in this case, as parents were not only recipients but also deliverers of the intervention, investing daily effort to obtain results, they may have been biased to see positive outcomes to justify their effort (Inzlicht et al., 2018).

The positive effects of ENGAGE may be due to it including many such aspects that have previously been shown to characterize effective EF interventions, such as offering the intervention in a group format, targeting children with difficulties related to everyday EF, and including strategy teaching and scaffolding in addition to direct training (Pauli-Pott et al., 2021; Scionti et al., 2020; Takacs & Kassai, 2019). In addition to parental scaffolding behaviors known to foster children's EF (Hammond et al., 2012), ENGAGE could potentially also improve other aspects of the parent–child relationship that are known to be important for children's EF, such as parental sensitivity and responsivity (e.g., Blair et al., 2014), attachment security (e.g., Bernier et al., 2015) and emotional warmth (e.g., Baker & Kuhn, 2017). Furthermore, although not directly a physical activity or mindfulness-based intervention, ENGAGE includes aspects of these effective approaches in the form of games requiring physical activity, such as hopscotch, and activities requiring focused attention in the present moment and bodily sensations, such as deep breathing and mental imagery. In addition to the relaxation and mindfulness-based activities that are supposed to enable children to learn the very foundations of emotion regulation, parents are guided to focus on their children's emotion regulation amidst all the games. Overall, ENGAGE can be seen as an intervention that addresses children's EF development in a holistic way—something previously highlighted as a key for effective EF interventions (Diamond, 2013).

4.3 Effect of ENGAGE on parenting stress

One aim of the present dissertation and, more specifically, Study III, was to examine the effect of ENGAGE on parenting stress overall as well as to investigate whether changes in children's behavior mediate this effect. A key finding was that the effects of ENGAGE on parenting stress were fully mediated through reductions in child aggressive/oppositional problems, highlighting the importance of considering the relationship between parenting stress and child aggressive/oppositional problems in interventional contexts. The significant mediated effects were found for the child and parent-child interaction domains as well as for total parenting stress but not for the parent domain of parenting stress. The results of Study III also showed that there was no overall effect of ENGAGE on any parenting stress domain. Considering the significant effects of ENGAGE on child behavior problems based on parent ratings found in Study II,

the non-significant overall effects, especially for child domain parenting stress, were not expected. However, we also found small but statistically significant decreases in the total and child domain parenting stress as well as a marginally significant decrease in the interaction domain in the ENGAGE group and no such decreases in the control group. Therefore, the results were partially in line with our hypotheses and may suggest a trend in the expected direction.

As expected, the positive effects of ENGAGE on parenting stress, more specifically in the child and parent-child interaction domains, were found to be mediated through reductions in children's aggressive/oppositional behavior problems. Multiple mediation analysis was used to examine this question, enabling us to sort out the unique contributions of correlated domains of behavior problems (inattentive, hyperactive/impulsive, and aggressive/oppositional) as mediators. The fact that the mediated effects were significant in the absence of a total intervention effect may be due to increased power to detect significant results for the mediated effects as compared to the total effects (O'Rourke & MacKinnon, 2015), and/or due to inconsistent mediation where the direct and indirect paths have opposing signs, reducing the total effect (O'Rourke & MacKinnon, 2018).

The fact that only aggressive/oppositional problems turned out as a significant mediator highlights its special importance for parenting stress. Aggressive and oppositional behavior defies social norms and sometimes can even constitute a threat to others' safety, due to which such behavior can elicit more severe social implications, such as strong disapproval and social isolation, than problems related to inattentiveness and hyperactivity/impulsivity. Overall, social exclusion is a known cause of distress for humans (MacDonald & Leary, 2005; Williams, 2007). In the same vein, Muñoz-Silva et al. (2017) found that the negative effect of child conduct problems on parenting stress are mediated through its effects on family's social relationships. In addition to social implications, parental attributions related to aggressive/oppositional problems can explain its special relationship with parenting stress. Parents generally view their child's oppositional and antisocial behavior as more controllable by their child (e.g. being due to lack of effort) than inattentive and hyperactive behavior (Johnston et al., 2006; Johnston & Patenaude, 1994; Palm et al., 2019), and such attributional style is known to cause more negative reactions in parents (Johnston et al., 2006; Johnston & Patenaude, 1994). Since the success of an intervention in allowing the parent to see the child in a more positive light and experience the interaction with the child as more rewarding and less dysfunctional is primarily contingent upon its ability to reduce child aggressive and oppositional behavior, tools to address such behavior are needed. This is the case even when such behavior is not the main target of an intervention and evident more as a co-occurring problem in milder forms, as was the case in the present study.

The mediated effect was significant for parenting stress in the child and parent–child interaction domains as well as for total parenting stress but not for parenting stress in the parent domain. In other words, decreases in child aggressive/oppositional behavior resulted in the parents seeing their child as

easier to manage and as more reinforcing and acceptable to their standards. The decreases in aggressive/oppositional behavior did not, however, translate into parents experiencing themselves as, for instance, more competent, less socially isolated and less depressed in their parent role. This is understandable considering the proximity of different constructs: the intervention-induced improvements in child behavior relieve parenting stress in areas that are somehow related to the child. In order for parents to feel more competent and less socially isolated in their parent roles, interventions may need to address these aspects more directly. In previous studies, behavioral parent training interventions (Abikoff et al., 2015; Anastopoulos et al., 1993; Maaskant et al., 2017; Pisterman et al., 1992) and interventions addressing parenting stress more directly (Kazdin & Whitley, 2003; Treacy et al., 2005) have been shown to reduce parenting stress in the child as well as parent domains. Therefore, the level of parenting stress in different domains may be an indicator for the most optimal intervention approach. In case parental factors are the main culprit for high parenting stress, interventions addressing parenting and parenting stress more directly can potentially be more effective. Interventions such as ENGAGE, which focus more on children's skill building, may be more suitable for parents who experience distress primarily due to their child's behavior and due to dysfunctional interaction with them.

4.4 Limitations and future directions

Some important limitations should be taken into consideration when interpreting the findings of the present dissertation. One main limitation is that both children's emotional and behavioral problems and everyday EF were measured using questionnaires, which might have made it difficult to identify truly distinct constructs. This can be due to both actual overlap between the constructs and measures but also due to the holistic way of raters to assess children's behavior and overlook more fine-grained differences between different behavioral domains. Actual overlap between measures may have affected particularly the results of Study I, which examined the relationship between everyday EF, specifically in the Impulsivity, Motor hyperactivity, and Sustaining attention domains of the ATTEX-P, and the Externalizing symptoms scale of the CBCL. However, the majority of the items (20 out of 24) on the Externalizing symptoms scale assess aggressive behavior—something not measured by the ATTEX-P. In regard to Study III, concerns have also been raised regarding potential overlap between the child domain parenting stress and child behavior problem measures (Theule et al., 2018). Although both include references to children's behavior, they can still be seen as measuring distinct constructs. Whereas measures addressing child behavior problems concern the frequency of a certain child's behaviors, the Difficult Child scale of PSI-SF concerns the parent's own appraisal of such behavior and how burdening they experience it as—in other words, a form of parenting stress. Nevertheless, the fact that the same persons provided

ratings for both constructs increases the risk that bias could have contributed to their association. Overall, adding more objective measures of EF, such as performance-based measures or observational measures, would have enriched the results.

The limitations posed by the research designs are also important to consider. First, using a wait-list control group in Study II controlled for the effects of being measured multiple times and children developing and changing across time from affecting the intervention results. However, the lack of blinded ratings and an active control group mean that placebo effects could have affected the results. Especially since the parents were active agents in delivering the intervention they may have been biased to see a positive outcome (Inzlicht et al., 2018). Replications with different kinds of active control groups would help disentangle the source of positive intervention effects. Second, in terms of Study III, the fact that the time points of measurement for both the mediators (change in child behavior from pre-intervention to post-intervention) and outcome variables (change in parenting stress from pre-intervention to post-intervention and from pre-intervention to follow-up) overlapped either entirely or to some degree means that the hypothesized temporal order of events (intervention yields positive effects on child behavior which then subsequently reduce parenting stress) are mainly based on theoretical assumptions. Small sample size should also be considered as a limitation in the results of Study I and Study III. In both cases, replications with larger samples are needed to gain confidence in the findings.

Attention should also be paid to the generalizability of the results of the present dissertation. In Studies II and III, the sample included parents that, on average, had a higher education level than that of the general population and that also scored relatively low in terms of parenting stress at pre-intervention. According to the original norms of PSI-SF, 88.4% of the parents had total parenting stress in the normal (below clinical) range at pre-intervention. Therefore, the generalizability of the results of Studies II and III, concerning the effect of the ENGAGE intervention on child and parent outcomes, to disadvantaged families is unsure, and replications with varied populations are encouraged. The relatively low level of parenting stress in Study III could also have contributed to the lack of significant overall intervention effects as there simply may not have been enough room for improvements. However, it is unsure how low or high the level of parenting stress was, as the original norms, gathered in the USA, may not ideally reflect the general levels of parenting stress among Finnish parents.

Finally, I would like to offer some future directions for research concerning ENGAGE and play-based EF interventions in general. As already mentioned, ENGAGE combines many aspects characterizing effective EF interventions, which can be seen as a strength and potential reason for its effectiveness. However, studying the overall effectiveness of multi-componential and holistic interventions does not reveal the relative importance of single components or aspects, and future studies sorting out the most essential ingredients of ENGAGE and interventions alike are needed to reduce unnecessary complexity and strain.

For instance, previous studies have shown that psychoeducation can, in itself, be effective in reducing children's ADHD symptoms (Dahl et al., 2020). Furthermore, a reduced version of a play-based EF intervention (TEAMS), including only weekly ADHD-related psychoeducation and support group sessions for parents and EF practice group sessions for children, was found to provide comparable benefits as the full TEAMS intervention including daily EF practice in addition to the group activities (Halperin et al., 2020). Therefore, the benefits of parental psychoeducation and support vs. EF training, and the added benefits of combining them, require further examination. Ideally, the question of who benefits from what would be incorporated into such studies as different families and children can benefit from different approaches.

In addition to the essential components, the causal pathways of ENGAGE and other similar interventions demand further examination. The main hypothesized mechanism of effect in these interventions is that repeated playing of EF-taxing games enhances children's underlying neurocognitive EF skills, which allows children to regulate themselves more effectively in everyday life (Halperin & Healey, 2011). Several studies have examined the effect of play-based EF interventions using performance-based EF tasks, thought to tap neurocognitive functioning, and yet none have found convincing evidence for improvement in such tasks following the interventions (Halperin et al., 2020; Healey & Healey, 2019; Tamm et al., 2014, 2019). It is possible that in addition to or instead of improving children's EF, ENGAGE and similar interventions may operate through other mechanisms. For instance, improved parent–child interaction and relationship quality are known to be related to the level of child's ADHD symptoms (Burt et al., 2005; Lifford et al., 2008). Measuring these alternative causal pathways would be highly insightful.

4.5 Practical implications

The results of this dissertation have implications for the assessment and intervention of EF difficulties in the health care context. Although the results show that distinct EF profiles are typical for children with externalizing, internalizing, and mild symptoms, they also underscore considerable individual variability both within and beyond these symptom groups. To illustrate the heterogeneity, approximately two thirds of children with internalizing and one third of children with mild and combined symptoms showed no clinically relevant EF difficulties in the ECE environment. The children with mainly externalizing symptoms tended to be more homogeneous in having severe difficulties; however, they also exhibited varying patterns of EF difficulties. These results suggest that, on an individual level, the type or level of a child's externalizing and internalizing symptoms is a relatively unreliable indicator for their everyday EF profile, and that screening of EF difficulties should take place regardless of such factors within the health care context. Furthermore, different combinations of internalizing and externalizing symptoms were a particularly

poor indicator for the child's behavior in certain domains of everyday EF, including directing and shifting attention, initiating activities, and planning. This further highlights the need for individualized assessment of these domains and cautions against making assumptions based on the child's symptomology.

In case signs of EF difficulties arise, a detailed understanding of the child's EF profile can bring attention to points of relative strength in addition to areas of weakness. The results of this dissertation suggest that, while the majority of children with emotional and behavioral problems show either weak or strong everyday EF skills overall, some children have more uneven profiles. Paying attention to EF-related strengths may be helpful in supporting children's self-regulatory efficacy, which tends to be lower among those who have difficulties related to attention and EF (Paananen et al., 2019). Such information may inform adults when considering intervention options, including in ECE where the assessment of everyday EF skills took place in the present dissertation. For example, placements of children in small groups can be made based on similarity or difference in EF profiles—both of which can have different benefits for children. Similar challenges can bring the benefits of peer support, whereas having children with different challenges and strengths can enable learning and modelling from peers (Dion et al., 2007).

The present dissertation also indicates that a novel play-based approach to improving the behavioral outcomes of preschool children with elevated inattention and hyperactivity/impulsivity is a viable option to be offered to families in Finnish health care. The effectiveness found in the present dissertation for ENGAGE strongly echoes that found in previous studies (Healey & Healey, 2019; Healey & Halperin, 2015), thus strengthening the overall evidence and extending it to another cultural context. Furthermore, high post-intervention acceptability ratings from interventionists and parents as well as satisfactory rates of attendance and adherence are all positive indicators for successful implementation in the health care setting. Nevertheless, the lack of significant intervention effects in the ECE teacher ratings may indicate the need to extend the intervention in some form to the ECE context. There is recent evidence suggesting that, when modified to the ECE context, ENGAGE can result in improved everyday EF based on ECE teacher ratings (Healey & Healey, 2022). However, parent ratings were not used, so it is not known whether the benefits were evident at home. A collaborative intervention involving some components for parents and some for ECE could potentially provide the widest benefits for children. However, the effects of such an intervention have yet to be studied.

Some differences between our study and the RCT conducted by Healey and Healey (2019) should be noted as it has implications in terms of who can benefit from ENGAGE. First, our study included slightly older children (4- to 5-year-olds vs. 3- to 4-year-olds), and the cut-off score of ADHD symptoms, used as inclusion criterion, was lower in our study (65th percentile vs. 84th percentile). Therefore, our study extends the viability of ENGAGE for slightly older children and children with milder problems. In other words, our results suggest that ENGAGE can work as a low-threshold intervention, offered to families where parental

concern has emerged but where the child's symptoms may still be relatively mild. Since EF difficulties and hyperactivity in the preschool period have been identified as reliable precursors of later ADHD diagnosis and also as malleable intervention targets (Shephard et al., 2022), intervening in the earliest stages possible is important. Furthermore, the present dissertation suggests that ENGAGE can provide benefits for parents in the form of reduced parenting stress. ENGAGE may be most suitable for parents who experience heightened parenting stress mainly due to factors related to the child and interaction with them. Other interventions, such as those focusing more directly on parenting stress or parenting, may be more suitable for those experiencing high parenting stress due to parental factors.

The present dissertation further highlights the importance of targeting child aggression and oppositional problems in the context of play-based EF interventions and possibly also other kinds of interventions offered to families in case of child's inattentive and hyperactive/impulsive problems. Besides being important for the child's sake, the success in reducing aggressive and oppositional behavior, specifically, seems to matter for parenting stress and therefore has bearings for the functioning of the family as a whole. One critical aspect of ENGAGE or any intervention intending to reduce such problems among children may be their ability to support children's emotion regulation, considering how dysfunctional emotion regulation underlies oppositional and aggressive behavior (Cavanagh et al., 2017; Di Maggio et al., 2016) in addition to being closely linked to ADHD (Sonuga-Barke et al., 2023). Those families where parents struggle with their child's emotion regulation problems should be identified during the early stages of the intervention and the parents' progress in supporting their child's emotion regulation should be monitored along the way. In ENGAGE, emotion regulation is specifically addressed through mindfulness-based activities, such as deep breathing and mental imagery, that aim to foster children's awareness and control of their bodily states. In addition to that, all play situations offer a possibility for parents to help their children learn emotion regulation strategies, because feelings of disappointment, frustration and anger are common in situations of not succeeding in games, not winning, or not getting one's way, for instance. The parents who have expressed having challenges related to children's emotion regulation should receive special guidance in relation to these situations—in addition to learning how to support children's core EF skills.

4.6 Concluding remarks

The aim of this dissertation was to investigate the nature and variability of everyday EF difficulties as well as to examine the effectiveness of a play-based EF intervention in reducing behavioral problems related to such difficulties and in improving parental functioning among preschool-aged children showing varying levels and types of emotional and behavioral problems. This dissertation

contributes to previous research by showing that, although connections between internalizing and externalizing symptom domains and everyday EF skills can be drawn, there is notable heterogeneity in EF both within the symptom domains and beyond them among children receiving psychiatric care. This highlights the need for individualized and comprehensive assessment of everyday EF regardless of the child's symptoms. Furthermore, this dissertation supports the effectiveness of a play-based EF intervention, ENGAGE, in reducing EF-related behavior problems among Finnish preschoolers with parental concern over elevated inattentive and hyperactive/impulsive problems and indicates its usefulness in the Finnish health care setting as a low-threshold intervention offered to families who are in the early stages of seeking help. Furthermore, the present dissertation shows that in ENGAGE, as well as potentially in other interventions with similar aims, reducing children's aggressive and oppositional behavior is an important target because the diminishing of parenting stress is contingent upon such a reduction.

YHTEENVETO (SUMMARY)

Arjen toiminnanohjauksen vaikeudet alle kouluikäisillä lapsilla ja taitojen tukeminen leikin avulla

Alle kouluikäiset, n. 3-6 vuoden ikäiset lapset tarvitsevat tyypillisesti paljon aikuisen tukea käyttäytymisensä, ajattelunsa ja tarkkaavuutensa sekä tunteidensa joutavassa ja tarkoituksenmukaisessa säätelyssä. Kognitiivisten taitojen joukkoa, jota tarvitaan kaikessa tavoitesuuntautuneessa ja tietoista ponnistelua vaativassa toiminnassa, nimitetään toiminnanohjaukseksi (Diamond, 2013; Nigg, 2017). Empiiriset tutkimukset ovat osoittaneet, että toiminnanohjaus on elämässä hyvin keskeinen taito. Alle kouluikäisenä mitatun toiminnanohjauksen on todettu ennustavan monia tärkeitä elämän osa-alueita myöhemmin, kuten mielenterveyttä sekä fyysistä terveyttä (Fleming et al., 2020; Moffitt et al., 2011; Morgan et al., 2019; Quistberg & Mueller, 2020; Yang et al., 2022), sosiaalisia suhteita ja sosiaalista kognitiota (Holmes et al., 2016; Hughes & Ensor, 2007; Marcovitch et al., 2015; Riggs et al., 2006), koulumenestystä (Ahmed et al., 2021; Kegel & Bus, 2014; McClelland et al., 2014; Morgan et al., 2019) sekä taloudellista pärjäämistä ja rikostuomioiden määrää (Moffitt et al., 2011). Laajoja yhteyksiä moniin elämän eri osa-alueisiin voi selittää osaltaan se, että toiminnanohjauksen vaikeuksista juontuvat ongelmat kasautuvat iän myötä (Ahmed et al., 2021). Toiminnanohjauksen vaikeudet hankaloittavat muiden elämän perustaitojen, kuten akateemisten ja sosiaalisten taitojen kehittymistä, jotka taas itsessään voivat altistaa yhä suuremmille ongelmille, kuten syrjäytymiseen. Siksi on tärkeää ymmärtää, minkälaisina toiminnanohjauksen vaikeudet ilmenevät varhaisessa lapsuudessa, ja miten lapsia voidaan mahdollisimman aikaisin tukea vaikeuksien ilmetessä.

Faktorianalyyttisissä tutkimuksissa toiminnanohjauksen on havaittu koostuvan kolmesta osataidosta: inhibitiosta, työmuistista sekä joustavuudesta, jotka ovat osittain erillisiä ja osittain yhteydessä toisiinsa (Miyake et al., 2000). Inhibitiolla tarkoitetaan yleensä ottaen hillinnän taitoa, ja sitä tarvitaan sekä motoristen reaktioiden että tarkkaavuuden ja ajatusten hillitsemiseen tai pysäyttämiseen (Diamond, 2013). Työmuistilla tarkoittaa kapasiteettia mielessä samalla kertaa pidettäville ja työstettäville asioille, ja joustavuus taas tarkoittaa kykyä vaihdella erilaisten ajatusmallien tai toimintatapojen välillä (Diamond, 2013). Tarkkaavuus ja työmuisti ovat läheiset käsitteet, sillä valikoiva tarkkaavuus, eli huomion kohdistaminen johonkin tiettyyn kohteeseen rajaten ulkopuoliset kohteet pois, luo pohjan työmuistille (Garon et al., 2008). Toiminnanohjauksen taitoja tarvitaan niin neutraaleissa ongelmanratkaisutilanteissa kuin tilanteissa, joissa tunteet ja motivaatio ovat eri tavoin läsnä, kuten henkilökohtaisia valintoja tehdessä ja tunteita säädellessä (Zelazo & Carlson, 2012). Toiminnanohjauksen ydintaidot ja tarkkaavuus kehittyvät vahvasti 3-5 vuoden ikäisillä lapsilla (Garon et al., 2008; Montroy et al., 2016; Reilly et al., 2022). Myös aivojen tasolla on havaittu, että toiminnanohjauksen kannalta keskeiset hermoverkot, joiden olennaisia alueita on etenkin etuotsalohkossa, kehittyvät nopeasti alle kouluikäisillä lapsilla (Fiske & Holmboe, 2019).

Toiminnanohjauksen vaikeudet ovat yleinen piirre monissa kehityksellisissä ja mielenterveyden häiriöissä (Snyder et al., 2015; Yang et al., 2022; Zelazo, 2020). Toiminnanohjausta onkin esitetty eräänlaiseksi diagnoosirajoja ylittäväksi epätyypillisen kehityksen indikaattoriksi (Zelazo, 2020). Mielenterveyden ongelmat ilmenevät harvemmin täysin erillisinä, ja sisäänpäin kääntyvät oireet (internalizing, INT) sekä ulospäin kääntyvät oireet (externalizing, EXT) käsittävien osa-alueiden on todettu kuvaavan hyvin erilaisten oireiden ja häiriöiden päällekkäistymistä lapsilla ja aikuisilla (Achenbach, 1966; Kessler et al., 2011; Lahey et al., 2017; Olino et al., 2014). INT-oireet alle kouluikäisillä lapsilla käsittävät itseen kohdistuvat oireet, kuten ahdistuneisuuden, masentuneisuuden ja vetäytymisen sosiaalisista kontakteista, kun taas EXT-oireet ilmenevät konfliktina toisten ja heidän odotustensa kanssa, esim. aggressiivinen käyttäytyminen ja hyperaktiivisuus (Achenbach & Rescorla, 2000). EXT-oireiden on todettu alle kouluikäisillä lapsilla, kuten vanhemmillakin lapsilla, yhdistyvän vaikeuksiin kaikissa toiminnanohjauksen kognitiivisissa osataidoissa (Pauli-Pott & Becker, 2011; Schoemaker et al., 2013) sekä laajoihin vaikeuksiin arjen toiminnanohjauksessa (Ezpeleta & Granero, 2015; Graziano et al., 2022; Mahone & Hoffman, 2007). INT-oireita ja toiminnanohjauksen välistä linkkiä koskeva näyttö on ristiriitaisempaa kognitiivisten taitojen osalta (Vilgis et al., 2015), ja alle kouluikäisiä on tutkittu harvoin — etenkin arjen toiminnanohjauksen suhteen.

EXT- ja INT-oireiden ja toiminnanohjauksen vaikeuksien välistä yhteyttä on pääosin tutkittu erilaisten oireisiin tai häiriöihin perustuvien ryhmien välisinä keskiarvovertailuina, mikä jättää pimentoon psyykkisesti oireilevien lasten toiminnanohjauksessa ilmenevän yksilöllisen vaihtelun. Alle kouluikäisten tai kouluiän kynnyksellä olevien lasten toiminnanohjauksessa ilmenevää yksilöllistä vaihtelua on tutkittu henkilökeskeisestä lähestymistavasta käsin joissain tutkimuksissa (Cumming et al., 2023; Litkowski et al., 2020), mutta otokset ovat olleet väestöpohjaisia tai lievästi oireileviin kohdistettuja. Toiminnanohjauksen profiileja on tutkittu hyvin vähän kliinisissä otoksissa, joissa psyykkinen oireilu on moninaista ja huomattavaa, ja joissa normatiivisen suoriutumisen suuri määrä ei peitä alleen eri tavoin oireilevilla ilmenevää hienovaraisempaa vaihtelua (kouluikäisten osalta ks. Kavanaugh ym., 2006). Väitöstutkimuksen ensimmäisen osatutkimuksen tarkoituksena oli selvittää, minkälaisia arjen toiminnanohjauksen profiileja psyykkisesti oireilevien alle kouluikäisten lasten moninaisesta joukosta on löydettävissä. Lisäksi tarkoituksena oli selvittää EXT- ja INT-oireiden sekä arjen toiminnanohjauksen välistä yhteyttä muuttujakeskeisellä (oireryhmien keskiarvovertailut) sekä henkilökeskeisellä (yksilölliseen vaihteluun perustuvien toiminnanohjauksen profiilien sekä oireryhmien välisten yhteyksien tarkasteleminen) tavalla.

Tällä hetkellä keskeisimmät ja tutkituimmat psykososiaaliset interventiot lapsille, joilla ilmenee käyttäytymisen ongelmia, kuten ADHD-oireita tai ADHD, perustuvat käyttäytymisterapeuttisiin menetelmiin (ADHD: Käypä hoito -suositus, 2019). Toisaalta lasten tarkkaavuuden tukemista ja käyttäytymisen ongelmien vähentämistä voidaan lähestyä myös toiminnanohjauksen näkökulmasta. Voidaan ajatella, että tukemalla lasten toiminnanohjausta voidaan vaikuttaa

niihin kognitiivisiin ydintaitoihin, jotka mahdollistavat paremman käyttäytymisen tason säätelyn (Halperin & Healey, 2011) ja tukevat elämänhallintaa pitkälle tulevaisuuteen (Moffitt et al., 2011). Monenlaisten toiminnanohjauksen interventioiden on todettu tehokkaasti kehittävän toiminnanohjauksen taitoja (Diamond & Lee, 2011; Pauli-Pott et al., 2021; Scionti et al., 2020; Takacs & Kassai, 2019). Kuitenkin on vain vähän tietoa siitä, minkälaiset toiminnanohjausta tukevat interventiot ovat toimivimpia alle kouluikäisillä lapsilla, joilla on käyttäytymiseen liittyviä ongelmia, ja siten kohonnut riski erilaisiin kumuloituviin ongelmiin.

Lupaavaa näyttöä on saatu vanhemman ja lapsen väliseen leikkiin ja pelaamiseen perustuvista interventioista, joissa vanhemmat leikkitilanteissa ohjaavat lastensa toiminnanohjausta (Halperin et al., 2020; Healey & Healey, 2019; Tamm et al., 2019). Tällaisten interventioiden on todettu olevan vähintään yhtä tehokkaita kuin muidenkin psykososiaalisten interventioiden (Halperin et al., 2020; Tamm et al., 2019), mukaan lukien behavioraalisen vanhempainohjauksen (Healey & Healey, 2019). Tämän väitöstutkimuksen toisen osatutkimuksen tarkoituksena oli selvittää leikkiperustaisen toiminnanohjauksen intervention, ENGAGE:n, vaikuttavuutta lasten toiminnanohjaukseen liittyvien käyttäytymisen ongelmien (tarkkaamattomuus, ylivilkkaus ja impulsiivisuus sekä aggressiivisuus ja uhmakkuus) vähentämisessä suomalaisessa 4-5-vuotiaita lapsia käsittävässä aineistossa. Uudessa-Seelannissa tehdyissä tutkimuksissa ENGAGE:sta on saatu lupaavaa näyttöä (Healey & Healey, 2019; Healey & Halperin, 2015) mutta tulosten yleistettävyys eri kulttuurisiin konteksteihin ei ole tiedossa.

Lapsen käyttäytyminen on aina monenlaisten ympäristötekijöiden ja lapseen liittyvien tekijöiden välisen vuorovaikutuksen tulosta (Sameroff, 2019), ja yhdeksi tärkeäksi lasten käyttäytymiseen linkittyväksi tekijäksi on todettu vanhempien kokema vanhemmuuden stressi (Deater-Deckard, 2004; Deater-Deckard, 1998). Vanhemmuuden stressillä tarkoitetaan stressiä, jota vanhempi kokee nimenomaan vanhemmuuden rooliin liittyen (Deater-Deckard, 2004). Abidinin vanhemmuuden stressiä koskevan mallin ja mittarin rakennetta mukaillen sen voidaan ajatella juontuvan vanhempaan, lapseen tai heidän väliseen vuorovaikutukseensa liittyvistä tekijöistä (Abidin, 2012). Vanhemmuuden stressin ja lapsen käyttäytymisen ongelmien on kummankin todettu vahvistavan toisiaan ajan kuluessa transaktionaalisessa suhteessa (Mackler et al., 2015; Neece et al., 2012), mikä tarkoittaa sitä, että ongelmat perheessä helposti kasautuvat. Tästä syystä on tärkeää, että lasten käyttäytymisen ongelmia vähentämään pyrkivät interventiot ovat tehokkaita vähentämään myös vanhemmuuden stressiä. Väitöstutkimuksen kolmannen osatutkimuksen tarkoituksena oli selvittää ENGAGE-intervention vaikuttavuutta vanhemmuuden stressiin yleisesti sekä lapsen käyttäytymisessä tapahtuvien muutosten välittämänä.

Väitöskirjan aineisto muodostuu kolmesta erillisestä otoksesta. Ensimmäisessä osatutkimuksessa hyödynnettiin kahta aineistoa. Ensimmäisessä osatutkimuksessa käytetty kliininen aineisto (N=171) kerättiin Helsingin yliopistollisen sairaalan pienten lasten psykiatrisiin yksiköihin ohjautuneilta perheiltä. Aineisto koostuu vanhempien ja varhaiskasvatuksen kyselylomakearvioista. Vanhemmat arvioivat lasten tunne-elämän ja käyttäytymisen vaikeuksia, ja

varhaiskasvatuksen opettajat arvioivat lasten arjen toiminnanohjausta. Ensimmäisen osatutkimuksen normatiivinen aineisto (*N*=667) kerättiin Lahden päiväkodeista. Normatiivinen aineisto koostuu varhaiskasvatuksen opettajien arvioista koskien lasten arjen toiminnanohjausta. Toisessa ja kolmannessa osatutkimuksessa hyödynnettiin Niilo Mäki Instituutissa vuonna 2017-2019 järjestetyssä Leikitään ja keskitytään -hankkeessa kerättyä aineistoa (*N*=95). Tutkimukseen rekrytoitiin eri kanavien (esim. varhaiskasvatuksen välityksellä, median kautta) kautta perheitä, joissa vanhemmilla on huolta heidän 4-5-vuotiaan lapsensa tarkkaamattomuudesta ja/tai ylivilkkaudesta ja impulsiivisuudesta. Aineisto koostuu vanhempien ja varhaiskasvattajien arvioista koskien lasten käyttäytymisen ongelmia, arjen toiminnanohjausta ja arjen toimintakykyä.

Ensimmäisessä osatutkimuksessa tutkittiin arjen toiminnanohjauksen vaikeuksien ilmenemistä psyykkisesti oireilevilla lapsilla sekä vaikeuksien yhteyttä psyykkisen oireilun eri muotoihin. Psyykkisten oireiden ja toiminnanohjauksen vaikeuksien yhteyksiä tutkittiin ensin muuttujakeskeisestä lähestymistavasta käsin, mikä piti sisällään eri oireryhmien (sisäänpäin kääntyvästi oireilevat, ulospäin kääntyvästi oireilevat, sisään- ja ulospäin kääntyvästi oireilevat, ja lievästi oireilevat) ja tyypillisesti kehittyvien lasten väliset keskiarvovertailut toiminnanohjauksen eri osa-alueiden suhteen. Nämä tarkastelut osoittivat, että keskimäärin kaikilla oireryhmillä oli tyypillisesti kehittyviä lapsia enemmän toiminnanohjauksen vaikeuksia. Ulospäin suuntautuvasti oireilevien ryhmässä korostuivat toisia oireryhmiä enemmän motoriseen hyperaktiivisuuteen ja impulsiivisuuteen liittyvät vaikeudet. Muuttujakeskeistä lähestymistapaa täydennettiin henkilökeskeisellä lähestymistavalla, jossa ensin pyrittiin tunnistamaan psyykkisesti oireilevien lasten joukosta erilaisia yksilölliseen vaihteluun perustuvia toiminnanohjauksen profiileja. Kaikkiaan toiminnanohjauksen profiileja tunnistettiin kliinisestä aineistosta viisi: 1) keskimääräinen suoriutuminen, 2) keskimääräistä hieman heikompi suoriutuminen, jossa toiminnan aloittamisen vaikeudet lievästi korostuvat, 3) korostuneet tarkkaavuuden vaikeudet, 4) korostuneet inhibition vaikeudet ja 5) laajat vaikeudet kaikilla osa-alueilla. Jatkotarkastelut osoittivat, että keskimääräisen suoriutumisen profiilissa korostuivat lievät oireet, tyttöjen suuri osuus sekä äidin korkea koulutus; keskimääräistä hieman heikommin suoriutuvien profiilissa korostui sisäänpäin suuntautuvat oireet, tyttöjen suuri osuus sekä äidin korkea koulutus; ja inhibitiovaikeuksien profiilissa korostui ulospäin suuntautuvat oireet, poikien suuri osuus ja äidin matala koulutus. Henkilökeskeinen lähestymistapa rikastutti kuvaa osoittamalla, että oireryhmät olivat painotuksista huolimatta keskenään varsin heterogeenisia toiminnanohjauksen profiilien suhteen. Lisäksi profiileissa ilmeni vaihtelua myös sellaisilla toiminnanohjauksen osa-alueilla, joissa keskiarvovertailut eivät tunnistaneet oirekohtaisia eroavaisuuksia, kuten tarkkaavuuden kohdistamisessa, ylläpitämisessä ja siirtämisessä sekä toiminnan suunnittelussa ja aloittamisessa.

Toisessa osatutkimuksessa selvitettiin ENGAGE-intervention vaikuttavuutta lasten toiminnanohjaukseen liittyviin käyttäytymisen ongelmiin sekä vaikutusten pysyvyyttä. Tulokset osoittivat, että ENGAGE-intervention myötä lasten tarkkaamattomuuteen, ylivilkkauteen ja impulsiivisuuteen sekä

aggressiiviseen ja uhmakkaaseen käyttäytymiseen liittyvät haasteet vähenivät vanhempien arvioon perustuen merkitsevästi enemmän kuin kontrolliryhmässä. Vanhempien arvioon perustuen lapsilla oli intervention myötä myös arjen eri tilanteissa (esim. syödessä, kyläillessä, itsekseen leikkiessä) merkitsevästi vähemmän keskittymisen haasteita. Efektikoot olivat kohtalaisia. Vaikutukset myös säilyivät 3 kuukautta intervention päättymisen jälkeen toteutettuun seurantamittaukseen saakka. Varhaiskasvatuksen arvioissa interventiolla ei havaittu vaikuttavuutta.

Kolmannessa osatutkimuksessa selvitettiin ENGAGE-intervention vaikuttavuutta vanhempien itse arvioimaan vanhemmuuden stressiin. Lisäksi selvitettiin, välittääkö lasten käyttäytymiseen liittyvien ongelmien väheneminen tätä vaikutusta. Vanhemmuuden stressin osalta eroteltiin kokonaisstressi sekä vanhemmasta, lapsesta, ja heidän välisestä vuorovaikutuksestaan kumpuava stressi. Lapsen käyttäytymisen osalta arvioitiin tarkkaamattomuuteen, ylivilkkauteen ja impulsiivisuuteen sekä aggressiiviseen ja uhmakkaaseen käyttäytymiseen liittyviä välittäviä vaikutuksia. Kokonaisvaikutuksia interventiosta vanhemmuuden stressiin ei havaittu millään vanhemmuuden stressin osa-alueilla. Mediaatioanalyysit kuitenkin osoittivat, että lasten aggressiivisen ja uhmakkaan käyttäytymisen väheneminen välitti malleissa täysin intervention vaikutusta vanhemmuuden stressiin niin lapsesta kuin vanhemman ja lapsen välisestä vuorovaikutuksesta kumpuavan stressin sekä kokonaisstressin osalta.

Tulosten perusteella voidaan todeta, että psyykkisesti oireilevien pienten lasten keskuudesta on löydettävissä tiettyjä arjen toiminnanohjauksen profiileja, joista osa myös yhdistyy mielekkäästi psyykkiseen oireilun tyyppiin sekä taustatekijöihin. Riskitekijöitä kasautuu tulosten mukaan eniten lapsille, joiden toiminnanohjauksen profiilissa korostuvat inhibitioon liittyvät vaikeudet. Profiilien kautta myös ilmeni huomattavaa toiminnanohjauksen taitoihin liittyvää yksilöllistä vaihtelua samalla tavoin oireilevien kesken sekä sellaisilla toiminnanohjauksen alueilla, joilla oireryhmiin liittyviä eroja ei löytynyt, esimerkiksi toiminnan suunnittelussa ja aloittamisessa. Tämä kertoo siitä, että lapsen psyykkisen oireilun luonne tai määrä (sisäänpäin kääntynyttä tai ulospäin kääntynyttä; lievää tai korkeaa) on yksilötasolla heikko indikaattori lapsen toiminnanohjauksen taidoista. Tämä korostaa tarvetta psyykkisesti oireilevien lasten arjen toiminnanohjauksen vaikeuksien seulomiseen lapsen oireista riippumatta. Mikäli viitteitä vaikeuksista ilmenee, on eri toiminnanohjauksen osa-alueiden kattava arvioiminen tärkeää, jotta saadaan ilmi sekä lapsen heikkoudet että vahvuudet liittyen toiminnanohjaukseen ja tietoa voidaan hyödyntää tukitoimia suunnitellessa. Väitöstutkimuksen tulokset myös tukevat ENGAGE-intervention kelpoisuutta terveydenhuollossa interventiona, jonka avulla voidaan tukea lapsiperheitä, joissa vanhemmilla on huolta 4-5-vuotiaan lapsensa käyttäytymisen haasteista, ensisijaisesti liittyen tarkkaamattomuuteen sekä ylivilkkauteen ja impulsiivisuuteen. ENGAGE voi soveltua erityisen hyvin matalan kynnyksen interventioksi, jota tarjotaan varhain vanhempien huolen herättyä. ENGAGE voi tukea myös koko perhettä laajemmin, kun lapsen aggressiivinen ja uhmakas käyttäytyminen otetaan huomioon ja sen vähentämisessä onnistutaan. Tämä edesauttaa siinä, että

vanhemmat alkavat nähdä lapsensa myönteisemmässä valossa ja kokevat vuorovaikutuksen lapsen kanssa palkitsevampana. Tulokset vahvistavat ajatusta siitä, että lapsen tunteiden säätelyn tukemisella on erityisen tärkeä merkitys EN-GAGE-interventiossa koko perheen kannalta.

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ORIGINAL PAPERS

I

HETEROGENEITY OF EXECUTIVE FUNCTIONS AMONG PRESCHOOL CHILDREN WITH PSYCHIATRIC SYMPTOMS

by

Sini Teivaanmäki, Hanna Huhdanpää, Noona Kiuru, Eeva Aronen, Vesa Närhi & Liisa Klenberg, 2020

ORIGINAL CONTRIBUTION

Heterogeneity of executive functions among preschool children with psychiatric symptoms

Sini Teivaanmäki[1,2] · Hanna Huhdanpää[3,4] · Noona Kiuru[1] · Eeva T. Aronen[3,4] · Vesa Närhi[5] ·
Liisa Klenberg[6]

Abstract

The aim of the present study was to investigate associations between internalizing and externalizing symptoms and deficits in executive functions (EF) as well as to examine the overall heterogeneity of EFs in a sample of preschool children attending a psychiatric clinic ($n = 171$). First, based on cut-off points signifying clinical levels of impairment on the parent-completed Child Behavior Checklist (CBCL), children were assigned into groups of internalizing, externalizing, combined or mild symptoms and compared to a reference group ($n = 667$) with regard to day care teacher ratings of EFs on the Attention and Executive Function Rating Inventory-Preschool (ATTEX-P). Second, latent profile analysis (LPA) was employed to identify distinct subgroups of children representing different EF profiles with unique strengths and weaknesses in EFs. The first set of analyses indicated that all symptom groups had more difficulties in EFs than the reference group did, and the internalizing group had less inhibition-related problems than the other symptom groups did. Using LPA, five EF profiles were identified: average, weak average, attentional problems, inhibitory problems, and overall problems. The EF profiles were significantly associated with gender, maternal education level, and psychiatric symptom type. Overall, the findings suggest that the comparison of means of internalizing and externalizing groups mainly captures the fairly obvious differences in inhibition-related domains among young psychiatric outpatient children, whereas the person-oriented approach, based on individual differences, identifies heterogeneity related to attentional functions, planning, and initiating one's action. The variability in EF difficulties suggests that a comprehensive evaluation of a child's EF profile is important regardless of the type of psychiatric symptoms the child presents with.

Keywords Executive functions · Preschool · Internalizing symptoms · Externalizing symptoms · Psychopathology

Introduction

According to a contemporary definition, EFs include basic functions related to inhibition of responses and distracting stimuli, working memory, and flexible shifting of attention

or response-set [1, 2] as well as more complex processes such as planning and use of strategies [3, 4]. EF difficulties are often present in children with different kinds of psychiatric problems [5–8]. Already in the preschool period, EF difficulties are common among young children referred to psychiatric care [9]. Previous studies examining the link between EFs and psychiatric symptoms have provided inconsistent findings and the majority of studies have focused on older children. In addition, only a few studies have examined

✉ Sini Teivaanmäki
sini.teivaanmaki@nmi.fi

1 Department of Psychology, University of Jyväskylä, P.O. Box 35, 40014, Jyvaskyla, Finland

2 Niilo Mäki Institute, P.O. Box 35, 40014 Jyvaskyla, Finland

3 Laboratory of Developmental Psychopathology, Pediatric Research Center, Child Psychiatry, Biomedicum Helsinki, P.O. Box 63, 00014 Helsinki, Finland

4 University of Helsinki and Helsinki University Hospital, Children's Hospital, Child Psychiatry, Puistosairaala, P.O. Box 281, 00029 Helsinki, Finland

5 Department of Education, University of Jyväskylä, P.O. Box 35, 40014 Jyvaskyla, Finland

6 Department of Psychology and Logopedics, University of Helsinki, P.O. Box 21, 00014 Helsinki, Finland

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the heterogeneity of EFs in mixed clinical groups on the level of individual variation instead of averaging across diagnostic/symptom groups.

EFs are known to follow a protracted course of development that parallels the relatively slow maturation of the prefrontal cortex [10], an essential part of the neuronal circuitry responsible for EFs. The basic forms of EF, particularly inhibition and working memory, start to develop in infancy [11]. Especially, the preschool period (roughly the ages of 3–6 years) is characterized by rapid development of EFs [11, 12]. During this time, gender differences are often evident, as girls tend to be ahead of boys in the development of EFs [13, 14]. Environmental factors also contribute to the development of EFs: especially, higher parental education and socioeconomic status have been associated with better EFs [14–16]. EFs are crucial for adjustment across all aspects of life. For children, EFs are important for school success [17, 18] and socioemotional competence [19]. They are also predictive of many outcomes, such as health and personal finances, later in life [20].

EF difficulties can be assessed with performance-based tests and behavioral rating scales. Performance-based tasks are administered under highly standardized conditions and yield information about the cognitive capacities related to EFs, while behavioral measures are based on observations of the child's EF behaviors in daily situations. Although the typically used performance-based measures may give a detailed account of the child's EF capacities, they do not correspond to the multifaceted and dynamic nature of real-world situations [21]. Thus, in addition to performance-based measures, rating scales should be used to provide clinical indicators of the child's functional ability related to EF competence and difficulties.

Typically, the relations between EF difficulties and psychiatric symptoms have been examined on the level of different diagnostic or externalizing/internalizing symptom groups. Externalizing symptoms refer to problems directed primarily outwards and involving conflict with others, such as aggression, conduct problems, and hyperactivity [22]. Most studies examining EF deficits related to externalizing symptoms in school-aged children have used performance-based measures. In these studies, deficits in inhibition, working memory and set shifting have consistently been found [23–26]. Parent and teacher ratings of EFs in school-aged children with externalizing symptoms have generally revealed wide-ranging difficulties, with an emphasis on difficulties in inhibition and working memory [15, 27, 28]. Accordingly, preschool children with externalizing symptoms have been found to have inhibitory deficits and, although somewhat less consistently, deficits in working memory and set shifting when examined using performance-based measures [7, 29]. Parent [30, 31] and teacher ratings [32, 33] of EFs have revealed broad difficulties in the everyday environment for these young children.

Internalizing symptoms refer to inward-directed problems, such as anxiety, depression, withdrawal, and somatic complaints [22]. A limited amount of studies has examined EFs in children with internalizing symptoms/disorders. In a meta-analysis concerning depressed children and adolescents, impairments in interference control, planning, working memory, shifting, and phonemic and semantic verbal fluency were found [8]. Recent empirical evidence indicates that a deficit in cognitive flexibility, referring to the ability to shift attention and response-set, may specifically relate to internalizing symptoms [34]. However, many studies have not found EF deficits in depressed children and adolescents [35], and the extent to which the variability reflects methodological differences in sample selection, inclusion criteria, and EF tasks is unclear.

The relations between EFs and internalizing symptoms among preschool children are even less studied. Skogan et al. [36] found broad EF difficulties in 3-year-old children with an internalizing disorder (anxiety) when using the Behavior Rating Inventory of Executive Function–Preschool Version (BRIEF-P) to assess EFs. Eisenberg et al. [32] utilized both performance-based and rating scale measures with multiple informants in examining executive control in 4–8-year-old children. They reported that the children high in internalizing symptoms were rated as less impulsive and lower in attentional control than the control children, but similar with regard to inhibitory control. Finally, some recent longitudinal studies have found that preschool EF difficulties, especially in inhibition and flexibility, are related to internalizing symptoms in the elementary school years [37, 38].

The conflicting evidence on EF dysfunction in children with internalizing and externalizing symptoms points towards the heterogeneity of EF abilities within these clinical groups and even within single disorders. Person-oriented methods, such as cluster analysis or latent profile/class analysis, provide a useful approach in such instances by allowing the empirical identification of distinct subgroups based on different indicators, such as EF abilities. In contrast to the variable-oriented approach, the focus is on the individual instead of the group and on the configuration of information instead of the single variable representing a given construct [39]. The theoretical roots of the person-oriented approach can be found in the holistic–interactionist paradigm formulated by Bergman and Magnuson [40], which highlights the importance of studying individuals as organized wholes based on their unique patterns of characteristics. The basic tenet is that, despite the structure and dynamics of behavior being partly unique to individuals, there is still lawfulness to development, and often only a rather small number of typical patterns is enough to describe it adequately [40]. From a methodological perspective, the person-oriented approach may allow avoiding the pitfalls of data aggregation that often do not do justice to the individual nor to the possible subpopulations within the sample [41].

Only a few studies have taken a person-oriented route and addressed the heterogeneity of EFs by identifying subgroups within samples of children with psychiatric symptoms. Kavanaugh et al. [42] examined the presence of neurocognitive subgroups within a sample of child psychiatric inpatients using cluster analysis. Their study included measures of EFs as well as other cognitive functioning. Four subgroups—intact, global dysfunction, organization/planning dysfunction, and inhibition-memory dysfunction—were found. Using BRIEF scales and the Statue subtest from NEPSY as EF indicators, Dajani et al. [43] identified average, above average and impaired subgroups of EFs in a sample consisting of typically developing children and children with neurodevelopmental disorders. They concluded that the nature of EFs is dimensional in children, because no differences in strengths and weaknesses between the subgroups were found. Therefore, it remains uncertain whether subgroups displaying not only quantitative, but also qualitative differences in EFs can be found in clinical groups of children via person-oriented methods.

The aim of the present study was to investigate inter child variability in EF difficulties among clinically referred children. This was done in two stages. First, we followed a traditional group comparison approach by examining the EF difficulties of children classified into groups according to their level of internalizing and externalizing symptoms. We predicted that the groups with mainly externalizing and both externalizing and internalizing symptoms would have elevated scores (indicating more problems) in all EF domains in comparison with controls. Due to some previous studies suggesting that particularly flexibility difficulties may be closely related to internalizing symptoms, we expected that the internalizing group would have more problems than the reference group in, at the least, shifting attention. The externalizing group was expected to have more difficulties than the internalizing group in, at the least, impulsivity and motor hyperactivity. The aim of the second stage was to derive subgroups of children with distinct EF profiles based on individual-level variation in EFs. Because no previous study that we are aware of has investigated EF profiles in a mixed clinical sample of preschool children, we took an exploratory approach without specific hypotheses about the outcome. Finally, subgroup differences in age, gender, maternal education level, and internalizing/externalizing symptoms were investigated.

Methods

Participants

The clinical group consisted of children recruited from two psychiatric outpatient clinics evaluating and treating preschool children at Helsinki University Hospital, Child Psychiatry Unit. The data were collected between March 2015 and May 2017. Inclusion criteria were (a) child's age between 4 and 7 years, (b) Finnish-speaking parents, and (c) child attending day care. Overall, 315 patients visited the two clinics during data collection, and 252 of them met the inclusion criteria and received the Attention and Executive Function Rating Inventory-Preschool (ATTEX-P) and CBCL questionnaires. Of them, 171 (67.8%) families returned both the study questionnaires. Due to lacking information about the non-participants, we were unable to perform a direct comparison between the participants and non-participants. However, the characteristics of the present sample were in line with the previous reports indicating high rates of comorbidity, a higher prevalence of boys than girls, and an overrepresentation of low maternal education among pre-school children referred to psychiatric care [44, 45]. The present sample was heterogeneous in terms of diagnoses: 39 (22.8%) children were diagnosed with ADHD, 29 (17.0%) children were diagnosed with either conduct disorder or oppositional defiant disorder, and diagnoses for other neurodevelopmental disorders, such as autism spectrum, learning, speech, and motor system disorders were also frequent ($n = 34$, 19.9%) [9]. 34 (19.9%) children had at least one Z-diagnosis describing psychosocial stress. In addition, 69 (40.4%) children had an unspecified neurodevelopmental diagnosis (F88 or F89), reflecting the fact that the psychiatric evaluation was not yet completed.

The reference group consisted of children who took part in the ATTEX-P [46] standardization study between August 2014 and May 2015. The data were collected from 28 day care units in a medium-sized city in the southern part of Finland. Inclusion criteria were (a) age between 4 and 7 years and (b) Finnish-speaking parents. Families delivered the ATTEX-P questionnaires to the day care units, and the questionnaires of 709 children were returned. The reference group was well representative of the Finnish population in terms of children's gender and mothers' educational-level distributions [47, 48].

Of the 880 participants, 8.3% had one or more missing observations on the ATTEX-P. In the clinical sample, a maximum of one value per participant was missing on any given scale, and all of the missing values were imputed by calculating the participant's mean value for the scale items. The missing values for maternal education level ($n = 3$) in the clinical sample were replaced with the mode value of maternal education level within the participant's respective symptom group. In the reference sample, participants with any missing values on the ATTEX-P ($n = 24$) or maternal education level ($n = 19$) were omitted from the analyses. These procedures resulted in a final sample of 838 participants, 667 in the reference group and 171 in the clinical group.

Measures

Executive functions

The ATTEX-P [46] is a 44-item rating scale designed for assessing EF behavior of children aged 4–7 years in a day care environment. ATTEX-P is an adaptation of the ATTEX rating scale for school-age children [15] and covers a wide range of behaviors reflecting both basic and complex EF processes. The day care teacher rates the frequency of EF difficulties on a three-point scale (0 = not a problem, 1 = sometimes a problem, and 2 = often a problem). The questionnaire yields a total score as well as scores for nine clinical subscales: (1) distractibility (5 items), (2) impulsivity (10 items), (3) motor hyperactivity (5 items), (4) directing attention (5 items), (5) sustaining attention (4 items), (6) shifting attention (4 items), (7) initiative (3 items), (8) planning (3 items), and execution of action (5 items). Higher scores on the scales indicate more problems. The total score and the subscales have demonstrated good internal consistency (ranging from 0.73 to 0.94), test–retest reliability (ranging from 0.81 to 0.94), and convergent validity (correlations with EF items in a school readiness questionnaire ranging from 0.49 to 0.75) [46]. Total or scale scores at or above the 90th percentile are considered to indicate clinically relevant deficits in EF behavior.

Emotional and behavioral problems

Parent ratings of the child's emotional and behavioral problems on the Child Behavior Checklist/1.5–5 (CBCL) [22] were used for grouping participants into subgroups according to externalizing and internalizing symptoms. CBCL is a parent-report form of a widely used questionnaire measuring children's behavioral and emotional problems. The form contains 99 problem items rated on a three-point scale (0 = not true, 1 = somewhat or sometimes true, 2 = very true or often true). The questionnaire has demonstrated good reliability and validity [22] as well as generalizability across 23 societies [49]. The broadband internalizing problem scale consists of the following four symptom scales: emotionally reactive; anxious/depressed; somatic complaints; and withdrawn. The broadband externalizing scale contains the remaining symptoms scales: attention problems and aggressive behavior.

Background information

Information on age, gender, and maternal education level was collected from parents via a short questionnaire.

Data analyses

Symptom group comparisons

For the symptom group comparisons, subgroups of children from the clinical sample were formed based on parent reports on the CBCL internalizing problems and externalizing problems scales. First, T scores of the raw scale scores were computed using ADM (9.1) scoring software. Children whose score reached the clinically significant problem level (T score > 63) on the Internalizing Problems or Externalizing Problems scale, but not on both scales, were included in the groups of children showing either internalizing symptoms (INT) or externalizing symptoms (EXT). Children with T scores greater than 63 on both scales were included in the combined group (COMB), and children with T scores below 63 on both scales were included in a group showing mild symptoms (MILD) (Table 1).

Using SPSS 24, the symptom groups were compared to the reference group in EF variables. Overall group differences on the ATTEX-P total score were analyzed with ANCOVA, and differences in the scale scores were examined with MANCOVA, followed by separate ANCOVAs for the scale scores and pairwise comparisons for group contrasts. A Bonferroni-corrected significance level $p < 0.005$ was applied in the pairwise comparisons to

Table 1 Descriptive variables concerning the symptom groups and the reference group

	INT	EXT	COMB	MILD	REF
Sample size, n	24	21	60	66	667
Age in years, M (SD)	5.7 (0.6)	5.8 (0.6)	5.6 (0.7)	5.8 (0.8)	6.0 (0.7)
Gender					
Male (%)	14 (58.3)	17 (81.0)	48 (80.0)	43 (65.2)	341 (51.1)
Female (%)	10 (41.7)	4 (19.0)	12 (20.0)	23 (34.8)	326 (48.9)
Mother's education					
Low (%)	7 (29.2)	13 (61.9)	34 (56.7)	38 (57.6)	273 (40.9)
High (%)	17 (70.8)	8 (38.1)	26 (43.3)	28 (42.5)	394 (59.1)

INT children with internalizing symptoms, *EXT* children with externalizing symptoms, *COMB* children with combined symptoms, *MILD* children with mild symptoms, *REF* reference children

account for the 10 comparisons. Variables representing age, gender, and maternal education level were included as covariates in all analyses. The effect sizes are reported as partial eta squared (η_p^2; small < 0.06, medium 0.06–0.13, large ≥ 0.14) for the MANOVA and ANOVA analyses and as Cohen's d (small < 0.50, medium < 0.80, large ≥ 0.80) for the pairwise comparisons [50].

Latent profile analysis (LPA)

Raw ATTEX-P scale scores were standardized according to the reference group to make the scales comparable to each other as well as to the level of typical development. Then, using Mplus 8.1 [51], models with different numbers of latent groups were fitted using the maximum likelihood method with robust standard errors as the estimation method. Only means were allowed to vary between groups. Different statistical criteria were considered when choosing the best-fitting model: Akaike's information criteria (AIC) and Bayesian information criteria (BIC) are model evaluation criteria that take into account model fit and parsimony. The model with the lowest value is preferred. Vuong–Lo–Mendell–Rubin likelihood ratio (VLMR), Lo–Mendell–Rubin adjusted likelihood ratio (LMR), and bootstrap likelihood ratio test (BLRT) assess relative model fit by comparing a model with k groups to one with $k-1$ groups, with a p value < 0.05 suggesting significant improvement in model fit. In addition, entropy, subgroup sample sizes, and overall model interpretability were evaluated when choosing the best model. Entropy is a standardized measure of the certainty of assigning participants into groups based on their model-derived posterior probabilities. The value of entropy ranges between 0 and 1, with higher values indicating clearer group delineation [52]. To ensure that the best log-likelihood value of each model did not reflect a local solution, 500 starting values were used, and the replication of the best log-likelihood was checked for each model. When interpreting the profiles, mean scores at or above the 90th percentile were considered to imply clinically significant impairment on a given scale, in accordance with the norms of ATTEX-P [46].

In the second phase, participants were assigned to groups based on their most likely profile membership. The relationship between group membership and background variables, including gender, age, and maternal education level, was examined via cross tabulation and x^2 tests. If the expected cell counts were less than 5 in 20% or more of the cells, exact tests were used. In addition, cross tabulation of the symptom groups with the person-oriented EF subgroups was performed to examine whether internalizing, externalizing, combined or mild symptoms were over- or underrepresented in the EF subgroups.

Results

Background characteristics of the symptom and reference groups

The means and standard deviations of the groups in demographic variables are displayed in Table 1. The groups differed significantly in gender ratio, $X^2(4) = 27.78$, $p < 0.001$, with the COMB group including more boys than the reference group, $X^2(1) = 18.45$, $p < 0.001$. The groups also differed in terms of age, $F(4, 833) = 6.25$, $p < 0.001$, $\eta_p^2 = 0.03$, with the COMB group including younger children than the reference group ($p = 0.001$). Although the groups also differed in maternal education level, $X^2(4) = 16.24$, $p = 0.003$, significant differences in column proportions between specific symptom groups were not found after adjusting for 10 group comparisons.

EF difficulties in the symptom and reference groups

Variables representing child's age, gender, and maternal education level were included as covariates in all group comparisons. The groups differed from one another in the total EF score, $F(4, 830) = 66.84$, $p < 0.001$, $\eta_p^2 = 0.24$. Pairwise comparisons revealed that all symptom groups had a higher total score than the reference group, with all p values < 0.001 and d ranging between 0.91 and 1.66. No significant differences between the symptom groups in the total EF score were found; however, the effect size for the difference between the INT and the EXT groups was close to large ($d = 0.75$), indicating more EF problems overall in the EXT group ($M = 46.19$, SD $= 12.86$) than in the INT group ($M = 29.38$, SD $= 20.92$). The groups differed from one another also in the scale scores, Wilks's lambda $= 0.71$, $F(36, 3082) = 8.38$, $p < 0.001$, $\eta_p^2 = 0.08$. ANCOVAs showed differences for each scale (Table 2). Pairwise comparisons revealed that all of the symptom groups had higher scores than the reference group on eight of the nine scales (p values ranging between < 0.001 and 0.039, d ranging between 0.66 and 1.68). On the motor hyperactivity scale, the difference between the REF and INT groups was not significant ($p = 0.066$, $d = 0.56$). The symptom groups differed from one another on impulsivity, with the INT group having a lower score than the EXT ($p = 0.009$, $d = 1.00$), COMB ($p = 0.035$, $d = 0.70$), and MILD ($p = 0.030$, $d = 0.71$) groups. On motor hyperactivity, the INT group had a lower score than the EXT ($p = 0.003$, $d = 1.09$) and COMB ($p = 0.036$, $d = 0.70$) groups. Of the insignificant differences between the INT and the EXT groups, the effect sizes for distractibility ($d = 0.79$), execution of action ($d = 0.75$), and sustaining attention ($d = 0.69$) were substantial, indicating more EF problems in

Table 2 Means (standard deviations), estimated marginal means (standard errors) and ANCOVA results for the symptom groups and the reference group on the ATTEX-P scales

EF scale	INT ($n=24$)		EXT ($n=21$)		COMB ($n=6$)		MILD ($n=66$)		REF ($n=667$)		$F(4, 830)$	p^{a}	η_{p}^{2}
	M (SD)	EMM (SE)	M (SD)	EMM (SE)	M (SD)	EMM (SE)	M (SD)	EMM (SE)	M (SD)	EMM (SE)			
Distractibility	4.32 (2.87)	4.30 (0.51)	6.86 (2.13)	6.28 (0.55)	6.03 (2.51)	5.46 (0.33)	5.49 (3.18)	5.19 (0.31)	1.92 (2.60)	2.02 (0.10)	56.00	<0.001	0.21
Impulsivity	6.53 (6.14)	6.54 (0.98)	12.24 (4.31)	11.33 (1.05)	10.80 (6.04)	9.93 (0.63)	10.40 (6.73)	9.94 (0.59)	3.17 (4.63)	3.32 (0.19)	58.44	<0.001	0.22
Motor hyperactivity	2.67 (2.87)	2.66 (0.49)	5.71 (2.33)	5.27 (0.52)	4.78 (3.21)	4.35 (0.31)	4.30 (3.62)	4.07 (0.30)	1.23 (2.23)	1.31 (0.09)	47.67	<0.001	0.19
Directing attention	3.42 (2.70)	3.42 (0.46)	4.10 (2.49)	3.71 (0.50)	3.85 (2.54)	3.46 (0.30)	3.98 (2.83)	3.76 (0.28)	1.56 (2.24)	1.63 (0.09)	24.43	<0.001	0.10
Sustaining attention	2.54 (2.25)	2.56 (0.40)	4.10 (2.49)	3.90 (0.42)	4.08 (2.44)	3.71 (0.25)	3.65 (2.76)	3.45 (0.24)	1.04 (1.88)	1.10 (0.08)	49.43	<0.001	0.19
Shifting attention	2.86 (2.40)	2.85 (0.41)	3.71 (2.12)	3.38 (0.44)	4.07 (2.46)	3.73 (0.26)	3.76 (2.71)	3.57 (0.25)	1.22 (1.93)	1.28 (0.08)	40.14	<0.001	0.16
Initiative	2.13 (1.90)	2.10 (0.32)	2.19 (1.57)	1.99 (0.34)	2.91 (1.99)	2.69 (0.20)	2.47 (2.08)	2.34 (0.19)	0.95 (1.47)	0.99 (0.06)	27.05	<0.001	0.12
Planning	1.88 (1.80)	1.90 (0.28)	2.29 (1.85)	2.02 (0.30)	2.65 (1.96)	2.40 (0.18)	2.54 (1.83)	2.39 (0.17)	0.69 (1.30)	0.74 (0.05)	40.43	<0.001	0.16
Execution of action	3.04 (2.54)	3.03 (0.39)	4.81 (1.66)	4.45 (0.42)	4.30 (2.59)	3.94 (0.25)	4.09 (2.72)	3.89 (0.24)	1.20 (1.80)	1.26 (0.07)	60.58	<0.001	0.23
Total score	29.38 (20.92)	29.35 (3.51)	46.19 (12.86)	42.33 (3.76)	43.47 (20.05)	39.68 (2.25)	40.69 (23.90)	38.59 (2.12)	12.98 (17.18)	13.65 (0.67)	66.84	<0.001	0.24

Child's age, gender and maternal education level were included as covariates in all analyses

INT children with internalizing symptoms, *EXT* children with externalizing symptoms, *COMB* children with combined symptoms, *MILD* children with mild symptoms, *REF* reference children

Higher scores on the scales indicate more problems

[a]Significant results of the pairwise comparisons for total score, distractibility, impulsivity, directing attention, sustaining attention, shifting attention, initiative, planning and execution of action: REF<EXT, COMB, MILD, INT; for motor hyperactivity: REF<EXT, COMB, MILD. The symptom groups differed from one another on impulsivity (INT<EXT, COMB, MILD) and on motor hyperactivity (INT<EXT, COMB)

the EXT than in the INT group in these domains. On the remaining scales (directing attention, shifting attention, initiation, and planning), the effect sizes for the insignificant differences between the INT and the EXT groups were small, with d ranging between 0.07 and 0.26.

EF difficulties in the person-oriented subgroups

A summary of LPA model fit indices is presented in Table S1 in Supplementary Materials. The BIC reached its lowest value in a five-group model, indicating an optimal solution. The AIC suggested six or more groups to be the preferred solution. Out of the comparative model fit indices, the BLRT suggested each consecutive model above a one-group model to provide a significant improvement in fit. The LMR and the VLMR indicated that four would be the maximum number of groups to consider. Thus, the statistical criteria gave support for models with four, five, and six groups. We rejected the six-group solution, because the sample size was too small in one subgroup ($n = 9$) and due to problems with interpretation. Both the four- and five-group solutions had adequate sample sizes in each subgroup as well as high entropy (0.93 and 0.92, respectively). We decided to prioritize the BIC, because it has been shown to perform better in the case of a small overall sample size and continuous indicator variables [53]. In addition, further analyses relating psychiatric symptoms to group membership provided support for the external validity of both the

groups that were merged into one in the four-group model. Therefore, we chose the five-group model.

EF profiles of the five obtained subgroups groups are shown in Fig. 1. The first group ($n = 29$, 17%), named average, had average EF abilities across all domains. On no indicator did this group perform worse than the reference group, and in directing attention, their performance was nearly half a standard deviation below the reference group (i.e., their performance was better). The second group ($n = 37$, 22%) had slightly below average abilities on all EF indicators and was named weak average. Despite a mild elevation on the Initiation scale (0.97 standard deviations above the typical level), they did not have clinically relevant impairment in any EF domain. The third group ($n = 25$, 15%) had clinically relevant deficits in all EF domains except in motor hyperactivity. Due to not having high motor hyperactivity but showing severe deficits in attention-related domains, especially in shifting attention, this group was named attentional problems. The fourth group ($n = 42$, 25%) exhibited a profile that was somewhat of a mirror image to the third group. These children had particularly high motor hyperactivity, but showed no clinically significant deficits in directing or shifting attention nor in initiating behavior and was named inhibitory problems. The fifth group ($n = 38$, 22%) had clinically relevant and severe deficits across all EF domains and was thus named overall problems.
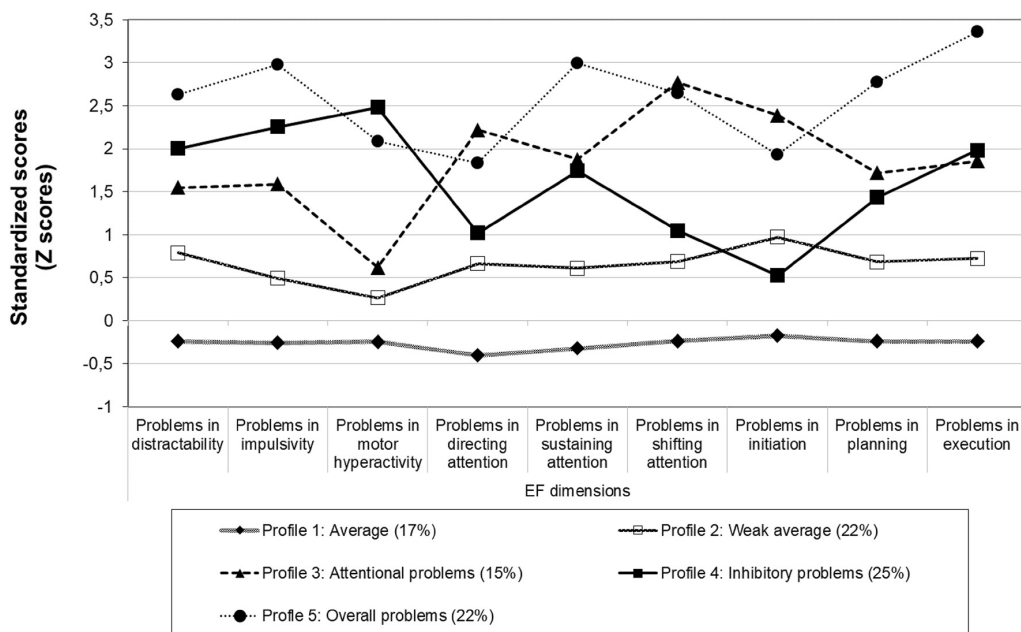
Fig. 1 EF profiles of the five subgroups identified via latent profile analysis. Higher scores on the scales indicate more problems

Significant mean differences between the groups on the EF scale scores were found, Wilks's lambda $= 0.03$, $F(36, 593) = 27.48$, $p = < 0.001$, $\eta_p^2 = 0.60$. As presented in Table S2 in the Supplementary Materials, the groups differed significantly from one another on all scales.

Background characteristics and psychiatric symptoms in the person-oriented subgroups

The results of the cross tabulation of the EF subgroups and background characteristics are presented in Table 3. The EF subgroups did not differ in terms of age, $F(4, 166) = 0.60$, $p = .595$, $\eta_p^2 = 0.02$. A significant association between group membership and gender was found, $X^2(4) = 31.14$, $p < .001$. The adjusted residuals suggested that there were more boys than expected in the inhibitory problem group (adj. res. $= 3.2$), and more girls than expected in the average (adj. res. $= 4.4$) and weak average (adj. res. $= 2.2$) groups. The groups also differed in terms of maternal education level, $X^2(4) = 15.63$, $p = .004$. Low maternal education was overrepresented in the inhibitory problem group (adj. res. $= 2.6$

as compared to the other groups, and high maternal education was overrepresented in the average and weak average groups (adj. res. $= 2.3$ and 2.2, respectively).

Cross tabulation of the EF and symptom groups was conducted to examine whether clinically significant levels of internalizing, externalizing, combined, or mild symptoms would be over- or underrepresented in certain EF subgroups (Table 3). Differences between the EF subgroups in symptom type were found ($p = 0.005$, Fisher's exact test). Externalizing symptoms were overrepresented in the inhibitory problem group (adj. res. $= 3.7$), and internalizing symptoms were overrepresented in the weak average group (adj. res. $= 2.6$), and mild symptoms were overrepresented in the average group (adj. res. $= 2.0$).

Discussion

The purpose of this study was to investigate EFs among preschoolers with psychiatric symptoms. First, we followed a traditional approach of comparing children classified into

Table 3 Distribution of child and contextual characteristics in the person-oriented EF subgroups

	Average	Weak average	Attentional problems	Inhibitory problems	Overall problems
N	29	37	25	42	38
Age in years[a], M (SD)	5.7 (0.7)	5.7 (0.7)	5.9 (0.6)	5.7 (0.7)	5.7 (0.8)
Gender					
Boys (%)	11 (9.0; 37.9)	21 (17.2; 56.8)	21 (17.2; 84,0)	38 (31.1; 90.5)	31 (25.4; 81.6)
Adj. res.	**− 4.4**	**− 2.2**	1.5	**3.2**	1.6
Girls (%)	16 (36.7; 62.1)	16 (32.7; 43.2)	4 (8.2; 16.0)	4 (8.2; 9.5)	7 (14.3; 18.4)
Adj. res.	**4.4**	**2.2**	− 1.5	**− 3.2**	− 1.6
Maternal education					
Low (%)	10 (10.9; 34.5)	14 (15.2; 37.8)	13 (14.1; 52.0)	30 (32.6; 71.4)	25 (27.2; 65.8)
Adj. res.	**− 2.3**	**− 2.2**	− 0.2	**2.6**	1.7
High (%)	19 (24.1; 65.5)	23 (29.1; 62.2)	12 (15.2; 48.0)	12 (15.2; 28.6)	13 (16.5; 34.2)
Adj. res.	**2.3**	**2.2**	0.2	**− 2.6**	− 1.7
Symptom group					
INT (%)	6 (25.0; 20.7)	10 (41.7; 27.0)	3 (12.5; 12.0)	2 (8.3; 4.8)	3 (12.5; 7.9)
Adj. res.	1.1	**2.6**	− 0.3	**− 2.0**	− 1.2
EXT (%)	0 (0.0; 0.0)	4 (19.0; 10.8)	1 (4.8; 4.0)	12 (57.1; 28.6)	4 (19.0; 10.5)
Adj. res.	**− 2.2**	− 0.3	− 1.4	**3.7**	− 0.4
COMB (%)	7 (11.7; 24.1)	13 (21.7; 35.1)	11 (18.3; 44.0)	15 (25.0; 35.7)	14 (23.3; 36.8)
Adj. res.	− 1.4	0.0	1.0	0.1	0.3
MILD (%)	16 (24.2; 55.2)	10 (15.2; 27.0)	10 (15.2; 40.0)	13 (19.7; 31.0)	17 (25.8; 44.7)
Adj. res.	**2.0**	− 1.6	0.2	− 1.2	0.9

Adjusted residuals (adj. res.) that have an absolute value over 1.96 (bolded in the table) are considered significant

Percentages are expressed as within row; within column

INT children with internalizing symptoms, *EXT* children with externalizing symptoms, *COMB* children with combined symptoms, *MILD* children with mild symptoms, *REF* reference children

[a] Group differences in mean age were non-significant

groups based on their level of internalizing and externalizing symptoms. Groups of children with internalizing, externalizing, combined, or mild symptoms were compared to a reference group and to one another on the ATTEX-P total and scale scores. Second, we further examined the heterogeneity of EFs within the clinical sample using a person-oriented approach of empirically identifying subgroups of children showing distinct EF profiles. Associations between the subgroups and different indicators, including gender, age, maternal education, and psychiatric symptoms, were then examined to understand differences between the subgroups also beyond EFs.

When controlling for gender, age, and maternal education, all of the symptom groups differed from the reference group in nearly all EF domains, suggesting that, overall, young psychiatric outpatients tend to demonstrate poorer EF abilities than their typically developing peers regardless of their type of emotional and behavioral symptoms. The broad EF problems of the preschoolers with mainly externalizing and both externalizing and internalizing symptoms were in accordance with our hypotheses and similar to previous studies using EF rating scales [30, 32, 33, 36]. In addition, in accordance with our hypotheses, the children with internalizing symptoms had more problems in shifting attention than those in the reference group. However, they had more problems than the reference group in nearly all other EF domains as well, indicating that their EF difficulties in the day care environment were widespread. In motor hyperactivity, the difference was not significant, yet the moderate effect size suggests that children with internalizing symptoms may have more problems with hyperactivity than children in general do. The findings concerning children with internalizing symptoms resemble those of Skogan et al. [36], who discovered that anxious preschoolers scored higher than reference children on all scales of the BRIEF-P. In addition, in accordance with our findings, Cataldo et al. [54] found increased levels of behavioral impulsivity in a clinical sample of school-aged depressed children. In contrast to our findings, Eisenberg et al. [32] found, in a normative sample, that children with internalizing symptoms were rated as less impulsive than controls were and concluded that these children seem to exhibit an "overcontrolled" style of regulation. The fact that the children with internalizing symptoms in our clinical sample were rated as more impulsive than the reference children, albeit to a lesser degree than the children with externalizing, combined, or even mild symptoms, could reflect differences in samples (clinical vs. normative). Somewhat different patterns of everyday EFs may be expected for children with internalizing symptoms within clinical and non-clinical settings, particularly in terms of impulsivity, highlighting the need to study the relationship between EFs and internalizing symptoms at different levels of symptom severity and comorbidity.

Differences between the symptom groups emerged in impulsivity and motor hyperactivity. The children with internalizing symptoms showed less problems in these aspects of EFs than other children with psychiatric symptoms, and as expected, the difference was most substantial between the internalizing and externalizing groups. The substantial effect sizes for differences between the internalizing and externalizing groups in distractibility and execution of action may indicate that differences in these EF domains exist as well, with the children high in externalizing symptoms having more problems. In accordance with the findings of Eisenberg et al. [32], the children with both internalizing and externalizing symptoms had similar EF difficulties as the children with mainly externalizing symptoms. Thus, high levels of combined symptoms do not seem to make children more or less prone to EF difficulties than having high externalizing symptoms only.

Apart from the differences in impulsivity and motor hyperactivity, the symptom groups had similar difficulties in most EF domains, suggesting that clinically referred children have more similarities than differences in terms of EF behaviors. However, it could also indicate that the classification of children based on their symptoms did not ideally capture the full heterogeneity of EFs present in the sample. By further investigating the latter option using LPA, five profiles were discerned, with one group of children showing average EF behaviors, one group showing weak average EF behaviors, and three groups showing major EF difficulties with either attentional problems, inhibitory problems, or problems in all aspects of the EFs evident (Fig. 1). The identification of qualitatively different subgroups implies that, in addition to the high overall rates of EF impairment present among young child psychiatric outpatients [9], considerable heterogeneity also exists. Importantly, examining individual-level differences in EFs seemed to provide more fine-grained information than did the comparisons of internalizing/externalizing groups. The person-oriented approach seemed to better display inter child differences in multiple different domains of EFs, such as in attentional functions, initiating action, and planning.

The finding that the subgroups differed not only in the severity, but also in the pattern of difficulties is in contrast with the findings of Dajani et al. [43], who identified only severity differences in the EF profiles of children with neurodevelopmental disorders. Importantly, a portion of the children—those belonging to the average and weak average groups—did not demonstrate clinically relevant impairment in any EF domain. Likewise, Kavanaugh et al. [42] reported that 68% of their sample of child psychiatric inpatients displayed neurocognitive impairment. They concluded that neurocognitive weaknesses are not present in all children with severe psychiatric disorders. Similarly, among preschool-aged psychiatric outpatients, a notable subgroup does not

seem to display clinically significant EF impairment in the day care context.

In addition to not showing clinically significant EF impairment, the children with an average EF profile were characterized by mild psychiatric symptoms (below clinical levels of both internalizing and externalizing symptoms). The reason for the psychiatric referral of these children could be primarily related to other problems than the child's behavior, e.g., crisis in the family or parenting issues. A weak average profile was associated with clinically significant levels of internalizing symptoms (with problems in initiation slightly standing out). A profile marked by inhibitory problems, evident as high levels of impulsivity, distractibility, and hyperactivity, was associated with clinically significant levels of externalizing symptoms, which is in accordance with the previous literature suggesting that children with externalizing symptoms have particular problems with respect to inhibition [31, 33, 36].

Neither high nor low internalizing and/or externalizing symptoms were related to the profiles marked by attentional or overall problems. The children showing these profiles may have psychiatric symptoms that are not well captured by the internalizing/externalizing domains of the CBCL, e.g., attentional symptoms related to the inattentive subtype (ADHD-I) and/or social and communicative symptoms characteristic of autism spectrum problems. Among school-aged children, inattention and autism-related problems have been considered as separate domains of psychopathology alongside with internalizing, externalizing, and non-specific domains [55]. Previous literature suggests that children with ADHD-I tend to have difficulties in many aspects of EFs, but less in response inhibition [56, 57], similar to the pattern of EFs shown by the attentional problem group. This group was also the most impaired in shifting attention, and deficits in set shifting or cognitive flexibility have been associated with autism spectrum problems [58, 59]. In addition, the profile marked by severe overall EF problems may be more related to the severity and chronicity of psychiatric symptoms than to any specific symptom type per se [34]. Similar EF problems have previously been indicated in children with both inattentiveness and hyperactivity [57] as well as autism spectrum problems [60, 61], and in comorbid groups [43].

In addition to psychiatric symptom type, EF subgroup membership was significantly associated with gender and maternal education level. The group with inhibitory problems was characterized by low maternal education and a high prevalence of boys. The groups with average and weak average EF profiles were characterized by a high prevalence of girls and high maternal education. This is in accordance with the previous findings suggesting that, in the preschool period, boys tend to display more EF difficulties than girls do [13, 14]. In addition, the previous studies have linked higher parental education to better EF abilities in children

[14, 15]. Our findings indicate that low maternal education is particularly pronounced in a subgroup of children showing inhibitory problems and not necessarily in the subgroup showing the highest overall levels of EF impairment. Externalizing symptoms were also pronounced in the inhibitory problem group, thus underlining the existence of a subgroup of preschoolers among whom cognitive, socioemotional, and environmental risk factors tend to accumulate.

The relationship between psychopathology and EF difficulties has been studied in methodologically diverse ways, which may explain some of the variability in results and make comparisons between studies difficult. In terms of the present study, it should be kept in mind that rating scales generally show only low-to-moderate correlations with performance-based measures, highlighting the fact that they tap somewhat different underlying constructs [62]. Ideally, future studies should utilize both performance-based measures and rating scales to validate the present findings. In addition, children's emotional and behavioral problems were evaluated by parents and EF behaviors by day care teachers. It is widely known that raters across different situations generally have low agreement [63], as different environments (day care, home) have different expectations and bring out different aspects of the child's behavior. Parents may be at an advantage to evaluate their children's internalizing problems, because these problems may not come out so easily in the day care or school environment [64]. In addition, teacher ratings of children's EFs might tap an aspect of the EF construct that has particular bearings on important school-related outcomes [65]. Overall, the utilization of different informants to report on different aspects of children's behavior can be seen as a strength of the present study, as it eliminates the possibility that the results would be due to same rater bias.

Some other limitations should also be noted. First, some overlap between the rating scale items measuring externalizing symptoms and EFs—mainly impulsivity, motor hyperactivity, and sustaining attention—exist and can artificially magnify the relationship between externalizing symptoms and the mentioned EF behaviors. Although the overlap is small, as the externalizing problems scale of the CBCL is mostly comprised of items assessing aggressive behavior, it should be taken into account when interpreting the results. Second, small symptom group sizes reduced the power to find significant effects, and therefore, effect sizes were examined in addition to *p* values for all pairwise comparisons. The clinical sample as a whole was also somewhat small for LPA. Replications of the group solution with larger clinical samples are needed to justify the existence of the subgroups identified here. Finally, the cross-sectional nature of the present study does not allow any conclusions to be drawn about the direction of relationships. It remains to be investigated whether primary EF problems can place a child at risk for the development of psychiatric problems or the

other way around, or whether the two kinds of problems reflect a common underlying vulnerability and thus often coexist.

A strength of the present study was its utilization of two complementary methodological approaches. Despite providing useful information on a group level, a drawback of the variable-oriented approach is its assumption of uniformity of the groups. For instance, the externalizing group may include children with very different kinds of symptoms, as some may have problems related to aggressive behavior and others mainly to hyperactivity. Thus, the EF profiles of these children may markedly differ from one another. In this study, the person-oriented approach was useful in revealing such heterogeneity within the internalizing/externalizing groups. For instance, although the internalizing group showed more EF problems overall than the reference group, the majority of the children with internalizing symptoms had average or close to average EF behaviors in all domains. However, approximately one-third had severe problems, and in psychiatric care, the identification of these children via screening is important. In addition, a benefit of the person-oriented approach is its ability to find underlying EF subgroups that may not correspond to any known diagnostic or symptom groups. If future studies validate these subgroups, EF interventions specifically targeted at children with matching EF profiles could be designed.

The present findings suggest that clinically referred preschool children, regardless of the type of psychiatric symptoms they have, tend to display more everyday EF problems than typically developing children do. Children with internalizing symptoms tend to have less difficulties in inhibiting undesirable behaviors than other children with psychiatric symptoms do, but beyond that, the diagnostic groups show little difference. Heterogeneity in other EF behaviors, including attention-related functions, planning and acting on one's own initiative becomes apparent when EF profiles are identified based on individual variation in EFs. Clinically, the present findings imply that the screening of EF difficulties is important regardless of a child's psychiatric symptoms. In case signs of EF difficulties arise, a comprehensive evaluation of the child's EF profile is important, so that the EF strengths and weaknesses may be identified and considered when planning for intervention.

Compliance with ethical standards

Conflict of interest The authors declare no conflicts of interest.

Ethical approval Ethical approval for the study was granted from the Helsinki University Central Hospital Ethical Committee for Paediatrics, Adolescent Medicine, and Psychiatry. All procedures performed in the study were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all study participants.

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II

EFFECTIVENESS OF ENGAGE IN REDUCING DIFFICULTIES IN EVERYDAY EXECUTIVE FUNCTIONS AMONG FINNISH PRESCHOOLERS: A RANDOMIZED CONTROLLED TRIAL

by

Liisa Klenberg, Sini Teivaanmäki, Vesa Närhi, Noona Kiuru & Dione Healey, 2023

Effectiveness of ENGAGE in Reducing Difficulties in Everyday Executive Functions among Finnish Preschoolers: A Randomized Controlled Trial

Liisa Klenberg[1], Sini Teivaanmäki[1, 2], Vesa Närhi[3], Noona Kiuru[2], and Dione Healey[4]

[1] Niilo Mäki Institute, Finland

[2] Department of Psychology, University of Jyväskylä, Finland

[3] Department of Education, University of Jyväskylä, Finland

[4] Department of Psychology, University of Otago, New Zealand

Author Note

Liisa Klenberg and Sini Teivaanmäki share the first authorship.

Liisa Klenberg, https://orcid.org/0000-0002-1600-8619

Vesa Närhi, https://orcid.org/0000-0002-2619-8364

Noona Kiuru, https://orcid.org/0000-0002-2334-8507

Corresponding author: Liisa Klenberg; Niilo Mäki Institute, POB 29, 40101 Jyväskylä, Finland; tel +358505449234; liisa.klenberg@nmi.fi

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Abstract

Effective interventions applicable for young preschool-age children are needed to reduce the risk of widespread and sustained adversities that are linked to early executive function (EF) difficulties. This randomized controlled trial (RCT) examined the effectiveness of the play-based ENGAGE intervention in improving behavioral outcomes related to EFs among Finnish preschool-age children with hyperactivity and/or inattention problems.

95 children between 4 and 5 years of age and their parents were randomly assigned to the ENGAGE intervention or a waitlist control group. Parents and early childhood education (ECE) teachers rated the children's EF difficulties and problem behaviors at pre-intervention, post-intervention, and 5-month follow-up. Repeated measures linear mixed modeling was used to examine the effect of ENGAGE on child outcomes. Those receiving ENGAGE exhibited significantly greater decreases in parent-rated attentional problems, hyperactivity/impulsivity, and acting out behaviors than the control group did, with mostly moderate effect sizes. No consistent improvements in the teacher ratings of children's EF related difficulties were found in either group. Low dropout (8%) from the intervention and high acceptability ratings indicated that ENGAGE is a palatable intervention for parents. The present study showed that findings from an earlier RCT on ENGAGE conducted in New Zealand could be generalized to a different cultural setting, as the intervention effectively reduced young Finnish children's EF difficulties in the home context. Extending ENGAGE and other play-based interventions into different everyday contexts of children, such as ECE, could further enhance the beneficial effects on children's EFs and behavior.

Keywords*: executive functions, play-based intervention, preschool children, training, RCT

Introduction

Difficulties in executive functions (EFs) are a major concern for young children's development. EFs refer to the skills and capacities that are needed for successful self-regulation, goal directed behavior, and learning new skills (Hofmann et al., 2012; Nigg, 2017). The commonly recognized core EFs—inhibition, working memory, and shifting (Miyake et al., 2000) —serve the immediate adaptive purpose of self-regulation (Nigg, 2017). In everyday functioning, these core EFs appear as the abilities to withhold and control motor and emotional reactions; to stay focused; to hold and process information in the mind; and to shift flexibly from one activity to another when taking action. Difficulties in EFs typically manifest as problems of inattention, hyperactivity, and impulsive behavior and are linked to a host of negative developmental trajectories including attention deficit hyperactivity disorder (ADHD), conduct disorder (CD), and autism spectrum disorders (ASD), poor educational attainment and learning difficulties (Best et al., 2011; Biederman et al., 2004; Blair & Raver, C.C., 2015; Gathercole et al., 2004; Morgan et al., 2019: O'Hearn et al., 2008; Rubia, 2011; Willcutt et al., 2005). For promoting the development of EF skills and for reducing the risk of widespread and sustained adversities that are linked to early EF difficulties, effective interventions that are applicable for young preschool-age children are acutely needed (Moffitt et al., 2011).

EFs develop rapidly during the preschool years. Between 3 and 5 years of age, children become able to suppress natural inclinations according to situational demands and to focus attention and hold information in working memory (Carlson, 2005; Diamond, 2013; Garon et al., 2008; Pauli-Pott & Becker, 2015). Although based on individual differences in neurobiology and inherent early response tendencies, the development of EFs is greatly malleable and influenced by daily interactions and activities (Blair, 2016; Rueda et al., 2005). During the preschool years, children get countless opportunities for practicing EF skills (e.g.,

controlling the speed on actions, paying attention to instructions) when playing and interacting with others. Children with difficulties in EF skills (e.g., do not focus; impulsively break the rules) may lag behind because of disadvantages in genetic underpinnings or early environmental conditions (e.g., stress; see Blair, 2016) and, even more so, they may get less practice than other children from engaging in activities that support EF development (evocative and active effects in gene-environment interactions, see Knafo & Jaffee, 2013). Thus, interventions targeting EF skills at preschool age, a potential sensitive period for the development of EFs (Pauli-Pott & Becker, 2015; Thompson & Steinbeis, 2020), allow highly specific treatment for children who have a heightened risk for accumulated difficulties stemming from poor EF and self-regulation.

According to a vast amount of research, training can effectively support the development of EFs (e.g., Blair, 2016; Diamond & Ling, 2016). Still, less is known about what kind of training is most beneficial for preschool-age children who show early difficulties in EFs. A few recent meta-analytic studies have examined whether there are differences in the effectiveness of various training/cognitive interventions for children with and without EF difficulties. In a series of meta-analyses, Takacs and Kassai (2019) compared the efficacy of five different types of interventions: explicit practicing of EFs, programs providing new strategies of self-regulation, EF-specific curricula, physical activity, or art activities. Interventions that focused on learning new strategies seemed to be more effective while explicit practice was less effective for samples with EF difficulties (e.g., symptoms of ADHD, ASD, behavior problems) as compared to typically developing samples. The findings implicated that those interventions that implicitly foster EFs may be similarly or more effective as well as more feasible (e.g., more enjoyable, more easily embedded in everyday activities) than explicit training. Yet, as only a few studies with preschool-age children with

EF difficulties were included, these findings do not directly give evidence for interventions directed toward young children.

Two meta-analytic reviews that have focused on preschool-age children have not found differences in the effectiveness of different kinds of EF interventions. In a study involving 3- to 6-year-old children, Scionti et al. (2020) included interventions that aimed at explicitly training one or more EFs via computerized or non-computer games and play. Explicit training was found to be effective for preschool-age participants in general although children with developmental risk of EF difficulties (ADHD symptoms) benefited more than did children without developmental risk. No differences between computerized and non-computer training were found. According to moderation analyses, however, group training was more effective than individual training for improving EFs. In another study with a similar age range, Pauli-Pott et al. (2020) included a large variety of interventions involving either explicit training of EFs, training of attention-directing strategies, cognitive scaffolding, or training social skills and emotional regulation. Again, overall effects of interventions on EF outcomes were found for both children with and without EF difficulties (ADD/ODD symptoms), but no significant differences among interventions emerged. Notably, the number of studies including children with EF difficulties was very low in all three aforementioned meta-analyses, implying the need to assess the effectiveness of interventions particularly in samples of children presenting these difficulties.

Although the meta-analytic studies do not offer clear evidence for what kinds of interventions best serve young preschool-age children who are "at risk" for accumulated problems due to EF difficulties, they point to the direction of group-based interventions that are embedded in the everyday activities of the child and include some means of learning strategies related to EFs. With these preliminary guidelines in mind, a promising approach to improving young children's EFs involves training through structured play. These

interventions include group sessions for children and parents while the main focus is on practicing EF skills during parent-guided play in everyday situations. Children's groups typically involve play activities targeting core EFs (e.g., inhibition, working memory) as well as metacognitive strategies and/or behavior modification to engage the children in the activities. Parents mainly receive EF-related psychoeducation and guidance for the activities and playing with their child at home.

Recent studies not included in the previously covered meta-analyses have examined the efficacy of several play-based EF interventions (Halperin et al., 2013; 2020; Healey & Halperin, 2015; Healey & Healey, 2019; Tamm et al. 2015; 2019). In a randomized controlled trial (RCT) conducted in the U.S., Tamm et al. (2019) compared the Generating Attention, Inhibition and Memory (GAIM) intervention to an active control group (children playing without metacognition, parent guidance not related to EFs, and no activities at home) in a sample of 3- to 4-year-old children with parent- and teacher-rated EF difficulties. Parents participating in GAIM rated the functional ability related to children's problem behaviors as significantly less severe and less frequent after the intervention than parents participating in the control condition (Tamm et al., 2019). In another recent RCT from the U.S., Halperin et al. (2020) compared Training Executive, Attention and Motor Skills (TEAMS) to an active control group involving a parent education group focusing primarily on topics related to ADHD. Both interventions yielded statistically significant benefits for 4- to 5-year-old children with diagnosed ADHD on ADHD symptom severity (as assessed by parents, teachers and clinicians), ADHD-related impairment (as assessed by parents and teacher), parenting factors (parent self-report), and neuropsychological outcomes.

Finally, Healey et al. (2015, 2019) have investigated the effectiveness of Enhancing Neurobehavioural Gains with the Aid of Games and Exercise (ENGAGE) in New Zealand among 3- to 4-year-old children with parent-rated problem behaviors. In an initial open trial,

Healey and Halperin (2015) reported significant improvements in parent-rated hyperactivity, inattention, and aggression problems that were maintained throughout a 12-month follow-up. In a recent RCT, Healey and Healey (2019) compared ENGAGE to the strongly evidence-based behavior management program Positive Parenting Program (Triple P) that involved psychoeducation of child management procedures to promote positive development and to manage misbehavior for parents. At post-intervention and throughout the 6- and 12-month follow-ups, ENGAGE was found to be as effective as Triple P based on parent ratings, with both interventions reducing children's problem behaviors related to hyperactivity, inattention, and aggression to within the typical range for their age.

Together, these studies suggest that play-based interventions could be a viable option for preschool children who have difficulties in EFs. However, replications of the RCTs as well as extensions to different populations and cultural contexts, are needed to strengthen the evidence from previous studies and to find out whether these interventions can be implemented in diverse cultural settings.

The present study examined the effectiveness of ENGAGE in 4- to 5-year-old Finnish children with difficulties in EFs. We sought to find out whether the findings of the previous studies concerning ENGAGE conducted in New Zealand (Healey & Halperin, 2015; Healey & Healey, 2019) could be replicated and applied to another cultural context. Based on the previous studies of play-based interventions, we hypothesized that ENGAGE would be effective in reducing children's problems related to hyperactivity, impulsivity, inattention, and aggressive behavior, and improving their functional ability. These effects were expected to remain stable across a -month follow-up. We expected to find intervention effects in both parent and early childhood education (ECE) teacher ratings, but based on the findings from previous studies, we anticipated that the effect would be larger in parent ratings from the home context as compared to teacher ratings from the context of ECE.

Methods

Participants and Procedures

Initially, 95 children (79 boys and 16 girls), aged 4 to 5 years, were recruited and deemed eligible for the study. The flow of the participants through the study is detailed in the CONSORT diagram in Figure 1. Inclusion criteria were the following: (1) parent's evaluation in the initial phone call that the group form is suitable for the child; (2) parental rating of their child's problems at or above the 65th percentile on the Attention Deficit / Hyperactivity Problems subscale of the Child Behavior Checklist (CBCL); (3) child's age between 4 and 5 years during the second assessment; (4) child attending ECE; (5) no other intervention directed at EFs or self-regulation implemented during the assessment period of five months; (6) parents having sufficient Finnish skills for taking part in the group discussions and being able to fill out the questionnaires. The mean age of the children in the final sample was 4.7 years and the vast majority were boys (84.9%) and had Finnish as their native language (95.3%). The parents in the sample were somewhat more highly educated than the general population. Sample details by allocation group are detailed in Table 1.

[Figure 1 near here]

[Table 1 near here]

Prior to the study, ethical approval for the study was granted from the Human Sciences Ethics Committee of the University of Jyväskylä. Families were informed about the possibility of taking part in the study via workers in early childhood education, child and family services, or the media. Recruitment and data collection were conducted between October 2017 and November 2018. Participants were recruited through advertisements in local ECE centers, family service centers and newspapers from three urban locations across Finland: Helsinki, Jyväskylä, and Rovaniemi. Interested families were instructed to contact the research team by phone. The families passing the initial eligibility criteria based on the

phone call (as detailed in the previous paragraph, received the questionnaires (CBCL and background information questionnaire) needed for the screening, along with the information sheet and consent forms, via mail. Written informed consent was obtained from the parents prior to the study and parents were asked to inform their child and consider their opinion in a developmentally appropriate manner. Once a block of 5-10 families had returned the completed forms and had been deemed eligible, they were randomly allocated to either the intervention or the control group and sent the pre-intervention questionnaires. Altogether, 20 groups were carried out. More participants were allocated to the intervention than the control condition in order to ensure that the intervention group sessions would have enough participants (at least 3, preferably 4) even in the case of slow recruitment. In terms of the questionnaires for the ECE teachers to complete, parents delivered the questionnaires to the staff and the staff returned them directly to the research team. Pre-intervention assessment (T1) was conducted approximately one or two weeks prior to the beginning of the intervention. Post-intervention assessment was conducted approximately at two months (T2), followed by a follow-up at five months (T3). The wait-list group received the intervention after the five-month follow-up assessment, they were not assessed after the intervention.

Intervention Description

The ENGAGE intervention was carried out according to the original manual that was translated into Finnish. The eight-week intervention involved parents playing a set of games that target EF skills at home with their children in a structured way as well as separate group meetings for the parents and children. During the first five weeks, parents and children attended weekly 90-minute group sessions in adjacent rooms, simultaneously. Each week, parents were introduced to a set of new games and encouraged to play the games with their child for 30 minutes per day throughout the eight weeks. Each game targeted one or several core EF skills, such as inhibition, working memory, and sustained attention (a list and a brief

description of the games involved is provided in Healey & Healey, 2019). In addition to learning new games, parents' sessions consisted of parents sharing about their play experiences at home during the past week and group leaders providing support in how to individualize and modify the games to match the child's developing EF skills. Furthermore, each parents' group session included one pre-defined exercise/topic, such as problem solving, time management, and emotion regulation. Meanwhile, children were taught and played the set of new games in their group. By week 5, all of the games had been introduced to the parents and taught to the children, and parents were urged to keep playing them. During weeks 6 and 7, parents received weekly individual phone call that provided personal support in adapting the games for the child and to help with any problems the parents might have encountered while playing with their child. In week 8, during the final "booster" group sessions, parents were encouraged to keep playing the games and applying the principles learned during the program. The children played their favorite games and received diplomas. The desired number of families per group was five; however, the actual number of families per group was three to five depending on the rate of the recruitment process. The parents' group leaders were mainly psychologists (9 psychologists and 1 social worker), and the children's group leaders were mainly ECE teachers (7 ECE teachers, 2 special education teachers, 2 psychologists, and 1 psychology student). The group leaders received a one-day training for the program, arranged by the first and third author, who had been trained in ENGAGE by the last author. The children's group leaders did not participate in assessing the children in the study.

Measures

Child Behavior Checklist/1.5-5 (CBCL)

The CBCL (Achenbach & Rescorla, 2000) was used as an inclusion criteria measure. The CBCL is a parent-report form used to assess children's emotional and behavioral

problems, containing altogether 99 problem items. The items group into different scales; both

empirically-based syndrome scales as well as clinically informed DSM-oriented scales can be

calculated. The items are rated on a three-point scale (0 = not true, 1 = somewhat or

sometimes true, 2 = very true or often true). The CBCL has good reliability and validity

properties (Achenbach & Rescorla, 2000) and has shown generalizability across 23 societies

(Ivanova et al., 2010). In the present study, the DSM-oriented subscale of Attention

Deficit/Hyperactivity Problems was used to set the criteria for inclusion of participation.

Five-To-Fifteen—Revised (5-15R)

The 5-15R (Kadesjö et al., 2017) was used to obtain parent reports of children's

problem behaviors related to EFs. The following subdomains were used as outcome

measures: Attention and Concentration (9 items), Overactivity and Impulsivity (9 items), and

Acting Out (13 items). The Acting Out subdomain includes items concerning aggressive and

defiant behavior. The 5-15R statements are endorsed as "Does not apply" (=0), "Applies

sometimes or to some extent" (=1) or "Definitely applies" (=2). Internal consistency

coefficients for the subdomains have been found to range from 0.69 to 0.94, demonstrating

acceptable to excellent internal consistency, and the test–retest reliability for subdomain

scores has been found to range from 0.55 to 0.89 (Kadesjö et al., 2004). Significant

correlations with corresponding scales of the CBCL and the neuropsychological assessment

instrument NEPSY (Korkman et al., 1998) suggest good convergent validity for the total

problems score and subdomain scores (Bohlin & Janols, 2004; Korkman et al., 2004). Mean

scores of the subdomain items were used as outcome measures. Thus, the highest possible

score for all the subdomains was 2.

Home and School Situations Questionnaire—Revised (HSQ-R and SSQ-R)

The HSQ-R and SSQ-R (DuPaul & Barkley, 1992) were used to obtain parents' and

ECE teachers' reports of the functional ability and severity of children's problems in

attending and concentrating in the home and ECE environments. The HSQ-R includes 14

typical home situations (e.g., when the child is playing alone or when people are visiting),

and the parent is instructed to choose whether the child has attentional difficulties in the

situation (yes/no) and to rate the severity of these problems on a 9-point scale (1 = mild, 9 =

severe). In the present study, one item ("When you are visiting someone else") was

accidentally left out of the questionnaire, thus making the number of items 13. The SSQ-R is

the teacher counterpart, including eight school situations. In the present study, one item

("During movies, filmstrips") was not included in the mean score used in the analyses,

because it was missing information in many cases, probably due to not being a regular part of

the program at the ECE centers. The wordings of one item in HSQ-R and two items in SSQ-

R were slightly modified to make them appropriate for the young age group and Finnish

culture. Both the HSQ-R and SSQ-R have shown good internal consistency (.93 and .95 for

the total scores of the HSQ-R and SSQ-R, respectively) as well as test–retest reliability (.91

and .88 for the HSQ-R and SSQ-R mean severity scores, respectively) (DuPaul & Barkley,

1992). The outcome measure used in the analyses was the mean severity score (the mean

severity of problems across the different situations). Thus, the highest possible score was 9.

The Attention and Executive Functions Rating Inventory—Preschool (ATTEX-P)

The ATTEX-P (Klenberg et al., 2017) was used to obtain ECE teacher's ratings of

children's EF difficulties manifested in the ECE environment. The ATTEX-P is an adaptation

of the ATTEX rating scale for school-age children (Klenberg et al., 2010) and consists of 44

items. The questionnaire yields scores for nine clinical subscales: Distractibility (5 items),

Impulsivity (10 items), Motor hyperactivity (5 items), Directing attention (5 items),

Sustaining attention (4 items), Shifting attention (4 items), Initiative (3 items), Planning (3

items), and Execution of action (5 items). The items include a three-point scale to assess the

frequency of EF difficulties (0 = not a problem, 1 = sometimes a problem, 2 = often a

problem). The highest possible sum scores obtainable on the subscales range between 6 and 20 (the number of items times two), and for the total score the theoretical maximum is 88. The total score and the subscales have been found to have good internal consistency (ranging from .73 to .94), test–retest reliability (ranging from .81 to .94), and convergent validity (correlations with EF items in a school readiness questionnaire ranging from .49 to .75; Klenberg et. al., 2017).

Abbreviated Acceptability Rating Profile (AARP)

The AARP (Tarnowski & Simonian, 1992) was used to measure parents' and intervention providers' appraisal of intervention acceptability. The AARP is a simplified version of the Intervention Rating Profile (IRP-15), consisting of 8 items (e.g., "This was an acceptable treatment for the child's behavior", "I liked this treatment", "Overall, the treatment helped the child") that load onto a single latent factor describing overall intervention acceptability. The items were rated on a six-point scale, ranging from 1 ("strongly disagree") to 6 ("strongly agree"). The measure has been found to have a good to excellent internal consistency (Tarnowski & Simonian, 1992). The mean score of the eight items was used as the outcome measure of acceptability, with 6 being the highest possible score.

Fidelity Measures

Intervention fidelity at home was measured using daily play diaries. In the diaries, families reported the games played and the amount of time spent playing each day. Furthermore, checklists filled by the group leaders were used to obtain information about adherence to the program during the group sessions as well as the frequency with which each family participated in the sessions.

Calculation of the Sum and Mean Scores

The amount of missing information at the item level was minor, varying from 0.21% to 1.90% per outcome measure at any given time point. Little's MCAR test suggested that values at the item level were missing completely at random ($p = .823$). In order to create sum scores for ATTEX-P, we used scale-wise mean substitution for missing values. In case a participant had more than 50% of information missing within any given scale (three cases at T1 and two cases at T3), substitution was not performed. Sample sizes therefore differed slightly for different scales of the ATTEX-P at different time points. For HSQ-R, SSQ-R, and 5-15R, mean scores were calculated and used in the analyses. On the HSQ-R T1 form, one participant had missing data on all items except one, due to which the participant's T1 score was not included in the analyses.

Statistical Analyses

First, we used *t* tests and x^2 tests to examine the equivalence of the ENGAGE and control groups regarding key background and outcome variables to assess the success of randomization. To examine the effect of ENGAGE on child outcomes, we used a repeated-measures approach utilizing restricted maximum likelihood (REML) estimation, implemented in the SPSS Linear Mixed Models (LMM) procedure. Within-subject errors were modelled using an unstructured covariance pattern, and Satterthwaite approximation was used to estimate the degrees of freedom. REML estimates model parameters and standard errors using all available data, producing unbiased estimates when data is missing at random (Little et al., 2016). Due to some expected attrition, this was a more favorable approach than the more traditional repeated measures analysis of variance that only uses cases with complete datasets and poses more strict assumptions about the missingness of the data (data is assumed to be missing completely at random). Therefore, all participants with data on at least one measurement occasion, regardless of attrition or adherence to the program, were included in the analyses.

To answer the first research question, the effect of the intervention, as indicated by change from T1 to T2, was analyzed. Fixed categorical effects included time (with two levels: T1 and T2), group (ENGAGE or control) and the interaction between the two. The interaction effect was of particular interest as it directly tested whether the two groups differed significantly over time. To answer the second question concerning the maintenance of the intervention effects, we ran similar models with T2 and T3 as the time points. Overall, 30 unadjusted tests were run to examine the intervention effect, half concerning the immediate effects and half concerning maintenance. All analyses were adjusted for father's education level, child's age, and time between assessments. Seven participants were lacking information about father's education level, and in these cases, mother's education level was used instead.

Results

Attrition

Of the 111 candidates assessed for eligibility, 13 were excluded before randomization due to not meeting inclusion criteria (score lower than 65th percentile on the Attention Deficit/Hyperactive Problems scale of the CBCL or the group form was suspected not to be suitable for the child due to aggressive behavior). Of the 95 participants randomized, retention rate with regard to parent assessments was 90.53% at T1, 81.05% at T2, and 66.32% at T3. Those lost between T1 and T2 all belonged to the intervention group. Overall, those who completed all the assessment ($n = 63$) did not significantly differ from those who completed only one, two or none of the assessments ($n = 32$) in terms of group allocation status, $X^2(1, N = 95) = 1.18$, $p = .277$; mother's education level, $X^2(1, N = 95) = 1.50$, $p = .221$; father's education level, $X^2(1, N = 95) = 0.43$, $p = .513$; child's gender, $X^2(1, N = 95) = 2.29$, $p = .130$; child's age, (completers $M = 56.21$, completers $SD = 6.36$, non-completers $M = 54.81$, non-completers $SD = 7.19$), $t(93) = -0.97$, $p = 0.335$, or CBCL Attention

Deficit/Hyperactivity Problems, (completers $M =8.87$, completers $SD = 1.93$, non-completers $M = 8.53$, non-completers $SD = 1.74$), $t(92) = -0.84$, $p = 0.406$; or CBCL Total Problems, (completers $M =51.53$, completers $SD = 18.34$, non-completers $M = 52.19$, non-completers $SD = 20.60$), $t(92) = 0.16$, $p = 0.875$.

There was a significant difference between the ENGAGE group and control group in time between assessments T1 and T2 with regard to both parent $t(75) = 3.28$, $p = .002$; and teacher questionnaires, $t(72) = 3.72$, $p < .001$, with the ENGAGE group having a shorter time period between the assessments than the control group. No group differences were found in time between assessments T2 and T3 with regard to parent, $t(61) = 0.14$, $p = .889$; or teacher questionnaires, $t(58) = -0.73$, $p = .469$. However, we included time between assessment points as a covariate in all analyses.

Intervention Fidelity and Acceptability

Of the 55 families allocated to the intervention group, 6 discontinued the study before the beginning of the intervention due to the group time schedule not being suitable ($n = 2$), parent no longer experiencing a need for the intervention ($n = 1$), family facing a sudden difficult situation in life ($n = 1$) and unknown reasons ($n = 2$). Two of them filled in and returned the pre-assessment questionnaires but no more. Of the 49 families that started the intervention, 4 (8.16%) discontinued the intervention due to either practical reasons (inability to fit the group sessions and playing into a tight schedule; 1 family), difficult life situation (death of a person close to them, health problems; 2 families) or feeling like the intervention did not fit the needs of the child (1 family). On average, parents attended 5.04 group sessions (range: 1–6), which was 84% of the maximum of 6 sessions. The mean number of days that parents reported having engaged in playing the games was 33.67 (range: 13–44 days), which was 69% of the maximum of 49 days (not including the group session days). The mean amount of

time spent playing per day was 28.32 minutes (range: 7.18–46.15 minutes), which was 94%

of the targeted 30 minutes.

Adherence to the intervention program on the part of the group leaders was 96.86% in

the parents' group sessions and 95.06% in the children's group sessions. The mean total score

of the AARP, measuring intervention acceptability, was 5.33 for parents and 5.50 for the

group leaders, with the maximum being 6.

Group Differences in Outcome and Background Variables

We examined group differences in background characteristics (child's age and

gender, and parents' educational level separately for both parents), as well as in all 15 parent-

and teacher-rated outcome variables measured pre-intervention (Table 1). Significant group

differences were found in father's educational level, parent-rated Acting out, and parent-rated

Attention and concentration. Due to the significant group difference in father's educational

level and the known effect of parental educational level on the measures of interest, we

included father's education level as a covariate in all analyses in addition to child's age and

time between T1 and T2. Child's age was included as a covariate due to its known effect on

the outcome measures.

In order to rule out the potential effect of the T1 group differences on the results, we

ran a series of ANCOVAs for all outcome measures with the T2 score as the dependent

variable and group (ENGAGE/control) as the independent variable (Table S1 in

Supplementary material). Covariates included T1 score of Attention and Concentration and

Acting out in addition to the T1 score of the outcome measure in question as well as father's

education level, child's age and time between measurements. These analyses suggested that

the T1 group differences were not a salient factor explaining the results.

Intervention Effects on Child Behavioral Outcomes

Mean scores and standard deviations of the ENGAGE and control groups on the outcome measures at each time point are shown in Table 2.

[Table 2 near here]

The results of the LMMs for parent-rated measures revealed that between pre- and post-interventions, the ENGAGE group showed significantly greater decreases in problem behaviors than the control group across all parent-rated measures (Table 3). Improvements due to intervention were found on Attention and Concentration, Hyperactivity and Impulsivity, and Acting out of the 5-15R, and in mean severity of attentional problems of the HSQ-R. Effect sizes (Cohen's *d*) were mainly in the moderate category, with a small effect for Hyperactivity and Impulsivity. With regard to teacher-ratings, the ENGAGE group showed significantly greater improvements than the control group on the Impulsivity scale in ATTEX-P (Table 3). This effect was mainly due to the nearly significant increase in symptoms in the control group and became evident only when including the covariates and, as such, may not be as robust as the other results. A similar pattern was found for Motor Hyperactivity, where a close-to-significant effect was found. Both effects were small in size.

[Table 3 near here]

There was no significant change from post-intervention to follow-up in the ENGAGE or control groups separately in terms of parent or teacher measures (Table 4), and the groups did not differ in terms of the change for any measure during the follow-up period (Table 3).

[Table 4 near here]

Discussion

In this randomized controlled trial, we examined the effectiveness of the play-based ENGAGE intervention in reducing young children's difficulties in everyday EFs and the suitability of the intervention when used within a new cultural context. Parent and teacher ratings of problem behaviors of 4- to 5-year-old Finnish children participating in ENGAGE

or a waitlist control group were compared, and acceptability and fidelity reports were obtained from both parents and group leaders. Across all parent ratings, children's EF-related problem behaviors diminished in the ENGAGE group while remaining mainly stable in the control group. The intervention effects were significant, with moderate effect sizes. Thus, as in the previous RCT of Healey and Healey (2019), the effectiveness of ENGAGE was evidenced in parent-reported behavior problems with inattention, hyperactivity, impulsivity, and acting out (aggressive and oppositional). Further, children's functioning in home situations was improved as shown in the reduction of the severity of attention-related problem behaviors that parents encountered across multiple everyday situations. As expected, no significant changes occurred in the parent ratings during the three-month follow-up period, suggesting that the gains were maintained.

Our findings on teacher ratings of EF difficulties showed group differences only for the impulsivity scale on the ATTEX-P. This difference was mainly due to the control group showing a trend for increase in problems at post-intervention rather than the ENGAGE group showing reduced problems. The finding could imply that the intervention in the home context may have had a preventive effect for the ECE context; that is, problems of impulsivity in ECE did not increase in the intervention group because parents were actively teaching these skills at home. Nevertheless, the relatively high number of analyses conducted can mean that this effect was due to type I error and, overall, the absence of consistent improvements in the teacher ratings indicates that the improvements evidenced in home situations were not fully transferred to the ECE environment. The situational demands on EFs at home and in ECE can be quite different. In the ECE context, children are often in large groups with other children and need to regulate their behavior in socially more challenging situations that at home. In order to yield benefits across settings, practice should take place across settings and in many different kinds of situations where a certain skill, for example, inhibitory control, might be

needed. Thus, interventions extending to both home and ECE environments should be preferred, in case the child's problems are evident in both environments.

Different outcomes from parent and teacher ratings may also indicate biases related to the raters (Gomez et al., 2003). As parents were active agents in the intervention and invested great effort to obtain positive change in the child's behavior, their ratings could be affected by the increased value they assigned to the outcome (Inzlicht et al., 2018). Parent ratings could therefore reflect their desire to see a positive outcome due to putting in high effort. In addition, it could be that the change in parent ratings reflects change in the way parents perceive their child rather than change in the child's behavior per se. For example, learning about EFs as developing skills and getting to know other parents with similar experiences may cause parents to perceive their child's behavior as less problematic. Teacher ratings, similarly, could be biased by the teacher's personal history related to the child (e.g., history of interactions, length of time observing the behavior of the child, tolerance for certain behaviors; DuPaul, 2003). Including other EF measures besides rating scales could help to clarify the relative contribution of these factors. As parental worry over the child's behavior was the main inclusion criterion in the present study, improved parent ratings can be seen as a particularly desirable outcome.

Regarding our aim related to the suitability of intervention in a new cultural context, ENGAGE proved to be a workable intervention for families in Finland. The low drop-out rate and high attendance for the weekly group sessions indicated high levels of fidelity, and, most importantly, families engaged in the daily playing at home. The parents also rated ENGAGE as a highly acceptable way of helping their child. Furthermore, acceptability and the adherence to the intervention program were also very good among the group leaders. As fidelity and social validity (indicated here by acceptability) are critical when implementing an

intervention, ENGAGE seems to have potential for spreading and taking root in the local health care system.

The results of the present study were remarkably similar with the previous RCT conducted in New Zealand (Healey & Healey, 2019), indicating that the beneficial effects of ENGAGE could be replicated and extended to a sample of Finnish preschoolers. When comparing these two studies, the similarities and differences should be kept in mind. The ENGAGE intervention was the same with similar group sessions, parent manual and set of games. The differences were related to the geographical and cultural setting as well as some features of the study design. First, a waitlist control group was used in the present study instead of an active control group. Second, there were some differences in the inclusion criteria. Children in the present study were somewhat older (4 to 5 vs. 3 to 4 years) and initially showed lower levels of hyperactivity (cut-off at or above the 65th percentile on the CBCL vs. the 84th percentile on the BASC-2). Thus, the present study extends the suitability of ENGAGE to a larger age group and indicates that it may be an effective preventive intervention for children with milder, subclinical problems of hyperactivity and inattention.

The findings of the present study further build up the evidence from earlier studies on play-based intervention. Previously, play-based practice of EF skills has been shown to be as effective as training behavior management and positive parenting skills (Healey & Healey, 2019) and ADHD-related psychoeducation (Halperin et al., 2020) in reducing aggressive behavior, functional impairment, and/or ADHD-symptoms in preschool-age children. Further, Tamm et al. (2019) showed that a play-based intervention was more effective than a control condition not including the main EF ingredients, thus indicating that the training of EFs may be an effective ingredient in these interventions. Together with the present study, these findings indicate that structured play conducted by parents at home is a viable way to

strengthen the EF skills of young preschool-age children with diagnosed ADHD or at risk of ADHD or other behavior problems.

The positive intervention effects can be understood in terms of ENGAGE including many important ingredients highlighted in recent meta-analyses (Pauli-Pott et al., 2021; Scionti et al., 2020; Takacs & Kassai, 2019): targeting children with difficulties in EFs, targeting multiple EFs at once, group delivery, and inclusion of strategy learning and scaffolding in addition to training skills in a fun and engaging way. Furthermore, although ENGAGE in not specifically a physical activity or a mindfulness intervention, it does include also these ingredients, known to be effective in improving EFs (Takacs & Kassai, 2019; Diamond & Lee, 2011). In ENGAGE, physical activity is included in games such as rope skipping and hopscotch, and mindfulness skills are enhanced in playful mental imagery and deep breathing exercises. Overall, it seems that ENGAGE combines many effective approaches to improving young children's EFs. The inclusion of several components into practical interventions is common, and in the future, identification of the most essential components will be critical for developing the most effective interventions.

Along with the limitations related to the lack of EF measures other than questionnaires, the present study leaves open the question of more specific mechanisms of the intervention. The main hypothesized mechanism of effect in play-based interventions is that training enhances EF skills, which results in improved behavioral outcomes. However, as the quality of the parent–child relationship is known to have a bearing on the child's level of externalizing symptoms (Burt et al., 2005; Lifford et al., 2008), it may be possible that the benefits were due to parents and children having more positive interaction together, resulting in improved parent–child relations and consequently reduced problem behaviors. Including an active control group with non-EF activities would have been more appropriate for finding

answers to these crucial questions. Certainly, the aforementioned hypothetical mechanisms do not have to be exclusive, and possibly both contribute to some extent.

In conclusion, the present study gives further support for the effectiveness of ENGAGE, indicating that young children's difficulties in everyday EFs are reduced after the intervention and that the findings from the earlier RCT conducted in New Zealand generalize to another population and to a different cultural setting. According to our findings, high intervention acceptability and fidelity with low drop-out rates in this study suggest that ENGAGE is a palatable intervention for parents who actively seek support for parenting. As an action-oriented intervention that focuses around more practical matters, such as how to engage the child in playing, rather than involving more general issues of parenting practices, ENGAGE may be easy to approach for parents. Consequently, ENGAGE may be particularly suitable as a low-threshold intervention for families with concerns related to a preschool-aged child's problem behaviors. From the perspective of training, ENGAGE allows children to practice EF skills in situations that are highly relevant for their everyday lives, yet still in a playful way where the stakes are perhaps not as high as in other everyday situations. In future studies, extending ENGAGE into different contexts, such as by applying similar play-based training in both home and ECE environments, could further enhance the beneficial effects on children's behavior. Indeed, there is already evidence that ENGAGE is also effective in the ECE context (Healey, Milne & Healey, 2022). Further, studies from other than occidental cultures are needed to learn more about the feasibility of play-based interventions. Finally, including different kinds of active control groups (e.g., non-EF play with equal amount of playing at home) as well as children with different kinds of EF difficulties (e.g., children with co-occurring psychiatric or social communication problems) could help to find out more about the critical mechanisms of ENGAGE and to whom it works.

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Figure captions

Figure 1. *Participant flow concerning study participation*

Table 1. *Sample characteristics by group*

	ENGAGE (*n* = 51)	Control (*n* = 35)	*t*/X^2 (*p*)
Age in months, *M* (*SD*)	57.16 (6.18)	54.62 (6.87)	1.79 (.077)
Gender, % male	86.3 %	82.9 %	0.19 (.664)
Native language Finnish, %	94.1 %	97.1 %	0.19 (.667)
Mother's education level			0.57 (.450)
Low	33.3 %	25.7 %	
High	66.7 %	74.3 %	
Father's education level			3.90 (.048)
Low	41.2 %	62.9 %	
High	56.9 %	37.1 %	
CBCL ADHD Problems, *M* (*SD*)	9.06 (1.89)	8.35 (1.81)	1.72 (.090)
5-15R Attention and concentration, *M* (*SD*)	1.21 (0.40)	1.00 (0.42)	2.36 (.020)
5-15R Hyperactivity and impulsivity, *M* (*SD*)	1.32 (0.43)	1.22 (0.37)	1.02 (.310)
5-15R Acting out, *M* (*SD*)	0.71 (0.29)	0.54 (0.35)	0.61 (.015)
HSQ-R mean severity of attentional problems (*SD*)	2.94 (1.47)	2.80 (1.43)	0.02 (.679)
ATTEX-P Distractibility, *M* (*SD*)	5.75 (2.70)	6.39 (2.30)	-1.13 (.261)
ATTEX-P Impulsivity, *M* (*SD*)	11.53 (5.72)	11.13 (5.59)	0.31 (.751)
ATTEX-P Motor hyperactivity, *M* (*SD*)	5.69 (3.26)	5.11 (3.15)	0.82 (.416)
ATTEX-P Directing attention, *M* (*SD*)	4.15 (2.90)	4.27 (2.38)	-0.20 (.844)
ATTEX-P Sustaining attention, *M* (*SD*)	3.60 (2.62)	3.76 (2.54)	-0.29 (.774)
ATTEX-P Shifting attention, *M* (*SD*)	3.67 (2.22)	4.06 (2.12)	-0.79 (.430)
ATTEX-P Initiative, *M* (*SD*)	2.58 (2.21)	2.32 (1.55)	0.59 (.559)
ATTEX-P Planning, *M* (*SD*)	2.67 (1.88)	2.45 (1.80)	0.53 (.599)
ATTEX-P Execution of action, *M* (*SD*)	4.75 (2.76)	4.58 (2.25)	0.30 (.762)
ATTEX-P Total score *M* (*SD*)	44.40 (21.15)	43.95 (19.33)	0.10 (.923)
SSQ-R mean severity of attentional problems (*SD*)	3.55 (2.28)	3.98 (2.23)	-0.85 (.395)

Table 2. *Ns and raw mean scores (standard deviation) for the outcome variables in the ENGAGE and control groups*

| | Pre-intervention | | | | Post-intervention | | | | 3-month follow-up | | | |
| | ENGAGE | | Control | | ENGAGE | | Control | | ENGAGE | | Control | |
	n	*M (SD)*	*n*	*M (SD)*	*n*	*M (SD)*	*n*	*M (SD)*	*n*	*M (SD)*	*n*	*M (SD)*
Parent ratings												
Attention and concentration	51	1.21 (0.40)	35	1.00 (0.42)	42	1.03 (0.34)	35	1.01 (0.54)	34	1.08 (0.40)	29	1.01 (0.51)
Hyperactivity and impulsivity	51	1.32 (0.43)	35	1.22 (0.37)	42	1.13 (0.42)	35	1.17 (0.45)	34	1.12 (0.41)	29	1.10 (0.46)
Acting out	51	0.71 (0.29)	35	0.54 (0.35)	42	0.52 (0.32)	35	0.54 (0.40)	34	0.50 (0.35)	29	0.48 (0.43)
Severity of attentional problems in home situations	51	2.94 (1.47)	34	2.80 (1.43)	42	2.37 (1.32)	35	2.82 (1.58)	34	2.48 (1.47)	29	2.58 (1.48)
Teacher ratings												
Distractibility	52	5.75 (2.70)	33	6.39 (2.30)	42	5.86 (2.75)	33	6.03 (2.50)	34	6.28 (2.49)	27	6.32 (2.81)
Impulsivity	52	11.53 (5.72)	33	11.13 (5.59)	42	11.86 (5.89)	33	11.23 (6.27)	34	11.50 (5.41)	27	10.87 (6.52)
Motor hyperactivity	52	5.69 (3.26)	33	5.11 (3.15)	42	5.81 (2.82)	33	5.17 (3.22)	34	5.68 (2.66)	27	4.78 (2.97)
Directing attention	52	4.15 (2.90)	33	4.27 (2.38)	42	4.38 (3.08)	33	4.09 (2.59)	34	4.38 (3.04)	27	4.09 (2.83)
Sustaining attention	52	3.60 (2.62)	33	3.76 (2.54)	42	3.74 (2.79)	33	3.23 (2.55)	34	3.97 (2.66)	27	3.50 (2.86)
Shifting attention	52	3.67 (2.22)	32	4.06 (2.12)	42	3.83 (2.51)	33	3.86 (2.38)	34	4.02 (2.27)	27	3.93 (2.34)
Initiation	52	2.58 (2.21)	33	2.32 (1.55)	42	2.67 (2.14)	33	1.97 (1.69)	34	2.76 (1.93)	27	2.39 (2.14)
Planning	52	2.67 (1.88)	31	2.45 (1.80)	42	2.63 (1.86)	33	2.45 (1.95)	34	2.74 (1.60)	26	2.42 (2.14)
Execution	52	4.75 (2.76)	33	4.58 (2.25)	42	4.93 (2.32)	33	4.45 (2.65)	34	4.69 (2.46)	26	4.52 (2.51)
Total problems	52	44.40 (21.15)	33	43.95 (19.33)	42	45.71 (20.48)	33	42.49 (21.69)	34	46.01 (19.17)	27	42.79 (22.16)
Severity of attentional problems in ECE situations	52	3.55 (2.28)	33	3.98 (2.23)	42	3.53 (2.03)	33	3.73 (2.27)	34	3.73 (1.96)	27	3.89 (2.70)

Table 3. *Results of the linear mixed models predicting child outcomes.*

	T1–T2 (Time x Condition)						T2– T3 (Time x Condition)					
	Estimate	*SE*	*df*	*t*	*p*	*d[a]*	Estimate	*SE*	*df*	*t*	*p*	*d[b]*
Parent assessments												
Attention problems	-0.22	0.09	72.30	-2.51	.014	-0.52	0.01	0.09	60.56	0.15	.882	0.02
Hyperactivity and impulsivity	-0.16	0.08	72.14	-2.03	.046	-0.38	0.06	0.09	60.39	0.68	.497	0.13
Acting out	-0.22	0.06	73.13	-3.60	.001	-0.65	0.09	0.06	58.10	1.33	.188	0.24
Severity of attentional problems in home situations	-0.71	0.23	71.97	-3.10	.003	-0.48	0.28	0.33	59.28	0.84	.402	0.19
Teacher assessments												
Distractibility	-0.21	0.39	69.04	-0.54	.592	-0.08	0.55	0.55	55.94	1.00	.320	0.20
Impulsivity	-1.94	0.92	69.13	-2.11	.038	-0.32	1.31	1.16	57.39	1.13	.264	0.21
Motor hyperactivity	-0.90	0.49	71.15	-1.82	.072	-0.28	0.62	0.58	58.92	1.08	.284	0.20
Directing attention	-0.39	0.56	69.88	-0.69	.491	-0.14	0.29	0.68	58.20	0.43	.672	0.10
Sustaining attention	0.23	0.50	71.24	0.47	.638	0.09	0.46	0.63	56.83	0.73	.466	0.16
Shifting attention	0.04	0.51	69.34	0.07	.943	0.02	0.51	0.56	57.31	0.91	.369	0.20
Initiative	0.01	0.37	71.41	0.03	.973	0.00	-0.17	0.40	57.43	-0.42	.677	-0.08
Planning	-0.50	0.45	71.25	-1.12	.268	-0.26	0.23	0.47	59.38	0.50	.618	0.11
Execution	-0.66	0.45	69.59	-1.48	.144	-0.24	0.25	0.55	55.95	0.45	.654	0.10
Total problems	-5.06	2.98	69.10	-1.69	.095	-0.23	4.33	4.09	56.67	1.06	.294	0.20
Severity of attentional problems in ECE situations	-0.45	0.47	71.64	-0.97	.336	-0.18	0.36	0.54	56.44	0.66	.509	0.17

Note. Negative estimates represent a decrease in the outcome (e.g. reduction in problems) in the ENGAGE group as compared to the control group at T2 (with T1 as reference) or T3 (with T2 as reference), and vice versa for positive estimates.

[a] Cohen's *d* was calculated by dividing the estimates by the pooled standard deviation at pre-intervention.

[b] Cohen's *d* was calculated by dividing the estimates by the pooled standard deviation at post-intervention.

Table 4. *Change from pre-intervention to post-intervention (T1-T2) and from post-intervention to follow-up (T2-T3) in the ENGAGE and control groups separately.*

| | T1-T2 | | | | | | T2-T3 | | | | | |
| | ENGAGE | | | Control | | | ENGAGE | | | Control | | |
	Mean change (*SE*)	*p*	*d*	Mean change (*SE*)	*p*	*d*	Mean change (*SE*)	*p*	*d*	Mean change (*SE*)	*p*	*d*
Parent assessments												
Attention problems	-0.19 (0.06)	.001	-0.44	0.03 (0.06)	.635	0.07	0.04 (0.06)	.555	0.09	0.02 (0.06)	.735	0.04
Hyperactivity and impulsivity	-0.19 (0.05)	< .001	-0.44	-0.03 (0.05)	.527	-0.07	0.01 (0.06)	.930	0.02	-0.06 (0.07)	.379	-0.13
Acting out	-0.21(0.04)	< .001	-0.61	0.01 (0.04)	.784	0.03	0.05 (0.04)	.285	0.13	-0.04 (0.05)	.635	-0.1
Severity of attentional problems in home situations	-0.64 (0.14)	< .001	-0.44	0.08 (0.16)	.643	0.05	0.14 (0.22)	.508	0.1	-0.13 (0.23)	.566	-0.09
Teacher assessments												
Distractibility	-0.26 (0.24)	.280	-0.10	-0.05 (0.28)	.858	-0.02	0.43 (0.35)	.226	0.16	-0.12 (0.40)	.771	-0.04
Impulsivity	-0.71 (0.56)	.210	-0.12	1.23 (0.65)	.063	0.19	0.19 (0.75)	.802	0.03	-1.12 (0.84)	.188	-0.19
Motor hyperactivity	-0.27 (0.30)	.362	-0.09	0.63 (0.35)	.081	0.20	-0.02 (0.37)	.952	-0.01	-0.65 (0.42)	.128	-0.22
Directing attention	-0.18 (0.34)	.593	-0.06	0.21 (0.40)	.610	0.07	0.01 (0.44)	.983	0.00	-0.28 (0.49)	.571	-0.09
Sustaining attention	-0.20 (0.30)	.504	-0.07	-0.44 (0.35)	.222	-0.15	0.42 (0.40)	.304	0.15	-0.04 (0.45)	.930	-0.01
Shifting attention	-0.01 (0.31)	.978	0.00	-0.04 (0.37)	.902	-0.02	0.23 (0.36)	.534	0.09	-0.28 (0.41)	.490	-0.11
Initiative	-0.17 (0.22)	.447	-0.08	-0.18 (0.26)	.488	-0.09	0.00 (0.26)	.994	0.00	0.17 (0.29)	.560	0.08
Planning	-0.32 (0.27)	.233	-0.16	0.18 (0.32)	.585	0.09	0.11 (0.30)	.707	0.06	-0.12 (0.34)	.723	-0.06
Execution	-0.44 (0.27)	.107	-0.17	0.22 (0.32)	.499	0.08	-0.08 (0.35)	.830	-0.03	-0.32 (0.40)	.423	-0.13
Total problems	-2.98 (1.82)	.106	-0.14	2.07 (2.12)	.332	0.09	1.36 (2.64)	.608	0.06	-2.97 (2.96)	.319	-0.14
Severity of attentional problems in ECE situations	-0.38 (0.28)	.178	-0.17	0.07 (0.34)	.838	0.03	.28 (0.35)	.415	0.13	-0.07 (0.39)	.853	-0.03

Note. Cohen's *d* was calculated by dividing the estimate by the pooled standard deviation of the two measurement points.

Supplementary data

Effectiveness of ENGAGE in Reducing Difficulties in Everyday Executive Functions among

Finnish Preschoolers: A Randomized Controlled Trial

Table S1. *ANCOVAs predicting child outcomes at T2 while controlling for group differences at T1.*

	N	F	df	p	n_p^2
Parent assessments					
Attention problems	77	4.60	1,70	.035	0.06
Hyperactivity and impulsivity	77	4.54	1,69	.037	0.06
Acting out	77	8.72	1,70	.004	0.11
Severity of attentional problems in home situations	76	11.94	1,68	< .001	0.15
Teacher assessments					
Distractibility	74	1.10	1,66	.297	0.02
Impulsivity	74	5.10	1,66	0.027	0.07
Motor hyperactivity	74	3.11	1,66	0.082	0.05
Directing attention	74	1.01	1,66	0.317	0.02
Sustaining attention	74	0.01	1,66	0.925	0.00
Shifting attention	73	0.18	1,65	0.677	0.00
Initiative	74	0.15	1,66	0.696	0.00
Planning	72	1.03	1,64	0.314	0.12
Execution	74	2.11	1,66	0.151	0.03
Total problems	74	3.63	1,66	0.061	0.05
Severity of attentional problems in ECE situations	74	2.34	1,66	0.131	0.03

Note. All models included the following covariates: Attention problems and Acting out scores at T1 as well as the T1 score of the outcome variable (in case not Attention problems or Acting out), child's age, father's education level, and the time difference between assessment points
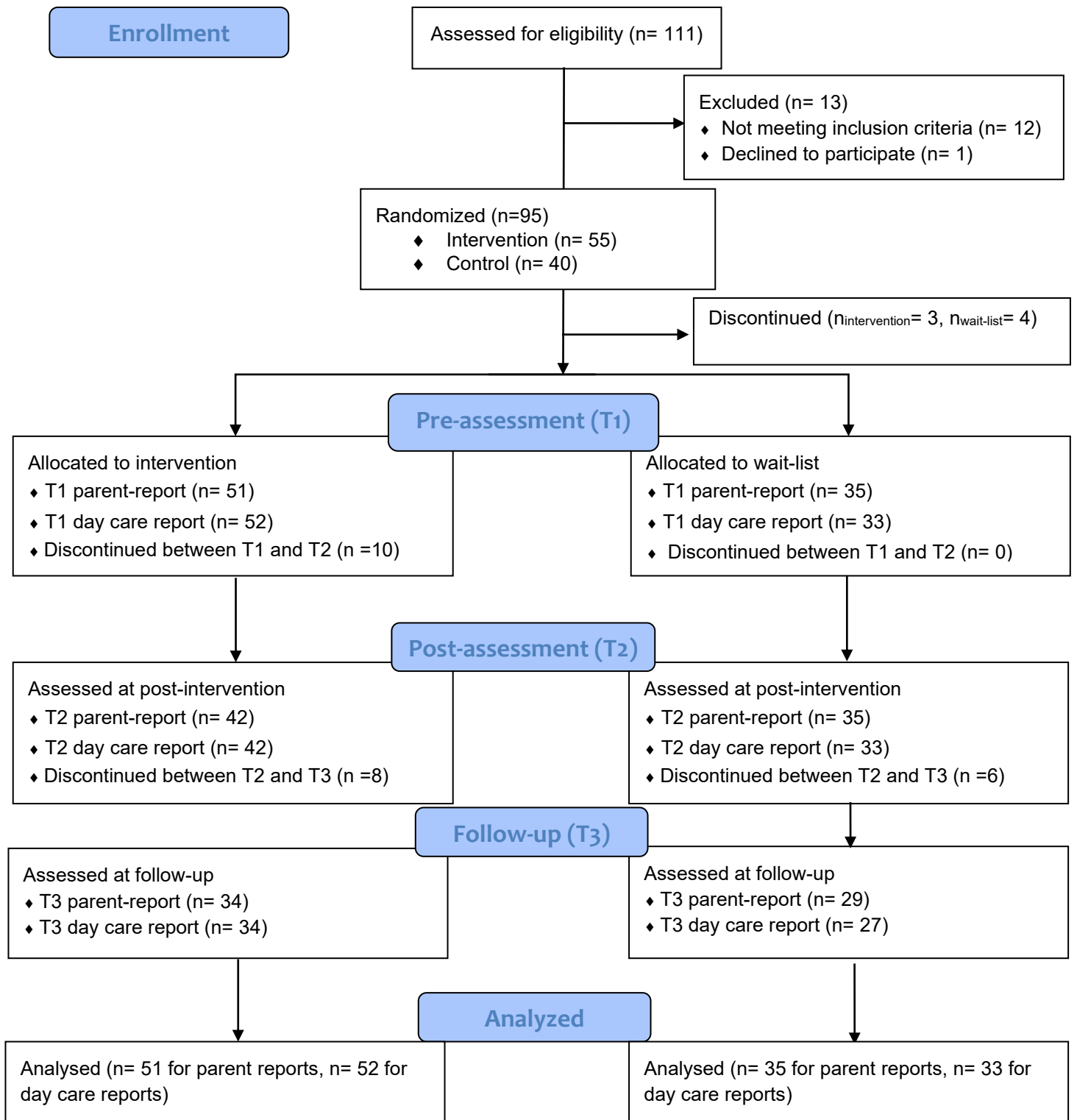
III

DECREASES IN CHILD AGGRESSIVE AND OPPOSITIONAL BEHAVIOR MEDIATE THE EFFECTS OF THE ENGAGE INTERVENTION ON PARENTING STRESS

by

Sini Teivaanmäki, Noona Kiuru, Vesa Närhi, Liisa Klenberg, 2024

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