JYU DISSERTATIONS 149

Mika Paananen

Mastering Learning Situations

Self-Regulation, Executive Functions and Self-Regulatory Efficacy among Elementary School Pupils

UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF EDUCATION AND PSYCHOLOGY

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ABSTRACT

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Success in scholastic endeavours is dependent not only on the individual's capabilities but also on confidence to manage learning-related situations and regulate oneself in these situations. The first goal of this dissertation was to investigate self-regulatory efficacy (i.e., confidence in managing learning and on-task situations) and sources of self-regulatory efficacy (i.e., efficacy-building experiences), and their associations with attention and learning difficulties among elementary school pupils. The second goal was to examine the efficacy of group-based attention and executive function (EF) interventions provided in schools for elementary school pupils with attention and EF deficits.

Altogether, the Studies I and II supported the hypothesised connections between sources of self-regulatory efficacy and self-regulatory efficacy. Nevertheless, a wide variability in self-regulatory experiences among elementary school pupils was found. The results showed further that heightened negative emotions were associated with lower self-regulatory efficacy in school-task situations. Finally, attention deficits and learning difficulties had detrimental effect on experienced sources of self-regulatory efficacy and one's sense of efficacy in managing learning and on-task behaviours. This effect was especially prominent among pupils with attention deficits (Study I).

The findings of Study III showed that implementing comprehensive behavioural, cognitive and skill-training interventions in the school context is an effective approach to reduce problems of attention and executive skills in classroom setting. The results also indicated that the level of severity of attention and EF problems moderated intervention outcomes: pupils with low or moderate symptoms at the pre-intervention (65% of the participants in the intervention group) benefited more from the intervention than those with severe symptoms.

The findings indicate that more attention should be paid to pupils' self-regulatory experiences, especially among pupils with attention deficit or learning difficulties. It is suggested that systematic and effective support methods should be used in schools for children with learning-related problems targeting at both regulatory skills and confidence in managing learning situations.

Keywords: self-regulation, self-regulatory efficacy, sources of self-efficacy, attention deficits, executive function deficits, leaning difficulties, intervention

TIIVISTELMÄ (FINNISH ABSTRACT)

Paananen, Mika
Itsesäätely ja toiminnanohjaus oppimistilanteissa: itsesäätelyn minäpystyvyys ja taitojen kehittäminen alakoululaisilla
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Itsesäätely ja toiminnanohjauksen taidot kehittyvät ympäristön ja lapsen välisessä vuorovaikutuksessa – lapsi kohtaa ikävaiheeseensa sopivia odotuksia ja vaatimuksia, hänelle opetetaan toimintatapoja ja hän saa toiminnastaan palautetta. Itsesäätelyn onnistumista oppimistilanteissa tukee lapsen käsitys omasta pystyvyydestään hallita omaa toimintaansa, ajatteluaan ja tunteitaan. Tämä niin sanottu minäpystyvyys kehittyy ja muokkautuu neljästä eri kokemuslähteestä: aiemmat onnistumiskokemukset, vertaisoppiminen ja -kokemukset, ympäristön antama palaute ja suoritustilanteisiin liittyvät tunteet ja keholliset tuntemukset. Tässä väitöskirjassa tarkastellaan ensinnäkin kyselylomakkeen tulosten pohjalta kouluikäisten lasten oppimistilanteisiin liittyvää itsesäätelyn minäpystyvyyttä ja sitä muokkaavia kokemuksia eli minäpystyvyyden lähteitä ja toiseksi kouluissa toteutettujen itsesäätelyn, tarkkaavuuden ja toiminnanohjauksen intervention vaikutuksia tarkkaavuusongelmaisten oppilaiden oppimiseen ja työskentelyyn luokkatilanteissa.

Kahden ensimmäisen osatutkimuksen tulokset osoittivat, että tutkittavien ryhmässä itsesäätelyyn liittyvät minäpystyvyyden lähteet eli pystyvyyttä tukevat kokemukset vaihtelivat suuresti. Lisäksi koululaisen perustaitoihin liittyvillä vaikeuksilla oli kielteinen yhteys itsesäätelyn lähteisiin, itsesäätelyn minäpystyvyyteen sekä lähteiden ja minäpystyvyyden välisiin yhteyksiin. Nämä ryhmävaikutukset olivat havaittavissa vahvemmin tarkkaavuuden ongelmissa kuin lukemisen ja matematiikan oppimisen ongelmissa. Tulokset osoittivat myös, että kielteisten kehollisten ja emotionaalisten kokemusten runsas määrä oli yhteydessä keskimääräistä heikompaan itsesäätelyn minäpystyvyyteen.

Väitöskirjan kolmas osatutkimus osoitti, että johdonmukaisesti toteutetuilla interventioilla voidaan vaikuttaa oppilaiden itsesäätelyn ja toiminnanohjauksen taitoihin sekä akateemisten perustaitojen kehitykseen. Interventiosta hyötyivät erityisesti ne lapset, joiden tarkkaavuuden ja toiminnanohjauksen ongelmat olivat lieviä tai ”keskivaikeita” (65 % koeryhmän lapsista).

Tämän väitöskirjan tulosten perusteella voidaan päätellä, että alakouluikäiset lapset pystyvät tunnistamaan itsesäätelyyn liittyviä kokemuksiaan ja että vaikeudet akateemisissa perustaidoissa tai tarkkaavuuden ongelmat altistavat heidät kokemuksille, jotka eivät vahvista luottamusta omiin kykyihin hallita oppimistilanteita. Tutkimustulokset tukevat ajatusta siitä, että oppimista tukevien interventioiden tulisi harjoittaa akateemisten perustaitojen ohella itsesäätelyä sekä toiminnanohjauksen taitoja. Lisäksi interventioiden tulisi taata lapsille kokemuksia oppimistilanteiden hallinnasta ja sitä kautta vahvistaa itsesäätelyn minäpystyvyyttä.

Avainsanat: itsesäätely, toiminnanohjaus, itsesäätelyn minäpystyvyys, minäpystyvyyden lähteet, tarkkaavuuden ongelmat, oppimisvaikeudet, interventio

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Professor Lea Pulkkinen, has said in many occasions that one needs to educate oneself to become a researcher, and to be qualified to call oneself as such. I believe her, why would I not. She is *primus inter pares* in psychological research.

To become a researcher, one must acquire scientific and methodological knowledge, get some insight what information can be reached and how, what is one's own vantage point and, of course, skills to analyse and communicate the findings. But, when you approach the finish line, you realize how much you do not know and how much you still have to learn. On the other hand, perhaps that knowledge of not knowing is the reason why people are so keen on science; one can resolve a small part of the puzzle at a time and perhaps someday one tiny puzzle may fit into a bigger landscape or change it.

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Jyväskylä 9.10.2019
Mika Paananen

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[1] Bush, Kate (1993).
[2] Kavanagh, Patrick (1946).
[3] Heaney, Seamus (1966).
[4] Bush, Kate (1993).
[5] Moore, Christy (1985).

LIST OF THE ORIGINAL PUBLICATIONS

This dissertation is based on the following original publications:

I Paananen, M., Aro, T., Viholainen, H., Koponen, T., Tolvanen, A., Westerholm, J., & Aro, M. (2019). Self-regulatory efficacy and sources of efficacy in elementary school pupils: Self-regulatory experiences in a population sample and pupils with attention and executive function difficulties. *Learning and Individual Differences, 70*, 53–61. *doi:* 10.1016/j.lindif.2019.01.003.

II Paananen, M., Aro, T., Koponen, T., Viholainen, H., Tolvanen, A., & Aro, M. Is the variation in sources of self-regulatory efficacy connected with self-regulatory efficacy and basic academic skills among children? Submitted manuscript.

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Description of the writer's contribution to the individual articles:
Taking into account the instructions given and comments made by the co-authors, the author of the thesis is the first author of all three individual articles. He had an active role in the study design, statistical analysis, data interpretation, manuscript preparation in all the individual articles. He also coordinated the data collection in Study III and partly in Study I.

CONTENTS

1 INTRODUCTION

Education has a significant influence on how individuals succeed in society. Therefore, understanding how different internal and external factors influence individuals' educational success is of great importance. Success in scholastic endeavours is not only the result of one's cognitive or basic academic skills. It is also dependent on the individual's capabilities to manage multiple learning-related situations and regulate oneself in these situations. *Self-regulation* and *executive functions* (*EF*), both dynamic processes that enable us to have control over our thoughts, emotions and actions, significantly influence our educational development and learning outcomes (Barkley, 1997; Blair & Raver, 2015).

Self-regulation evolves in social interactions. Children's interactions with their social environment as well as their development of verbal and other cognitive abilities result in increasing their volitional management of attention, emotions, stress responses and behaviour (Ursache, Blair, & Raver, 2012). The social environment and the models it provides as well as the feedback that individuals obtain from the environment and significant others create the standards, directions and goals for regulative behaviours (Bandura, 1997, p. 61; Hofmann, Schmeichel, & Baddeley, 2012). Education and cognitive development eventually result in the conscious use of strategies that enable individuals to control both cognitive functioning and emotion regulation (Nigg, 2017), which allow for successful engagement in school and learning activities, and thus affect academic development (Zimmerman, 2008).

Self-regulation has been investigated within various theoretical traditions and disciplines, and this has created diverse perspectives on the phenomenon and different definitions of the concept. However, different approaches and traditions share the view that self-regulation is set of processes that enable individual to control one's own cognition, emotions and actions (McClelland & Cameron, 2011). While self-regulation can be associated with unconscious and conscious processes related to adapting physical and emotional reactions to adjust to environmental conditions, it is also regarded as goal-oriented behaviour, requiring several cognitive and social skills (Vohs & Baumeister, 2000). Especially on educational field, self-regulation may refer to variety of proactive processes

such as goal-setting, adaptive use of strategies, self-monitoring and evaluation (Zimmerman, 2000). Whereas, in neuropsychologically oriented research EF, the core processes of self-directed behaviour, enable self-regulation (Nigg, 2017). As the aim of this dissertation is to tap into the ability to master one's own learning processes, it incorporates of the aforementioned aspects: control of cognition (executive control), emotions and behaviour. In the two first sub-studies, focus is on the control aspect of self-regulation, that is, top-down processes that enables cognitive (attention) and action control, and especially in beliefs related to one's own self-regulatory skills. In the third sub-study, intervention study, vantage point broadens to the learning strategies.

In addition to an individual's competencies and abilities, an essential part of learning is getting oneself to use these abilities and to engage in learning activities in different situations, even when faced with obstacles or distractions. Engagement in different learning activities is influenced by *self-efficacy;* that is, beliefs an individual holds about 'one's capabilities to organize and execute the courses of actions required to produce given attainments' (Bandura, 1997, p. 3). Self-efficacy does not only concern beliefs related to academic skills but also individuals' sense of confidence in their ability to manage different learning and on-task situations and to have control over their emotions and physiological reactions while working (Bandura, 2012). The beliefs related to self and one's capabilities to organise and regulate actions in learning settings, that is *self-regulatory efficacy*, have a significant influence on motivation, educational development and, finally, academic achievement (Caprara et al., 2008). Self-efficacy and self-regulatory efficacy develop and are modified through information that one receives from four sources—mastery experiences, vicarious experiences, social persuasion and physiological and emotional states—as well as interpretations of the received information (Badura, 1997, p 79; Joët, Usher, & Bressoux, 2011).

Thus, both self-regulation and self-regulatory efficacy develop in interactions with the environment and the variety of stimuli and opportunities to practice regulation provided by the environment. Thus, an encouraging and reflective environment with an appropriate structure and predictability facilitates development (Blair & Diamond, 2008). Self-perceptions and appraisals are one part of the loop where behaviours and actions interact with the social environment. Self-beliefs and interpretations of environmental feedback influence children's emotional, social and cognitive engagement in school and learning (Bong & Saalvik, 2003). At best, a supportive and reflective environment promotes effective regulation and builds positive self-beliefs with regard to one's own capabilities to manage actions, thoughts and emotions. These self-beliefs interact with other functions and processes, i.e. neural processes, environmental and social interactions, and are therefore dynamic contributors to the process of self-regulation development (Blair & Diamond, 2008).

Self-regulatory difficulties are common in school and in school-related activities. Learning and attention difficulties may contribute negatively to educational development and self-regulation, thereby diminishing the amount

of mastery experiences, vicarious experiences or social persuasion, and resulting in the emergence of negative emotions, which may eventually affect the formation of self-regulatory efficacy. Thus, studying self-regulatory efficacy and its sources among pupils with learning-related problems is of special interest. Therefore, in this dissertation, the first aim is to investigate how pupils with attention and EF deficits and learning difficulties view their self-regulatory efficacy and sources of efficacy, and whether these self-appraisals differ compared to their peers.

Historically, children's self-regulatory behaviour in school or home settings has been assessed with rating scales filled in by parents or teachers, or through observations. In this dissertation's first two studies, attention was paid to the children's own self-regulatory experiences and to the children's own views of their capabilities to regulate their own actions in on-task situations in the school setting. Better knowledge of a child's own confidence in his/her self-regulatory abilities and the type of experiences he/she has had with regard to self-regulation would steer and guide educational and support approaches targeted at pupils with attention deficits and learning difficulties.

Although children's development of self-regulatory skills is largely based on their cognitive development and their everyday interactions with the environment, they should also be taught skills and behaviours that enable learning and adaptive functioning in learning settings. This is especially important for children with attention deficits and learning difficulties. There is increasing evidence that different psychosocial interventions for self-regulation and EF benefit children with attention deficits or children at risk for school learning failures (Blair & Diamond, 2008; Evans, Owens & Bunford, 2014; Fabiano et al., 2015; Rantanen, Vierikko & Nieminen, 2018). Teaching children strategies and adequate on-task behaviours have been shown to improve their attention control and task completion (Abikoff et al., 2013; Pfiffner et al., 2014). Improved strategy use may also be associated with increased motivation, self-efficacy and effort (Meltzer & Bagnato, 2010). However, more research is needed on school-based interventions, especially in the Finnish school context where intervention programmes on attention and EF have not yet been studied. Therefore, the second aim of this dissertation is to present the findings concerning the effects of an intervention on attention and EF implemented in the school context.

1.1 Self-regulation and EF

In many contexts, self-regulation is defined as the ability to regulate one's internal state and behaviour, so that they support efforts to reach situational goals. In the educational field, self-regulation is described as a goal-oriented behaviour requiring regulation of thoughts, emotions, motivation and actions in

learning settings (Klassen, 2010; Zimmerman, 2008). From the psychological perspective, however, self-regulation also includes attention and inhibitory control (or interference control), processes and abilities that control reactivity and actions (Blair & Diamond, 2008). From the neural perspective, a number of prefrontal functions and neuropsychological processes are involved in self-regulation (Blair & Raver, 2015) and are suggested as the core processes of self-directed behaviour, i.e. EF (Diamond, 2013; Nigg, 2017). Historically, literature and research on self-regulation and EF have mostly followed different traditions and used different definitions of the concepts (Hofmann et al., 2012), but recently, there have been attempts to link these two fields. It has been suggested that self-regulation, understood as volitional control of arousal, attention, emotions and stress reactions, 'facilitates the use of EF in the service of goal-directed actions' (Ursache et al., 2012, p. 123). More recently, it has been argued that self-regulation and EF should be considered overlapping constructs and EF as the means that enables self-regulation (Nigg, 2017). Accordingly, self-regulation is viewed as goal-directed behaviour in various contexts, while EF is defined as a set of prefrontal functions and cognitive components that serve self-regulation (Roebers, 2017) and are the means for goal-directed behaviour (Barkley, 2012, p. 60).

In their seminal article, Miyake et al. (2000) presented three EF processes, namely inhibition, working memory (or updating) and cognitive flexibility (or set sifting), which have been largely accepted as the core constructs or processes of EF (Diamond, 2013) and are involved in self-regulation and self-control processes. Inhibition refers to stopping prepotent actions and exercising control over inner impulses. Working memory involves holding and updating information in mind while performing operations that serve goal-directed behaviour. Cognitive flexibility or set shifting enables changing one's focus of attention between task demands and strategic approaches. These three processes are theoretically distinct but are constantly functioning in interactions (Roebers, 2017). Of these three processes, inhibition and working memory develop early and establish the foundation for cognitive flexibility (Nigg, 2017). Together, these three processes enable the development of more complex EF, i.e. reasoning, problem solving and planning (Diamond, 2013). Complex EF could be understood as the deliberate control and selection of behaviours and strategies that enable the attainment of future goals, and basic EF processes control cognition, serving the function of complex EF (Nigg, 2017).

Historically, EF has been described as top-down and deliberate processes that require cognitive information processing, reasoning and action sequencing. EF has also been used to refer to cognitive control over mental processes, without a clear connection to emotional regulation or social extent. However, many authors have recently employed a broader perspective of EF as well. According to this view, top-down processes orchestrate and exert control over one's motivationally significant behaviour and internal states, including emotions (Barkley, 2012, p. 26; Diamond, 2013; Nigg, 2017; Zelazo & Carlson, 2015). Accordingly, prefrontal networks are involved in several processes that are also

involved in emotion regulation, and they mediate emotional information that facilitate EF and self-regulation (Blair & Diamond, 2008; Blair & Raver, 2015; Ursache et al., 2012). Barkley (2012) highlighted the importance of EF also in social adaptation and in managing social and emotional behaviour as well as emphasized social adaptation as one of the most important roles of EF. The ability to function in social relationships enables the distribution and exchange of cultural information and learning in social contexts that are necessary for living in society. Altogether, EF is an essential part of self-regulation, and it could be regarded as volitional and effortful processing that are involved in all top-down information processing, including cognitive and executive control, cognitive information management, strategic planning, and emotion and behaviour regulation in social interactions (Barkley, 2012, p. 60; Nigg, 2017).

1.2 Self-regulatory efficacy and sources of self-efficacy in school context

According to social cognitive theory, humans strive to be agents of their own lives and intentionally influence the course of events through their own actions and behaviours (Bandura, 2012). The sense of agency is influenced by the beliefs an individual holds about one's own capabilities to exercise control over actions, thoughts and emotions (Pajares, 2002). The beliefs create situational expectations and moods that influence how actions and outcomes will be realized. A salient framework for the study of confidence-related self-beliefs is the theory of *self-efficacy* (Bandura, 1997). Self-efficacy refers to the individual's certainty about his/her ability to accomplish and execute different activities or given attainments. Thus, these efficacy appraisals are always specific to distinct domains of activities and particular behaviours (Pajares, 2002). Self-efficacy plays a significant role in cognitive processes that influence and modify thought patterns, emotional reactions, motivation and behaviour (Feltz, Short, & Sullivan, 2008). It is, therefore, a critical determinant of what tasks individuals are ready to undertake and how persistent they are with the tasks (Bandura, 2012). Hence, in the learning context, pupils who are highly confident in their academic skills engage more in learning activities and challenging tasks and, consequently, gain more practice, which leads to enhancing their skills (Klassen, 2010).

A theoretical framework for investigating individuals' confidence in regulating their own actions and reactions is the construct of self-efficacy for self-regulation (self-regulatory efficacy; Ahn, Bong, & Kim, 2017; Usher & Pajares, 2008). In the school context, self-regulatory efficacy refers to pupils' beliefs in their ability to regulate and have control over their own thoughts, emotions and behaviour in a variety of on-task and learning situations (Zimmerman, 2008). Likewise, since pupils with high academic self-efficacy are engaged and show a high level of effort in academic learning (Usher & Pajares, 2008), it can be assumed that pupils with high self-regulatory efficacy engage in strategic

learning and self-monitoring in on-task settings. Accordingly, self-regulatory efficacy has been shown to have a great impact on children's and adolescents' academic success and outcomes (Caprara et al., 2008). In the school setting, both self-regulation and confidence are linked with a variety of circumstances, school subjects, and problem solving and social situations. Therefore, not only difficulties in self-regulation and EF skills (Best, Miller, & Naglieri, 2011) but also low self-regulatory efficacy may undermine academic functioning and development (Klassen, 2010).

Self-efficacy is developed and revised through experiences. According to Bandura's (1997) theory, self-efficacy is developed and modified through four primary sources: (1) mastery experiences, i.e. interpretations of past performance accomplishments; (2) vicarious experiences, i.e. information obtained from reference groups' actions and modelling; (3) social persuasions, i.e. verbal persuasion, support and evaluative feedback from significant others; and (4) physiological and emotional states, i.e. emotional and physical arousal and interpretations of these in different conditions. The same sources have also been shown to influence the formation of self-regulatory efficacy (Joët et al., 2012). Previous research has established that among students, mastery experiences are the most powerful efficacy-building source and have the strongest influence on academic self-efficacy and self-regulatory efficacy (Ahn et al., 2017; Hampton, 1998; Usher & Pajares, 2006). In addition, previous studies have shown that heightened emotional and physiological states have a negative influence on self-regulatory efficacy (Joët et al., 2011; Usher & Pajares, 2006), and they are associated with low academic achievement (Chen & Usher, 2013). Otherwise, findings concerning the influence of the other sources vary according to the context of the assessment and the group studied. For example, as children grow, their experiences accumulate and their skills mature; thus, they become more competent with interpreting situational information, which leads to greater variability in self-appraisals (Ahn, et al. 2017; Usher & Pajares, 2009). In addition, the weighting of the source information may vary between different school subjects (Butz & Usher, 2015).

In previous studies among students, *self-regulatory efficacy* has been assessed mainly with questionnaires that tap into the manifestation of complex EF, i.e. how confident students are in their abilities to guide and motivate themselves to organise learning situations and get tasks done (Hampton & Mason, 2003; Klassen, 2010; Usher & Pajares, 2006). In contrast to these earlier studies, self-regulatory efficacy items in the present research covered instances in which children might be in demanding situation (distractions) or under pressure (test situations or difficult tasks), and in which they needed self-regulation and EF to accomplish tasks (see Bandura, 2006). For example, '*How confident are you that you can get yourself to study when there are other interesting things to do?', 'How confident are you that you can push on even if the tasks are difficult?', 'How confident are you that you can get yourself to do schoolwork during class even when the tasks make you nervous?'* Furthermore, the self-regulatory questionnaire used in the present study did not include items about motivation or organisational abilities in the learning setting. In a similar vein, previous studies on *sources of self-regulatory*

efficacy have used questionnaires in which the participants rated items covering experiences on general academic domains, e.g. *'I got good grades in school last term'* (Usher & Pajares, 2006), or specific academic subjects, e.g. *'I have always done well on mathematics assignments'* (Joët et al., 2011). However, they did not include items that tapped directly into self-regulation in school tasks or learning situations. In the two original papers of this dissertation, sources of self-regulatory efficacy were scrutinised with items that assessed control of attention and interference, executive control and emotion regulation in learning and on-task situations. For example, *'I have always been able to focus on tasks during class'* (mastery experiences); *'If I have any problems in class, I feel so nervous that I am unable to focus'* (physical and emotional states). This approach was selected, as our aim was specifically to investigate self-appraisals related to control aspect of self-regulation, and how these self-appraisals are connected with attention deficits and problems in basic academic skills.

1.3 Problems of self-regulation in the school setting

Self-regulation is required in a variety of learning and problem-solving situations. Likewise, problems with self-regulation and EF may affect many school activities in which the pupils are involved. These problems manifest themselves not only in the child's behaviour but also in his/her mental processes, impairing learning and academic achievements. Problems with self-regulation are associated with many childhood deficits and developmental difficulties, i.e. conduct problems (Lochman, Powell, Whidby, & FitzGerald, 2012), autism spectrum disorders (Hill, 2003), and externalising and internalising disorders (Kendal, 2012). In the school context, severe deficits in self-regulation are commonly related to attention deficits and hyperactivity disorder (ADHD; Barkley, 2006; Hinshaw & Arnold, 2015). Self-regulation problems, perhaps more specifically problems in executive control, especially those related to fluent and automatic information processing, are connected with learning difficulties (Hecht, 2002; Pikulski & Chard, 2005). Although, learning difficulties (LD) are associated with self-regulatory and EF problems (Fuchs & Fuchs, 2015), LD themselves do not necessarily cause problems in self-regulation and EF. Rather, LD may negatively affect self-regulatory resources and competencies for managing on-task and learning situations. Dysfluent basic skills strain attention resources and working memory capacity (Pikulski & Chard, 2005). In contrast, well-developed and fluent basic academic skills allow attention resources and working memory capacity to focus on the characteristics of the tasks and problem solving (Fuchs, Geary, Fuchs, Comptom, & Hamlett, 2016; Geary, Hoard, Nugent, & Bailey, 2012).

Common inattention problems, that is, attention deficits with or without a formal ADHD diagnose, overlap with poorly developed basic EF, i.e. inhibition, working memory and cognitive flexibility (Hinshaw & Arnold, 2015), which results in below age level and impaired development of complex EF and goal-directed behaviour (Meltzer, 2010). An inability to focus on relevant information

and prevent the mind from wandering may result in relying on irrelevant information (Diamond, 2013). Poor inhibitory control and inferior response inhibition are associated with a tendency to react quickly and without essential forethought (Milch-Reich, Campbell, Pelham, Connelly, & Geva, 1999), which undermine the development of cognitive flexibility (Diamond, 2013) and cognitive control (Nigg, 2017; Sonuga-Barke, 2002). Stimulus-driven impulsivity results in situational choices that are short-sighted and do not benefit long-rewarding goal-oriented behaviour (Nigg, 2017).

Altogether, in the educational setting, both LD and attention deficits can create difficulties in attention control and the integration of different cognitive and academic subskills into planning, information processing and self-monitoring, which may all interfere with the development of working habits and may have a long-lasting influence on academic achievements (Meltzer, 2010).

Self-regulation does not only manifest itself in academic or other 'cold' information and on-task situations but also in emotion regulation (Blair & Raver, 2015). Ineffective self-regulation and EF make individuals vulnerable to emotional and behavioural disturbances (Martel et al., 2017). Inferior cognitive control may also expose individuals to high levels of negative emotionality and stimulus-driven reactivity, resulting in conflicts in social interactions (Hofmann, et al., 2012). However, an individual's development of self-regulation is a balance between cognitive control and emotionality. Emotions do not only disrupt goal-directed actions; they must also be understood as the willpower and motivator needed to attain goals (Barkley, 2012, p. 26). Thus, self-regulation plays a critical role in suppressing disruptive and negatively loaded emotions and prompting positive emotions that facilitate persistence and effort when cognitive control is needed (Blair & Diamond, 2008)

1.4 Self-regulatory efficacy and learning-related difficulties

Earlier in this review, it was argued that basic academic, self-regulatory and EF skills affect the development of self-regulatory efficacy. It was also suggested that a reciprocal relationship exists between scholarly difficulties and learning experiences in school-related activities and self-regulatory efficacy. Accordingly, attention and EF deficits and LD may influence the sense of control and agency in on-task performances; therefore, pupils with these problems probably have fewer positive experiences to support self-regulatory efficacy.

Only a few studies have investigated self-regulatory efficacy among pupils with LD (Hampton & Mason, 2003; Klassen, 2010), and no studies have researched this issue among pupils with attention and EF deficits. However, some research has been conducted on general academic self-efficacy among students with ADHD. These studies revealed that students with ADHD have lower academic self-efficacy compared to their typically achieving peers (Tabassam & Grainger, 2002). There are also indications that among students with ADHD, self-efficacy has a stronger connection with academic achievements

than among non-ADHD students, suggesting that for students with ADHD, a sense of confidence has a greater influence on their perseverance compared to their peers (Martin, Burns, & Collie, 2016).

The existing studies specifically concerning self-regulatory efficacy among pupils with LD have shown that pupils with mathematics and reading difficulties (Hampton & Mason, 2003; Klassen, 2010) report lower self-regulatory efficacy and have less efficacy-building experiences, i.e. sources, than their peers. Interestingly, in Usher and Pajares' (2006) study, pupils with weak reading ability did not differ in self-regulatory efficacy from their peers even though they reported fewer mastery experiences and higher level of physiological and emotional states.

In addition, pupils' levels of basic academic skills have been shown to influence the relationship between sources of efficacy and self-regulatory efficacy. In Hampton and Mason's (2003) study, LD was connected to self-regulatory efficacy indirectly through sources. In their analyses, Hampton and Mason used a single composite score to reflect sources of self-efficacy. Thus, their findings do not reveal the unique effects of various sources on self-regulatory efficacy. Usher and Pajares (2006) examined the unique effects of different sources on self-regulatory efficacy among elementary school pupils with different levels of reading ability. Their findings showed that all sources were significantly related to self-regulatory efficacy in the full sample. Mastery experiences had the strongest connection with self-regulatory efficacy in pupils whose reading skills were at or above their grade level. In addition, for pupils with reading skills above grade level, emotional and physiological states, and for pupils with reading skills at grade level, social persuasion had an effect on self-regulatory efficacy. However, among pupils with low-level reading skills, only emotional and physiological states were connected (negatively) with self-regulatory efficacy. This suggests that pupils who are struggling with their learning are prone to negative emotional experiences and do not benefit from past mastery experiences, which impairs their confidence in their regulation capabilities. To date, very little is known how attention deficits or different learning difficulties (reading, mathematics and comorbid) affect school-aged children's self-regulatory experiences. In addition, much uncertainty exists about the relationship between sources and self-regulatory efficacy among pupils with attention deficits. Therefore, more research is needed in order to fill this gap in literature.

1.5 Interventions on self-regulation, attention and EF among elementary school pupils

Psychosocial interventions targeting self-regulation and EF have been developed and designed to meet different goals. Specific goals of the interventions have ranged from improving pupils' social skills (Evans et al., 2016), emotion

regulation (Blair & Raver, 2015), information processing skills (Boyer, Geurts, Prins, & Van der Oord, 2015; Deaño, Alfonso, & Das, 2015; Meltzer, 2010), organisational skills (Langberg et al., 2017) and to decreasing their disruptive behaviour (Hinshaw & Arnold, 2015). All these approaches are relevant for supporting the self-regulatory abilities necessary for learning in school settings. Perhaps the most extensive work has been conducted in developing interventions for attention and EF problems and, specifically, ADHD. As symptoms of ADHD, i.e. problems with inhibition and impulse control, hyperactivity, inattention, social impairments and motivational deficits (see Pfiffner, DuPaul, & Barkley, 2006), are associated with different areas of self-regulation, interventions for ADHD have also established guidelines for psychosocial interventions for self-regulation and EF in many ways.

The reviews of the evidence-based practices for children with ADHD have implicated the effectiveness of the behavioural treatments (Evans et al., 2017; Fabiano, Schatz, Aloe, Chacko, & Chronis-Tuscano, 2015). Usually, the interventions have focused on behaviour management in classroom settings and the home environment and involved manipulation of situational contingencies. Behavioural changes are expected to result from clearly displayed behaviour expectations and operant conditioning; that is, increased target behaviour is achieved by reinforcements and rewards. Especially among children with attention deficits, one of the core problems is an aversion to delayed rewards (Sonuga-Barke, 2002). Therefore, rewards and consequences of behaviours and actions should be delivered frequently and with a necessary magnitude to have an effect on the children's behaviour (Pfiffner et al., 2006).

Overall, there seems to be a consensus among different authors that in order to gain intervention benefits, the delivery settings should be relevant to the objectives of the intervention, and the interventions should be implemented in contexts where the problems arise and interfere with daily functioning (Abikoff, 2009; Chronis, Jones, & Raggi, 2006; DuPaul et al., 2012; Meltzer, 2010). Although behavioural methods are effective in reducing disruptive behaviours in school settings, they may not have an effect on the EF skills necessary for academic learning, i.e. information processing, attention and executive control. In addition, it has been suggested that the behavioural improvement gained with contingency-based behavioural interventions is limited only to the situations where the contingencies were delivered, and generalization is weak across different situations (Abikoff, 2009). Therefore, interventions should not only target disruptive and impulsive behaviour, but they should aim at skill-building and teaching strategies that compensate impairments. Children should be taught behaviours and skills that are necessary for them to function adequately in multiple settings (Abikoff, 2009; Fuchs & Fuchs, 2015).

Previous research has indicated that academic interventions and explicit skills teaching that focus on the acquisition of basic academic skills, materials use and instructions have resulted in positive academic outcomes among children with ADHD and children at-risk for academic difficulties (Kearns & Fuchs, 2013). In addition, instructing children in strategy use, such as problem solving and

information processing skills, has improved attention control, time management and task completion in task situations (Meltzer & Bagnato, 2010; Pfiffner et al., 2014). Increased time used on tasks and enhanced task completion are expected to result in improved learning and academic outcomes. Importantly, the effective use of strategies is associated with higher motivation, self-efficacy and effort, and thus has an influence on persistence in school tasks and, ultimately, academic outcomes (Meltzer & Bagnato, 2010).

Many interventions that effectively promote self-regulation and EF in the school context are comprehensive and integrate methods and approaches from different traditions. Usually, they combine behavioural intervention elements with skills practices. Although traditional methods of cognitive-behavioural therapy have not been shown to be effective for decreasing self-regulation problems in children or adolescents with attention and EF deficits (Pelham & Fabiano, 2008), some of the skills training programmes have successfully used cognitive-behavioural therapy techniques, such as cognitive restructuring, as part of adolescent interventions (Boyer et al., 2015).

In addition to supporting academic skills and behavioural control, pupils with self-regulatory problems should be helped with their motivational and emotional regulation (Blair & Diamond, 2008). It has also been suggested that integrating different methods, i.e. skill-building practices, behavioural management procedures and explicit feedback or extrinsic rewards, will also increase motivation towards self-regulation among pupils and students with self-regulatory deficits (Miller & Hinshaw, 2012). Feedback methods that emphasise effort, sustained attention and the use of learned information processing strategies may promote a positive attitude toward academic goals and learning (Meltzer, 2010). However, the benefits from focused interventions on self-regulation and EF can be limited if the individual's emotional, social or physical well-being are compromised. It has been suggested that the most effective interventions not only teach and modify abilities and behaviours but also indirectly support self-regulation and EF by reducing the effects of factors that hinder progress in these skills (Diamond & Ling, 2016). At best, interventions advance social relatedness, increase positive moods, and decrease experiences of stress (Diamond & Ling, 2016; Kendal, 2012).

Children's willingness and persistence in using strategies and control over their actions are also dependent on their sense of confidence in managing particular situations. Therefore, it is advisable that interventions target both regulatory abilities and confidence. Previous research has shown that children with LD build their confidence for academic self-efficacy mainly on past successful accomplishments, i.e. mastery experiences (Butz & Usher, 2015; Hampton, 1998; Joët et al., 2011; Usher & Pajares, 2008). Relationships between abilities, motivation and confidence are reciprocal: improved self-regulation and EF promote children's agency and motivation to use specific strategies and behaviours, and eventually 'enhance their motivation to continue additional cycles of learning' (Zimmerman, 2008, p. 179).

1.6 Aims of the research

The three original studies were part of the Self-Efficacy and Learning Disability Intervention (SELDI: 2013–2015) research project. The studies had two main goals. The first was to investigate elementary school pupils' self-regulation–related experiences. The second was to study the effect of group-based intervention on attention and EF skills. The intervention was targeted at pupils with attention and EF difficulties.

The main interest in Study I and II of this dissertation was to scrutinise how elementary school pupils report their self-regulatory efficacy and sources of efficacy (control of attention, cognition, emotions and actions in learning and on-task situations) and how attention and EF difficulties and low-level basic academic skills influence on these self-appraisals. In Study I, the aim was also to study how source experiences are connected to self-regulatory efficacy and if different sources influence self-regulatory efficacy with the same weight in the attention and EF difficulty group and the peer group. In Study II, variations in the sources of self-regulatory efficacy were analysed using latent profile analysis (LPA) to discover different source profiles and subpopulations among participants, and how pupils with low-performance (pupils achieving below grade level in reading, mathematics or both [comorbid learning difficulties]) are distributed in the profile groups. In addition, variations of self-regulatory efficacy and academic skills were investigated across different source profile groups.

In Study III, a group-based intervention for pupils with attention and EF deficits was implemented in elementary school settings as part of special education. The intervention used in in this study is based on previous intervention studies and findings among children with ADHD. The intervention was aimed at improving executive skills and functioning in on-task situations. The main purpose of the study was to investigate the effects of the intervention on pupils' on-task behaviour in the classroom setting and on their learning. Pupils' attentive behaviour and complex EF were investigated with teacher-rated questionnaires. The ratings tapped into the diagnostic behavioural core symptoms of attention deficits (inattention, impulsivity and hyperactivity; Sonuga-Barke et al., 2013) and behavioural manifestations of EF (executive control). In addition to the intervention effects on these behavioural markers, the development of reading and arithmetic fluency were assessed to investigate the intervention effect on these basic academic skills. Teacher-rated observations and academic tests were used as the focus was on the possible generalisation of intervention effects outside the intervention context.

2 OVERVIEW OF THE ORIGINAL STUDIES

2.1 Study I: Self-regulatory efficacy and sources of efficacy in elementary school pupils: Self-regulatory experiences in a population sample and pupils with attention and executive function difficulties

In Study I, of special interest was to investigate source-related experiences and connections between sources and self-regulatory efficacy in two groups of elementary school pupils: a population-based sample and pupils with attention and EF difficulties. First, self-regulatory efficacy and its four sources were compared between the two groups. Second, connections between sources and self-regulatory efficacy were investigated in both groups, as well as whether there were differences between the groups in how the sources influenced self-regulatory efficacy.

2.1.1 Participants

In Study I, the participants were from two different samples. The first of these was a large sample of elementary school pupils from Grades 2 to 5 (PS group; n = 1,284, age M = 9.96 years and SD = 1.06, 48.3% girls and 51.7% boys) from 20 different elementary schools in Eastern and Central Finland. The school districts were urban, suburban and rural. All participants followed the standard curriculum.

The second sample were pupils from Grades 2 to 6, who were identified in school with problems of attention and EF problems (AED group; n = 61, age M = 9.94 years and SD = 1.19, 12.7% girls and 87.3% boys). All participants in the AED group followed the normal school curriculum. Pupils in the AED group were from 14 different elementary schools in Southern, Central and Eastern Finland, and like the PS group, the schools were from urban, suburban and rural areas. Inclusion in the AED group was based on teachers' evaluations and consisted of three criteria: (1) pupils had observable symptoms of attention and EF deficits, (2)

pupils had problems in daily school routines that were caused by attention and EF deficits, and (3) these deficits were reasons for attending special education support.

2.1.2 Measures and statistical analysis

The outcome measures were the self-regulatory efficacy and sources of self-efficacy questionnaires filled in by pupils. The questionnaire of self-regulatory efficacy consisted of eight items and assessed pupils' confidence in their abilities to manage their own behaviour and control task performances in academic learning situations. The items measured especially control of attention and interference and emotion regulation. The sources of self-regulatory efficacy questionnaire consisted of 13 items (four on mastery experiences, two on vicarious experiences, four on social persuasion and three on emotional and physiological states items), measuring regulation experience related to academic on-task situations. Both questionnaires utilised a seven-point Likert scale ranging from *I'm totally confident I can't* (1) to *I'm totally confident I can* (7) in the efficacy questionnaire, and from *never true* (1) to *always true* (7) in the sources questionnaire. The assessments were conducted in groups in the pupils' schools.

First, the measurement model was tested, which consisted of one self-regulatory efficacy factor and four sources of self-regulatory efficacy. Next, group mean score differences in efficacy and sources between the AED and PS groups were assessed, and last, using the Cholesky decomposition method, multiple regression analyses were done to estimate the unique influences of four sources of self-efficacy on self-regulatory efficacy beliefs. The effects of age, gender, and reading and math skills were controlled for in all analyses.

2.1.3 Results and conclusions

The model fitted the data well and supported the proposed theory-based structure of the one self-regulatory efficacy factor and the four sources of efficacy factors. The group comparisons indicated that pupils in the AED group rated their self-regulatory efficacy lower and reported fewer mastery experiences and more negative emotional and physiological states experiences compared to their peers. The results of regression analyses showed that in both groups, mastery experiences and emotional and physiological states explained the highest proportion of variances in self-regulatory efficacy. Although interactions between groups, sources and self-regulated efficacy were not significant, some differences in source-efficacy connections were detected. First, in the PS group, sources of self-regulatory efficacy shared a high amount of variance, and therefore, individual sources had a very small or no unique effect on self-regulatory efficacy. In the AED group, unique effects of significant connections were higher than in the PS group, indicating that sources had fewer shared variances. Second, in the AED group, vicarious experiences had a significant negative connection with self-regulatory efficacy, whereas in the PS group, vicarious experiences had no connection with self-regulatory efficacy.

The conclusions were that attention and EF-related problems were associated with lower self-regulatory efficacy and fewer positive efficacy-building experiences. Among pupils without such problems, the accumulation of multiple positive source experiences were associated with higher efficacy. The findings also demonstrated that pupils with attention and EF problems had a higher tendency for negative emotional and physiological reactions that might further undermine their building of regulatory confidence. In addition, among pupils with attention and EF problems, vicarious experiences, i.e. peers' successful regulation accomplishments, do not necessarily support efficacy building and, on the contrary, may increase the sense of incapability and undermine self-regulatory confidence.

2.2 Study II: Is the variation in sources of self-regulatory efficacy connected with self-regulatory efficacy and basic academic skills among children?

In Study II, the same self-regulatory efficacy and sources of self-regulatory efficacy questionnaires as in Study I were applied to examine confidence in regulatory capabilities and regulatory experiences among elementary school pupils. The first aim was to examine variations in sources of efficacy among all the participants with LPA. The aim was to identify subgroups with similar profiles of sources of efficacy and to investigate whether emerged latent profile groups showed differences in their self-regulatory efficacy and basic academic skills, and to analyse how differently performing pupils were clustered in the profile groups and whether low-performing pupils were clustered in certain profile groups. Last was investigated possible group differences in self-regulatory efficacy and sources of efficacy between typically and low-performing pupils.

2.2.1 Participants

The participants of Study II consisted of the population sample that was introduced in Study I. The participants were divided into four different subgroups based on performances in reading and arithmetic tasks. Four basic academic skills groups were typically achieving pupils (TA; n = 1,011, girls 50.6%), low performance in reading (n = 90, girls 36.7%), low performance in mathematics (n = 117, girls 51.3%) and comorbid low performance in reading and mathematics (n = 66, girls 33.3%). Low performance in both reading and mathematics was defined as a deviation of more than one standard deviation from the mean of the sample.

2.2.2 Measures and statistical analysis

In this study, the self-regulatory efficacy and sources of self-regulatory efficacy measures were the same as those in Study I. Basic reading skills were assessed with reading fluency tests, and mathematical basic skills with addition and subtraction fluency tests and a basic arithmetic test. The first, data was explored using LPA to discover groups of pupils with similarly rated sources of self-regulatory efficacy. The next, the analyses aimed to determine whether there were differences in the self-regulatory efficacy and academic basic skill mean scores between the different profile groups and how pupils with low performance were distributed in different profile groups. Last was explored group differences in self-regulatory efficacy and sources of the four reading and mathematics performance groups.

2.2.3 Results and conclusions

LPA showed the best fit for a five-class solution, and the emerged five profile groups varied both quantitatively and qualitatively. The largest proportion of pupils (48.4%) was in the *Positive multi-source* group with highly positive responses in all four source scales (above average values in mastery experiences, vicarious experiences and social persuasion and very few negative emotional states). The second largest group (29.4%) was the *Low social support* group in which both vicarious experiences and social persuasion were rated relatively low. Two groups, the *Negative states* group (11.1%) and the *Extreme negative states* group (4.0%), were characterised by high and very high negative emotional experiences, respectively, while the other three sources were near average values.

The most worrying group was the fifth group, the *Negative multi-source* group (7.0%), which was the negative contrast to the Positive multi-source group, as the pupils rated their mastery experiences, vicarious experiences and social persuasion experiences below average and reported high negative emotional experiences. These two groups were also on the opposite ends of the continuum in their self-regulatory efficacy; the Positive multi-source groups reported their self-regulatory efficacy higher than all the other groups, whereas the Negative multi-source group rated their self-regulatory efficacy lower than all the other profile groups. The Extreme negative states group reported the second lowest efficacy, and it was lower than the other three profile groups—Positive multi-source group, Low social support group and Negative states group. These findings, like Study I, support the hypothetical connection between sources and self-regulatory efficacy among children.

Pupils with low performance were distributed unequally across the profile groups: nearly two thirds of these pupils (65.3%) were in the profile groups with one or multiple low sources or were in groups that rated high negative emotional experiences. The proportion of typically achieving pupils in these groups with one or multiple low sources was clearly lower (45.6%). In addition, 20.1% of the low-performance pupils were in the Negative multi-source group and the Extreme negative states group, whereas only 8% of the TA pupils were in these

two group. The relative proportion of pupils with low performance in mathematics were distributed unequally. The ratios of these pupils were highest in the Negative multi-source group and the Extreme negative states group, indicating a connection between problems in mathematics and negative emotional experiences.

Group comparisons between basic academic skills groups revealed that low-performance groups reported lower self-regulatory efficacy and less mastery experiences, social persuasion and more negative emotional and physiological states than typically achieving pupils. However, the effect sizes of the statistically significant differences were small, indicating only minor differences between groups. Between the three low-performance groups, there were no significant differences in self-reported efficacy or sources.

This study demonstrated that there is great variation in self-regulatory experiences among elementary school pupils, and it supported the idea that self-regulatory experiences that tap into control of attention and interference, executive control and emotion regulation are connected to self-regulatory efficacy. The study also showed that low academic skills are a risk for negative self-regulatory experiences and negative emotional reactions in task situations, although the connection seemed to be weaker for low academic skills than it was for attention and EF problems (see Study I).

2.3 Study III: Group-based intervention on attention and executive functions in the school context

The aim of the study was to investigate the effect of a group-based intervention on attention and EF conducted in the school context. The intervention was targeted at pupils with attention and EF problems and aimed to improve adaptive on-task behaviour in the classroom setting.

2.3.1 Participants

The 90 participants were pupils from Grades 1 to 6, who were identified in school with problems of attention and EF. Sixty-two of them formed the intervention group (age M = 9.33. years and SD = 1.12, 80.77% boys), and 28 were in the waitlist control group (age M = 9.25 years and SD = 1.36, 78.57% boys).

2.3.2 Intervention

The used programme, Maltti (Patience; Paananen, Heinonen, Knoll, Närhi & Leppänen, 2011), is a theory-driven and group-based intervention for elementary school pupils with attention and EF problems. It can be implemented in an elementary school context and in accordance with the normal procedures of special educational support. The Maltti manual provides detailed instructions for conducting 20 sessions. The Maltti programme is a comprehensive behavioural,

cognitive and skill-training approach and aims to improve pupils' on-task behaviour. The programme consists of tasks and exercises that particularly aim to train skills needed in academic on-task situations, i.e. attention control, action selection and inhibition, planning and the use of strategies. SELDI research project personnel trained intervention providers. Altogether, 26 school staff members conducted 14 intervention groups. In 10 of 14 groups, intervention providers were novices in terms of the programme. In three groups, the intervention provider or the other of the two was also the participating pupils' classroom teacher.

2.3.3 Measures and statistical analysis

The outcome measures were norm-referenced and a teacher-completed rating scale, the ATTEX questionnaire (Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, & Korkman, 2010) and basic academic skills tests. The ATTEX assesses pupils' problems with attention and EF observed in the classroom setting. The outcome measure was the total score of the ATTEX questionnaire. Basic reading skills were assessed with reading fluency tests and basic mathematical skills with an addition/subtraction fluency test and a basic arithmetic skills test. ATTEX and academic skills were assessed at three time points—pre-intervention, post-intervention and follow-up. The statistical analysis aimed to explore changes in outcome measures at the three assessment time points.

2.3.4 Results and conclusions

The results of the teacher-rated ATTEX questionnaire did not indicate statistically significant intervention effects across the three time points (pre-, post- and follow-up). However, pairwise comparisons of different time points and groups showed an almost significant interaction ($F (1, 70.00) = 3.14$; $p = .08$; $\eta_p^2 = .04$) between pre- and post-assessments. Therefore, moderation analyses were conducted using the Johnson-Neyman method (Hayes, 2013). The results of the moderation analysis showed that the severity of attention and EF deficits influenced the intervention effect at pre- and post-assessments; pupils with low or moderately severe symptoms at the pre-intervention benefited more from the intervention than those with highly severe symptoms. An additional group comparison was conducted using a sample of pupils with low and moderate symptom severity. The differences between the groups were statistically significant both between the pre- and post-intervention assessments ($F (1, 40) = 19.94$, $p < .000$, $\eta_p^2 = .33$) and between the pre- and follow-up assessments ($F (1, 40) = 4.38$, $p = .043$, $\eta_p^2 = .10$).

The interactions of time and group in academic tests were not significant across the three time points (pre-, post- and follow-up). However, between pre- and post-intervention assessments, group and time interactions were significant for two of the four academic tests. The intervention group improved more in a simple word-recognition test and a simple addition/subtraction fluency test than the control group. The group and time effects between pre- and post-assessments

were not significant in the reading fluency test with the reading comprehension component and the arithmetic test with more complex tasks. This result indicates that improved attention control and span benefited performances especially in simple tasks. Altogether, the findings demonstrated that a comprehensive behavioural, cognitive and skill-training intervention for elementary school pupils with attention and EF problems improved their executive skills in classroom settings.

3 DISCUSSION

The present dissertation had two goals. First, it focused on how elementary school pupils evaluate their self-regulatory efficacy and its sources, i.e. experiences that influence and develop efficacy beliefs. Specific objectives were to investigate how learning and attention and EF difficulties influence confidence in managing school activities and on-task situations, and whether these difficulties are associated with sources of self-regulatory efficacy or have an influence on efficacy building. The second aim was to investigate the effects of a theory-based self-regulation intervention in the school context on attention and EF in on-task situations among pupils with attention and EF deficits.

3.1 Self-regulatory efficacy and its sources among elementary school pupils with or without learning-related problems

The results of the present research revealed that great variations exist in the self-regulatory experiences of elementary school pupils. Most of the pupils reported highly positive self-regulatory efficacy and had positive source experiences, supporting efficacy beliefs. However, deficient executive skills and attention, reading and arithmetic fluency problems were associated with lower self-regulatory efficacy and fewer positive efficacy-building experiences. This was evident in Study I, when pupils with attention and EF difficulties (AED group) and pupils in the population-based sample (PS groups) were compared. Pupils in the AED group reported on average lower self-regulatory efficacy (Cohen's d = 0.48), fewer mastery experiences (Cohen's d = 0.56) and more negative emotions and physiological states (Cohen's d = 0.86) in learning situations than pupils in the PS group. It is noteworthy that the difference between the groups was especially large for emotional and physiological states.

In Study I, a theory-based source–efficacy connection was investigated in more detail among pupils using regression analysis. It was found that the explanation ratios of the source factors together explained 56% of the total

variation of self-regulatory efficacy in the AED group and 54% in the PS group. The findings supported the relevance of mastery experiences and were consistent with previous findings (Butz & Usher, 2015; Chen & Usher, 2013; Hampton, 1998; Joët et al., 2011; Usher & Pajares, 2006). In both groups, mastery experiences had the highest unique influence on efficacy. Emotional and physiological states also had a statistically significant connection with self-regulatory efficacy in both groups.

In addition to the similarities, some differences in the source–efficacy connection were detected between the groups. In the AED group, unique effects of the different sources on efficacy were higher than in the PS group. This suggests that among pupils with attention and EF-related problems, sources share less common variances, and the weight of the particular source–efficacy connection varied more strongly between individuals in the AED groups and, thus, have higher unique explanation ratios than the PS group. In the PS group, sources correlated highly, and at the same time, sources had low or no unique effect on self-regulatory efficacy, indicating that the sources shared a substantial amount of variance. It is therefore likely that typically achieving pupils get multiple positive experiences, and they benefit from all source information. The availability of multiple sources has previously been shown to be related to favourable achievements (see Chen & Usher, 2013), and thus, they may be associated with higher self-regulatory efficacy (Usher & Pajares, 2006). Among pupils with attention and EF problems, the accumulation of different positive source information may be weaker, contributing to lower self-regulatory efficacy compared to pupils without attention and EF problems.

The second difference in the source–efficacy connection between groups was that in the AED group, vicarious experiences had a negative association with self-regulatory efficacy, whereas in the PS group, vicarious experiences had no effect on self-regulatory efficacy. Though many previous studies have shown that the effect of vicarious experiences on efficacy varies depending on modelled behaviours or skills or who is modelled, no other study has previously detected negative effects of vicarious experiences on efficacy (see also Ahn et al., 2017; Joët et al., 2011). Our result suggests that among pupils with attention and EF difficulties, peers' successful regulatory behaviours in the classroom may increase the sense of incapability in task-related activities rather than support self-efficacy. The likelihood of relying on modelled actions and behaviours is higher when individuals have poor knowledge of their capabilities to perform particular actions or tasks (Usher & Pajares, 2008). This is in contrast with the classroom situations where many tasks or behaviours are familiar to all pupils, and they are expected to be easily mastered. Therefore, others' mastery over self-regulatory behaviours in classroom settings may not serve as a model for correct situational behaviour. Instead, it can turn out to be negative feedback for pupils with attention and EF difficulties, when they observe that they are not meeting the expectations.

Altogether, Study I supported the theory-based connection between sources of self-regulatory efficacy, i.e. regulation experiences in the academic

context, and self-regulatory efficacy. The study also showed that attention and EF problems compromise the development of self-regulatory efficacy. The findings suggest that differences in self-regulatory efficacy between groups emerge partly through experiences, i.e. sources. Pupils with problems in attention and EF reported less positive sources and more negative emotional experiences and their physiological correlates, which may, according to the theory-based source–efficacy connection (Bandura, 1997), result in lower self-regulatory efficacy compared to their peers. In addition, in the AED group, the effect of vicarious experiences on efficacy was negative. This result was somewhat surprising given that the theory assumes positive vicarious influences. The finding concerning emotional and physiological states is in line with the stance that negative emotions and their physiological correlates may reinforce a cycle in which poor executive processes hinder gaining positive self-regulatory experiences (see Blair & Diamond, 2008). Given the findings of the study, self-regulatory efficacy and experiences are important issues for future research and the design of educational support for pupils with attention and EF deficits.

To analyse variations in the sources of self-regulatory efficacy in more detail, person-oriented LPA was conducted in Study II. Five profile groups emerged, showing great variations in self-regulatory experiences. The finding also supported the theory-based connection between sources and self-regulatory efficacy. The profile group with multiple low sources and the profile group with negative emotional experiences were connected with low self-regulatory efficacy. In addition, multiple low sources and high level of negative emotional experiences were associated with low level of academic basic skills. In contrast, pupils in the profile group with multiple positive sources reported higher self-regulatory efficacy than all the other groups and had the highest basic academic skill level.

Both pupils with low-performing and typically achieving (TA) pupils were found in all profile groups. However, the proportion of pupils with low-level basic academic skills was not distributed similarly across profile groups compared to the TA pupils. Almost two thirds of the pupils with low-performance (65.3%) were in the profile groups with low sources or high negative emotional experiences whereas less than half (45.56%) of the TA pupils were in these groups. In addition, one fifth of the pupils with low-performance belonged to two of the most 'problematic' groups, the Negative multi-source group and the Extreme negative states group, whereas only 8% of the TA pupils were in these two groups. This suggests that a large proportion of pupils with low-level basic academic skills may not be exposed to positive efficacy-building information to the same extent as their peers, and are therefore more prone to have an inferior sense of confidence in self-management in school and learning-related activities.

Furthermore, different low-performance subtypes were distributed differently in the five profile groups. The relative proportion of pupils with low-level reading skills was equal across profile groups, whereas the relative proportion of pupils with low-level arithmetic skills was highest in the Negative

multi-source group and Extreme negative states group, and comorbid low-level reading and arithmetic skills was highest in the Extreme negative states group. This finding indicates, in accordance with previous studies, that problems in learning mathematics may be associated with deficient working routines, regulatory weaknesses and negative emotional reactions or even anxiety (see Ma, 1999; Sorvo et al., 2017; Wu, Willcutt, Escovar, & Menon, 2014). However, more research is needed to gain a better understanding of the self-regulatory experiences of pupils with problems in learning mathematics.

The emotional and physiological states source factor was sensitive in detecting differences in efficacy-building experiences among elementary school pupils, and this finding supports the view that the emotions and their physiological correlates play a pertinent role for self-regulation in learning settings (Ursache et al., 2012). The results also indicated that, in general, heightened negative emotions were associated with lower self-regulatory efficacy in school-task situations. According to Bandura (1997, p. 150), a high level of positive mastery experiences protects individuals from negative emotions and anxiety. However, according to our findings in Study II, this is not necessarily true for everyone. As the results of the LPA revealed, in two groups (Negative states and Extreme negative states), pupils rated their mastery experiences high, but they also reported negative emotional/physiological states that clearly deviated towards a negative direction from the average scores. These two groups also reported low self-regulatory efficacy. This result indicates that, although some pupils may have good on-task skills and manage successfully on-task and learning situations, their positive self-regulatory mastery experiences do not necessarily prevent them from experiencing negative emotions (nervousness and tension in this case) in academic activities. In addition to pupils with low-level basic academic skills, these two groups may include pupils in pursuit of higher grades who may therefore have performance anxiety (see also Parhiala, Torppa, Vasalampi, Eklund, Poikkeus, & Aro, 2018). It is possible that negative emotional reactions create a self-perpetuating loop as low control over emotions negatively influences self-regulatory efficacy, and low efficacy beliefs are associated with the emotions that one wishes to avoid. Therefore, the ability to control negative emotions and cope with negative thoughts may be more essential for reducing performance anxiety than self-efficacy in specific skills (Feltz et al., 2008).

Last, in Study II, was explored group differences in self-regulatory efficacy and sources of the four reading and mathematics performance groups. The results revealed that low-performing pupils in basic reading and/or arithmetic skills rated their self-regulatory efficacy lower compared to their typically achieving peers. In addition, they reported fewer mastery experiences, less social persuasion and more emotional and physiological states. However, the effect sizes of these statistically significant differences were very small; the Cohen's d ranged from 0.09 to 0.13, indicating minor differences. The findings suggest that the learning problems in basic academic skills do not necessarily reduce self-regulatory efficacy, and quite similar variances in self-regulatory experiences and

confidence would exist among low-performing pupils and their peers. This outcome was slightly different from what was detected in Study I, as pupils with attention and EF deficits rated clearly lower levels of efficacy, mastery experiences and emotional and physiological states than their peers, indicating that attention and EF problems have a stronger influence on regulatory experiences.

Overall, Study I and Study II supported the hypothesised connection between sources of self-regulatory efficacy, i.e. regulation experiences in the academic context, and self-regulatory efficacy. These findings, while preliminary, suggest that children are able to recognise and judge self-related regulation experiences. In addition, the results of Study I and Study II were consistent with previous findings (Hampton & Mason, 2003; Klassen, 2010; Usher & Pajares, 2006), indicating that learning-related difficulties have an influence on self-regulatory experiences and the sense of confidence in managing learning and on-task behaviours in classroom settings. Poor attention and EF and basic academic skills may undermine pupils' sense of control over different learning situations in school settings. The implication for support is that interventions should include skill-building practices, teach basic academic skills, and through skill acquisition, expose pupils to experiences that will build confidence in managing learning situations. Interventions should also support regulatory confidence by using effective feedback methods, building social relatedness and reducing exposure to negative emotions in learning settings (see below).

3.2 Intervention on attention and EF skills

The aim of Study III was to explore the effect of the group-based Maltti intervention, targeting attention and EF skills among pupils with attention and EF deficits. The intervention was implemented in school contexts in small groups during school hours and in accordance with customary special educational support procedures. The intervention was specifically aimed to improve on-task behaviour in the classroom.

The results showed that attention and EF behaviour in the classroom settings improved among the intervention participants during the intervention. Furthermore, maintenance of this improvement in behaviour was detected in the follow-up assessment the subsequent semester. However, a statistically significant intervention effect was detected between pre- and post-assessments and only among pupils with moderate symptom severity. This result indicates that the severity of the attention and EF deficits is associated with intervention outcomes, and pupils with severe problems would not benefit to the same extent from interventions that specifically target on-task behaviour as their peers with less severe symptoms. Similar influences of symptom severity have been detected previously in other interventions targeting school task-completion skills (Langberg et al., 2010; Owens et al., 2003). It is possible that increased levels of symptoms implicate not only attention problems but also severe problems of

disruptive behaviour. It can be surmised that, because the Maltti intervention focused on cognitive and learning-related executive skills and not specifically on hyperactivity/impulsivity or disruptive behaviour, significant changes in behaviour in the classroom setting could not be detected among pupils with high symptom levels in the pre-intervention assessment (see also Katajamäki, 2019).

Interestingly, a positive intervention effect was found between the pre- and post-intervention assessments also in academic skills, both in arithmetic fluency and basic reading skills. The severity of the pre-intervention symptoms did not moderate a gain in the academic tasks, which could indicate that the intervention had some effect on academic skills also among intervention participants with high symptom levels at the pre-intervention. The intervention effect could only be detected in simple academic tasks (reading and basic arithmetic fluency) but not in more complex mathematics reasoning and sentence reading and comprehension. This could indicate that the intervention improved attention control and span, and finally, the efficacy of task completion in simple tasks.

Although the results showed benefits for the intervention group and declining problems in the classroom settings, there was great variability in the changes among the participants, and thus, not all pupils reached low or even moderate symptom levels. However, among pupils who were identified as having a moderate level of pre-intervention symptoms, the changes in attention and EF skills in classroom settings were shown to be clinically meaningful. Their ATTEX mean score for attention and EF problems declined below the cut-off score for correctly identifying a diagnosis of ADHD, both in post- and follow-up assessments (cut-off score for boys 36.5 points; Klenberg et al., 2010).

Altogether, the findings of Study III indicate that a comprehensive school-based group intervention, combining behavioural, cognitive and skill training, was effective in reducing attention and EF deficits in the classroom setting and did also generalise to academic skills that were not practiced in the intervention. There are several possible reasons for the effectiveness of this type of intervention. School-based interventions on attention and EF deficits appear to be effective when the intervention goals are adequately related to the abilities needed in academic settings and when the intervention enables enough practising to achieve changes in behaviours and competencies *(*see Abikoff et al., 2009; Deaño et al., 2015; Langberg et al., 2012). Accordingly, the Maltti programme focused on only a few behaviours and skills that are supposed to benefit school task accomplishment: inhibitory control in on-task situations, prolonging attention span and time spent on focusing on relevant information and processing necessary actions. It can be assumed that the intervention improved the EF skills necessary for academic learning, i.e. sustained attention, information processing and executive control. In addition, the modelling practices aimed at the conscious use of strategies created the needed structure for behaviours and actions that helped to control and manage learning and on-task situations in the classroom context.

3.3 General conclusions and practical implications

As mentioned earlier, pupils with attention and EF deficits are prone to poor forethought and planning in on-task situations (Miller & Hinshaw, 2012). Therefore, they may fail to perform on the level of their true capacity. Underachievement and poor abilities to manage on-task situations may produce confusion and distress for both pupils with attention and EF deficits and those with poor basic academic skills. They may perceive themselves as less able to manage their emotions and stress reactions in learning settings. Negative emotions influence one's orientation to the environment, cognitive responses, and interpretations, and may therefore have a negative impact on overall wellbeing (Kendal, 2012).

The findings of this dissertation support the idea that school-based interventions should support both academic skills and confidence in skills management in learning situations. Learning-related self-beliefs evolve quickly as children enter school. Therefore, children with self-regulation and EF difficulties should be identified early, and they should receive support as soon as difficulties are identified. Study III of this dissertation showed that the intervention programme on attention and EF skills benefited children with attention deficits. This result was in a similar vein with other studies, indicating the effectiveness of psychosocial interventions (Abikoff et al., 2013; Deaño et al., 2015; Langberg et al., 2017; Pfiffner et al., 2014). These findings support the implication that children with problems of self-regulation, attention and EF should be systematically supported and with effective programmes. Without exception, all support methods try to build structures and predictable environments around children that enable them to regulate their own actions more easily and help them direct their energy with appropriate situational behaviour. In addition, an encouraging and reflective environment with an appropriate structure would not only facilitate the development of regulation. It would also support a sense of agency and self-regulatory efficacy.

As was previously concluded, children are able to recognise and judge self-related regulatory experiences, and these self-appraisals could be used as part of reflective interactions. Successful interventions emphasise non-specific effects, e.g. increased social relatedness, positive moods, and decreased experiences of stress, sadness and worry (Diamond & Ling, 2016; Kendal, 2012), which also support skill building indirectly in addition to those gained through 'cold' cognitive practices. The results of Study I showed that among pupils with attention and EF deficits, vicarious experiences do not support the development of self-regulatory efficacy and may even have a negative effect on efficacy. However, in a small intervention group where all participants have attentional and EF difficulties, the children may consider each other similar and, thus, serve more easily as positive models than peers in the classroom. In addition, in a small intervention group, it is possible to emphasise positive feedback that provides participants with regular and reliable information of their successful

accomplishments and progress in on-task skills. Altogether, successful on-task accomplishments (mastery experiences), positive feedback (verbal persuasion) and peer modelling (vicarious experiences) may increase social relatedness and engagement in academic activities, not only in small groups but also in classroom settings. Eventually, these experiences may decrease negative emotional reactivity and stresses and enhance self-regulatory efficacy, goal-directed behaviour and learning in the long term.

3.4 Limitations and suggestions for future research

The present research has some limitations that are worth noting. In both Study I and Study II, newly constructed self-regulatory efficacy and sources of efficacy questionnaires were used. Although in Study II, the invariance test showed that the structure of the scales was similar across the achievement groups, genders and grade levels, future studies should test whether the five factors of the questionnaires and the model are robust with other samples. It must be noted that the vicarious experiences factor consisted of only two questions. Although the vicarious experiences factor had a high Cronbach's alpha and fitted well in the measurement model, the factor would be more robust and reliable with additional items.

The second obvious limitation in Study I was the small number of participants in the AED group. More research should be conducted with a larger sample of pupils with attention and EF deficits to re-examine the measurement model and the unique effects of the sources on self-regulatory efficacy. The third limitation of Study I was that the occurrence of the problems of attention and EF were not evaluated in the population sample (PS group). Based on the prevalence rates of attention difficulties, it was expected that the PS group would include from 5% (ADHD diagnosed; Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007) to 16% (diagnosed with ADHD or exhibiting symptoms without clinical diagnosis; Barbaresi et al., 2002) pupils with attention and EF difficulties. Identification and exclusion of these pupils could have made the study design clearer. Study I showed that among pupils with attention difficulties, vicarious experiences had a negative connection with self-regulatory efficacy. Further studies focusing on vicarious experiences and on how different peer factors, e.g. similarity, gender or skill level, influence vicarious experiences in classrooms and how positive peer modelling could be improved and facilitated in the school setting should be undertaken.

Fourth, both Study I and Study II focused on subjective experiences and investigated regulatory confidence and experiences, relying mainly on self-reported data. Therefore, future studies should also use other sources of information that could enlighten the findings regarding self-regulatory experiences. For example, in assessments of emotional and physiological experiences, more objective assessment methods and data could be used beside self-reports. Physiological measurements and assessments could reveal real-time

situational reactions that could be integrated with self-reports and information related to academic performances in natural settings. This kind of procedure would provide a deeper understanding of how experiences of stress, anxiety or tension are connected with actual physiological reactions and learning as well as with other sources of efficacy (see Chen & Usher, 2013).

A major concern in the intervention study (Study III) was the small sample size; although, this is not rare in intervention studies conducted in natural settings. In addition, randomisation of the participating pupils or schools was not possible due to predefined groups of school personnel receiving training. Therefore, an intervention study with the same training method should be replicated with a larger sample and with randomised schools. An intervention study in a natural school environment is difficult to conduct blinded, and teachers are often inevitably aware of the status of participating pupils. Therefore, in the future, independent, blind observations and multi-informant methods should be included in a study to avoid possible bias caused by the potential expectancy effect.

A further study that focusses more on the factors affecting the treatment response is suggested. The intervention study only analysed the effect of ADHD symptom severity on intervention outcomes and revealed that high symptom severity was associated with poor intervention outcomes. Previous studies have also suggested that cognitive abilities and working memory (Fuchs et al., 2010) and social-emotional skills (Blair & Raver, 2015) influence learning across many domains. Further studies that consider cognitive abilities, working memory and symptoms of behavioural problems as moderators of intervention outcomes should be undertaken in order to determine who should be targeted for comprehensive interventions and which conditions are optimal for positive change.

YHTEENVETO (SUMMARY)

Itsesäätely ja toiminnanohjaus oppimistilanteissa: itsesäätelyn minäpystyvyys ja taitojen kehittäminen alakoululaisilla

Tällä väitöskirjalla on kaksi tavoitetta. Ensimmäinen tavoite on tarkastella lasten oppimistilanteisiin liittyvää itsesäätelyn minäpystyvyyttä erityisesti lapsilla, joilla on tarkkaavuuden ja toiminnanohjauksen ongelmia tai oppimisvaikeuksia. Toinen tavoite on tutkia itsesäätelyyn, tarkkaavuuteen ja toiminnanohjaukseen kohdentuvan intervention vaikutuksia tarkkaavuusongelmaisten lasten tehtävätilannekäyttäytymiseen luokkatilanteissa sekä akateemisten perustaitojen kehittymiseen.

Ihminen pyrkii proaktiivisesti, ja usein päämäärätietoisesti, säätelemään toimintaansa sekä muokkaamaan ympäristöään, jotta se edistäisi hänen toimintamahdollisuuksiaan. Tilanteiden ja itsen hallinnan tekee mahdolliseksi itsesäätelykyky. Yksinkertaisesti ja tiiviisti määriteltynä itsesäätelyllä tarkoitetaan kykyä säädellä omaa käyttäytymistä tilanteen vaatimusten mukaisesti. Jotta tämä tilannekohtainen säätely onnistuisi, ihmisen on kyettävä kohdentamaan huomio olennaisiin tilannetekijöihin sekä ohjaamaan omaa ajatteluaan, tunnereagointiaan sekä käyttäytymistään. Toiminnanohjaus tarkoittaa taitoja ja kognitiivisia prosesseja, joiden varaan itsesäätely rakentuu. Toiminnanohjauksen prosesseista keskeisiä ovat automaattisten tai yliopittujen reaktioiden hallinta, työmuisti ja tarkkaavuus (kohdentaminen ja ylläpito) sekä kognitiivinen joustavuus. Nämä mahdollistavat oman toiminnan ja käyttäytymisen säätelyn moninaisissa tilanteissa sekä tavoitesuuntautuneen toiminnan.

Käyttäytymiseen, toimintojen valintaan sekä toiminnan sinnikkyyteen vaikuttaa kognitiivisten kykyjen lisäksi se, kuinka vahvasti ihminen luottaa omiin kykyihinsä suorittaa tilanteiden vaatimia tai tavoitteen saavuttamisen kannalta vaadittavia tekoja. Arviota omista kyvyistä toimia ja suoriutua eri tilanteissa kuvaa minäpystyvyyden käsite. Aiemmat tutkimukset ovat osoittaneet, että minäpystyvyyden vaikutus suoritusten lopputulokseen voi olla suurempi kuin tilanteessa vaadittavien taitojen vaikutus.

Tilannekohtaiseen suoriutumiseen vaikuttaa erityisesti itsesäätelyyn liittyvä minäpystyvyys (self-regulatory efficacy) eli luottamus omiin kykyihin säädellä ajatuksia, tunteita ja käyttäytymistä suoritustilanteissa. Oppimistilanteissa juuri itsesäätelyn minäpystyvyys vaikuttaa siihen, kuinka yksilö ylläpitää tarkkaavuutta ja myönteistä mielialaa sekä ponnistelee tehtäväsuoritusten vaiheiden läpi.

Minäpystyvyys kehittyy ja muokkautuu ihmisen toiminnan ja ympäristöstä saadun palautteen sekä niihin liittyvien tulkintojen kautta. Sosiokognitiivisessa (Bandura, 1997) teoriassa nämä kokemukset on tiivistetty neljään pystyvyyden lähteeseen: onnistumiskokemuksiin, vertaiskokemuksiin (-oppimiseen), ympäristön antamaan palautteeseen ja kannustukseen sekä tilannekohtaisten tunnetilojen ja fyysisten tuntemusten tulkintaan (myöhemmin emotionaaliset tunte-

mukset). Aiemmat tutkimushavainnot ovat osoittaneet, että vahvimmin minäpystyvyyteen ovat yhteydessä onnistumiskokemukset. Muiden minäpystyvyyden lähteiden yhteys pystyvyyteen vaihtelee tutkittavan ryhmän, toiminnan ja tehtävän mukaan.

Tämän väitöskirjan kahdessa ensimmäisessä osatutkimuksesta tarkasteltiin alakouluikäisten lasten itsesäätelyyn liittyvää minäpystyvyyttä sekä lasten kokemuksia itsesäätelystään. Lapset vastasivat kysymyksiin, jotka koskivat itsesäätelyn minäpystyvyyttä (esim. "*Kuinka varma olet, että pystyt seuraamaan tarkasti opettajan antamia ohjeita?*") ja sen lähteitä (esim. "*Olen aina jaksanut keskittyä oppitunneilla opetukseen*", "*Ystäväni keskittyvät hyvin koulutunneilla*"). Sekä itsesäätelyn minäpystyvyyttä että sen lähteitä arvioitiin kysymyksillä, jotka liittyivät erityisesti tarkkaavuuden ja kognition sekä tunteiden hallintaan oppimistilanteissa. Aiempi tutkimus lasten itsesäätelyyn ja tehtävätilanteiden hallintaan liittyvistä kokemuksista on vähäistä.

Ensimmäisessä tutkimuksessa verrattiin itsesäätelyn minäpystyvyyttä ja sen lähteitä kahden ryhmän, tarkkaavuusongelmaisten lasten (n = 61) ja laajan väestöpohjaisen otosryhmän (n = 1 284), välillä. Lisäksi molemmissa ryhmissä tarkasteltiin kunkin itsesäätelyn minäpystyvyyden lähteen spesifiä yhteyttä (lähteiden yhteinen jaettu varianssi poistettu) itsesäätelyn minäpystyvyyteen: kuinka vahvoja yhteydet ovat kahdessa ryhmässä, onko niissä eroja ryhmien välillä ja minkä suuntaisia vaikutukset ovat? Tulokset osoittivat, että tarkkaavuusongelmaryhmässä lapset arvioivat itsesäätelyn minäpystyvyytensä heikommaksi kuin väestöotoksen lapset (Cohenin d = 0,48). Pystyvyyden lähteissä ryhmäero löytyi onnistumiskokemuksista ja emotionaalisista tuntemuksista: tarkkaavuusongelmaryhmässä lapset kuvasivat itsellään olevan vähemmän onnistumiskokemuksia (Cohenin d = 0,56) ja enemmän kielteisiä emotionaalisia tuntemuksia (Cohenin d = 0,86) oppimistilanteissa kuin lapset väestöpohjaisessa ryhmässä.

Myös pystyvyyden lähteiden ja itsesäätelyn minäpystyvyyden välisissä yhteyksissä havaittiin eroja ryhmien välillä. Väestöpohjaisessa otoksessa itsesäätelyn minäpystyvyys ja sen lähteet korreloivat voimakkaammin kuin tarkkaavuusongelmaryhmässä. Regressioanalyysi osoitti, että väestöpohjaisessa otoksessa pystyvyyden lähteistä kolmella – onnistumiskokemuksilla, palautteella ja emotionaalisilla tuntemuksilla – oli tilastollisesti merkitsevä spesifi yhteys itsesäätelyn minäpystyvyyteen. Näiden selitysaste oli kuitenkin hyvin heikko (1–12 %), mikä viittaa (yhdessä korkeiden korrelaatiokerrointen kanssa) siihen, että eri pystyvyyden lähteillä oli runsaasti yhteistä vaihtelua ja jaettua varianssia. Sen sijaan tarkkaavuusongelmaryhmässä regressioanalyysi osoitti vahvempia yhteyksiä pystyvyyden lähteiden ja itsesäätelyn minäpystyvyyden välillä. Onnistumiskokemukset selittivät minäpystyvyydestä 27 %. Yllättäen tarkkaavuusongelmaryhmässä itsesäätelyyn liittyvillä vertaiskokemuksilla oli negatiivinen yhteys itsesäätelyn minäpystyvyyteen ja se selitti 15 % pystyvyyden vaihtelusta. Väestöpohjaisessa otoksessa vertaiskokemuksilla ei ollut lainkaan vaikutusta itsesäätelyn minäpystyvyyteen.

Itsesäätelyn minäpystyvyyden ja sen lähteiden yhteyden tutkiminen edellä mainituissa kahdessa ryhmässä osoitti, että itsesäätelyn onnistumiskokemuksilla

oli vahvin yhteys itsesäätelyn minäpystyvyyteen. Tulokset osoittivat myös, että väestöpohjaisessa otoksessa itsesäätelyn lähteiden vaikutus oli kasautuvaa ja päällekkäistä. Sen sijaan lapsilla, joilla oli todettu koulussa tarkkaavuuden ongelmia, pystyvyyden lähteiden vaikutukset eivät olleet samassa määrin päällekkäisiä ja yksittäisten lähteiden vaikutuksen voimakkuus vaihteli lasten välillä. Lisäksi tulokset osoittivat, että oppimistilanteiden hallintaan liittyvillä vertaiskokemuksilla oli negatiivinen yhteys itsesäätelyn minäpystyvyyteen. Toisten oppilaiden onnistumiset oppimistilanteiden hallinnassa voivat siis korostaa tarkkaavuusongelmaisen lapsen kokemusta vaikeuksistaan ja toimia kielteisenä palautteena. Oppimistilanteiden hallinta on osaamista, johon helposti liittyy ajatus siitä, että ”kaikkien pitäisi pystyä tähän…”, mikä voi osaltaan korostaa vertaiskokemuksen negatiivista vaikutusta.

Toisessa osatutkimuksessa tarkasteltiin minäpystyvyyden lähteiden vaihtelua alakouluikäisillä lapsilla. Latentin profiilianalyysin avulla pyrittiin tunnistamaan lapsiryhmiä, joiden vastaukset eri pystyvyyden lähteissä vastaavat toisiaan, ja tutkimaan erityisesti sitä, kuinka itsesäätelyn minäpystyvyys ja akateemisten perustaitojen taso vaihtelevat eri profiiliryhmien välillä. Lisäksi tarkasteltiin, kuinka oppimisvaikeusryhmän lapset sijoittuvat eri profiiliryhmiin. Tutkittavien joukko oli jaettu lukemisen ja matematiikan perustaitojen osaamisen perusteella tyypillisesti suoriutuvien ryhmään (n = 1 011) ja oppimisvaikeusryhmään (n = 273). Oppimisvaikeusryhmä oli edelleen jaettu kolmeen alaryhmään: lukemisen (n = 90), matematiikan (n = 117) ja komorbidiin lukemisen ja matematiikan (n = 66) oppimisvaikeuden ryhmiin. Viimeisenä osatutkimuksessa tarkasteltiin lukemisen ja matematiikan perustaidoissa erilaisten ryhmien keskiarvoeroja itsesäätelyn minäpystyvyydessä ja sen lähteissä.

Latentin profiilianalyysin perusteella löydettiin viisi profiiliryhmää. Ryhmät poikkesivat toisistaan sekä pystyvyyden lähteiden keskiarvojen vaihtelun että keskiarvojen yleisen tason perusteella. Suurimman ryhmän (*Positive multi-source* group, 48,4 %) muodostivat lapset, joilla oli runsaasti oppimistilanteisiin liittyviä myönteisiä pystyvyyskokemuksia ja vähän negatiivista tunnereagointia. Tässä ryhmässä lapset arvioivat myös itsesäätelyn pystyvyytensä kaikkein korkeimmaksi. Toiseksi suurimpaan ryhmään (*Low social support* group, 29,4 %) kuuluivat lapset, jotka kokivat saavansa vain vähän myönteisiä vertaiskokemuksia ja kannustusta. Kahden ryhmän vastauksissa (*Negative states* group, 11,1 %, ja *Extreme negative states* group, 4,0 %) korostui kielteisten emotionaalisten tuntemusten suuri määrä; muut minäpystyvyyden lähteet olivat lähellä keskiarvoa. Näistä kahdesta ryhmästä toisessa, *Extreme negative states* group, lasten arvioima emotionaalisten tuntemusten määrä oli huomattavan suuri (poikkeama koko otoksen keskiarvosta: z = - 3,22). Kielteiset emotionaaliset tuntemukset olivat myös yhteydessä heikkoon itsesäätelyn pystyvyyteen. Viimeisen ryhmän muodostivat lapset, joilla oli vain vähän oppimistilanteisiin liittyviä myönteisiä pystyvyyskokemuksia ja runsaasti negatiivista tunnereagointia oppimistilanteissa (*Negative multi-source* group, 7,0 %). Tämä ryhmä arvioi myös itsesäätelyn minäpystyvyytensä kaikkia muita ryhmiä alhaisemmaksi.

Oppimisvaikeusryhmässä ja tavanomaisesti oppivien ryhmässä lapset jakautuivat profiiliryhmiin eri tavoin. Lähes kaksi kolmasosaa (65,3 %) oppimisvaikeusryhmän lapsista kuului ryhmiin, jotka arvioivat yhden tai useamman pystyvyyden lähteensä selkeästi keskiarvoa vähäisemmäksi. Sen sijaan tavanomaisesti suoriutuvien ryhmästä selkeästi pienempi osa, 45,6 %, arvioi yhden tai useamman pystyvyyden lähteen keskiarvoa matalammaksi. Huomattavaa oli, että noin viidennes oppimisvaikeusryhmän lapsista kuului joko ryhmään, jossa lapset arvioivat kaikki pystyvyyden lähteet vähäisiksi, tai ryhmään, joka kuvasi itsellään olevan äärimmäisen voimakkaita emotionaalisia tuntemuksia. Tavanomaisesti oppivien ryhmässä vain 8 % lapsista kuului näihin ryhmiin. Tarkasteltaessa eri oppimisvaikeusryhmien lasten sijoittumista profiiliryhmiin voitiin todeta, että matematiikan oppimisvaikeus -alaryhmän lasten suhteellinen osuus oli odotusarvoa suurempi ryhmässä, jossa kaikki pystyvyyden lähteet oli arvoitu vähäisiksi, ja ryhmässä, joka kuvasi itsellään äärimmäisen voimakkaita emotionaalisia tuntemuksia. Tämä tulos voi viitata yhdessä aiempien tutkimustulosten kanssa siihen, että matematiikan oppimisvaikeudet ovat jossain määrin yhteydessä kielteisiin tunnekokemuksiin ja ahdistukseen.

Oppimisvaikeusryhmien ja tyypillisesti suoriutuvien ryhmän keskiarvovertailu osoitti, että oppimisvaikeusryhmien arviot poikkesivat tilastollisesti merkitsevästi tyypillisesti suoriutuvien lasten vastauksista itsesäätelyn minäpystyvyydessä ja kolmessa neljästä pystyvyyden lähteestä: onnistumiskokemuksissa, kannustuksessa ja palautteessa sekä emotionaalisissa tuntemuksissa. Nämä erot olivat kuitenkin pieniä: efektikoko (Cohenin *d*) oli 0,07 – 0,16. Oppimisvaikeusryhmien välillä ei havaittu eroja itsesäätelyn minäpystyvyydessä tai sen lähteissä.

Väitöskirjan kaksi ensimmäistä tutkimusta tukivat oletusta itsesäätelyn minäpystyvyyden ja sen lähteiden yhteydestä. Lisäksi tutkimushavainnot osoittivat, että lapset pystyvät tunnistamaan ja arvioimaan itsesäätelyyn liittyviä kokemuksiaan. Tutkimukset osoittivat, että oppimiseen liittyvät vaikeudet vaikuttavat kielteisesti sekä itsesäätelyn minäpystyvyyttä tukeviin kokemuksiin että itsesäätelyn minäpystyvyyteen oppimistilanteissa eli siihen, kuinka vahvasti lapsi luottaa osaavansa oppimistilanteessa säädellä tunteitaan sekä kontrolloida tarkkaavuuttaan, ajatteluaan ja käyttäytymistään. Nämä vaikutukset olivat havaittavissa vahvemmin tarkkaavuuden ongelmissa kuin lukemisen ja matematiikan oppimisen ongelmissa. Tulokset osoittivat myös, että kielteisten kehollisten ja emotionaalisten kokemusten runsas määrä oli yhteydessä keskimääräistä heikompaan itsesäätelyn minäpystyvyyteen.

Lasten tarkkaavuuden ja toiminnanohjauksen kehittämiseen ja niissä ilmenevien ongelmien lievittämiseen on kehitetty useita psykososiaalisia interventioita, ja enenevässä määrin on myös näyttöä niiden tehokkuudesta. Jotta interventio olisi tehokas, se tulisi toteuttaa siinä ympäristössä, jossa ongelmat ilmenevät. Useimmiten tarkkaavuuden ja toiminnanohjauksen ongelmat vaikeuttavat toimimista koululuokassa ja koulutehtävien suorittamista, jolloin kouluympäristö on luonteva paikka tukea tarkkaavuuden ja toiminnanohjauksen taitoja. Suomessa tarkkaavuuden ja toiminnanohjauksen interventioita on tutkittu niukasti

eikä kouluympäristössä toteutettuja käsikirjapohjaisia interventioita ole tähän mennessä tutkittu laisinkaan.

Väitöskirjan kolmas osatutkimus oli kokeellisella asetelmalla toteutettu interventiotutkimus. Tutkimuksessa tarkasteltiin tarkkaavuuden ja toiminnanohjauksen intervention, Maltti-ohjelman (Paananen ym., 2011), vaikutuksia lasten tehtävätilannekäyttäytymiseen koululuokassa sekä suoriutumiseen lukemisen ja aritmetiikan sujuvuustehtävissä. Lisäksi tutkimuksessa tarkasteltiin ongelmien vaikeusasteen vaikutusta intervention tuloksellisuuteen. Tutkittavat olivat alakoululaisia, joilla on tunnistettu koulussa tarkkaavuuteen ja toiminnanohjaukseen liittyviä ongelmia. Tutkittavien ryhmä oli jaettu koe- (n = 61) ja kontrolliryhmään (n = 28). Kontrolliryhmä muodostui interventiota odottavista lapsista (*waitlist control group*). Maltti-interventiolla pyritään ensisijaisesti kehittämään tarkkaavuusongelmaisten lasten tehtävätilanneosaamista. Harjoittelu tähtää tarkkaavuuden ja kognitiivisen kontrollin edistymiseen tehtävätilanteissa. Lisäksi osallistuville lapsille opetetaan tehtävien suorittamista edistäviä toimintamalleja ja strategioita. Interventio on ryhmämuotoinen, joten se tarjoaa myös mahdollisuuden käyttää vertaisoppimista tukemaan sekä oppimista että pystyvyyden tunteen kasvua. Ohjelman 20 tapaamiskertaa on kuvattu käsikirjassa, ja tässä tutkimuksessa intervention toteutuksen tuli seurata tätä ohjeistusta. Intervention vetäjinä kouluissa toimivat tutkimushankkeen kouluttamat koulun henkilöstön jäsenet. Kahdessa ryhmässä ohjaajat eivät toteuttaneet interventiota käsikirjan mukaisesti, minkä vuoksi nämä kaksi ryhmää ja niissä olleet yhdeksän lasta eivät olleet mukana lopullisissa tuloksellisuutta arvioivissa analyyseissa. Oppilaiden luokanopettajat arvioivat Keskittymiskyselyllä (Klenberg ym., 2010) lasten tarkkaavuutta ja toiminnanohjausta luokkatilanteissa ennen interventiota ja sen jälkeen sekä seurantamittauksessa. Akateemisten perustaitojen kehittymistä arvioitiin lukemisen ja aritmeettisen päättelyn sujuvuustehtävillä.

Opettajien arviot osoittivat koeryhmässä tapahtuneen myönteistä muutosta tarkkaavuuden toiminnoissa ja toiminnanohjauksessa. Tulokset eivät kuitenkaan osoittaneet tilastollisesti merkitsevää interventiovaikutusta, kun muutosta tarkasteltiin kolmessa mittauspisteessä: ennen ja jälkeen intervention ja seurantamittauksessa. Sen sijaan ennen ja jälkeen intervention -arvioinneissa interventiovaikutus oli lähes tilastollisesti merkitsevä. Moderaattori-analyysi osoitti, että ongelmien vaikeusaste vaikutti intervention tuloksellisuuteen siten, että interventiosta hyötyivät erityisesti ne lapset, joiden tarkkaavuuden ja toiminnanohjauksen ongelmat olivat lieviä tai ”keskivaikeita” (65 % koeryhmän lapsista). Kun analyyseihin valittiin vain ne lapset, joiden tarkkaavuuden ja toiminnanohjauksen vaikeudet olivat lieviä tai keskivaikeita, interventiovaikutus oli tilastollisesti merkitsevä sekä heti intervention jälkeen ($F (1, 40) = 19.94$, $p < .000$, $\eta_p^2 = .33$) että seuranta-ajankohdassa ($F (1, 40) = 4.38$, $p = .043$, $\eta_p^2 = .10$).

Koeryhmän suoritukset paranivat kontrolliryhmää enemmän yksinkertaisissa lukemisen ja aritmetiikan sujuvuustehtävissä. Tilastollisesti merkitsevä ero suorituksissa oli havaittavissa kuitenkin vain ennen ja jälkeen intervention -arvioinneissa: sanantunnistustehtävässä ($F (1, 63) = 4.61$, $p = .036$, $\eta_p^2 = .07$) ja yhteen- ja vähennyslaskujen sujuvuustehtävässä ($F = (1, 63) = 5.64$, $p = .021$, $\eta_p^2 = .08$). Sen

sijaan lukemisen tehtävässä, johon sisältyi lukemisen ymmärtämisen komponentti, ja monimuotoisessa aritmetiikan tehtävässä intervention yhteyttä tuloksiin ei havaittu. Kokonaisuudessaan interventiotutkimus osoitti, että suunnitelmallisilla ja systemaattisilla tukikeinoilla voidaan kehittää koulussa tarvittavia tehtävätilannetaitoja myös lapsilla, joilla on erityisiä tarkkaavuuden ja toiminnanohjauksen ongelmia.

Tämän väitöskirjan tulokset osoittivat, että alakouluikäiset lapset pystyvät itse tunnistamaan itsesäätelyyn liittyviä kokemuksiaan ja että lasten vaikeudet akateemisissa perustaidoissa tai tarkkaavuuden ongelmat altistavat heidät kokemuksille, jotka eivät vahvista luottamusta omiin kykyihin hallita oppimistilanteita. Lisäksi tulokset osoittivat, että interventioilla, jotka tähtäävät erityisesti tehtävätilannehallinnan kehittymiseen, voidaan vaikuttaa myönteisesti tarkkaavuusongelmaisten oppilaiden itsesäätelyyn oppimistilanteissa. Tutkimustulokset tukevat ajatusta siitä, että opetus ja oppimisen interventioiden tulisi harjoittaa akateemisten perustaitojen lisäksi itsesäätelyä sekä toiminnanohjauksen taitoja. Opetuksen ja interventioiden tulisi taata lapsille kokemuksia oppimistilanteiden hallinnasta ja sitä kautta vahvistaa itsesäätelyn minäpystyvyyttä.

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ORIGINAL PAPERS

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SELF-REGULATORY EFFICACY AND SOURCES OF EFFICACY IN ELEMENTARY SCHOOL PUPILS: SELF-REGULATORY EXPERIENCES IN POPULATION SAMPLE AND PUPILS WITH ATTENTION AND EXECUTIVE FUNCTION DIFFICULTIES

by

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Self-regulatory efficacy and sources of efficacy in elementary school pupils: Self-regulatory experiences in a population sample and pupils with attention and executive function difficulties

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ABSTRACT

In this study, we examined self-regulatory efficacy and sources of self-efficacy (mastery experiences, vicarious experiences, social persuasion and physiological/emotional states) and the relationships between self-efficacy and its sources among elementary school pupils. Two groups were compared: a population sample (PS, $N = 1284$) and pupils with difficulties in attention and executive functions (AED, $N = 61$). Data gathered from self-report questionnaires indicated that pupils in the PS group had more positive efficacy beliefs and mastery experiences and fewer negative physiological/emotional states than the AED group. Analyses showed strong connections between sources and self-regulatory efficacy. In the PS group, the sources had small unique influences on self-regulatory efficacy, indicating that most of the variance was shared between the sources. In the AED group, sources had less shared variance compared to the PS group. Mastery experiences alone had a strong effect on self-regulatory efficacy, while vicarious experiences had a negative effect on self-efficacy.

1. Introduction

Learning and academic achievement in the school environment not only require cognitive and basic academic skills, i.e. reading and mathematics, but also the capability to regulate and organise actions, namely the ability to master one's own learning processes, such as control of attention, cognition (or executive control), affect (Blair & Diamond, 2008; Diamond, 2013; Nigg, 2017) and behaviour in a learning context (Schunk & Zimmerman, 2007; Zimmerman, 2008). In addition to actual self-regulatory skills, a sense of confidence and agency in organising and managing academic activities, i.e. self-regulatory efficacy (Bandura, 1997), has a significant influence on educational development and learning outcomes (Caprara et al., 2008). It is assumed that these learning-related self-beliefs evolve rapidly during a child's first few years at school (Bandura, 1997). In this study, we aimed to investigate self-regulatory efficacy and self-regulation–related experiences among children with difficulties in attention and executive functions (EF) and their peers.

1.1. Self-regulatory efficacy and its sources

A salient theoretical framework for the study of self-beliefs is social cognitive theory, particularly the construct of *self-efficacy* (Bandura, 1997). In the school context, *self-regulatory efficacy* (also *self-efficacy for self-regulated learning*), defined as the confidence to achieve control over one's own attention and actions in different task situations and to use adaptive strategies, is associated with motivation, persistence and effort in a variety of academic learning situations (Klassen, 2010). Thus, self-regulatory efficacy is also one of the key elements for predicting academic achievement (Caprara et al., 2008).

According to social cognitive theory (Bandura, 1997), self-efficacy is developed and modified through four sources: (1) interpretations of

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past performance accomplishments (*mastery experiences*); (2) information obtained from reference groups' actions and modelling (*vicarious experiences*); (3) verbal persuasion, support and evaluative feedback from significant others (*social persuasion*); and (4) emotional and physical arousal and interpretations of these in on-task situations (*physiological and emotional states*). Of these four sources, mastery experiences have been shown to have the strongest association with academic self-efficacy among elementary school pupils (Butz & Usher, 2015; Joët, Usher, & Bressoux, 2011; Usher & Pajares, 2008) and with self-regulatory efficacy among high school students (Hampton, 1998).

1.2. Self-regulatory efficacy, its sources and children with learning-related problems

Although it has been suggested that the four sources are also essential for the formation of one's self-regulatory efficacy (Joët et al., 2011), little is known about self-beliefs concerning self-regulatory confidence in elementary school pupils with learning-related problems, especially those with attention and EF difficulties. The lack of previous research is lamentable since self-regulatory difficulties are core problems for children with ADHD (Hinshaw & Arnold, 2015) as well as children with no formal ADHD diagnosis but who have deficits in attention and EF (Loe & Feldman, 2007). Many of the pupils' school activities are affected by these self-regulation problems, which manifest themselves not only in their behaviours but also in their mental processes in several ways, impairing learning and academic achievements (Barkley, 2006).

Although the existing literature on self-regulatory efficacy does not contain studies on children with attention deficits, some research has been conducted on general academic efficacy among students with ADHD. These studies have shown that students with ADHD have a tendency to rate their academic self-efficacy lower compared to non-ADHD and typically achieving peers (Tabassam & Grainger, 2002). In addition, academic self-efficacy has a stronger connection with academic achievements among students with ADHD than non-ADHD students (Martin, Burns, & Collie, 2017).

Studies that have investigated self-regulatory efficacy among children with learning disabilities (LD) in comparison to their peers have yielded differences in efficacy and source-related experiences. In Klassen's (2010) study, high school students with reading and mathematics LD reported lower self-regulatory efficacy than non-LD students. Hampton and Mason (2003) found that high school students with diagnosed LD (reading and mathematics LD or comorbid LD and language deficits) not only reported lower self-regulatory efficacy but also fewer mastery experiences, vicarious experiences, weaker social persuasion and more physiological arousal (a more negative physiological/emotional state) than non-LD students. There are also contradictory findings, showing that both students with LD and ADHD may overestimate their ability to carry out future tasks as well as their past performances and skills (Klassen & Lynch, 2007; Owens, Goldfine, Evangelista, Hoza, & Kaiser, 2007). However, it seems that only a subset of students with ADHD have this tendency to overestimate (Bourchtein, Langberg, Owens, Evans, & Perera, 2017).

Previous studies have also shown that the relationships between sources and self-regulatory efficacy may differ as a function of LD or the level of academic skills. In Hampton and Mason's (2003) study, LD status had an indirect effect on self-regulatory efficacy through sources. Because Hampton and Mason used aggregated scores of the sources of self-efficacy, the effects of individual sources could not be determined. However, in an earlier study with a sample of LD students, Hampton (1998) found that only mastery and vicarious experiences were correlated with self-regulatory efficacy among students with LD. In this study, however, the use of hierarchical regression analysis might explain the observed low effects of the two remaining source variables (social persuasion and physiological/emotional states) on efficacy. More research is needed to reveal the unique effect of different sources on efficacy in subgroups with scholastic difficulties. More recently, Usher and Pajares (2006) examined self-regulatory efficacy and sources of academic self-efficacy in groups of children with different levels of reading ability, and they found differences among the groups in the relationships between sources and efficacy. Mastery experiences were the most influential source of self-regulatory efficacy for groups of pupils whose reading ability was at or above the expected level for their grade, whereas in pupils whose reading ability was below the expected level for their grade, physiological and emotional states alone significantly (negatively) influenced self-regulatory efficacy.

Since attention and EF deficits influence the development of self-regulation skills (Brocki, 2007) and, thus, also on-task performance in school settings (Abikoff et al., 2013; Miller & Hinshaw, 2012), pupils with attention difficulties may have fewer positive experiences to support self-regulatory efficacy. This could mean that, similar to pupils with LDs, pupils with attention and EF difficulties are trapped in an unfavourable cycle; they have fewer learning- or self-regulation–related positive experiences, which consequently leads to lower self-regulatory efficacy and, thus, further affects academic achievements negatively (Usher & Pajares, 2008).

1.3. Rationale for the present study

In diagnostic processes or the customary special education procedures with elementary school children, parents and teachers usually provide information about the child's self-regulation–related behaviour, i.e. problems with attention and on-task behaviour, and less attention is paid to the child's experiences and his or her confidence to master learning situations (see Farrington et al., 2012). Knowledge of pupils' levels of confidence from different subgroups in self-regulation with regard to managing schoolwork and the type of self-regulation–related experiences they have had would provide more tools to support pupils' motivation as well as their sense of efficacy and agency to organise and manage academic activities. An improved understanding would not only help educators respond to the needs of pupils with self-regulation–related problems, but it would also inform the development of interventions. Since no studies have addressed the self-regulatory efficacy of children with attention and EF difficulties, particular attention should be paid to this group of elementary school pupils in this respect. The theory of self-efficacy offers a valuable framework to scrutinise self-regulatory confidence and the experiences of pupils with attention deficits.

Despite the growing interest in the sources of self-efficacy among elementary school pupils, studies assessing the sources of self-regulatory efficacy with questions directly related to self-regulation are lacking. Previous studies have approached sources with questions related to general academic domains, e.g. 'I got good grades in school last term' (Usher & Pajares, 2006), or to specific academic subjects, e.g. 'I have always done well on mathematics assignments' (Joët et al., 2011), but not with questions that directly tap into self-regulation. Therefore, the present study used source-related questions covering core areas of self-regulation in the school setting and school-related activities: control of attention and interference (Diamond, 2013), executive control and emotion regulation (Nigg, 2017). The items used aimed to tap into the four source areas in the context of self-regulative behaviour in typical school-related tasks.

Our study aimed to extend the literature by assessing self-regulatory efficacy and its four sources, i.e. mastery experiences, vicarious experiences, social persuasion and physiological/emotional states, in two groups: pupils from a population-based sample and pupils with symptoms of attention and EF deficits observed in the classroom. First, we conducted a preliminary analysis to test the factor structure of the questionnaires of self-regulatory efficacy and theory-based sources of self-regulatory efficacy. To answer the main questions of the study, we first explored self-regulatory efficacy and the sources of efficacy in both groups and examined whether self-regulatory efficacy and source-

related experiences varied between the groups. Based on previous studies (Hampton & Mason, 2003; Klassen, 2010), we assumed that pupils with learning-related problems, in this case attention and EF problems, have lower self-regulatory efficacy and fewer sources of efficacy experiences than pupils in the population sample. Second, we analysed the associations between the four sources of efficacy and self-regulatory efficacy in both groups, and we assumed, based on previous findings (Hampton, 1998; Usher & Pajares, 2006), that mastery experiences have the greatest influence on self-regulatory efficacy. Third, we explored whether associations differed between the groups. Since only a small number of previous studies have studied self-appraisals, and to the best of our knowledge, no studies have approached self-regulatory efficacy and the sources of self-regulatory efficacy among pupils with attention and EF deficit symptoms, we did not set any specific hypotheses for the question concerning differences in source-efficacy connections in the two groups of interest.

2. Materials and methods

2.1. Participants and procedure

The participants were 1348 elementary school pupils (Grades 2 to 6, M = 3.56, ages 7–13 years with M = 9.94 years, SD = 1.08, 46.4% girls) who followed the standard curriculum. The study was part of the *Self-Efficacy and Learning Disability Intervention* (SELDI: 2013–2015) research project. Participation was voluntary for both the schools and the pupils, and written consent for the children to participate was obtained from their parents. In addition, the Ethical Committee of the University of Jyväskylä approved the study before the research began.

Two different samples from 34 different schools were used to examine self-regulatory efficacy and sources of self-regulatory efficacy and to answer the research questions. The first of these was the *population sample* (PS group; n = 1284, elementary school Grades 2 to 5, M = 3.61 and SD = 0.98, ages 7–13 years with M = 9.96 years, SD = 1.06, 48.3% girls and 51.7% boys) collected in 20 different primary schools across urban, suburban and rural districts in Eastern and Central Finland.

The second sample consisted of the pupils identified with attention and EF deficit symptoms. These pupils were from 14 other schools across urban, suburban and rural areas in Southern, Central and Eastern Finland. All pupils in this group followed the standard curriculum and were in inclusive classrooms. The initial identification for this group was based on the teachers' evaluations of three inclusion criteria: (1) symptoms of attention and EF deficits in classroom settings, (2) symptoms that caused problems in daily school routines, and (3) attention and EF problems were reasons for attending special education support. After the initial identification made by the teacher, the problems of attention and EF in classroom setting were evaluated using the Attention and Executive Function Rating Inventory (ATTEX; Klenberg, Jämsä, Häyrinen, Lahti-Knuuttila, & Korkman, 2010; see below); the final inclusion criterion for the attention and EF deficit symptoms group was that the ATTEX score, as rated by a teacher, showed at least moderate attention and EF problems. A total score of 17 on the ATTEX was set as the cut-off point, which corresponds to the 75th percentile for elementary school pupils (see Klenberg et al., 2010). Originally, 64 children were identified, but three participants obtained fewer than 17 points in the ATTEX and were thus judged not to have attention and EF problems and were excluded from the group. Eventually, this group consisted of 61 elementary school pupils from Grades 2 to 6 (M = 3.49 and SD = 1.06), ages 8–12 years (M = 9.94 months and SD = 1.19), 12.7% girls and 87.3% boys. Their ATTEX scores ranged from 17 to 99 (maximum 110) with an average score of 55.75. We named this group *an attention and EF difficulties group* (AED group). In the AED group, the grade range was larger since two participants were in the sixth grade. However, there was no difference in the mean ages of the groups.

The participants in both groups completed questionnaires related to self-regulatory efficacy and sources of self-regulatory efficacy and were also given tasks assessing their reading and arithmetic skills. The AED group completed the questionnaires in small groups, and the PS group completed them in classrooms. For both groups, a trained research assistant supervised the assessments, familiarising the pupils with the questionnaires and the scales, and reading aloud the questionnaire items. The AED group were given reading and mathematics tests individually, while the PS group completed these tests in group situations in their classrooms.

2.2. Measures

2.2.1. Self-regulatory efficacy and sources of self-regulatory efficacy

The self-regulatory efficacy questionnaire, based on Bandura's (2006) guidelines, consisted of eight items. The items were tailored to meet the object of interest of the present study and covered three areas of self-regulatory efficacy in academic tasks: control of cognition, affect and behaviour (for example, *How confident are you that you finish your homework even if it is difficult for you?*, *How confident are you that you get yourself to study when there are other interesting things to do?* and *How confident are you that you get yourself to do schoolwork during class even when the tasks make you nervous?*). The questions aimed to tap into functions relevant to control of attention and interference and executive control in the classroom setting and school-related activities. The participants gave their responses on a 7-point Likert-type scale with the opposing poles of *I'm totally confident I can't* (at 1) and *I'm totally confident I can* (at 7). Reliability calculated for factor scores was 0.93 for the self-regulatory efficacy factor.

The sources of the self-regulatory efficacy questionnaire were closely based on the ideas of Usher and Pajares (2008, 2009) and consisted of 14 items, all of which were related to self-regulation in the school setting or in school-related activities. Four items assessed mastery experiences, e.g. *I have always been able to focus on tasks during class*, two items assessed vicarious experiences regarding peers, e.g. *My friends focus on teaching during class*, four items assessed social persuasion, e.g. *My teacher said that I pay attention to teaching during class*, and four items assessed physiological and emotional states, e.g. *I feel nervous when I do my homework*. Each statement was rated using a Likert scale: 1 (*never true*), 2–3 (*almost never true*), 4 (*sometimes true*), 5–6 (*almost always true*) and 7 (*always true*). Reliability calculated for the factor scores was 0.94 for the mastery experiences factor, 0.84 for the vicarious experiences factor, 0.94 for the social persuasion factor and 0.83 for the physiological and emotional factor. The factor structures and loadings obtained from confirmatory factor analysis are presented in Appendix A.

2.2.2. Attention and EF symptoms

A norm-referenced rating scale filled in by the teacher, the ATTEX questionnaire (Klenberg et al., 2010), was used to assess problems of attention and EF in the school setting. The ATTEX has high internal consistency (total score α = 0.98) and good criterion validity (Klenberg et al., 2010). Among 61 pupils in the AED group, the alpha for the ATTEX was 0.96. The ATTEX contains 55 items covering 10 areas of attention and EF as follows: distractibility (four items), impulsivity (nine items), motor hyperactivity (seven items), directing attention (five items), sustaining attention (six items), shifting attention (four items), initiation (five items), planning (four items), execution of action (eight items), and evaluation (three items). The items were rated on a 3-point scale: 0 (*not a problem*), 1 (*sometimes a problem*), and 2 (*often a problem*).

2.2.3. Academic skills

Reading performance was assessed using two different reading skills tests. The Word Recognition test (Lindeman, 1998) assessed basic reading skills and consisted of 78 word-chains containing two to four words. The pupils were asked to use a pencil to mark word boundaries within each chain, e.g. minä/ei/me/tulla (I/no/we/come), as fast and

as accurately as they could. The time limit was 3.5 min, and the score was the number of correctly identified words. In the Luksu Reading Fluency test (Salmi, Eklund, Järvisalo, & Aro, 2011), the pupils were provided with a sheet showing 70 simple sentences and were instructed to read these as fast as possible and then decide whether the sentences were true or false, e.g. 'Strawberries are red'. The time limit was 2 min, and the test score was the number of correct answers. The test scores of both reading tests were standardised with data obtained from the PS, and z-score values were calculated by grade level. The mean of the two reading tests' z-scores was used as the basic reading skills variable. Cronbach's alpha for the reading skills test was 0.83.

Basic arithmetic skills were assessed using two time-limited paper-and-pencil group tasks. The first test comprised the two-minute addition fluency task (Koponen & Mononen, 2010a) and the two-minute subtraction fluency task (Koponen & Mononen, 2010b), both consisting of 120 simple tasks—the addition task with addends smaller than 10 and the subtraction task with results in the range of 1–9. The total number of correct answers during the two-minute time limit formed the task score. The addition and subtraction scores were summed, and this total was used as the test score of the arithmetic fluency. Second, the three-minute basic arithmetic test (Aunola & Räsänen, 2007) consisted of 30 addition, subtraction, division and multiplication items of increasing difficulty. The total number of correct answers in the three-minute time limit formed the test score. The test scores were standardised as z-score values by grade level with the PS data. The mean of the two z-scores (the arithmetic fluency test and the basic arithmetic test) was used as the basic arithmetic skills variable. Cronbach's alpha for the basic arithmetic skills test was 0.85.

2.3. Statistical analysis

2.3.1. Preliminary analysis

Analyses were conducted with Mplus version 7.3 (Muthén & Muthén, 1998–2017). First, with data from the PS group, we tested the measurement structure using confirmatory factor analysis, consisting of one self-regulatory efficacy factor and four sources of efficacy factors. With the help of modification indices, the measurement model was modified by adding residual covariances to the model.

All of the models were estimated using the full information maximum likelihood method with robust standard errors and scale corrected chi-square test values (MLR estimator in Mplus). The proportion of missing values varied from 0.1% to 4.2%. Little's Missing Completely At Random (MCAR) test showed statistically non-significant results for sources of self-regulatory efficacy variables. The MCAR test result was statistically significant for self-regulatory efficacy items, although only 32 to 36 (2.5% to 2.8%) values were missing per question. As the number of missing values was this low for such a large sample, the results can still be considered unbiased.

Model fit was evaluated with the comparative fit index (CFI), the Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA) and standardised root mean square residual (SRMR). For a good fitting model, CFI and TLI are close to 0.95, RMSEA is lower than 0.06 and SRMR is lower than 0.08 (Hu & Bentler, 1999; Mplus Technical Appendix; Muthén, 1998–2004). Usually the chi-square test is part of the model testing, and for good model fit, the chi-square test is non-significant. However, the chi-square test is highly sensitive when the sample size is large, like in this study.

Based on the prevalence of attention problems, it was expected that the PS sample would include 5% (ADHD diagnosed; Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007) to 16% (diagnosed with ADHD or exhibiting symptoms without clinical diagnosis; Barbaresi et al., 2002) pupils with attention difficulties. Furthermore, it was assumed that the measurement structure of the questionnaires was similar across the population, and children in AED group were expected to correspond to those individuals with similar problems in the PS group. Accordingly, we expected the measurement structure to be similar between the PS and AED samples.

2.3.2. Group comparisons

To study the factor mean differences between the PS and the AED groups, we estimated the data of the AED group simultaneously with the PS group using a multigroup method. In this model, factor loadings, intercepts of observed variables and residual covariances were set as equal between the groups. The model made it possible to test factor (mastery experiences, vicarious experiences, social persuasion and physiological/emotional states) mean differences between the groups. In this model, factor means of the PS group were set to zero. Cohen's *d* was calculated from the differences between factor means divided by the standard deviations of the PS group. Since the gender ratio was not equal in the two groups, the effect of gender was controlled in the model. As grade levels ranged from 2 to 6 among the participants, the effect of the age was also controlled in the model. As the prevalence rates of specific LDs, i.e. deficits in basic academic skills, in population samples are known to range from 4% to 9% in reading and from 3% to 7% in mathematics (see, e.g., Landerl & Moll, 2010), and at least a quarter of children with attention and EF deficits are assumed to exhibit LDs (see Miller & Hinshaw, 2012), this may affect self-regulatory efficacy (Klassen, 2010). Therefore, in the analyses, we also controlled for the effect of the level of basic reading and mathematics skills.

2.3.3. Regression analysis

Next, to analyse the specific effect of each source, we regressed self-regulatory efficacy on mastery experiences, vicarious experiences, social persuasion and physiological/emotional states. Since our main focus was to analyse the specific influence of each source of efficacy on self-regulatory efficacy in the two groups, we used the Cholesky decomposition method to build a hierarchical model (see de Jong, 1999). The Cholesky method can be used when independent variables are correlated, and it deconstructs the explained variance of each variable into unique and common proportions. Following the Cholesky procedure, we conducted four separate analyses in which mastery experiences, vicarious experiences, social persuasion and physiological/emotional states were set to four pre-specified orders. In these four consecutive Cholesky analyses, each source factor was set into the regression equation in the last step. With this procedure, we removed all the influences of the previous variables so that we could determine the unique proportion of variance of each variable on self-regulatory efficacy. Similar to previous analyses, the effects of gender, age, reading and mathematical skills were controlled in the model.

Last, we compared regression coefficients between the two groups. Comparisons could be conducted using estimates of coefficient differences and corresponding standard error (Muthén & Muthén, 1998–2017).

In Finland, differences in students' performances are very small between schools (Arffman, Välijärvi, & Linnakylä, 2010). Therefore, no variation between students' abilities and schooling was expected. However, we calculated the intraclass correlation coefficient (ICC) for schools. The results showed that four out of five (self-regulatory efficacy [0.020], vicarious experiences [0.012], social persuasion [0.010] and physiological/emotional states [0.014]) ICCs were not significant. In mastery experiences, the ICC reached significance, but the ICC value was only 0.017 and, therefore, a single-level analysis was conducted.

3. Results

3.1. Preliminary analysis

Correlations between the variables are presented in Table 1. Table 1 shows that in the PS group, the strength of positive correlations between the factors of the interest (self-regulatory efficacy and four sources) varied from 0.39 to 0.69 and negative correlations from −0.51 to −0.19, and in the AED group, the strength of positive correlations

Table 1
Bivariate correlations of the factors basic reading and arithmetic skills and age for the PS group (n = 1284; below the diagonal) and the AED group (n = 61; above the diagonal).

Variables	Self-regulatory efficacy	Mastery experiences	Vicarious experiences	Social persuasion	Physiological/ emotional states	Reading skill	Arithmetic skill	Age	Gender
Self-regulatory efficacy	–	0.56***	0.19	0.29	−0.36*	−0.04	−0.04	−0.10	0.02
Mastery experiences	0.69***	–	0.67***	0.56***	−0.20	−0.09	0.12	−0.08	0.07
Vicarious experiences	0.39***	0.52***	–	0.14	−0.20	−0.41**	−0.18	0.16	−0.12
Social persuasion	0.49***	0.64***	0.55***	–	0.14	−0.19	0.20	−0.09	0.06
Physiological/ Emotional states	−0.51***	−38***	−0.19***	−0.25***	–	−0.13	−0.03	−0.23	−0.09
Reading skill	0.20***	0.14***	0.02	0.06*	−0.22***	–	0.41***	−0.21*	−0.18
Arithmetic skill	0.24***	0.17**	0.08	0.12***	−0.20***	0.49***	–	−0.17	0.14
Age	−0.15***	−0.19***	−0.16***	−0.11***	−0.05	0.00	−0.01	–	0.03
Gender[a]	−0.09**	−0.19***	−0.12**	−0.16***	0.05	−0.17***	0.05	0.04	–

Note.
*** < .001.
** < .01.
* < .05.
[a] Negative correlations denote lower values for boys.

varied from 0.14 to 0.67 and negative correlations from −0.36 to −0.20. In the PS group, all correlations between the factors were significant, whereas in the AED group, 4 out of 10 correlations were significant. Non-significant correlations were probably due not only to the smaller coefficients but also to the smaller AED group size. Also, it is noteworthy that in the PS group, the sources correlated on average more highly than in the AED group, indicating a considerable amount of common variance between the four sources of self-regulatory efficacy in the PS group (see Table 1).

The unconstrained theoretical measurement model did not provide a satisfying model fit: χ^2 (179) = 690.60, p < .001, CFI = 0.931, TLI = 0.919, RMSEA = 0.047, RMSEA 90% C.I. (0.043–0.051) and SRMR = 0.052. Therefore, based on large modification indices, five residual covariances within the same factor and with same valence (between three efficacy items [1, 2 and 3; see Appendix A], two mastery experience items [3 and 4; see Appendix A] and two physiological/emotional state items [3 and 4; see Appendix A]) were allowed to estimate freely. It was concluded that these items had some shared information and evaluated closely similar experiences. The final model consisting of one efficacy factor and four source factors fitted the data well: χ^2 (174) = 380.84, p < .001, CFI = 0.972, TLI = 0.966, RMSEA = 0.030, RMSEA 90% C.I. (0.026–0.035) and SRMR = 0.036 (factor structures and loadings are presented in Appendix A). The chi-square value was statistically significant due to the large sample size in this study.

In the PS group, skewness of variables ranged from −2.11 to 2.05 and kurtoses from −1.99 to 5.45. In the AED group, skewness ranged from −2.19 to 0.57 and kurtoses from −1.20 to 2.78. Therefore, as it was assumed that not all variables were normally distributed, a robust estimation method that is resistant to distribution abnormalities was used in the regression models.

3.2. Group comparisons

To answer the main questions of the study, first, we tested whether the means of self-regulatory efficacy and source-related experiences differed between the groups. The estimates (deviations from zero as factor means of the PS group are set to zero) and standard errors of factor means of the AED group for self-regulatory efficacy and the sources of efficacy are presented in Table 2. The results revealed statistically significant group differences in self-regulatory efficacy, mastery experiences and physiological/emotional states after controlling for gender, age, reading and arithmetic skills (see Table 2). Effect sizes varied from moderate to strong. The PS group gave more positive responses regarding self-regulatory efficacy and mastery experiences, while pupils in the AED group reported experiencing more negative physiological/emotional reactions.

3.3. Regression analysis

Second, we conducted regression analysis using factor scores and Cholesky decomposition to estimate the unique influence of the four sources of efficacy on self-regulatory efficacy, which was our main interest. The source factors together explained 54% of the variance of the self-regulatory efficacy factor in the PS group and 56% in the AED group (see Table 3). The model showed that in the PS group, three of the four sources, i.e. mastery experiences, social persuasion and physiological/emotional states, were significantly related to self-regulatory efficacy (see Table 3). However, in the PS group, the explanation ratio showed that the social persuasion factor had no unique effect (ΔR2 = 0.01) on self-regulatory efficacy.

In the AED group, mastery experiences, vicarious experiences and physiological/emotional states were significantly related to self-regulatory efficacy (see Table 3). The coefficient of vicarious experiences was negative (−0.39), indicating a negative influence of vicarious experiences on self-regulatory efficacy in the AED group. In both groups, physiological/emotional states were associated with self-regulatory efficacy (coefficient for the PS group −0.26. and for the AED group −0.30), indicating that heightened negative emotions were associated with lower self-regulatory efficacy.

The mastery experiences accounted for the greatest proportion of the variance in self-regulatory efficacy in both the PS and AED groups. The explanation ratios showed that in the AED group, mastery experiences had a large positive unique effect (ΔR^2 = 0.27) and vicarious experiences (ΔR^2 = 0.15) had a medium negative effect on self-regulatory efficacy (see Table 3). Although the strength of correlations between self-regulatory efficacy and sources varied from 0.39 to 0.69 in the PS group (see Table 1), source factors had a small or no unique additional influence on self-regulatory efficacy (ranging from 0.00 to 0.12; see Table 3), indicating that in the PS group, sources overlapped and most of the variance was shared between the sources.

Finally, we compared the regression coefficients of the sources of efficacy between the groups (see Table 3). No significant differences were found between the groups.

4. Discussion

The present study investigated self-rated self-regulatory efficacy and its four sources (mastery experiences, vicarious experiences, social persuasion and physiological/emotional states) in two groups of

Table 2
Unstandardised estimates (deviations from zero), standard errors (SE) and standard deviation (SD) of the factor means of the AED group and analysis of the mean differences between groups.

Variable	Estimate	SE	Estimate/SE	*p*	AED group SD	PS group SD	Cohen's d
Self-regulatory efficacy	−0.29	0.12	−2.41	.016	0.86	0.60	0.48
Mastery experiences	−0.51	0.18	−2.74	.006	1.32	0.90	0.56
Vicarious experiences	−0.02	0.20	−0.09	.928	1.29	0.96	0.02
Social persuasion	0.10	0.23	0.42	.675	1.63	1.42	0.07
Physiological/emotional states	1.03	0.28	3.75	< .001	1.68	1.20	0.86

Note. Factor means of the PS group are set to zero. Cohen's *d* is calculated with an equation in which unstandardised estimates of deviations from zero are divided by standard deviations of unstandardised values of the population. Factor means of the population are set to 0.

elementary school pupils: a large population-based sample (PS group) and pupils with attention and EF difficulties (AED group). Concerning the preliminary analysis, it was found that the proposed model with one efficacy factor and four source factors fitted the data well and supported the theory-based structure of the sources of efficacy questionnaire and the assumed structure of the self-regulatory efficacy questionnaire among elementary school-age children.

The results of the main analyses indicated, as assumed, that attention and EF difficulties are associated with self-appraisals. First, as assumed, the AED group rated their self-regulatory efficacy lower than pupils in the PS group. This finding is consistent with those of previous studies showing lower self-regulatory efficacy in pupils with LD (Hampton & Mason, 2003; Klassen, 2010). Significant differences between the groups were also observed in the sources of self-regulatory efficacy. The AED group reported fewer mastery experiences and higher physiological and emotional arousal than their peers. Previously, Hampton and Mason (2003) reported similar differences in mastery experiences and interpretations of physiological and emotional states between LD pupils and non-LD pupils, and Usher and Pajares (2006) between groups with different levels of reading ability. According to Bandura (1997), unfavourable interpretations of physiological and emotional states are more potent when indicators of positive mastery experiences are weak. Following this argument, it is possible that a lack of experiences of control over one's actions can potentially predispose a pupil to negative affective-state interpretations.

The second aim of the study was to investigate the relationship between sources of efficacy and self-regulatory efficacy and compare these relationships in the PS and AED groups. Overall, the model fitted the data well, and the sources explained 54% of the total variation of self-regulatory efficacy in the PS group and 56% in the AED group. From four sources, mastery experiences explained the largest proportion of variance in self-regulatory efficacy in both groups, which was in accordance with the results of previous studies (Butz & Usher, 2015; Chen & Usher, 2013; Hampton, 1998; Joët et al., 2011; Usher & Pajares, 2006). In the PS group, besides mastery experiences, two other sources – social persuasion and physiological/emotional states – were related to self-regulatory efficacy. In the AED group, mastery experiences, vicarious experiences and physiological/emotional states were related to self-regulatory efficacy. As the items in the physiological/emotional states factor were problem-oriented, in both groups, the relationships between efficacy and physiological/emotional states were negative; heightened negative emotions were associated with lower self-regulatory efficacy. Interestingly, in the AED group, vicarious experiences had negative influence on self-regulatory efficacy, whereas in the PS group, vicarious experiences had no unique influence on efficacy.

Third, we explored differences in source-efficacy connections in the two groups of interest. The interactions between the groups and sources of self-regulatory efficacy were not significant. However, when examining the regression models and correlations more closely, some group-related variability was observed. Mastery experiences alone accounted for 27% of the variance in self-regulatory efficacy in the AED group, whereas in the PS group, mastery experiences only accounted for 12%. This result is in line with Hampton's (1998) findings among students with LD, where mastery experiences covered most of the variance (33%) of self-regulatory efficacy. These findings suggest that pupils with attention and EF difficulties or LDs build their confidence in self-regulation by relying mostly on past performance accomplishments that give immediate feedback and can be easily interpreted. It is also possible that weak self-regulatory skills result in poor knowledge and self-awareness of successful on-task behaviours or performances (Klassen & Lynch, 2007), which then weaken the connection between information originating from multiple sources of efficacy and self-regulatory efficacy. Accordingly, in the present study, mastery experiences, which have been shown to be the most potent source of efficacy (Usher & Pajares, 2008), had a high unique association with self-regulatory efficacy in the AED group.

As mentioned above, in the AED group, vicarious experiences had a negative association with self-regulatory efficacy. This result suggests that peers' successful accomplishments in the classroom may increase sense of inabilities in task-related activities among pupils with attention deficits. This is contradictory to Hampton's (1998) findings with children with LDs; in his study, vicarious efficacy had a significant positive influence on self-regulatory efficacy. One reason for the different findings stems from the content of the questionnaire items; the items used by Hampton (1998) reflected modelling from adults, whereas the present study used peer-related items. The items assessing vicarious

Table 3
Unique influence of the four sources of efficacy on self-regulatory efficacy; test for coefficient differences between groups and unique explanation ratios (ΔR^2).

Variable	PS group (n = 1210)	AED group (n = 61)	Difference	SE for difference	*p*	PS group ΔR^2	AED group ΔR^2
Mastery experiences	0.35***	0.52**	0.17	0.31	.182	0.12	0.27
Vicarious experiences	0.01	−0.39*	0.40	0.24	.100	0.00	0.15
Social persuasion	0.08*	−0.10	0.18	0.24	.286	0.01	0.01
Physiological/emotional states	−0.26***	−0.30*	0.04	0.17	.816	0.07	0.09
Model	R^2 = 0.54	R^2 = 0.56					

Note. Unique betas unstandardised values. Difference-value divided by the correspondent SE produce the *t*-values, and *p*-values are obtained from the *t*-distribution. Unique explanation ratios counted from the standardised values.

*** < .001.

** < .01.

* < .05.

experiences from different models are likely to produce inconsistent results (Ahn, Bong, & Kim, 2017).

In the PS group, the sources had a low unique explanation ratio or no unique effect on efficacy, and at the same time, the sources of self-regulatory efficacy correlated highly, which indicates that the sources had a substantial amount of shared variance. Thus, it can be assumed that in the PS group, multiple experiences have a positive effect on self-regulatory efficacy. It has previously been shown that this type of effect of multiple sources is related to favourable achievements (see Chen & Usher, 2013). Our findings suggest that the multiple sources available to the PS group contribute to their more favourable self-regulatory efficacy. Interestingly, in the AED group, the sources had higher unique explanation ratios and shared less common variance than in the PS group. This finding suggests that attention and EF-related problems might decrease the accumulation of positive experiences and contribute to less positive efficacy beliefs concerning regulative competence.

The findings of the present study offer evidence that attention and EF difficulties are related to pupils' sources of efficacy-related experiences, and furthermore, that these difficulties and experiences can affect pupils' confidence in their self-regulatory competencies. Pupils' negative self-regulatory experiences may be a risk for decreased motivation and self-regulatory effort in demanding task situations and, thus, may continue the cycle of negative behavioural control and negative feedback. These negative trajectories can result in a tendency to avoid these situations, further limiting their opportunities to practice and develop self-regulation and EF (Sonuga-Barke, 2005). Some research findings suggest that teachers also have influence on these trajectories. Teachers may become frustrated with pupils with self-regulatory difficulties and expect poor on-task behaviour, and thus strengthen the negative cycle (Blair & Diamond, 2008). Although some pupils fail to manage academic activities due to lower self-regulatory abilities, teachers may not always deliver sufficient support and opportunities to effectively practise and develop self-regulatory skills in academic tasks (Peeters, De Backer, Kindekens, Triquet, & Lombaerts, 2016).

Since the pupils with attention deficits primarily build their confidence for managing tasks and learning situations on previous successful performances, the intervention methods should develop pupils' skills to manage learning tasks and situations in school, thereby raising the probability of positive self-regulatory mastery experiences (see Martin et al., 2017). It has been shown that interventions that target skills for working more effectively on academic tasks are beneficial with regard to attention and EF problems (see Evans, Owens, & Bunford, 2014). Improved self-regulatory skills can promote a pupil's self-efficacy and consequently 'enhance their motivation to continue additional cycles of learning', as Zimmerman (2008, p. 179) stated. The results of the present study implicate that peer modelling in a classroom context is not necessarily a positive source for building confidence in self-regulatory skills for pupils with attention and EF difficulties and may even have a negative effect on efficacy, at least when the peer group does not have attentional and EF difficulties. In order to diminish the possible negative vicarious effects, interventions should also emphasise positive feedback methods that provide pupils with adequate and reliable information regarding their own performance and progress in regulatory skills.

Some limitations of the present study and its findings are worth noting. A major limitation of the present study was the small number of participants in the AED group compared to the PS group. Unequal group sizes affected the statistical power of the analyses, particularly in the regression analysis, making direct comparisons somewhat challenging. In the analyses, we did assume a measurement invariance across groups. However, due to the small number of participants in AED group, a full test of measurement invariance could not be conducted reliably. Future studies with larger samples are needed to further test the invariance. Second, in the present study, the data concerning efficacy and sources were obtained with newly constructed scales; therefore, these results should be considered as preliminary. Future research should be conducted with other samples, particularly a larger attention deficit sample, to examine further self-regulatory efficacy among elementary school pupils. Third, the problems of attention and EF were not evaluated in the PS group; therefore, it was not possible to identify pupils with attention and EF difficulties in this group. Based on the findings concerning the proportion of such problems in the general population (Barbaresi et al., 2002; Polanczyk et al., 2007), it can be assumed that the proportion ranged between 5% and 16% in the present sample. However, due to the large sample size of the PS group, it can be assumed that the ratings of these pupils did not affect the results. Last, the great difference in gender ratio in AED group – 12.7% girls and 87.3% boys – was a limitation. This could be due to inclusion criteria that emphasise problems observable in classroom which are more prominent for boys.

The present study raises a few questions that are worth investigating in the future. This study showed that sources of efficacy and their relationships with self-regulatory efficacy could be investigated with questions that specifically address self-regulation–related concerns, i.e. control of attention and interference, executive control and emotion regulation. In the future, using the same method, it would be worthwhile to investigate different subgroups with different skills or achievement levels. This research design would provide greater insights into how self-regulatory experiences drive self-regulatory efficacy and how other learning-related indicators moderate these relationships. Previous studies have shown that among students with ADHD, self-appraisals may vary strongly (see Bourchtein et al., 2017); therefore, in the future, person-oriented methods should be used to investigate variations in self-regulatory efficacy and its sources in children with attention deficits. In this study, among pupils with attention and EF difficulties, vicarious experiences had a negative association with self-regulatory efficacy. Although the explanation ratio was high (15%), we have to consider this result as preliminary, and therefore, further studies that focus more on vicarious experiences are suggested (see also Ahn et al., 2017). Also, further research should be undertaken to investigate how other classroom-level factors influence self-regulatory efficacy and sources of efficacy. Such factors could be, for example, the teachers' practices in structuring the learning environments and situations, giving feedback or modelling task processes. The findings of the present study raise an important question regarding the role of physiological and emotional reactions. The results showed the greatest differences between the groups for this variable. Further work is required to investigate the role of physiological and emotional reactions in real time for on-task behaviour and self-regulation, and whether these reactions have reciprocal connections with other sources of efficacy (see also Chen & Usher, 2013). Clarification of this relationship would direct both the assessment of attention and self-regulatory problems and the development of intervention methods.

Conflict of Interest: Author Mika Paananen declares that he has no conflict of interest. Author Tuija Aro declares that she has no conflict of interest. Author Helena Viholainen declares that she has no conflict of interest. Author Tuire Koponen declares that she has no conflict of interest. Author Asko Tolvanen declares that he has no conflict of interest. Author Jari Westerholm declares that he has no conflict of interest. Author Mikko Aro declares that he has no conflict of interest.

Compliance with ethical standards

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Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Written informed consent was obtained from all legal guardians of the children and informed consent from the teachers included in the study.

Appendix A. Standardised factor structure of the self-regulatory efficacy and sources of self-efficacy questionnaire

Variables	Estimate	SE	Est/SE	*p*-Value
Self-regulatory efficacy by: *How confident are you*				
1. …that you finish your homework even if it is difficult for you?	0.53	0.03	17.60	< .001
2. …that you can push on even if the tasks are difficult?	0.52	0.03	17.69	< .001
3. …that you can do your best even if you notice that the test is difficult for you?	0.49	0.03	15.04	< .001
4. …that you can always focus on school subjects during class?	0.67	0.02	28.34	< .001
5. …that you can follow the instructions presented by the teacher?	0.63	0.03	19.62	< .001
6. …that you get yourself to prepare for a test?	0.62	0.03	23.39	< .001
7. …that you get yourself to study when there are other interesting things to do?	0.75	0.02	38.98	< .001
8. …that you get yourself to do schoolwork during class even when the tasks make you nervous?	0.73	0.02	34.42	< .001
Mastery experiences by:				
1. I have always been able to focus on homework.	0.68	0.02	28.63	< .001
2. I always listen to the teacher when she/he is teaching.	0.78	0.02	41.59	< .001
3. I have always been able to pay attention to teaching during class.	0.83	0.02	44.50	< .001
4. I have always been able to focus on tasks during class.	0.86	0.01	60.10	< .001
Vicarious experiences by:				
1. My friends pay attention to teaching during class.	0.66	0.03	19.78	< .001
2. My friends work and try their best during class.	0.74	0.04	20.86	< .001
Social persuasion by:				
1. My parents said that I concentrate well on homework.	0.72	0.02	37.66	< .001
2. My teacher said that I pay attention to teaching during class.	0.82	0.02	51.64	< .001
3. My friends say that I pay attention to teaching.	0.78	0.02	39.37	< .001
4. Many have praised me for how I concentrate.	0.80	0.02	47.71	< .001
Physiological/Emotional states by:				
1. I feel nervous when I do my homework.	0.70	0.04	17.12	< .001
2. If there are any problems in class, I feel nervous and I am unable to do my tasks.	0.65	0.04	15.99	< .001
3. If there are any problems in class, I feel nervous and I am unable to focus.	0.64	0.04	15.98	< .001

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II

IS THE VARIATION IN SOURCES OF SELF-REGULATORY EFFICACY CONNECTED WITH SELF-REGULATORY EFFICACY AND BASIC ACADEMIC SKILLS AMONG CHILDREN?

by

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III

GROUP-BASED INTERVENTION ON ATTENTION AND EXECUTIVE FUNCTIONS IN THE SCHOOL CONTEXT

by

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Group-based Intervention on Attention and Executive Functions in the School Context

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Group-based Intervention on Attention and Executive Functions in the School Context

Abstract

The objective of the study was to examine the effects of a group-based behavioural, cognitive and skills training intervention (Maltti) provided in schools for elementary school pupils with attention and executive function (EF) deficits. The treatment effects were identified by comparing an intervention group (n = 46) with a waitlist control group (n = 26). Specific effects of the intervention on behavioural deficits in attention and EF in a classroom setting as well as on academic skills were examined. Our analysis indicated that significant intervention effects could be found in the behavioural manifestation of attentional and executive skills in the classroom setting among children (n = 30) who were evaluated as having moderate symptoms in the pre-intervention assessment. Positive effects of the intervention were also observed in arithmetic and reading skills. The severity level of pre-intervention attention and EF deficits did not moderate the results observed in the academic skills tests. The results of this study suggest that a combination of behavioural, cognitive and skills training methods applied in a school context can be effective in reducing attention and EF problems and enhancing the academic performance of children with attention and EF deficits.

Keywords: attention deficits; executive function deficits; intervention; treatment efficacy

Problems of attention and executive functions are extremely common, and approximately 5% of the school-age population meets the criteria for attention deficit hyperactivity disorder (ADHD) (Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007). In the school setting, ADHD causes significant social, behavioural, and functional impairment, as well as poor academic performance (Barkley, 1997; Murphy, Barkley, & Bush, 2002). Even among children who do not have a formal diagnosis of ADHD, symptoms and features of ADHD are associated with adverse academic outcomes (Loe & Feldman, 2007).

Problems in the executive functions (EFs) overlap with attention deficit problems, and thus they are included as an essential component in contemporary models of ADHD (Hinshaw & Arnold, 2015). It has been suggested that both ADHD symptoms and deficits in EFs reflect the hypoactivity and immaturity of frontal brain structures (Rapport, Orban, Kofler, & Friedman, 2013; Sonuga-Barke, 2002). The approaches used in different studies to measure deficits in attention and EFs include rating the diagnostic behavioural core symptoms of attention deficit (inattention, impulsivity and hyperactivity) (Sonuga-Barke et al., 2013), the behavioural manifestations of EFs (Evans et al., 2014), performance in cognitive laboratory tests (Rapport et al., 2013), and performance in neuropsychological tests (Evans et al., 2014), all of which tap into deficits in these functions.

Learning situations in school make multiple demands on children's EFs (e.g., inhibitory control, behavioural control, sustained and selective attention, problem-solving and planning; Diamond, 2013). Since children with ADHD frequently have problems with on-task behaviour, which reflects their deficits in the EFs (Barkley, 1997; Sonuga-Barke, 2002), they are at risk for deficits in academic achievement (Rapport et al., 2013). It is therefore important that interventions for attention deficits not only aim to reduce the social and behavioural problems caused by the ADHD symptoms, but that they also aim to improve the EFs required to succeed in the academic setting. In a similar vein, outcome measures that

detect changes in learning-related functions should be used in intervention studies as they assess the age-relevant capabilities needed in the everyday context (Evans et al., 2014). In the present study, our interest was to explore the effects of an intervention aimed at attention and EF, and in particular, the behavioural manifestations of EFs, that is, in relation to on-task behaviour in the classroom setting and in relation to basic academic skills.

Medical and behavioural treatments are effective in reducing the core symptoms of attention deficit and disruptive behaviour, but these methods have not been shown to have strongly positive academic or educational outcomes (Hinshaw & Arnold, 2015; Loe & Feldman, 2007). The behavioural improvement gained with contingency-based behavioural interventions is often observed only in the intervention setting where the contingencies are delivered, and generalization across different settings is limited (Abikoff, 2009). Cognitive-behavioural interventions for children with ADHD, or with characteristic ADHD behaviour, have shown conflicting results: they have variously been shown to be ineffective (Pelham & Fabiano, 2009), promising (Toplak et al., 2008; Kearns & Fuchs, 2013; Sonuga-Barge et al., 2013), effective in single-case studies (DuPaul, Eckert, & Vilardo, 2012,), and effective with a subclinical level of deficits (Miller & Hinshaw, 2012) in reducing ADHD and other behavioural symptoms. Traditionally, cognitive-behavioural methods utilize self-monitoring and self-control, but these are seen as the core weaknesses of children with attention deficits, so this might be one reason why these interventions have shown limited effectiveness (Schultz, Storer, Watabe, Sadler, & Evans, 2011).

To promote a generalization of the effect of an intervention to academic learning, the delivery setting should be relevant to the objectives of the intervention and the focus of the intervention should be on the behaviours and skills necessary for children to function adequately in their everyday settings (Abikoff, 2009). Due to the high rate of academic difficulty among children with attention and EF deficits, the first line of treatment should be

interventions developed for and implemented in the school setting (DuPaul et al., 2012; Evans, Owens, & Bunford, 2014; Schultz et al., 2011). There is strong evidence to show that among children with ADHD and children at-risk for academic difficulties academic interventions and explicit skills-teaching that focus on academic instructions and the use of materials are associated with positive academic outcomes. However, they do not necessarily result in behavioural change (DuPaul et al., 2012; Kearns & Fuchs, 2013).

To overcome the limitations of each intervention method, DuPaul et al. (2012) suggest that the incorporation of elements from several interventional approaches could address the academic, behavioural and EF difficulties of children with ADHD symptoms more effectively than the use of any single intervention strategy alone. Comprehensive methods, such as specific skills training combined with behavioural (Abikoff et al., 2013; Langberg, Epstein, Becker, Girio-Herrera, & Vaughn, 2012) or cognitive elements (Deaño, Alfonso, & Das, 2015) and implemented in a school context have shown promising results in both behaviour and academic skills in children with attention deficits, but more research is needed.

In order to prevent unwanted consequences and the accumulation of problems, supportive arrangements in schools should be started as soon as problems of attention and EF are noticed (ADHD: Current Care Guidelines Abstract, 2017). This approach is also supported by findings showing that academic skills such as reading and mathematics are strongly correlated with the development of EFs (Best, Miller, & Naglieri, 2011). Overall, there is a need to develop and to study empirically comprehensive methods that can ameliorate both the behavioural and academic problems of children with attention and EF problems that interfere with their school performance. These methods should promote both the EFs and the ability to function adequately in a school setting. Furthermore, there is a need

to explore the effectiveness of these combined behavioural, cognitive and skills training approaches when implemented in a natural setting (i.e., the school context).

In this study, we aimed to implement an experimental attention and EF intervention in a normal Finnish elementary school setting and in accordance with the customary special education procedures of Finnish schools. This approach was appropriate because in Finland deficits in learning, attention and EFs as observed by teachers are considered eligibility criteria for the provision of special educational support and intervention by the school. In other words, no medical diagnosis is needed. Most special education support and instruction is given in regular schools, either in general education classrooms or in small groups. Special education is employed extensively in Finland, with almost one fourth of pupils participating in special education at some point during their elementary or middle school years (Björn, Koponen, Aro, Fuchs, & Fuchs, 2015). In line with the principles and procedures of Finnish special education, participation in the intervention for this study did not require a diagnosis of ADHD.

The group-based and comprehensive Maltti ("Patience") intervention (Paananen, Heinonen, Knoll, Leppänen, & Närhi, 2011) used in the present study is based on previous intervention studies and findings among children with ADHD. Maltti is designed to be implemented in a school context as part of the special education support provided for children with problems in attention and EFs. Provided in manual form, it combines behavioural management techniques with methods that focus on cognitive and executive skills building (see Table 1). Behavioural management in Maltti involves a reward system, praise and positive attention to increase the occurrence of target behaviours and strategies (Evans et al., 2014; Toplak et al., 2008). The cognitive and learning-related executive skills-building components of Maltti aim to improve the executive processes required in learning (Abikoff, 2009; Das, Parrila, & Papadopoulos, 2000).

The Maltti programme aims to improve on-task skills and behaviours that a child can use and modify in different learning contexts (Abikoff, 2009) and thereby achieve generalization of these treatment effects to task situations outside of the intervention setting (i.e., classroom and learning settings). In the present study, the main interest was in exploring the effects of the intervention on children's behaviour in the classroom setting and on their learning, particularly in relation to attentional functions, EFs, and academic skills. The specific research questions concerned the effects of the intervention on (a) attention and EFs and (b) the development of academic skills (reading and arithmetic fluency). Based on earlier research (Abikoff et al., 2013; Deaño et al., 2015; DuPault et al., 2012), we hypothesized that the comprehensive Maltti programme would have an effect on attention and EFs. Furthermore, based on the finding that enhanced EF is associated with positive effects on reading and arithmetic (Best et al., 2011) we anticipated it would affect the development of reading and mathematical skills.

We also examined the effects of symptom severity in attention and EF deficits on intervention outcomes. Owens et al. (2003) and Langberg et al. (2010) have previously shown that baseline symptom severity may have an effect on intervention outcomes. Owens et al. (2003) found that high levels of initial severity were associated with poor treatment outcomes. Langberg et al. (2010) showed that an intervention combining both behavioural treatment and medication was more effective for children with low to moderate symptom severity (the 75% of the sample with less severe symptoms) as compared to other interventions. However, while children with high symptom severity (the highest 25%) showed large improvements in target behaviour, there were no differences in the effectiveness of the different interventions (medication, behavioural treatment, a combination of the two, and community care; Langberg et al., 2010). Based on the findings of Owens et

al. (2003) and Langberg et al. (2010), we hypothesized that baseline symptom severity would moderate the effect of the intervention.

Method

Participants

Ninety children from grades one to six (ages 7–12) participated in the study. Sixty-two of them (10 girls and 52 boys) participated in the attention and EF intervention (the Maltti programme) and twenty-eight children (6 girls and 22 boys) were in a waitlist group that served as a control for the study. Two boys from the intervention group discontinued their participation due to their changing schools. All children were Caucasian and all but one (a Russian) spoke Finnish as their mother tongue.

The children in the intervention group came from 14 schools in ten different towns and municipalities in Southern, Central, and Eastern Finland. School districts were diverse (i.e., urban, suburban, and rural). The control group children came from four schools situated in urban areas of two small towns in Central and Eastern Finland and were waitlisted to participate in the intervention (the Maltti programme) at a later date. As differences between schools and in students' performances between schools are very small in Finland (Linnakylä, Välijärvi, & Arffman, 2011), it was assumed that there was no variation between students' schooling and abilities.

The initiative to include a particular child in the intervention came from the classroom teachers, as is the common practice in Finland, and the final selection of the students was conducted in a joint discussion between the researchers and the intervention providers (usually the school's special education teacher and/or school psychologist). Inclusion criteria were the same for both the intervention group and the control group: (1) the children were identified in classroom settings as showing symptoms of attention and/or EF deficits, and (2) these deficits caused problems in their daily school routines and learning

situations. The parents' consent was obtained for the children to participate in both the intervention and the study. Participation in the study was voluntary.

Intervention participants were in grades 1–6 and control participants in grades 1–5. All participants followed the normal school curriculum, but 48% of the intervention group and 50% of the control group children already received special education support (in addition to the Maltti intervention to be received by the intervention group). For 13% of the children from the intervention group and 11% from the control group, special education had been arranged for both behavioural and learning difficulties. Special education in mathematics was given to 6% of children in the intervention group and 14% of children in the control group, and for reading to 29% in the intervention group and 25% in the control group. Ten children (16%) in the intervention group and three (11%) in the control group had a diagnosis of ADHD. Eight of these children were receiving ADHD medication (Methylphenidate): six from the intervention group and two from the control group. The medication status of the participating children did not change during the period of the study.

Materials

Maltti programme

The Maltti programme (Paananen et al., 2011) is a theory-driven, manualized intervention developed for use in a school setting with elementary school aged children with problems in attention control and EFs. It is a group-based, behavioural, cognitive, and skills-building approach (see Table 1). The manual provides detailed instructions for 20 sessions.

The behavioural methods (i.e., feedback and contingency management) of the Maltti programme aim to support sustained attention and persistence and thus lengthen on-task working periods. This is based on the motivational dysfunction model, which claims that ADHD is related to attentional problems in situations where reinforcements are delivered infrequently (Aase & Sagvolden, 2006), and it is also related to an aversion to delayed reward

(Sonuga-Barke, 2002) leading to difficulties in sustaining attention (Aase & Sagvolden, 2006). Contingency management is also used to reinforce practiced skills and their use during the sessions. The methods used in Maltti to enhance cognitive and learning-related executive skills seek to improve cognitive control processes, such as the skill to focus on relevant information and on-task behaviour. The tasks that are used require inhibitory control and are intended to develop attention control and prolong processing time in task situations. This is based on the assumption that children with ADHD have inhibition difficulties (Barkley, 1997) and that they observe cues for a shorter amount of time and use less information for the processing of actions (Milch-Reich, Campbell, Pelham, Connelly, & Geva, 1999). Through modelling and strategy training, Maltti supports executive skill building and the control of on-task behaviour (e.g., task planning skills, organizing of task performance and materials, and planning check out) (Abikoff et al., 2013; Deaño et al., 2015). This is based on the assumptions that improvement in the ability to focus on relevant information (Abikoff, 2009), enhanced strategy use, and better self-organization in task situations (Abikoff et al., 2013; Das, Parrila, & Papadopoulos, 2000; Langberg et al., 2012) will all enhance children's on-task behaviour and ultimately their academic performance.

The programme consists of three parts comprising exercises and tasks emphasising different aspects of on-task behaviour and EFs: inhibition and attention control (5 sessions), inhibitory control and planning (4 sessions), and strategy training (11 sessions). At the onset of the programme, exercises are simple pencil and paper visual search tasks, auditory attention tasks, and problem solving tasks with visual materials that aim to introduce the participants to working routines and the elements of strategic skills. As the programme progresses, the tasks become more closely related to actual schoolwork. Mathematical reasoning tasks, reading comprehension tasks, social skills, and game practises target improvement in both the executive functions and adaptive behaviour in the classroom setting.

During the sessions, every task is initiated with verbalisation, modelling, and scaffolding. Selective and sustained attention and inhibitory control are emphasised throughout the programme (see also Table 1).

In the present study, the teachers had structured guidelines for running each session and for the systematic use of feedback and verbal praise. During the intervention, the desired behaviour and activities were reinforced by a token system. The behavioural expectations of the group meetings were explicit. Every treatment session had the same structure and routines and included four programme topics: orientation, practices, reward management (tokens), and a play or game exercise (except for the first session, which had three topics). Each session lasted 60 to 75 minutes. Sessions started with a short warm-up during which every participant was acknowledged. Next, the day's tasks and the reasons for receiving rewards were presented. After performing the actual on-task practices, processes related to task completion were reinforced by tokens. The session ended with game practices, which were intended to be both a fun ending to the meeting while also presenting demands for executive functions. Self-efficacy was promoted by explicit supportive feedback and by controlling the level of difficulty of tasks. The difficulty levels of the tasks varied as a function of the grade level in the tasks requiring reading and math skills.

Treatment fidelity was evaluated by means of provider interviews and checklists filled in by the providers after each session. The checklist covered the topics covered during each session and was used to verify if the sessions had included all the intended four topics. In addition, all providers were interviewed, which allowed for the evaluation and confirmation of fidelity information. The percentage of topics covered in each session was calculated on the basis of the checklists: 80% coverage of topics was set as a limit of acceptable fidelity. Intervention providers were asked to report drop-outs and non-attendance of participants.

Measures

Attention and EFs. Problems of attention and executive functions in school were assessed using a norm-referenced teacher-completed rating scale, the ATTEX questionnaire (Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, & Korkman, 2010). The ATTEX has high internal consistency (total score $\alpha = 0.98$) and good criterion validity (Klenberg et al., 2010). It has 55 items which cover ten different areas of attention and EFs: distractibility (four items), impulsivity (nine items), motor hyperactivity (seven items), directing attention (five items), sustaining attention (six items), shifting attention (four items), initiation (five items), planning (four items), execution of action (eight items), and evaluation (three items). The items are rated on a three-point scale: 0 for "not a problem," 1 for "sometimes a problem," and 2 for "often a problem." Total score range from 0 to 110 with higher score indicating greater symptom severity.

Academic skills. Reading performance was assessed with the Word Recognition Test (Lindeman, 1998) and the Luksu Reading Fluency Test (Salmi, Eklund, Järvisalo, & Aro, 2011). The Word Recognition Test assesses basic reading skills. It consists of 78 word-chains containing two to four words. The child is asked to mark with a pencil word boundaries within each chain (e.g., minä/ei/me/tulla; me/no/us/come). Children are asked to proceed as fast as possible, with a time limit of 3 minutes and 30 seconds. The score is the number of correctly identified words. Correlations in the range of 0.63 to 0.73 have been found between teacher-rated reading performance and the Word Recognition Test (Leppänen, Aunola, & Nurmi, 2005). The test has two parallel versions, which were used alternately in the assessments (with this sample, correlation between the parallel versions was 0.90).

In the Luksu Reading Fluency Test (Salmi et al., 2011), children are provided with 70 simple sentences and asked to read them as fast as possible and then to decide whether they are true or false. The time limit is two minutes. The score is the number of correct answers.

The test has three parallel versions, and at each assessment point a different version was used. Cronbach's alpha ranges from 0.94 to 0.95 for all versions.

Arithmetic skills were assessed with three tests: the Addition Fluency Test (Koponen & Mononen, 2010a), the Subtraction Fluency Test (Koponen & Mononen, 2010b), and the Basic Arithmetic Test (Aunola & Räsänen, 2007). The Addition and Subtraction Fluency Tests consists of easy addition and subtraction tasks on paper. Both tests have a time limit of two minutes and the test score is the total number of correct responses. This test also has three parallel versions, which were rotated across assessments. Cronbach's alpha is available for the first two of the parallel tests: 0.88 for the Addition Fluency Test and 0.90 for the Subtraction Fluency test. In the present study, the sum score of the Addition and Subtraction Tests was used as the Arithmetic Fluency Test (for this sample, Cronbach's alpha was 0.87).

The Basic Arithmetic Test contains 28 items on paper (14 addition and 14 subtraction items) of increasing difficulty. Children are asked to proceed as fast as possible. The total number of correct answers during the time limit of three minutes forms the test score. Test-retest reliability for this test is 0.86 (Räsänen, Salminen, Wilson, Aunio, & Dehaene, 2009).

Procedure

Intervention providers and training.

The Maltti programme was delivered at schools by school personnel. The intervention providers consisted of teachers (seven), special education teachers (seven), and school psychologists (four). Teacher education is at the same standard in every part of Finland and all basic education teachers are required to have a master's degree**.** The high standard of education of the providers ensured adequate staff proficiency in the implementation of the Maltti programme. Altogether, there were 14 intervention groups (one group in each participating school) consisting of four to seven participants. The intervention groups had 18 to 20 sessions held once per school week. The intervention took place during or after school

hours. The intervention period lasted from October (the middle of the autumn semester) to April (the second-to-last month of the spring semester).

The intervention providers were recruited from participants in the Maltti intervention training. This cost-free training, organized by the Finnish Board of Education and the Niilo Mäki Institute, targets school staff, teachers, special education teachers, and school psychologists. The intervention providers for ten of the groups participated in the Maltti training, consisting of four six-hour training sessions, two before the intervention period (in October) and two during it (in December and March). Providers started their intervention groups after the first two training sessions. The intervention providers for ten of the groups in the study were novices in terms of the Maltti programme, and had got to know the programme only during the training. The providers in four of the groups had received their training earlier, and at the start of the study, they were already familiar with the method and had experience in running a Maltti intervention. They started the intervention earlier (in the preceding school year) than the other ten groups. The providers of these four groups received guidance from the research team only on the assessments. Twelve of the groups had two intervention providers and two groups had just one provider. In three groups, the intervention provider was also the children's classroom teacher. The waitlist control group was recruited by teachers attending the later Maltti intervention training. The control group started its intervention only after the follow-up assessments. Because the groups receiving the Maltti intervention training were predefined, we had to make some compromises with design, and thus the ideal experimental design (e.g., with randomization and blinded participants) was not applicable.

Screening and assessment procedure

Pupils with attention and EF deficits that affected their school performance were identified by their class teachers in consultation with the intervention providers. The parents gave written

consent for their children to participate in the study. After that, pre-intervention questionnaires were sent to both parents and teachers. The parents of four of the children identified for participation in the intervention did not consent to their child participating in the study.

The pre-intervention data was gathered in the autumn before the interventions started. Post-intervention assessments were conducted the following spring and subsequent follow-up assessments the following autumn, one month after the beginning of the school year. There was a period of seven months between the pre- and post-intervention assessments, and five months between the post-intervention and follow-up assessments. For each assessment the classroom teachers filled in the attention and EF questionnaires, while parents filled in a questionnaire concerning their child's possible diagnoses and current medication, and the children were assessed for their reading and arithmetic skills. In 11 groups out of the 14, the classroom teachers were not involved with the intervention. In the other three groups, the classroom teacher was an intervention provider. Parents were also asked about their own level of education: (1) compulsory education up to the completion of grade 9, (2) senior high school, (3) vocational school, (4) three-year education at a college and (5) university education.

Assessments of the children's academic performance were conducted at pre-intervention, post-intervention, and follow-up by the research team, the local school psychologists, or by special education teachers in cooperation with the research team. The pre-intervention assessment was performed individually. Due to time restraints, the post-intervention and follow-up assessments were done in small groups of two to four children. These academic tests were not conducted with the four groups (14 participants) that had started the intervention during the preceding school year.

Data analysis

First, the groups were compared at baseline for different variables (age, grade level, attention and EF problems as rated by teachers, reading skills, math skills, and parents' education) with one-way ANOVA to study their equivalency. Second, mixed-model ANOVAs were used to analyse changes in outcome measurements, ATTEX, and academic skills at the assessment time points (pre-intervention, post-intervention, and follow-up) as within-subjects factors and with the group as a between-subjects factor. Additional pairwise comparisons were made between pre- and post-assessment time-points to investigate possible immediate intervention effects. Third, moderation analyses were performed using the Johnson-Neyman method (Hayes, 2013). This method made it possible to study the extent to which the pre-intervention level of symptoms (pre-intervention ATTEX score) was associated with the outcomes (post-intervention ATTEX score and academic skills scores), that is, to establish regions of significance associated with the changes observed in the post-ATTEX or academic test scores of the control and intervention groups. Fourth, once the subjects that were in the region of significance (in terms of difference between groups) were analysed through moderation analyses (Johnson-Neyman), the mixed-model ANOVA was used to analyse the changes in outcome measurements, ATTEX, and academic skills, with the assessment time points (pre-intervention, post-intervention, and follow-up) as the within-subjects factors and the groups as the between-subjects factor.

Results

Attendance and Fidelity

Attrition and the collected data are presented in Table 2. There were no differences between groups at the baseline in terms of age, grade level, attention and EF problems, reading skills, math skills, or parents' education (Table 3).

According to the checklist information (and confirmed with interviews), the percentage of the treatment contents for the four topics covered in each session varied from 74.68% to 100%. Two groups had fidelity of less than 80% (74.68% and 78.48%), even though these groups both had the full 20 sessions. These groups did not follow the planned structure for the intervention sessions: the last topic of the session programme (the play/game exercise) was completed by these groups in only 10.5% and 20% of the sessions, respectively. These two groups with poor fidelity (nine participants) were excluded from the analyses.

Change in Attention and EFs

The means and standard deviations from the pre-, post- and follow-up assessments are presented in Table 4**.** The mixed-model ANOVA result for the interaction of time (pre-intervention, post-intervention, and follow-up) and the group for the total ATTEX score was not significant ($F (2, 68.00) = 1.57$; $p = .22$; $\eta_p^2 = .04$). The pairwise comparison of time (pre- and post-assessment) and group did not quite reach significance ($F (1, 70.00) = 3.14$; $p = .08$; $\eta_p^2 = .04$).

The Johnson-Neyman method (Hayes, 2013), which was used to determine the extent to which pre-intervention symptom severity (ATTEX score) influenced the intervention effect, showed significant group differences for 58.33% of participants. The analysis revealed that when pre-intervention ATTEX scores were between 14 and 60, there was a significant relationship between pre- and post-intervention ATTEX scores, and within this score range children in the intervention and control groups progressed differently. However, when the pre-assessment ATTEX score was lower than 14 points or higher than 60 points, there were no significant relationships between the ATTEX pre- and post-intervention assessment. This indicates that children with either high or low pre-intervention ATTEX problem scores showed no difference subsequent to the intervention. There was only one child in each group

that had a score lower than 14 in the ATTEX pre-assessment, and in the post-assessment they both showed a small change in their points (from 9 to 11 and from 1 to 5), indicating a low behavioural problem rating by their teacher in both the pre- and post-assessments. An additional mixed method ANOVA for the ATTEX total score was applied to the subjects (n = 42) who were in the region of significance. The results revealed that the interaction of time (pre-intervention, post-intervention, and follow-up) and group was significant for the ATTEX total score ($F (2, 39) = 10.09$, $p < .000$, $\eta_p^2 = .34$), suggesting positive development in the intervention group (intervention group pre-assessment (n = 30), M = 41.00 (SD = 11.98), post-assessment M = 32.97 (SD = 15.44) and follow-up M = 35.65 (SD = 23.50); control group (n = 12), pre-assessment M = 43.92 (SD = 12.35), post-assessment M = 58.00 (SD = 18.57) and follow-up M = 53.88 (SD = 21.64)). Pairwise comparisons between the three time points revealed significant differences between the groups between the pre- and post-intervention assessments ($F (1, 40) = 19.94$, $p < .000$, $\eta_p^2 = .33$) as well as between the pre- and follow-up assessments ($F (1, 40) = 4.38$, $p = .043$, $\eta_p^2 = .10$). There was no significant interaction for time and group in relation to the post-intervention and follow-up assessments.

The results for academic skills

The scores for academic tests at the three assessment time points are presented in Table 5. The mixed method ANOVA indicates that the interaction of time (pre-intervention, post-intervention, and follow-up) and group in the Word Recognition Test almost achieved significance ($F (2, 60) = 3.06$, $p = .054$, $\eta_p^2 = .09$). Pairwise comparisons revealed that the intervention group had a significantly greater gain in the Word Recognition Test between the pre- and post-intervention assessments ($F (1, 63) = 4.61$, $p = .036$, $\eta_p^2 = .07$). Interaction between time (pre-intervention, post-intervention, and follow-up) and group in the Arithmetic Fluency Test scores was not significant, but a pairwise comparison did reveal significant interaction between the pre- and post-assessment ($F = (1, 63) = 5.64$, $p = .021$, $\eta_p^2 = .08$),

indicating that during this period the intervention group improved more than the control group. No significant effects were found for the Basic Arithmetic Test or the Luksu Reading Fluency Test. Moderation analysis revealed that pre-intervention symptom severity (ATTEX score) did not moderate the development of academic skills.

Discussion

The current study examined the effects of behavioural, cognitive, and skills training intervention (the Maltti programme) in a normal elementary school setting with children with attention and EF deficits as identified by their teachers. The intervention was implemented by school personnel as part of the special education support offered in Finnish schools, and it aimed to improve executive skills and functioning in task situations in the school setting. Positive effects from the treatment were found in attention and EF and also in academic skills, but the improvement in attention and EF varied according to the initial severity of the problem.

As expected on the basis of the findings by Langberg et al. (2010) and Owens et al. (2003), symptom severity moderated the observed effects of the intervention on attention and EF. Moderation analysis indicated differences in the progress of attention and EF between the Maltti group and the control group in relation to the pre-intervention severity levels of symptoms of attention and EF deficits. Positive intervention effects in relation to attention and EFs in the classroom setting were found among children from the Maltti intervention group who were identified as having moderate symptoms in the pre-intervention assessment. It has been suggested that children with high symptom severity are less likely to show differences in treatment effect (Owens et al., 2003). It can be assumed that children with high symptom severity are “resistant” to treatment effects (Miller & Hinshaw, 2012). These children may therefore need more individualized or prolonged intervention before behavioural change can be detected in the classroom setting.

A positive intervention effect was found in both arithmetic fluency and basic reading skills between the pre- and post-intervention assessments. These results were not moderated by the pre-intervention symptom severity. The long-term gains (from the pre-intervention to follow-up assessments) were greater for the intervention group in relation to the academic skills mentioned above than they were for the control group, but the difference did not reach significance. The intervention effect could be seen only in simple academic tasks, that is, in basic reading skills (word recognition) and in basic math fluency. In more complex tasks or in tasks that demand set changes (sentence reading and comprehension or arithmetic reasoning) the groups progressed equally. Altogether, these results are in line with earlier findings showing that comprehensive interventions implemented in school with specific goals (Abikoff et al., 2013; Deaño et al., 2015; Langberg et al., 2012) are effective in reducing attention and EF deficits and in improving performance in tasks tapping basic academic skills.

To maximise treatment benefits, treatment goals should be adequately considered and sufficient opportunities should be given to practice and develop competence; these can then facilitate learning (Abikoff, 2009). The Maltti programme's focus is on a fairly limited set of behaviours and skills: it aims to help children focus on relevant information, thereby prolonging the time of sustained attention in order to enhance a child's attention span in task situations (Abikoff et al., 2009). It can be assumed that the benefits identified arise from improved inhibitory control in on-task situations and prolonged time used for processing required actions. In addition, the modelling practices aimed at conscious use of strategies, while the structuring of task fulfilment probably improved the executive skills needed to manage task situations in school and to control on-task behaviour.

It should be remembered that significant effects are not necessarily clinically meaningful. At the group level, the mean for the ATTEX total scores did not reach the level

of ‘normality’, and there was a large variation in the extent to which the children’s scores changed. Nevertheless after the intervention, the mean score for ATTEX in the moderate severity group dropped below the level that is considered a cut-off score for correctly identifying a diagnosis of ADHD for boys (36.5 points; Klenberg et al., 2010). It can hardly be expected that the intervention would normalize the behaviour of the children or remove their core deficits, such as poor control of vigilance or delayed reward aversion. However, we can claim that the intervention can reduce symptoms and behavioural impairments. These changes can further affect academic performance, and this is pedagogically meaningful. If a teacher registers favourable change in a child’s behaviour, it may facilitate positive development in the long run.

Another essential issue in treatment studies is generalization across settings and skills. In the present study, no attempts were made to include treatments occurring in other settings where the children operate daily (i.e., in the classroom or home). Despite this, the generalization of the intervention effects to both the classroom behaviour (of children with moderate severity symptoms) and academic functioning was evident.

The participation of three classroom teachers as intervention providers may have had an effect on their questionnaire ratings. It is also possible that these teachers implemented the intervention principles in the classroom setting as well, thereby producing a larger intervention effect. Additional analyses revealed that in the moderate symptom group there were higher gains in attention and EF in the classroom setting for the pupils of these particular teachers. However, when the main analysis was replicated without these children with the possible proximal effect (again among a group of children with moderate severity symptoms), the results indicated a significant time x group interaction.

The findings regarding improvements in arithmetic and reading tests (suggesting a transfer effect to academic skills) are interesting, since they can be interpreted as being

independent of the possible bias caused by teachers being aware of the intervention status. Gordon et al. (2006) have proposed that functional assessments, such as academic tests, should be used to evaluate the adverse effects of attention deficits as well as intervention effects. Previous studies have demonstrated that EF tasks correlate with math and reading performance and that EF-related cognitive processes (e.g., impulse control, self-monitoring, and plan generation) are relevant for both math learning and reading (Best et al., 2011; Jacob & Parkinson, 2015). The present findings are in line with this assumption: as interventions promote ability in attention and EFs, they also facilitate fluency in mathematical and reading performance.

It is necessary to point out some limitations of the study: First, the sample size was quite small, which is often the case with studies in natural settings. Poor fidelity further reduced the sample by nine participants. A larger sample would have given more power to the analyses and limited the effects of the wide variance of outcome measurements noted and of the potential heterogeneity of the sample. Second, randomization was not possible, and a quasi-experimental design was employed in the study, thus threatening the equivalency of the intervention and control groups. Nonetheless, the groups had equal age and class levels, nearly the same gender ratio, and a comparable ratio of children who received special educational support at school or were diagnosed and medicated. Also, there were no statistically significant differences between the groups in the outcome measures in the pre-treatment assessment. Third, because teachers were aware of the intervention status of particular children, their ratings were subject to an expectancy effect. In the future, a multi-informant method should be used to avoid possible bias. Lastly, there was a leak of intervention content to the control group. The control group's future intervention providers had received the Maltti training during the previous spring, before the follow-up assessment, and interviews with the control group's school principals revealed that three of their four

schools had started to foster pupils' task engagement in classroom settings (partly based on the Maltti programme procedures) before the follow-up assessment. The probable leak of training to the control group was unfortunate, and it is possible that it affected the results of this group in the follow-up phase. This kind of leak can be difficult to avoid after training in the intervention method has happened in small and active educational communities.

The present study raises a few research questions that are worth further consideration. First, the effects of an intervention that combines small-group behavioural, cognitive, and skills training with classroom intervention should be studied further to see if this kind of extension of intervention would have an impact on the power, generalization, and maintenance of the effects. Second, a better understanding of the factors affecting treatment response is needed (Langberg, Becker, Epstein, Vaughn, & Girio-Herrera, 2013) in order to know to whom the intervention should be targeted and which circumstances are optimal for it. Third, there is a need for more knowledge regarding the effects of the intervention on academic skills, and therefore other areas of academic skills should be included. Lastly, the children's own views and opinions on the acceptability of the intervention should be included. This kind of information would expose how children experience the intervention and how these experiences correlate with the intervention outcomes.

To conclude, the results of the current study are encouraging and support the idea that combining behavioural and cognitive intervention with skills training and providing it in the natural everyday context is an efficient treatment approach. The intervention used in this study was carried out in schools and the effects of the intervention were examined in the school context. The results showed that the intervention improved the behaviour and functioning in a classroom setting of children with moderate symptoms of attention and EF deficit. The positive intervention effects were also evaluated by means of academic ability tests. The findings suggest that the intervention effects did generalize to other settings and to

non-practiced skills (i.e., fluency). It was not assumed that the intervention could remove attention problems. However, it does seem that improving skills related to on-task functioning and learning may underlie the observed generalization of treatment outcomes. As Miller and Hinshaw (2012) have stated, even when an intervention fails to normalize the underlying deficits, a successful intervention can facilitate adaptive functioning and the long-term course of development.

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Table 1. Treatment features of the Maltti intervention

Treatment feature	Maltti
Length of intervention	• 20 sessions; scheduled time of completion: six to seven months
Targets	• Attention control (focus, sustaining) • Inhibition (suppress automatic or overlearned responses) • Improve school related on-task behaviour
Intervention setting	• Elementary school, special education
Methods and techniques	• Behavioural management o structured sessions (routines and rules) o verbal praise and reinforcement of processes related to task-completion by a token system o effective communication methods: clear requests a ignoring o stop and go signals • Cognitive and learning-related executive skills building o exercises demanding sustained attention and control of focus o strategy training and suppression of automatic or overlearned responses: focusing on relevant information, managing information and materials, planning completion of tasks

	○ modelling ○ scaffolding and verbalization
Materials and practices	• Visual and auditory attention tasks (e.g. visual searching tasks, auditory repetition tasks) • Visual and logical problem-solving tasks (e.g. organising card series, reasoning of the rules in visual problem-solving tasks) • Social problem-solving tasks (e.g. strategy use in social/peer problem situations) • Academic skills (e.g. strategy use in reading comprehension, mathematical verification, and problem solving tasks) • Games (board games and card games)
Assisting materials	• Psycho-educative stories
Session content (four topics)	• I. Warm-up and review of previously learned skills and presentation of new materials and skills • II. Practice of required skills and practice with materials and tasks • III. Feedback • IV. Game or play practice

Table 2. Attrition of participants and data obtained (from ATTEX and academic tests) for analysis

		Missing data					Data for analysis	
	n initial stage	Drop-out	Poor fidelity	Pre	Post	Follow-up	n Pre vs. Post	n Pre vs. Follow-up
ATTEX		Teacher Questionnaire						
- Intervention group	62	2	9	4	1	1	46	45
- Waitlist control group	28	0	-	0	2	0	26	26
Academic tests		Reading / Math						
- Intervention group	49	2	9	0 / 0	1 / 1	2 / 3	37 / 37 [a]	35 / 34 [a]
- Waitlist control group	28	0	-	0 / 0	0 / 0	0 / 0	28 / 28	28 / 28

Note. [a] Intervention group n in ANOVA analyses, reading / math.

Table 3. Comparison of baseline mean values of the groups included in the analyses

Variables	Intervention group (n = 46) M (SD)	Waitlist control group (n = 28) M (SD)	Mean difference
Age (month)			
ATTEX analyses	112 (13.44)	111 (16.35)	ns.
Academic test analyses	113 (14.78)	113 (18.31)	ns.
Grade level			
ATTEX analyses	2.80 (1.05)	2.84 (1.31)	ns.
Academic test analyses	3.05 (1.20)	3.00 (1.26)	ns.
ATTEX total score	52.20 (21.80)	59.62 (24.21)	ns.
Reading scores			
Word Recognition Test	54.03 (39.42)	51.04 (36.77)	ns.
Luksu Fluency Test	20.73 (10.29)	17.07 (10.64)	ns.
Math scores			
Arithmetic Fluency Test	41.05 (21.88)	39.36 (16.00)	ns.
Basic Arithmetic Test	10.97 (5.26)	9.43 (5.29)	ns.
Parents education			
Mother	3.33 (0.90)	3.20 (0.96)	ns.
Father	3.25 (0.86)	3.10 (0.87)	ns.
	percentage	percentage	comparison of proportions
Diagnoses of ADHD	17%	11%	ns.
ADHD medication	13%	7%	ns.

Note. In ATTEX analyses, waitlist control group n = 26 and in academic test analyses intervention group n = 37.

Table 4. ATTEX scores at pre-, post-, and follow-up assessments

Variable	Intervention group (n = 46)[a]			Waitlist control group (n = 26)		
	Pre M (SD)	Post M (SD)	Follow-up M (SD)	Pre M (SD)	Post M (SD)	Follow-up M (SD)
ATTEX total score	52.20 (21.80)	41.83 (22.65)	42.34 (25.33)	59.62 (24.21)	57.77 (22.33)	53.15 (27.00)

Note. [a] In the follow-up assessment, N = 45, the pre-assessment score of 45 subjects= 51.24 (21.05). Higher scores indicate greater symptom severity.

Table 5. Academic test results

	Intervention group (n = 37)[a]			Waitlist control group (n = 28)		
	Pre M (SD)	Post M (SD)	Follow-up M (SD)	Pre M (SD)	Post M (SD)	Follow-up M (SD)
Word Recognition	54.03 (39.42)	77.14 (49.28)	84.26 (50.84)	51.03 (36.77)	64.14 (35.20)	72.32 (39.73)
Reading Fluency	20.73 (10.29)	24.73 (8.79)	26.23 (10.93)	17.07 (10.64)	21.57 (9.97)	25.75 (11.20)
Arithmetic Fluency	41.43 (21.59)	53.68 (25.00)	56.24 (27.72)	39.56 (16.00)	45.29 (17.13)	51.18 (23.95)
Basic Arithmetic	10.97 (5.25)	12.23 (4.75)	14.35 (5.07)	9.42 (5.29)	11.46 (4.85)	12.68 (6.40)

Note. [a]In the follow-up assessment, the number of participants was 35 in the reading tests and 34 in the mathematical tests, and pre-assessment values: Word Recognition (n = 35) M = 53.17 (39.73), Reading Fluency (n = 35) M = 20.63 (10.57), Arithmetic Fluency (n = 34) M = 41.74 (22.25) and Basic Arithmetic (n = 34) M = 11.09 (5.48).