Bilingualism and Teacher-Rated Executive Functions in School Children

Lea Gädda, 34845
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Supervisors: Matti Laine and Vesa Närhi
Faculty of Arts, Psychology and Theology
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Author: Lea Gädda
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Abstract:
It has been hypothesized that bilingualism may facilitate executive functioning (EF) due to the cognitive challenges of managing two languages, but the results have been equivocal. The present study examined the associations of language background, gender and grade with teacher-rated EFs in a large sample of 432 typically developing school children aged 6-16 years. A background questionnaire was filled out by the parents while the teachers rated the children's EF abilities with the ATTEX rating scale (Klenberg, Jämsä, Häyrinen, & Korkman, 2010). First, an exploratory factor analysis was conducted to examine the latent structure of ATTEX. Two main factors were identified, labeled as "Attention & Executive Function" and "Restlessness & Impulsivity". Besides summative scores based on these factors, the ATTEX total score was also employed as a dependent variable in the following main analyses. The main analyses indicated that boys had higher scores (i.e., more problems) than girls on all three dependent variables. This effect was modified by an interaction between gender and language: bilingual boys received higher scores than monolingual boys on all three dependent variables when controlling for maternal education. There was no such difference between the language groups among girls. An effect of grade was found only on the variable "Attention & Executive Function" where children in the first grade received significantly higher scores than children in the upper primary school. The results speak against a bilingual executive advantage hypothesis but highlight the need for taking gender and language background into account when assessing executive functioning in school children.

Keywords: Bilingualism, Bilingual Executive Advantage (BEA), Executive Function, Rating Scale, Cognitive Advantage

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Lea Gädda

ÅBO AKADEMI – FAKULTETEN FÖR HUMANIORA, PSYKOLOGI OCH TEOLOGI

Ämne: Psykologi
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Avhandlingens titel: Tvåspråkighet och lärarskattade exekutiva funktioner hos elever i grundskolan
Handledare: Matti Laine och Vesa Närhi
Abstrakt: Det har hypotiserats att tvåspråkighet skulle främja exekutiva funktioner på grund av den kognitiva stimulans som bemästringen av två språk medför. Resultaten har dock varit tvetydiga. I föreliggande studie undersöktes sambandet mellan kön, språkbakgrund samt årskurs på lärarskattade exekutiva funktioner i ett stort sampel med 432 icke-kliniska skolelever i åldern 6–16 år. Detta gjordes med hjälp av ett bakgrundsformulär som fylldes i av föräldrarna och med skattningsformuläret *Kesky – frågeformulär om koncentrationsförmåga* (Klenberg, Jämsä, Häyrinen, & Korkman, 2010) som fylldes i av lärarna. Inledningsvis genomfördes en explorativ faktoranalys för att undersöka den latenta strukturen i Kesky. Två huvudfaktorer identifierades och betecknades ”uppmärksamhet & exekutiv funktion” samt ”rastlöshet & impulsivitet”. Utöver summapoängen baserade på faktorerna så analyserades även Kesky totalpoäng som en beroendevariabel i huvudanalyserna. Resultaten från studien indikerade att pojkar generellt skattades med högre poäng (vilket indikerar mera problem) än flickorna på samtliga tre beroendevariabler. Denna effekt modifierades av en interaktion mellan kön och språk: tvåspråkiga pojkar skattades med mera exekutiva problem än enspråkiga pojkar på samtliga beroendevariabler, även då man kontrollerat för moderns utbildningsnivå. Ingen liknande skillnad mellan språkgrupperna fanns bland flickorna. Endast på variabeln ”uppmärksamhet & exekutiv funktion” fanns en effekt av årskurs, där barnen på årskurs 1 skattades med signifikant mera exekutiva problem än barnen i högstadiet. Resultaten ifrågasätter hypotesen om en tvåspråkig exekutiv fördel men belyser vikten av att beakta kön och språkbakgrund vid kartläggning av exekutiva funktioner hos skolbarn.
Nyckelord: Tvåspråkighet, exekutiva funktioner, skattningsskalor, kognitiva funktioner
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Turku, September 2018
Lea Gädda

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1 INTRODUCTION

The relationship between bilingualism and cognitive abilities has attracted research interest for almost a century and still, until this day, there is no consensus on the issue. The early research on children in the 1920s resulted in urgent warnings, according to which bilingualism might be harmful to a developing and learning child (see e.g. Bhatia & Ritchie, 2006; Hakuta, 1986, for reviews). The opposite idea, that bilingual individuals would gain cognitive advantages, was raised in a study by Pearl & Lambert (1962) where bilingual children outperformed monolinguals on both verbal and non-verbal cognitive tests. Hakuta and Diaz (1985) pointed out that the study by Pearl and Lambert not only changed the direction of the discussion, but also strengthened the research methodology in the field by raising awareness on problems concerning appropriate sample selection, different definitions and competence level of bilingualism, and other significant confounding variables (e.g. socioeconomic status, urban-rural contexts, age and gender). The research in the previous four decades had not taken these factors into consideration.

Bialystok (2015), one of the most productive researchers in the field, has stated that since Pearl and Lambert's (1962) seminal findings, a large number of studies has supported the idea of a bilingual advantage in cognitive development, especially in children. In addition to differences between the monolinguals and bilinguals on cognitive tests, differences have also been discovered in neural measures (for reviews, see e.g., Abutalebi, 2008; Bialystok, 2017; Li, Legault, & Litcofsky, 2014). There are, however, also studies that have not been able to find a cognitive advantage in bilingual individuals (e.g. Duñabeitia et al., 2014; Hilchey & Klein, 2011; Paap & Greenberg, 2013). Failures finding these cognitive advantages are often ascribed to methodological differences between the studies, such as population differences, variability in the definition of bilingualism, and the use of different experimental tasks (Kroll & Bialystok, 2013). Bialystok (2015) concluded that studies failing to report a difference between bilinguals' and monolinguals' cognitive abilities can be seen as challenges to the idea of cognitive advantages, rather than an indication of a cognitive disadvantage due to bilingualism.

Researchers have been investigating the possible effect of bilingualism on a range of different functions related to human cognition, such as metacognition, attentional control, verbal ability, different executive functions, metalinguistic awareness, symbolic representation and abstract reasoning, metacognitive awareness,

problem solving, theory of mind, working memory, cognitive flexibility, and creative and divergent thinking (Adesope, Lavin, Thompson, & Ungerleider, 2010). Of all the different cognitive functions studied in bilinguals, executive functions (EFs) have drawn most attention, possibly because of their central role in human mental activity and behavior. Thus, the main aim of the present study was to investigate the associations of language background, gender and grade with EFs in Finnish school children. In contrast to most earlier studies, EFs were here evaluated with teacher-ratings. Rating scale measures are closer to everyday behavior, but they have been used only little in the research on bilingualism and EFs. There was also a subsidiary aim for the present study, which is to explore the latent structure of the rating scale ATTEX (Klenberg, Jämsä, Häyrinen, & Korkman, 2010) used in the present study, and to compile summative scores based on the extracted factors. These were then employed in the main analyses as dependent variables.

1.1 Definition, Development and Assessment of Executive Functions

EFs are an umbrella term for human high-level cognitive control functions that are present in complex mental activities (Lehtonen et al., 2018). Klenberg (2015) stated that EFs refer to the cognitive functions in charge of directing, coordinating, and controlling behavior and other cognitive abilities and summarized these functions as follows:

> *EFs include a large group of partly separable and also overlapping cognitive processes and behaviors. According to current models and developmental studies, the processes of inhibition and working memory can be postulated as the relatively simple core processes of EFs. The relatively more complex EFs include goal-oriented behaviors such as initiation, planning, monitoring, and evaluating actions. Processes of focusing, shifting, and sustaining attention are closely related to EFs and enable the selection of adequate information for the performance of EFs.* (Klenberg, 2015, p. 12)

EFs play a critical role in goal-directed behavior (Miyake et al., 2000) and are important in novel contexts where no former well-learned behaviors are available (Shallice, 1990). Better EFs are also associated with higher academic achievement (Best, Miller, & Naglieri, 2011), which in turn are associated with well-being and long-term health (Duncan, Ziol-Guest, & Kalil, 2010). Conversely, EF deficits directly affect real-life situations and are of great relevance in clinical settings. EF

deficits may lead to problems with judgement and decision-making, improper social behavior, and difficulties with organizing, initiating, shifting, and following plans (e.g., Strauss, Sherman, & Spreen, 2006). EF deficits are common in several childhood disorders, such as Attention Deficit/Hyperactivity Disorders (ADHD with its different presentations), resulting in self-regulation challenges and problems with learning and adaptation into school environments (Klenberg, 2015).

Socioeconomic status (SES) has shown to consistently interact with EFs (Lawson, Hook, & Farah, 2018) and is hence considered a confounding variable that needs to be accounted for in the studies of bilingualism and EFs. SES usually refers to a combination of parental education, income and occupation but different definitions of SES can be seen across studies. Parental education alone has also been shown to interact with ratings of EFs (Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, & Korkman, 2010). Moreover, Krabbe, Thoutenhooft, Conradi, Pijl, and Batstra (2014) pointed out that several international studies have found birth month to also be a confound when diagnosing ADHD (which consists of EF problems), so that being born late in the year increases the likelihood of being diagnosed with ADHD as compared to being born early in the year.

There are several proposals to the mental organization of EFs, but their fundamental components remain unclear. The probably most frequently adopted model of EF structure was introduced by Miyake et al. (2000). It consists of three subcomponents, namely working memory updating, inhibition of irrelevant information and set shifting (Miyake & Friedman, 2012). In a review, Anderson (2002) introduces another extended view of the possible organization of EFs. In this developmental model, EFs consists of four separate but inter-related executive domains: cognitive flexibility, attentional control, information processing, and goal setting. These domains function interactively to enable so-called “executive control”. Anderson (2002) further describes the maturation of the different executive domains. According to developmental and normative studies, attentional control emerges in infancy and develop rapidly in early childhood. However, the development may not be linear, but rather appear in spurts. Concerning cognitive flexibility, information processing, and goal setting, there appears to be a critical development period between ages 7 to 9, to attain relative maturity by 12 years of age. By mid-adolescence or early adulthood, most of the executive processes are completely established.

In clinical and neuropsychological contexts, EFs are traditionally measured in two different ways, by performance-based measures and/or by rating scales. Performance-based measures are standardized tests that typically tap response time and/or accuracy. Regarding rating scales of EFs, the person him- or herself or an informant close to the person (e.g. a parent or teacher) rates the difficulties the person may have in daily routines, thus offering ecologically more valid interpretations (Toplak, West, & Stanovic, 2013).

There is an ongoing discussion on whether the two measurement approaches tap the same underlying mental construct of EFs. In a review, Toplak and colleagues (2013) investigated the relationships between performance-based and rating measures (both proxy and subjective ratings) of EFs among both children and adults. In terms of convergent validity, different measures of the same construct are supposed to correlate highly. However, this was not the case in their study, as the correlations between the performance-based and rating measures of EFs were found to be very low (Toplak et al., 2013). The researchers suggested that performance-based and rating measures of EF estimate distinct dimensions and levels of cognitive and behavioral functions that contribute independently to clinical difficulties.

Ackerman (1994) made a distinction between optimal/maximal performance and typical performance, the first one referring to situations where the task is precisely described and where the person is supposed to maximize performance. Typical performance, on the other hand, refers to situations where the interpretation of the task is somehow left open and must be interpreted by the participant. This reveals a person's typical behaviors and decisions when given only a few clues. Toplak et al. (2013) interlaces these different views and states that performance-based measurement is carried out under optimal conditions and captures the participant's optimal/maximal performance, since the task instructions are given by an external examiner and demands less interpretation by the participant. In contrast, in ratings of EFs, the interpretation of the participant's behaviors and abilities to carry out daily routines is left to the rater. With the latter method comes challenges concerning informant reports, such as various context effects and the fact that different raters tend to judge behavior differently (see e.g., Barkley, 2006).

1.2 Defining Bilingualism

Language development and language learning continues throughout the lifespan. The complex system of language starts to develop at, or even before birth, and continues throughout adulthood, making it challenging to define monolingualism and bilingualism (Kohnert, 2013). A monolingual child is typically from a family where both parents are predominantly speaking one single language, and the child naturally acquires the language in question. Bilingual children, on the other hand, can be defined in several ways, each way serving different purposes. The most commonly applied definitions are based on proficiency or age of language acquisition.

Proficiency-based definitions consider either (1) the bilingual child's abilities in each language as compared to the abilities of monolingual peers in each language, (2) the bilingual child's knowledge in one language as compared to the knowledge in the other language (*balanced bilingualism* vs *dominant language*), or (3) the bilingual child's language knowledge as compared to other bilingual peers, when matched on age and experience (Kohnert, 2013).

The other way to classify bilinguals is by age of acquisition. When the parents are speaking different languages to the child right from birth, the child becomes *simultaneously bilingual* (Kohnert, 2013). On the other hand, a child become a *sequential/successive bilingual* when adopting the first language (L1) at birth and the second language (L2) later in childhood. Sequential bilingualism refers to a situation where the child begins to learn L2 after L1 is relatively stable, usually after the age of three (Paradis, 2010). When introducing a second language after birth but before the first language is stable (i.e. before the age of three) the term *early successive bilingualism* is often used (Genesee, Paradis, & Crago, 2004).

In the present study, all bilinguals had acquired both languages at birth. Thus, they represented simultaneous bilingualism.

1.3 Recent Meta-Analyses on Cognitive Advantages in Bilinguals

The extensive body of research on the possible bilingual executive advantage (BEA) has been analyzed in several meta-analyses and systematic reviews with rather varied results. In a systematic review and meta-analysis on the cognitive correlates of bilingualism in 63 studies, Adesope and colleagues (2010) found bilingualism to be associated with several enhanced cognitive functions. The

cognitive correlates explored in the study were attentional control, working memory, metalinguistic awareness, metacognitive awareness, problem solving, abstract reasoning, symbolic reasoning, creative thinking, and divergent thinking. The results indicated better working memory, metalinguistic awareness, attentional control, as well as abstract and symbolic representation skills in bilingual as compared to monolingual individuals.

Hilchey and Klein (2011) performed a systematic review of 13 studies on bilingualism and different nonverbal inhibitory control functions in both child and adult samples. A bilingual advantage was found in the interference effect in elderly and middle-aged participants, but not in children or young adults. However, in a later study the advantages seemed to disappear (Hilchey, Saint-Aubin, & Klein, 2015).

In a review from 2015, Paap, Johnson, and Sawi did not find consistent support for BEA when examining nonverbal set shifting and inhibition tasks. In fact, they typically found a bilingual advantage in studies with small samples, and mainly no differences when the sample was larger ($n > 50$). Thus, their conclusion was that BEA probably does not exist, and if it does exist, it is probably limited to certain types of bilingual experiences that enhance only certain aspects of EFs.

Donnelly (2016) performed two meta-analyses on healthy children and adults to examine if the bilingual advantage is moderated by theoretically important variables (dependent variable, age, task, research lab and age of L2 acquisition). The first meta-analysis examined interference-control tasks and included 168 effect sizes from 43 studies and the results showed an interaction between age and dependent variable: bilingual children performed better on interference-control tasks than young bilingual adults. Additionally, bilingual older adults performed better than younger bilingual adults. They also found an interaction between age of language acquisition and dependent variable: bilingual samples with early L2 learners performed better than bilingual samples with late L2 learners. However, the author attributed the results to publication bias that was also present. The second meta-analysis examined set-shifting tasks and included 30 effect sizes from 10 studies. No bilingual advantage could be found on these tasks, and the results showed no effect of research group.

In a meta-analysis on the effect of bilingualism on working memory in children and adults, Grundy and Timmer (2017) found a small to moderate effect to the benefit of bilinguals. The effect size was largest in children and was moderated by

the language of a verbal task so that the advantage was smaller when the task was performed in a second language. This meta-analysis did not find a publication bias.

In the most recent, extensive meta-analysis on healthy adults, Lehtonen et al. (2018) studied the effect of bilingualism on a range of EFs (monitoring, inhibition, working memory, attention, shifting, and verbal fluency). Before correcting for publication bias, they found a small bilingual advantage on shifting, working memory, and inhibitory control, and a very small monolingual advantage on verbal fluency. However, the small bilingual advantages on all included EFs disappeared after accounting for an estimated publication bias. When investigating age as a possible moderator, they found no systematic bilingual advantages on EFs when comparing younger and older adults. However, the meta-analysis did not address the possible effect of bilingualism on EF in children (Lehtonen et al., 2018).

The meta-analyses shortly described above have addressed different aspects in relation to BEA (e.g. age, language pairs, age of language acquisition, SES, type of bilingualism, gender, and cognitive domain) to gain further knowledge about the issue. However, like many other research areas, the research on BEA is also challenged by publication bias. In a meta-analysis that focused on this matter, de Bruin, Treccani, and Della Sala (2015) found that studies in support of BEA were most likely to be published, followed by studies with mixed results. Least likely to be published were studies challenging BEA. This is an aspect that meta-analyses must take into consideration and that make the interpretations and generalizations of the results challenging.

1.4 Possible Underlying Mechanisms of a Bilingual Cognitive Advantage

There have been many theoretical attempts to explain the mechanisms of bilingual advantages in different cognitive functions. These explanations have mainly considered inhibition of irrelevant information and set shifting. The inhibition accounts have suggested that BEA stems from the challenges that the use of two languages puts on the cognitive control system. In a bilingual person, both languages have been shown to be activated concurrently while communicating in one of them (Wu & Thierry, 2010). Thus, when producing a word in the target language, the corresponding word is activated in the nontarget language, leading to a conflict between the two alternatives. An efficient control function (inhibition) is then needed to prevent interference and to enable flexible and fluent language use (Green, 1998).

The set shifting account is related to the effects of language switching. Prior and MacWhinney (2010) suggested that frequent switching between different languages may train domain-general executive functions. Green and Abutalebi (2013) have put forth a hypothesis about adaptive control, which proposes that living in a dual language context where one needs to switch between languages when conversing with different people provides training for executive functions. However, Jylkkä (2017) could not find such a training effect of EFs in adult bilinguals.

BEA has also been found in young children, for whom the development of language functions has not yet reached its peak and an extensive training of inhibition or switching has probably not yet occurred. When raising this issue, Bialystok (2015) proposed that an early bilingual experience may change the attentional focus on the environment. The different language sounds, structures, and facial expressions draw an infant's attention to the contrasts, and creates a representational structure including two languages, instead of one. At this point, EFs are required to sustain attention to the language in use. This view differs from the theory of inhibition: instead of inhibiting the nontarget language, children are identifying two different organizational systems and need to use attention to discriminate between them.

Furthermore, the effect of bilingualism on cognitive function may not be equal throughout the life-span, nor between different age groups. In a study on the effect of age and bilingualism on EFs, Bialystok, Martin, and Viswanathan (2005) found that bilinguals outperformed monolinguals on the Simon task, a measure of inhibitory control, in childhood, adulthood, and later adulthood. However, there was no effect of language background among young adults. The absence of an effect in this age group was thought to be related to young adults being at the peak of their EFs, with bilingualism providing no further advantage.

1.5 Bilingualism and Rating-Based Executive Functions

Despite the large body of research investigating the effect of bilingualism on different performance-based EF measures, the studies investigating the relationship between bilingualism and rating-based measures of EFs are rather few. These studies are shortly reviewed below and summarized in Table 1.

Moore (2010) compared 97 non-clinical early bilinguals, late bilinguals, and monolinguals (18-25 years) on two self-rated measures of EFs (The BRIEF-A and

the BASC-2 Self-Report of Personality-College; Reynolds & Kamphaus, 2004). The hypothesis on a bilingual advantage (on the BASC Attentional control scale and on the BRIEF-A Working Memory scale) for early bilinguals as compared to late bilinguals and monolinguals was not supported. Neither did early and late bilinguals show an advantage over monolinguals on the BRIEF-A inhibition scales and on the BASC Behavioral control scale. They found no difference between the language groups on the BASC Problem solving scale or the BRIEF-A Plan/organize scale either.

Weber, Johnson, and Wiley (2011) investigated possible group differences on parent-rated EFs (The BRIEF; Gioia et al., 2000) in 59 bilingual vs. monolingual non-clinical preschool children aged 4-7 years. The results showed a significant bilingual advantage on the subscales Organization of materials, Working memory, and on the Metacognition index. Economic stress and age were used as covariates in the study.

Hermodson-Olsen (2012) investigated the effect of bilingualism on EFs in a clinical outpatient sample of 150 children (mean age = 10.3; range = 3.5 to 19.08). Both rating-based (teacher and parent ratings on the BRIEF) and performance-based measures (WISC-IV, Working memory index and TOVA) were employed. The results showed that according to teacher-ratings of general EFs, children living in bilingual homes had less EF problems as compared to children from monolingual homes. On the other hand, there was no difference between the two language groups on performance-based measures and parent ratings.

Loe and Feldman (2016) examined the possible effect of bilingualism on EFs in 161 preschool children (3-5 year old) born either preterm or full term with parent-rated EFs and performance tests. The results showed significantly poorer EFs (both ratings and performance tests) in children born preterm, but language experience showed no impact on rating-based nor performance-based cognitive abilities in either group.

Table 1.

Previous studies on bilingualism and rating-based measures of EFs

	Test	Age	Results
Moore (2010)	Self-reports (BRIEF-A, BASC-2)	97 non-clinical; Age 18-25 years	No difference between language groups
Weber, Johnson, & Wiley (2011)	Parent-rating (BRIEF-P)	59 non-clinical; Age 4-7 years	Bilingual advantage on organization of materials, working memory, and metacognition index
Hermodson-Olsen (2012)	Teacher- and parent-ratings (BRIEF), and performance tests (WISC-IV, TOVA)	150 clinical outpatients; Age 3.5 – 19.08; mean 10.3	Bilingual advantage on general EFs with teacher-ratings. No difference on parent-ratings or performance tests
Loe & Feldman (2016)	Parent-rating, performance tests	161 pre-term- and full-term-born; Age 3-5 years	No effect of language

The rating-based studies summarized above have compared different aspects of EFs, used different groups (clinical and non-clinical) and raters (self, parent or teacher), and focused on different age groups (preschoolers, school children or young adults). The studies have also used different definitions of bilingualism and are therefore not immediately comparable. These discrepancies as well as the variable results prompt further studies on the topic.

1.6 Aims of the Study

There was one subsidiary and one main aim of the present study. The subsidiary aim concerned the latent structure of the EF rating scale ATTEX used in the study. In the manual (Klenberg, Jämsä, Häyrinen, & Korkman, 2010) ATTEX is claimed to have one single dimension, even though the functions are divided into 10 distinct sub-functions. Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, and Korkman (2010) also found ATTEX to be sensitive in differentiating children with ADHD Inattentive type from those with ADHD Combined type. Hence, the first aim was to

examine the latent structure of the ATTEX rating scale with a new sample, and then use the identified factor or factors as the basis for dependent variables in the second, main part of the study.

The main aim of the study was to test the BEA hypothesis in children by using factor-based summative scores of EF rating variables. In contrast to the performance-based measures traditionally used in the field of bilingualism and EFs, in the present study, EFs are assessed with the teacher-rating measure ATTEX. Despite the earlier literature suggesting a cognitive and executive advantage of bilingualism under optimal and controlled circumstances, few studies have investigated the effects of bilingualism on normal children's behavior in less controlled, "real life"-conditions. Real-life situations demand higher internal executive control as compared to the more controlled performance-based situations. Additionally, the effect of gender was examined, since Klenberg, Jämsä, Häyrinen, and Korkman (2010) found a significant gender effect on the same rating measure of EFs employed in the present study, with young boys exhibiting weaker EFs than girls. Lastly, age effects were examined to investigate a possible developmental curve of EFs on the teacher-rated measures, even though this effect was mainly absent in the normative study by Klenberg, Jämsä, Häyrinen, and Korkman (2010). In sum, the aim of the second and main part of this study was to investigate the effects of language background, gender and grade on teacher-rated EFs in a non-clinical sample of Swedish-speaking and bilingual children in Finland.

2 METHOD

The data for the present study was drawn from a four-year research project (InLärning och Stöd; ILS-projekt 2015-2018) by the Niilo Mäki Institute, a Finnish organization for multidisciplinary research and development work for learning disabilities. The aim of the ILS project is to produce and apply research-based knowledge for professionals working with children with learning difficulties in Swedish-speaking schools and daycare centers in Finland. Extensive cross-sectional data has been gathered within the ILS project with performance tests of reading and cognitive abilities, teacher rating scales, and a comprehensive background questionnaire from nearly 2000 children in the age of 4-16 years. The present study utilized selected parts of this data base to explore the possible effects of language background, gender and grade on EFs as measured by teacher ratings.

2.1 Procedure

Initially, ethical permission was granted by the University of Jyväskylä Ethical Committee. Research consent was then obtained from the municipal education departments and from the 26 randomly chosen schools. To ensure sample representativeness, two schools were added later on. Subsequently, the parents were asked for permission to participate on behalf of their children and only the children whose parents approved were tested. To ensure the participants' anonymity, each participant was given an individual code in the data file.

The aim of the ILS project was to test and gather information from a minimum of 75 school-aged children per grade 1, 3, 5, 7 and 9 (i.e. a minimum of 375 school children). Grades 7 and 9 were later combined to ensure sufficient sample size. A stratified sampling procedure was used, employing the following four geographical regions: Ostrobothnia, the capital region, Åland Islands, and the remaining Swedish-speaking areas in Finland. From the 28 schools included, every fourth child from the participating grades was selected in alphabetical order, with a maximum of four children per class. If a child or the parent of a child did not give permission to participate, the following child was selected from the alphabetical list.

The children were rated on the ATTEX rating measure by their teachers, and the parents of the children completed a background questionnaire. Every child completed a reading ability test under the supervision of speech therapist students. Additionally, the children in grades 1 and 3 performed several cognitive tests administrated by psychology students. The testing was carried out during the school year of 2015-2016. The present study employed only the rating measure and the background questionnaire.

2.2 Sample

The initial sample of the ILS project consisted of 1950 children in day care centers, primary schools, and upper primary schools. A subsample of 522 school-aged children (aged 6-16) participated in the ratings of EFs and were included in the present study. There were altogether 45 participants whose parents did not return the background questionnaire and they were therefore excluded from the analyses (see section 3.1 for statistics). Additionally, 27 participants reported not being either monolingually Swedish-speaking or bilingually Swedish-Finnish-speaking and were therefore excluded. Lastly, 18 participants had been diagnosed with neurological

disorders that may affect the EF ratings and were excluded (see Appendix for a list of included and excluded diagnoses). A total of 90 participants were excluded and the final sample thus consisted of 432 participants, of whom 51.6 % were girls, and 48.4 % boys. The inclusion and exclusion process is presented in the flow chart in *Figure 1*. The demographics and characteristics of the sample is shown in Table 2, and the distribution of language background and gender by grade is illustrated in Table 3.

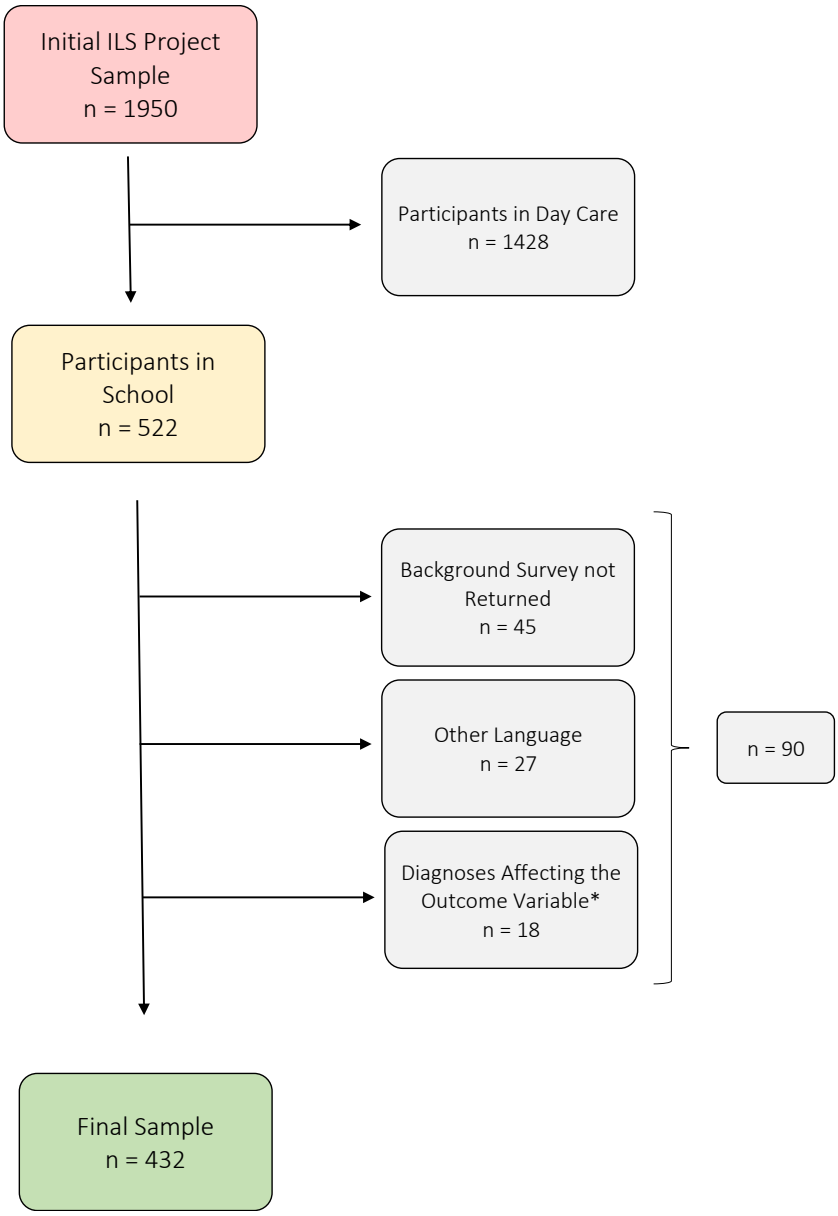

Figure 1. Flow Chart of the Inclusion and Exclusion Process

*ADHD, ADD, epilepsy, dyscalculia, dyslexia, or learning disability (diagnosed by a professional as reported by the parents)

Table 2.

Demographics and Background Characteristics of the Sample (N=432)

		Total(%)	Bilingual	Mono-lingual
Gender	*Girls*	223(51.6)	114	109
	Boys	209(48.4)	88	121
Participants per grade	*Grade 1*	116(26.9)	53	63
	Grade 3	104(24.1)	45	59
	Grade 5	99(22.9)	41	58
	Grade 7 – 9	113(26.2)	63	50
Age	*Min*	6.0	6.0	6.5
	Max	16.1	16.1	15.9
	Mean(SD)	10.5(2.6)	10.7(2.7)	10.4(2.5)
Language background	*Monolingual*	230(53.2)		
	Bilingual	202(46.8)		
Maternal Education Level %	*Primary School*	1.9	1.5	2.2
	High School Diploma	16.2	16.8	15.7
	Occupational Institute	12.3	8.4	15.7
	B.A Level	24.5	27.2	22.2
	M.A Level	30.1	30.7	29.6
	Postgraduate Degree	4.9	5.4	4.3
	Missing	10.2	9.9	10.4
Paternal Education Level %	*Primary School*	5.1	5.9	4.3
	High School Diploma	26.9	25.2	28.3
	Occupational Institute	13.2	14.4	12.2
	B.A Level	18.5	16.8	20.0
	M.A Level	29.6	30.7	28.7
	Postgraduate Degree	3.9	4.5	3.5
	Missing	2.8	2.5	3.0

Table 3.

The Distribution of Language Background and Gender by Grade

	Grade 1	Grade 3	Grade 5	Grade 7-9
Monolinguals n (%)	**63 (54.3)**	**59 (56.7)**	**58 (58.6)**	**50 (44.2)**
Girls n (%)	29 (25.0)	27 (26.0)	31 (31.3)	22 (19.5)
Boys n (%)	34 (29.3)	32 (30.8)	27 (27.3)	28 (24.8)
Bilinguals n (%)	**53 (45.7)**	**45 (43.3)**	**41 (41.4)**	**63 (55.8)**
Girls n (%)	28 (24.1)	26 (25.0)	21 (21.2)	39 (34.5)
Boys n (%)	25 (21.6)	19 (18.3)	20 (20.2)	24 (21.2)

2.2.1 Bilingualism in the Present Study

In Finland one can, by law, only be registered with one first language in the Finnish Population Information System. Thus, there are no official records of bilingualism at an individual level, as it is considered as a part of personal identity (Strategy for the National Languages of Finland, 2012).

In the present study, the participants from the Swedish-speaking schools are either monolingual Swedish-speaking or bilingual Swedish-Finnish-speaking, based on the information from the parents' background questionnaire. The monolingual Swedish-speaking children lived in families where the language of both parents was primarily Swedish. The bilingual Swedish-Finnish-speaking children lived in families where the primary language of one parent was Swedish and the primary language of the other was Finnish. A child was thus considered bilingual in this sample, if s/he had acquired two languages in the family environment where both parents spoke their native language. Thus, the present bilingual children were *simultaneous bilinguals*. Five of the participants had acquired the second language after birth but early (e.g. before the age of 3) and were therefore included. No late bilinguals were reported in the background questionnaires. Children other than Swedish monolinguals or simultaneous Swedish-Finnish bilinguals were excluded from the present study.

2.3 Instruments

The present study incorporated a teacher-rating measure of EFs (ATTEX; see 2.3.1) and relevant parts of a comprehensive background questionnaire regarding demographic information, family situation, language background and behavior, parents' level of education and current profession, health situation, possible challenges related to language development or any neurodevelopmental disorders and possible medication, as well as media and reading habits.

2.3.1 The Attention and Executive Function Rating Inventory (ATTEX)

The ATTEX (in Swedish *Kesky – frågeformulär om koncentrationsförmåga;* in Finnish *Kesky – Keskittymiskysely*; Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, & Korkman, 2010), is a teacher-rated measure of EFs, attention and concentration abilities of children in primary and upper primary school. The ATTEX is intended to be administered by psychologists or physicians and can be used in school

environments as an evaluation method, contributing to information on schoolchildren's attention abilities and executive functioning, and guiding the implementation of interventions in school. In health care services, it can support the diagnostic processes of disorders related to executive functioning (Käypä hoito, 2017). The ATTEX was developed as a Finnish counterpart of the BRIEF, The Behavior Rating Inventory of Executive Function (Gioia, Isquith, Guy, & Kenworthy, 2000) and relevant norms in Finland were gathered (Klenberg, Jämsä, Häyrinen, & Korkman, 2010).

The ATTEX consists of three separate parts, where the teacher rates the child's behavior on one quantitative and two qualitative measures.

1. **The teacher's rating of the child's executive functioning**
2. The teacher's evaluation of the child's strengths
3. Description of possible implemented interventions in school

For the present study, only the first part was analyzed. In the first part, the teacher rates the child on 55 different items. Each item is rated on a three-graded scale: no problems – problems sometimes – often problems. The items are clustered into 10 different sub-functions and 3 domains, which are presented in Table 4.

Table 4.

The Different Functions and Domains of the ATTEX items as Presented in Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, & Korkman (2010)

	Functions (Number of Items)	Domain (Number of Items)
1.	Distractibility (4)	
2.	Impulsivity (9)	Inhibition (20)
3.	Motor Hyperactivity (7)	
4.	Directing Attention (5)	
5.	Sustaining Attention (6)	Attention (15)
6.	Shifting Attention (4)	
7.	Initiative (5)	
8.	Planning (4)	Executive Functions (20)
9.	Execution of Action (8)	
10.	Evaluation (3)	

Note: A total of 55 items covering 10 functions and 3 domains

The standardization work and the norms of ATTEX are based on 692 non-clinical Finnish children, 191 children with diagnosed ADHD Combined type, and 27 children with diagnosed ADHD Inattentive type (N = 910). The minimum total score a child can receive on ATTEX is 0 (no problem occurring) and the maximum score is 110. Klenberg, Jämsä, Häyrinen, and Korkman (2010) found no effect of age on the different functions, besides on motoric restlessness where 7-year-olds scored higher than 14-year-olds. There was, however, a highly significant effect of gender, with boys consistently scoring significantly higher than girls.

In a factor analysis of the Finnish normative sample, ATTEX was interpreted as one-dimensional. All items correlated strongly with each other. The one-dimensionality was explained in two ways. First, concentration problems are accumulative: if a child has one problem related to concentration, the child will most likely also have other problems related to concentration. Secondly, if a teacher recognizes one problem related to concentration, s/he most likely sees other concentration problems as well (the halo-effect) (Klenberg, Jämsä, Häyrinen, & Korkman, 2010).

The original reliability analyses of ATTEX showed that the bivariate correlations between all 10 functions varied between 0.485-0.794, with all correlations being statistically highly significant. The internal consistency for all age groups (7-15 years) and for both diagnostic groups (ADHD Combined type and ADHD Inattentive type) of ATTEX was analyzed with Cronbach's alpha. Except for 8 of the 55 sections, all alpha coefficients were above 0.7. Klenberg, Jämsä, Häyrinen, and Korkman (2010) states that high reliability is expected when using rating measures. No inter-rater reliability tests have been conducted since the rater is supposed to be the person who is closest to the child in the school environment. Another rater would be in a different position to the child and hence the results would not be comparable. Test-retest reliability has not been examined either, since evaluations on rating measures are usually considered to be rather congruent. (Klenberg, Jämsä, Häyrinen, & Korkman, 2010).

ATTEX has been validated against the *ADHD Rating Scale-IV: School version* and the criterion validity was rather high, ranging from .58 to .95 (Klenberg, 2015). Klenberg, Jämsä, Häyrinen, and Korkman (2010) suggested a total cut-off score of 29.5 (sensitivity 0.872, specificity 0.864) for ADHD screening on ATTEX. Since there was a significant effect of gender, there is also a suggested cut-off score of 19.5

for girls (sensitivity 0.808, specificity 0.858) and a cut-off score of 35.5 for boys (sensitivity 0.857, specificity 0.839) in screening for ADHD. Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, and Korkman (2010) also found ATTEX to be able to differentiate between ADHD Inattentive type and ADHD Combined type, which speaks for a possible dimensionality in the rating scale. The relationship between ATTEX ratings and performance-based measures of cognitive and executive functions has not been explored.

2.4 Data Analysis

The statistical analyses were performed using IBM SPSS Statistics 24.0 for Windows (IBM Corp., 2016). Initially, independent groups t-tests were performed to determine if the participants for whom the background questionnaire had not been returned could be excluded from the analyses without distorting the results. The t-tests between the background questionnaire missing group and the non-missing group were computed separately for each of the three dependent variables included in the study. An interrater reliability test (Cohen's K) was conducted to determine if there was agreement between a psychology student and a professional neuropsychologist in determining which diagnoses could have an impact on the cognitive functions that the ATTEX rating scales measures, and hence should be excluded from the analysis. Furthermore, bivariate correlations (Pearson's) were conducted between age and all three dependent variables (ATTEX Total score, Factor 1, and Factor 2) separately for each grade, to explore if birth time of the year was a confounding variable in the study. To explore if language background was independent from geographical area, a contingency table analysis (Chi-Square test) of the variables was performed.

For the subsidiary aim, an exploratory factor analysis was then run on the 55 items of ATTEX, to examine its latent structure and to compile sum scores based on the factor or factors obtained. Prior to running the factor analysis, the factorability of the 55 items was analyzed by the Kaiser-Meyer Olkin measure of sampling adequacy and the Bartlett's test of sphericity. Principal Axis Factoring (PAF) with an oblique rotation was used, as it could be assumed that the factors would correlate with each other. To analyze the internal consistency of each extracted factor, Cronbach's alpha was computed. The sum scores based on the two extracted factors (see the results section) were used in the main analyses as dependent variables.

For the main analyses, two analyses of covariance (ANCOVA) and one three-way independent factorial analysis of variance (factorial ANOVA) were conducted to explore the possible effects of gender (girl vs. boy), language (monolingual Swedish vs. bilingual Swedish-Finnish) and grade (1, 3, 5, and upper primary school) separately for the three dependent variables. The dependent variables in the ANCOVAs were the ATTEX total score and the sum score based on the first extracted factor derived from the current factor analysis. Maternal education was entered as a covariate after ensuring that it did not correlate with the independent variables. Since maternal education did not correlate with the second extracted factor, the third variance analysis was conducted as a three-way independent factorial ANOVA without the covariate. The independent variables were the same as in the previous analyses, and the dependent variable was the sum score based on the second extracted factor derived from the current factor analysis. Prior to running the main analyses, the assumptions of ANCOVA and factorial ANOVA were also checked for.

3 RESULTS

3.1 Representativeness of the Final Sample

There was no difference on any of the three dependent variables between those who had returned the background inquiry and those who had not (ATTEX Total, $t(59, 937) = .582$, $p = .563$; Factor 1, $t(520) = .089$, $p = .929$; Factor 2, $t(59, 325) = 1.169$, $p = .247$). Thus, there was no indication that the exclusion of the 45 participants with no background information would have distorted the results.

In 50 cases, the child was reported to have some form of diagnosis. An interrater reliability test (Cohen's K) was conducted to estimate the agreement between a psychology student and a professional neuropsychologist on whether the 50 cases where the child reported to have some diagnosis could potentially impact the results and should thus be excluded from the analysis. There was a substantial agreement between the raters' judgements, $K = .795$, $p < .001$. There were five cases where the judges were not in agreement. After a consensus meeting, these five cases were included since the participants in question had not a diagnosis from a professional. A remaining 18 participants, with a diagnosis given by a professional and where the diagnosis was deemed by both raters to potentially influence the dependent variables, were then excluded.

There were no significant bivariate correlations (Pearson's) between age and ATTEX total score on any of the grades (grade 1, r = .134, p = .168; grade 3, r = .081, p = .420; grade 5, r = -.064, p = .539; grade 7-9, r = .022, p = .841). All bivariate correlations between age and Factor 1 and Factor 2 were also non-significant (Factor 1: grade 1, r = .105, p = .281; grade 3, r = .097, p = .333; grade 5, r = -.086, p = .410; grade 7-9, r = .047, p = .665; Factor 2: grade 1, r = .149, p = .123; grade 3, r = .015, p = .880; grade 5, r = -.023, p = .823; grade 7-9, r = -.021, p = .847). This indicates that age did not appear as a confounding variable in this sample on any of the dependent variables.

Finally, a contingency table analysis (Chi-Square test) of language background and geographical area was performed (Table 5). The results revealed that language background was significantly dependent on geographical area, χ^2 (3) = 64,84, p < .001, V = .3, and hence, geographical area might be a confound in the analyses.

Table 5.

Crosstabulation of Language Background and Geographical Area

Language Background		Geographical Area				
		Ostrobothnia	Åland Islands	The Capital Area	Other Swedish-speaking Areas	Total
Monolinguals	Count	95	47	37	51	230
	Expected	75.6	27.7	54.8	71.9	230
	% of Total	22%	10.9%	8.6%	11.8%	53.2%
Bilinguals	Count	47	5	66	84	202
	Expected	66.4	24.3	48.2	63.1	202
	% of Total	10.9%	1.2%	15.3%	19.4%	46.8%

3.2 Exploratory Factor Analysis

First, the factorability of the 55 items on the ATTEX rating scale was analyzed. The Kaiser-Meyer Olkin (KMO) measure of sampling adequacy was over .6 and hence at an acceptable level (KMO=.956). The Bartlett's Test of Sphericity was significant (χ^2(1485) = 19106.506, p < .001), implying factorability. Principal Axis Factoring (PAF) with an oblique (Oblimin) rotation was conducted. Eight factors were initially extracted with eigenvalues >1 and loadings >.3, explaining 67.5% of the cumulative variance. Of the eight originally extracted factors, a two-factor solution was deemed as most suitable based on eigenvalues, cumulative variance (Table 6) and inspection of scree plot (*Figure 2*). The two factors explained 51.8% of

the cumulative variance. The factor loadings and communalities of the ATTEX items, and the correlation between the factors are presented in Table 7.

Table 6.

The Variances, Cumulative Variances and Eigenvalues of the Eight Factors in the Initial Factor Solution

	1	**2**	3	4	5	6	7	8
Cumulative Variance %	**44.7**	**51.8**	55.7	58.6	61.1	63.5	65.6	67.5
Variance %	**44.7**	**7.1**	3.7	3.0	2.5	2.4	2.1	1.9
Eigenvalue	**24.59**	**3.91**	2.06	1.67	1.39	1.31	1.16	1.06

Note: Bolded factors were deemed as most suitable and used in further analyses

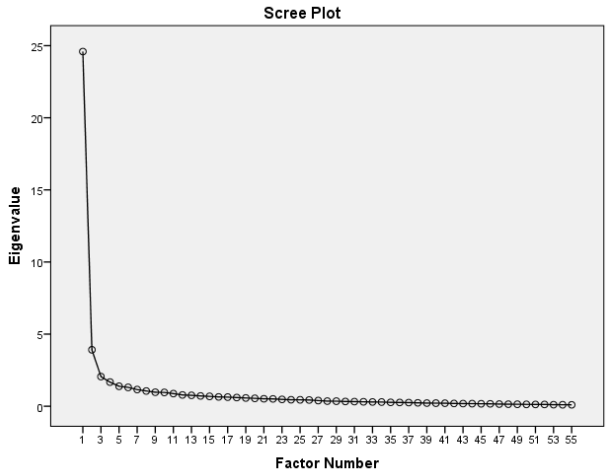

Figure 2. Scree Plot of the Initial Factor Solution

After rerunning the factor analysis with number factors fixed to two, there was one item (Item 4) which loaded <.3 and was not included in either of the factors. Additionally, there were 11 cross-loadings of which the higher loading was used. The first factor, explaining 44.7% of the variance, received loadings >.30 from 34 of the 55 items and was labelled as the "Attention & Executive Function" factor. The second factor, explaining 7.1% of the variance, included 20 of the items and was labelled as the "Restlessness & Impulsivity" factor. The internal consistency of the two factors was calculated with Chronbach's alpha, and both values were high. The factor "Attention & Executive Function" gained $\alpha = 0.97$, and the factor "Restlessness & Impulsivity" gained $\alpha = 0.95$. The items are depicted in the original study by Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, and Korkman (2010).

Table 7.

The Factor Loadings and Communalities of the ATTEX Items, and the Correlation Between the Factors in the Final Analysis.

Item No	Attention & Executive Function	Restlessness & Impulsivity	Communality
1	.349 *	**.547** *	.643
2	.385 *	**.483** *	.599
3	.408 *	**.402** *	.519
4	.138	.241	.116
5	-.004	**.801**	.638
6	-.015	**.713**	.497
7	**.427** *	.376 *	.510
8	-.071	**.826**	.619
9	-.167	**.873**	.621
10	**.409** *	.305 *	.405
11	.284	**.380**	.351
12	**.510**	.140	.363
13	.116	**.692**	.585
14	.235	**.463**	.396
15	.131	**.532**	.381
16	.119	**.721**	.634
17	-.074	**.699**	.433
18	.020	**.575**	.345
19	-.174	**.803**	.513
20	.110	**.593**	.439
21	**.728**	.072	.595
22	**.535** *	.314 *	.579
23	**.776**	.018	.619
24	**.839**	-.173	.565
25	**.836**	-.164	.566
26	**.752**	.039	.601
27	**.592**	.288	.632
28	**.484** *	.434 *	.667
29	**.621**	.171	.539
30	**.821**	-.112	.580
31	**.420** *	.392 *	.521
32	**.706**	.051	.543
33	**.639**	.098	.490
34	**.622**	.057	.431
35	**.538**	.295	.561
36	**.812**	-.016	.644
37	**.692**	.120	.590
38	**.652**	.053	.469
39	**.746**	-.205	.420
40	**.638**	-.086	.351
41	**.317** *	**.505** *	.542
42	**.489**	.339 *	.548
43	**.653**	.175	.590
44	**.439** *	.387 *	.540
45	**.782**	-.031	.584
46	**.648**	.185	.593
47	**.466**	.282	.450
48	.101	**.564**	.395
49	.302 *	**.318** *	.304
50	**.616**	-.138	.299
51	**.330**	.217	.239
52	**.542**	.172	.431
53	.298	**.491**	.499
54	**.501**	.261	.472
55	**.658**	.083	.503
Factor 1	1		
Factor 2	.582	1	

Note: Items with bolded loadings were used to calculate the unweighted factor-based summative scores. * Cross-loading of which the higher loading was used.

3.3 Descriptive Statistics

Table 8 presents the mean score of each scale and the ATTEX total score divided by gender in the present study and in the ATTEX normative sample (Klenberg, Jämsä, Häyrinen, & Korkman, 2010). In sum, the present study showed higher scores on 7 out of the 10 scales, as compared to the ATTEX norm sample. The boys scored higher on all 10 scales, while the girls scored lower on all scales in the present study, as compared to the ATTEX norm sample. However, no significance testing was performed on the differences. The total mean score for both genders (13.13) and the boys' total mean score (19.52) was higher, while the girls' total mean score (7.15) was lower in the present study, as compared to the ATTEX normative sample (Total, 12.69; girls, 8.93; boys, 16.43). Table 9 presents the descriptive statistics for the ATTEX Total score as well as the Factor 1 and Factor 2 summative scores separately for boys and girls. Table 10 presents the descriptive statistics for the three dependent variables per grade.

Table 8.

Present Sample Mean Scores (N=432) of the Scales as Compared to the Normative Group ATTEX Mean Scores

ATTEX Scales	**Present Study Mean**	Girls Mean	Boys Mean	**ATTEX Norms Mean**	Girls Mean	Boys Mean
Distractibility	**1.30^**	0.81	1.82^	**1.12**	0.84	1.44
Impulsivity	**2.37^**	1.25	3.57^	**2.12**	1.38	2.94
Motor Hyperactivity	**1.19^**	0.49	1.94^	**1.05**	0.55	1.58
Directing Attention	**1.60^**	0.94	2.31^	**1.59**	1.27	1.93
Sustaining Attention	**1.35**	0.68	2.08^	**1.52**	1.14	1.93
Shifting Attention	**0.86^**	0.52	1.21^	**0.79**	0.61	0.99
Initiative	**1.29^**	0.74	1.88^	**1.24**	0.94	1.57
Planning	**0.81^**	0.43	1.20^	**0.79**	0.56	1.05
Execution of Action	**1.83**	1.04	2.68^	**1.89**	1.51	2.30
Evaluation	**0.56**	0.25	0.89^	**0.58**	0.37	0.43
Total score	**13.13^**	7.15	19.52^	**12.69**	8.93	16.43

Note: ^ Higher mean score in the present sample as compared to the ATTEX normative sample mean score (Klenberg, Jämsä, Häyrinen & Korkman, 2010), no significance testing performed

Table 9.

Descriptive Values for the ATTEX Total, Factor 1, and Factor 2 Scores, Separately for Gender and Language Background (N=432)

Dependent variables	Bilingual Mean (SD)	Monolingual Mean (SD)	Total Mean (SD)
Girls			
ATTEX Total	7.97 (13.23)	6.29 (11.71)	7.15 (12.86)
Factor 1	5.00 (8.82)	3.70 (8.15)	4.36 (8.51)
Factor 2	2.67 (5.27)	2.40 (4.79)	2.54 (5.03)
Boys			
ATTEX Total	26.83 (24.77)	14.20 (15.90)	19.52 (21.01)
Factor 1	15.85 (15.98)	8.55 (11.41)	11.63 (13.96)
Factor 2	10.69 (9.95)	5.45 (5.98)	7.66 (8.29)

Table 10.

Descriptive Values for the ATTEX Total, Factor 1, and Factor 2, Scores, per Grade (N=432)

	ATTEX Total Mean (SD)	Factor 1 Mean (SD)	Factor 2 Mean (SD)
Grade 1	15.72 (19.32)	9.62 (12.80)	5.87 (7.74)
Grade 3	14.06 (16.57)	8.47 (11.93)	5.31 (5.90)
Grade 5	13.41 (19.13)	8.01 (12.24)	5.14 (7.89)
Grade 7-9	9.38 (17.79)	5.42 (10.79)	3.76 (7.25)
Total	13.13 (18.34)	7.88 (12.02)	5.01 (7.27)

3.4 The Main Analyses

Initially, the assumptions of Analysis of Covariance (ANCOVA) and factorial Analysis of Variance (ANOVA) were analyzed. All participants diagnosed by a professional, with a diagnosis that may have an impact on the cognitive functions that ATTEX aims to measure, were then removed. The distributions of the dependent variables were positively skewed, both according to visual inspection of histograms, Q-Q plots and normality tests. Both Kolmogorov-Smirnov and Shapiro-Wilk were significant ($p < .001$) for all three dependent variables, indicating that the sample distributions were non-normal. However, according to Field (2013), analyses can be carried out in cases of non-normality if the group sizes are big enough.

Furthermore, concerning the homogeneity of variance, Levene's Test of Equality of Error Variance was significant for all three dependent variables ($p < .001$), indicating that the assumption was violated. However, according to Field (2013), this test should be interpreted cautiously. Linear tests such as ANCOVA and ANOVA are usually robust to this assumption if groups are big enough (>15), and

Field (2013) points out that the assumption of homogeneity of residuals is more important. Unfortunately, homogeneity of residuals was not ideal on any of the three dependent variables in the present study either, as both Kolomogorov-Smirnov and Shapiro-Wilk's tests of normality of residuals were $p < .001$ in all cases, and a visual inspection of the histograms showed slightly sharp normal distributions. However, the visual inspection of the equality of variances on all levels of the independent variables was satisfying. This might indicate that the models are not optimal, but as far as the author knows, SPSS does not provide a robust test for ANCOVA (Field, 2013), hence the results gained must be interpreted with caution. For ANCOVAs there are two more important considerations, namely homogeneity of regression slopes, and independence of the covariate and the independent variables. For the dependent variables ATTEX Total score, Factor 1 and Factor 2 scores, the assumption of homogeneity of regressions slopes was met for each interaction of the independent variable and covariate ($p > .05$). The independent variables did not differ on maternal education (gender, $t(386) = .329$, $p = .74$; language, $t(386) = -.90$, $p = .37$; grade, $F(3, 384) = 1.04$, $p = .38$), indicating that the assumption of independence of the independent variables and the covariate was met and maternal education could be set as a covariate.

In the first ANCOVA, the covariate, maternal education, was significantly related to the ATTEX Total score, $F(1, 371) = 9.29$, $p = .002$, $r = -.13$, meaning that the higher the maternal education, the less rated problems of EFs were present. When controlling for the covariate, there were significant main effects of gender, $F(1, 371) = 66.54$, $p < .001$, partial $\eta 2 = .15$, and language, $F(1, 371) = 18.93$, $p < .001$, partial $\eta 2 = .05$. The main effect of grade on ATTEX total score was non-significant, $F(3, 371) = 2.46$, $p = .063$, partial $\eta 2 = .02$. There was also a significant interaction between gender and language background, $F(1, 371) = 9.13$, $p = .003$, partial $\eta 2 = .02$. This interaction indicated that language background affects boys and girls differently, so that bilingual boys had significantly higher ATTEX Total scores (higher scores meaning more problems; $M = 27.27$, $SD = 24.63$) than monolingual boys ($M = 15.01$, $SD = 16.47$). In contrast, among girls there was no significant difference between mono- and bilinguals (bilinguals, $M = 7.55$, $SD = 12.98$; monolinguals, $M = 5.97$, $SD = 11.71$). Table 11 provides a summary of the analysis.

Table 11.

Analysis of Covariance Summary for ATTEX Total

Source	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	30990.930[a]	16	1936.933	6.978	.000	.231
Intercept	24127.010	1	24127.010	86.919	.000	.190
Maternal Education	2577.325	1	2577.325	9.285	**.002**	.024
Grade	2046.273	3	682.091	2.457	.063	.019
Language	5254.391	1	5254.391	18.929	**.000**	.049
Gender	18470.215	1	18470.215	66.540	**.000**	.152
Grade*Language	140.182	3	46.727	.168	.918	.001
Grade*Gender	449.611	3	149.870	.540	.655	.004
Language*Gender	2532.784	1	2532.784	9.125	**.003**	.024
Grade*Language*Gender	110.729	3	36.910	.133	.940	.001
Error	102982.049	371	277.580			
Total	203932.000	388				
Corrected Total	133972.979	387				

a. R Squared = .231 (Adjusted R Squared = .198)

Note: significant results highlighted

In the second ANCOVA, the covariate maternal education was also significantly related to the "Attention & Executive Function" summative score, $F(1, 371) = 11.71$, $p = .001$, $r = -.15$. After controlling for the covariate, there were significant main effects of gender, $F(1, 371) = 53.35$, $p < .001$, partial $\eta 2 = .13$, language background, $F(1, 371) = 14.81$, $p = .001$, partial $\eta 2 = .04$, and grade, $F(3, 371) = 2.75$, $p = .0.43$, partial $\eta 2 = .02$. Bonferroni *post hoc* tests revealed that the participants in the first grade received significantly higher scores ($M = 9.62$) than the participants in the upper primary school ($M = 5.42$), $p = .028$. There were no significant differences between the other grades. There was also a significant interaction between gender and language background, $F(1, 371) = 5.97$, $p = .015$, partial $\eta 2 = .02$. This effect stemmed from the fact that bilingual boys received significantly higher ratings on the "Attention & Executive Function" summative score ($M = 16.16$, $SD = 15.94$) than monolingual boys ($M = 9.22$, $SD = 11.91$), while for girls there was no significant difference between mono- and bilinguals (bilinguals, $M = 4.71$, $SD = 8.55$; monolinguals, $M = 3.46$, $SD = 7.60$). Table 12 provides a summary of the analysis.

Table 12.

Analysis of Covariance Summary for the "Attention & Executive Function" Summative Score

Source	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	11931.019[a]	16	745.689	6.060	.000	.207
Intercept	10049.166	1	10049.166	81.670	.000	.180
Maternal Educat.	1441.325	1	1441.325	11.714	**.001**	.031
Grade	1015.267	3	338.422	2.750	**.043**	.022
Language	1821.854	1	1821.854	14.806	**.000**	.038
Gender	6564.581	1	6564.581	53.351	**.000**	.126
Grade*Language	207.797	3	69.266	.563	.640	.005
Grade*Gender	247.616	3	82.539	.671	.570	.005
Language*Gender	734.551	1	734.551	5.970	**.015**	.016
Grade*Language* Gender	26.626	3	8.875	.072	.975	.001
Error	45650.001	371	123.046			
Total	82960.000	388				
Corrected Total	57581.021	387				

a. R Squared = .207 (Adjusted R Squared = .173)

Note: Significant results highlighted

In the third ANCOVA, the "Restlessness & Impulsivity" summative score served as the dependent variable. As a bivariate correlation showed that maternal education was not significantly associated with the dependent variable (r = -.076, p = .133), the analysis was conducted as a 2x2x4 factorial ANOVA. There were significant main effects of gender, $F(1, 416) = 71.61$, $p < .001$, partial $\eta 2 = .15$, and language background, $F(1, 416) = 20.68$, $p = .001$, partial $\eta 2 = .05$. The main effect of grade was non-significant, $F(3, 416) = 1.68$, $p = .171$, partial $\eta 2 = .01$. There was also a significant interaction between gender and language background, $F(1, 416) = 13.71$, $p < .001$, partial $\eta 2 = .03$. This effect reflected the fact that bilingual boys obtained significantly higher "Restlessness & Impulsivity" ratings ($M = 10.69$, $SD = 9.95$) than monolingual boys ($M = 5.45$, $SD = 5.98$), while there was no significant difference between mono- and bilingual girls (bilinguals, $M = 2.68$, $SD = 5.27$; monolinguals, $M = 2.48$, $SD = 4.79$). Table 13 provides a summary of the analysis.

Table 13.

Factorial Analysis of Variance Summary for the "Restlessness & Impulsivity" Summative Score

Source	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	4783.654[a]	15	318.910	7.385	.000	.210
Intercept	11764.533	1	11764.533	272.418	.000	.396
Grade	217.353	3	72.451	1.678	.171	.012
Language	893.222	1	893.222	20.683	**.000**	.047
Gender	3092.412	1	3092.412	71.607	**.000**	.147
Grade*Language	35.307	3	11.769	.273	.845	.002
Grade*Gender	155.648	3	51.883	1.201	.309	.009
Language*Gender	591.990	1	591.990	13.708	**.000**	.032
Grade*Language*Gender	122.920	3	40.973	.949	.417	.007
Error	17965.233	416	43.186			
Total	33619.000	432				
Corrected Total	22748.887	431				

a. R Squared = .210 (Adjusted R Squared = .182)

Note: Significant results highlighted

4 DISCUSSION

The possible existence of BEA has been extensively examined with performance-based EFs, but the results are still conflicting. The general aim of the present study was to compare mono- and bilingual school children on a teacher rating-based measure of EFs, which, to the author's knowledge, is a relatively unexplored area. Most research to date has examined the possible cognitive and executive advantages under optimal and controlled circumstances with so called performance-based testing. This study, however, investigated the effects of bilingualism on executive behavior in less controlled, "real-life" conditions, since there is some evidence that these two aspects of EFs reflect different underlying constructs (Toplak et al., 2013). In sum, the main aim of the study was to investigate the effects of bilingualism (monolingual Swedish speakers vs. bilingual Swedish-Finnish speakers), gender (girls vs. boys) and grade (1, 3, 5 and 7 – 9) on teacher-rated EFs in a sample of non-clinical Swedish-speaking and Swedish-Finnish speaking children in Finland.

For this purpose, the rating instrument ATTEX was first analyzed by factor-analytic means to determine its latent structure in the present sample. The extracted factors and a total score of ATTEX were then used in the group comparisons, which included language background, gender, and grade as independent variables.

The EFs in this study were assessed with ATTEX, a teacher rating scale developed by Klenberg, Jämsä, Häyrinen, and Korkman (2010). The final sample consisted of 432 children, of whom 53.2% were monolingual Swedish-speaking and 46.8% were bilingual Swedish-Finnish-speaking individuals. Of the total sample, 51.6% were girls and 48.4% were boys. The present study was a part of the ILS research project (2015-2018) by the Niilo Mäki Institute.

To sum up the results, boys in general had more EF problems than girls as measured with ATTEX. Moreover, there was an interaction between gender and language background so that bilingual boys got rated with more EF difficulties than monolingual boys, when controlling for maternal education. No difference was found between the language groups among girls. A developmental effect was found only on the "Attention & Executive Function" factor, where the children in the first grade had more EF problems than the children in the upper primary school. Pre-analyses revealed that language background was significantly dependent on geographical area: a larger proportion of the monolingual participants were from rural areas and a larger proportion of the bilingual participants were from urban areas. Hence, geographical region and factors related to that (e.g. stress level, class sizes) might serve as confounding variables in the present study and should be considered in the interpretations.

4.1 Latent Structure of ATTEX

The exploratory factor analysis on the 55 ATTEX items resulted in eight factors, but a two-factor solution was deemed as most suitable for further analyses based on eigenvalues, cumulative variance and inspection of the scree plot. The two factors were named "Attention & Executive Function" and "Restlessness & Impulsivity" and summative scores based on these factors were used as dependent variables in the main analyses, in addition to the ATTEX Total score. During the development process of ATTEX, Klenberg, Jämsä, Häyrinen, and Korkman (2010) performed a factor analysis on 704 children from different parts of Finland, which resulted in a five-factor solution, but the instrument was nevertheless deemed as rather one-dimensional due to high shared variance. The authors interpreted the one-dimensionality to be due to attention problems often piling in a child – if there is an attention problem, s/he most likely has other problems related to attention. On the other hand, Klenberg, Jämsä, Häyrinen, and Korkman (2010) point out that teacher-

ratings are piling up as well – if a child has an attention problem, the rater also easily sees more problems related to attention. In contrast to Klenberg, Jämsä, Häyrinen, and Korkman (2010), the present factor analysis points to two domains covered by ATTEX being on the one hand related to attention and "control of the mind", and to motoric aspects of EFs such as control of motoric impulses and restlessness on the other. In the original norm sample, ATTEX has also been able to differentiate between ADHD Inattentive type and ADHD Combined type (Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, & Korkman, 2010), which speaks for a possible dimensionality of the rating scale and would support the suggested latent structure derived from the present factor analysis. However, there was a significant number of items that loaded on both factors in the present analysis as well. This could be seen as support for a single-factor solution for the present sample as well, even though there seems to exist an underlying dimensionality in the rating scale. A possible reason for the cross-loadings pertains to issues on the items themselves. Some of the items are namely formulated similarly even though they are supposed to cover different sub-functions. Compare e.g. item no 26 on scale Sustaining Attention ("Has difficulties completing tasks") and item no 46 on scale Execution of Action ("Leaves tasks uncompleted")[1]. The items are overlapping and not discriminative enough.

4.2 Main Findings and Interpretation

Concerning the main aims of the present study, the results consistently showed more EF-related problems among boys than among girls on all three dependent variables (ATTEX Total score, "Attention & Executive Function" and "Restlessness & Impulsivity"). The results also showed significantly more EF problems among bilingual boys than monolingual boys on all three dependent variables, even when controlling for maternal education. However, there was no difference among bilingual and monolingual girls. Only on one of the three factors, namely "Attention & Executive Function", could a main effect of grade be found. Post hoc tests showed that the EF problems were decreasing per grade, but the difference was only statistically significant between the first grade and the upper primary school (grade 7–9), indicating that attention-related EFs tend to develop with age among children, whilst EFs related to control of motor behavior might be more stable within the

[1] For copyright reasons, the reader is referred to the original study (Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, & Korkman, 2010) where all the items are depicted.

studied age range. No interaction effects between language background and grade, gender and grade, or language, gender and grade were found.

An effect of gender was found during the development of ATTEX (Klenberg, Jämsä, Häyrinen, & Korkman, 2010), but a possible effect of language was not investigated in the norm sample of ATTEX, which makes the present study results important when assessing EFs in children. Furthermore, Klenberg, Jämsä, Häyrinen, and Korkman (2010) found no effect of age in the study of ATTEX normative sample, except for on the sub-function "Motor hyperactivity", where 7-year old children showed significantly more problems than 14-year old children. The present study did not analyze the different sub-functions separately, but factor-based summative scores. The present study, again, found no effect of grade on the "Restlessness & Impulsivity" summative score.

When assessing and analyzing EFs, socioeconomic status (SES) has generally been found to interact with the results, so that higher SES is associated with higher EFs (see e.g. a meta-analysis by Lawson, Hook, & Farah, 2018). Therefore, SES is often recommended to be accounted for in the studies of bilingualism and EFs. SES usually refers to parent education, income and occupation. In the present study, however, only parental education level was probed. In the analyses, ATTEX Total and "Attention & Executive Function" both correlated with the level of maternal education (higher education, less problems related to EFs) and were hence set as a covariate in the two analyses. The factor "Restlessness & Impulsivity" was not related to the level of maternal education in this study.

To the author's knowledge, no previous studies have explored the bilingual advantage with teacher-ratings of EFs on a non-clinical sample of school children. Hermodson-Olsen (2012) studied teacher-, parent-, and performance-based EFs in school children, where a bilingual advantage could be found in the teacher-ratings, but no difference between the language groups was found in the other two conditions. However, her study was conducted on a sample of children who were clinical outpatients, whereas the present study was conducted on a non-clinical sample. Moore (2010), Weber, Johnson, and Wiley (2011), and Loe and Feldman (2016) have also studied different aspects of rating-based EFs (see Table 1) but with varying age samples and different raters and instruments, making it difficult to draw clear conclusions from the studies. Nonetheless, the findings to date have either consistently shown that no difference between language groups exists or a that there

exists a bilingual advantage, which makes the bilingual disadvantage finding among the boys in the present study unique. This result is also the opposite to what the BEA hypothesis predicts. The finding raises the question of what might be happening in the classroom that could explain the bilingual disadvantage among boys. There might be several possible explanations on the present result. First, the teachers might for some reason be more prone to judge bilingual boys as having more EF-related problems. Second, bilingual boys might experience some verbal difficulties at school (e.g. Lehtonen et al., 2018), which in turn could affect tasks that require EFs. This difficulty might become evident in the classroom where most of the tasks are based on verbal instructions and dependent on verbal understanding and expression. A third possible interpretation is related to the distribution of language background in the different geographical areas. The pre-analyses revealed that language background was significantly dependent on geographical area, with a larger proportion of the monolingual participants being from rural areas and a larger proportion of the bilingual participants being from urban areas. Hence, the differences between the language groups could be confounded by factors related to differences between urban-rural contexts, such as stress-levels and class-sizes. This is a factor that has been explored in earlier studies as well (discussed in Hakuta & Diaz, 1985). One could speculate whether such a putative effect could surface up more easily in boys than in girls, as boys in general show more EF-related problems.

4.3 Clinical Significance of the Results

The results of the study underline the need for deepening our understanding on rating-based EFs, as well as on the effects of bilingualism. The studies to date are scarce and the results are discrepant, one supporting a bilingual cognitive advantage (Weber, Johnson, & Wiley, 2011), two showing no difference (Loe & Feldman, 2016; Moore, 2010), and the present study showing a bilingual cognitive disadvantage. Thus, replication, systematic reviews and meta-analyses are needed. If replicated, the results may call for different norms for bilinguals and monolinguals when developing rating-scales of EFs, as well as more support, especially for bilingual boys, in school. However, this study does present normative data for Swedish-speaking and Swedish-Finnish speaking boys and girls in Finland.

4.4 Strengths and Limitations of the Study

The selection of the participants to the present study was stratified and consisted of four geographically separate regions which represent both urban and rural areas. The schools, as well as the participants from each school, were also randomly selected which strengthen its representativeness of the Swedish-speaking and Swedish-Finnish-speaking population in Finland. Additionally, the sample size of the study was rather large which endorses the statistical analyses made. These factors can be considered strengths of the study.

There are, however, some limitations or considerations in the study that need to be noted. The first issue concerns the operationalization of EFs. In the present study, EFs were only assessed with a teacher-rating scale, which differs from self-rating, parent-rating, and performance-based EFs. These assessment methods are not interchangeable, and the results must be interpreted in the light of the method used. When using a proxy rating, there is also the risk of different raters bringing their own subjective understandings into the ratings which might bias the results, leading to some caution when interpreting the findings.

The second limitation concerns the definition of language background in the study. Green and Abutalebi (2013) suggest that a bilingual advantage might be most visible in the so-called dual language context, where the individual uses different languages in different situations or with different persons. The present study, however, used the bilingual definition of *early simultaneous bilingualism*, which does not account for any language habits or knowledge levels. Being born into a bilingual family does not automatically reveal the nature of the language use in the family.

Thirdly, the contingency table analysis of language background and geographical area revealed a significant relationship between the variables, indicating that the distribution of language background was uneven so that a significant amount of the monolingual participants were from rural Swedish-speaking areas such as the Åland Islands and Ostrobothnia, while a significant amount of the bilinguals were from urban areas. Hence, the difference between the language groups might be confounded by factors related to geographical region (e.g., level of stress and class size), leading to caution when interpreting the results.

Fourthly, there are some limitations concerning the statistical analyses. The assumption of normality of residuals in ANCOVA and factorial ANOVA was

violated. However, according to Field (2013), the F-statistics are rather robust to this assumption if the sample sizes are big enough.

Finally, like most of the studies in the field of bilingualism and EFs, the present study design is cross-sectional. Causality cannot be determined in the study design in question. In a recent review, Laine & Lehtonen (2017) have discussed this issue as well as two other problem areas (lack of a detailed theory, employment of different measures) in BEA studies. A prospective longitudinal study design would be needed to be able to make causal interpretations.

4.5 Conclusions

The findings from this rating scale study with a non-clinical Finnish sample showed that boys overall were rated by their teacher as having more EF problems than girls. The results also showed an interaction between gender and language, with bilingual Swedish-Finnish-speaking boys having more EF problems than monolingual Swedish-speaking boys, even when controlling for maternal education. There was no difference between the language groups among girls. A developmental difference was found on a summative attentional measure derived from the EF rating scale, where children in the upper primary school had better EFs than children in the first grade. A similar effect could not be found on the second summative score that measures motor aspects of EFs, nor on the total ATTEX scale sum score. The finding concerning bilingual boys' more frequent attentional problems differed from earlier findings, and hence, highlights the importance of replication with further large-scale studies examining the effect of bilingualism on rating-based EFs. In the future, one should take language background into consideration when assessing EFs in children and when standardizing EF rating scales. If replicated, it may also call for different norms for monolingual vs. bilingual boys in EF ratings.

Swedish Summary

Tvåspråkighet och lärarskattade exekutiva funktioner hos elever i grundskolan

Sambandet mellan tvåspråkighet och kognitiva förmågor har väckt intresse i snart ett århundrade och forskare är fortfarande inte eniga i frågan. Till en början varnades det för att tvåspråkighet var skadligt för ett barn i utveckling (för översikt se Bhatia & Ritchie, 2006; Hakuta, 1986). Efter att Pearl och Lambert (1962) gjort viktiga forskningsmetodologiska förbättringar fann de i en studie att tvåspråkiga, de facto, presterade bättre på både verbala och icke-verbala kognitiva test. Förbättringarna handlade om att lyfta frågor om sampelurval, definition av tvåspråkighet och olika störande variabler som till exempel socioekonomisk status, stads- och landsbygdsmiljö, ålder och kön (Hakuta & Diaz, 1985). Idag är forskningsunderlaget i ämnet stort, där både fynd som stöder tanken om att tvåspråkighet leder till vissa kognitiva fördelar finns (ex. Bialystok, 2015) men även fynd som visar på motsatsen eller att tvåspråkiga och enspråkiga presterar lika bra (ex. Duñabeitia et al., 2014; Hilchey & Klein, 2011; Paap & Greenberg, 2013). De kognitiva områden som oftast studerats är metakognition, uppmärksamhetskontroll, exekutiva funktioner, verbal förmåga, abstrakt resonerande, problemlösning, *theory of mind*, kognitiv flexibilitet och kreativt tänkande (Adesope, Lavin, Thompson & Ungerleider, 2010). Det mest studerade området handlar om exekutiva funktioner (EF), möjligen eftersom det spelar en central roll i all mänskligt beteende.

Forskningsfältet om tvåspråkighet och kognitiva funktioner är omfattande och man har gjort en del meta-analyser, de flesta med vuxet eller blandat ålderssampel och resultaten är varierande. I en meta-analys av 63 studier fann man till exempel bättre arbetsminne, metalingvistisk medvetenhet, uppmärksamhetskontroll och abstrakt och symbolisk framställningsförmåga bland tvåspråkiga (Adesope et al., 2010). I en sammanfattning (Paap, Johnson & Sawi, 2015) fann man å andra sidan inget stöd för en omfattande tvåspråkig fördel gällande icke-verbal växlings- och inhibitionsuppgifter. De fann tvåspråkiga fördelar i studier var samplen var små och huvudsakligen inga skillnader när samplen var större (>50). Studier har också visat att det finns en del publiceringsbias inom fältet där resultat med nollfynd tenderar lämna opublicerade, vilket framtida meta-analyser måste ta i beaktande. I en färsk meta-analys (Lehtonen et al., 2018) med friska vuxna fann man, efter korrigering för

publiceringsbias, ingen tvåspråkig fördel på en rad exekutiva funktioner (monitorering, inhibering, arbetsminne, uppmärksamhet, växling och verbal fluens). Meta-analysen studerade inte effekten av tvåspråkighet på barns kognitiva funktioner.

De teoretiska förklaringarna till den möjliga tvåspråkiga kognitiva fördelen är många men de mest tillämpade gäller inhibering (av oväsentlig information) och växling. Idén om inhibering (Green, 1998) handlar om att båda språken är aktiverade samtidigt när en tvåspråkig person kommunicerar på det ena språket (Wu & Thierry, 2010) och att det andra språket då måste inhiberas så att ett flytande och flexibelt språkbruk är möjligt. Tanken om växling handlar i sin tur om att frekvent språkbyte skulle träna domängenerella EF (Prior & MacWhinney, 2010). Green och Abutalebi (2013) har utvecklat en adaptiv kontrollhypotes med tre olika interaktionskontexter som enligt hypotesen belastar kontrollfunktionen olika och resulterar i skilda träningseffekter av EF. En tvåspråkig fördel har också hittats bland barn där språkfunktionerna inte är fullt utvecklade och träningseffekter av språkbyte och inhibering troligen inte ännu förekommit och Bialystok (2015) föreslog då att uppmärksamhet spelar en viktig roll där tvåspråkighet leder till att barn, med hjälp av uppmärksamhet, lär sig skilja på de två olika språksystemen, och att EF krävs för att upprätthålla uppmärksamhet vid det önskade språket. Effekten av tvåspråkighet på kognitiva funktioner har också föreslagits vara olika genom livet där effekten av tvåspråkighet kan vara starkare hos barn, unga, och äldre, medan det inte finns någon skillnad mellan språkgrupperna bland unga vuxna då den kognitiva utvecklingen annars också är på topp.

EF, den mest studerade kognitiva funktionen inom fältet, har många definitioner. Kort kan det beskrivas som ett paraplybegrepp för mänskliga kognitiva kontrollfunktioner som är närvarande i komplexa mentala aktiviteter (Lehtonen et al., 2018). EF är viktiga i målinriktat beteende (Miyake & Friedman, 2012), i nya, obekanta situationer (Shallice, 1990) och de är associerade med bättre akademisk framgång (Best, Miller & Naglieri, 2011) vilket i sin tur är associerat med högre livskvalitet och långsiktigt välmående (Duncan, Ziol-Guest & Kalil, 2010). Försämrade EF leder till problem med bland annat omdömesförmåga, socialt beteende, organisering, initiering och genomförande av planer (Strauss, Sherman & Spreen, 2006) och är nedsatta vid flera neuropsykiatriska funktionsnedsättningar (Klenberg, 2015). Den mest använda strukturella modellen av EF består av

arbetsminne, inhibering av irrelevant information och växling (Miyake et al., 2000). Utvecklingen av EFs delfunktioner sker i olika takt men i ung vuxenålder räknas EF vara fullt utvecklade (Anderson, 2002).

Traditionellt kan EF mätas på två olika sätt: med prestationstest och med olika skattningsskalor. Det är en pågående diskussion om dessa två mätningstraditioner mäter samma underliggande mentala konstruktion. Toplak, West och Stanovich (2013) argumenterar för att de två mätningstraditionerna mäter olika aspekter av EF då de fann att både barn och vuxna med ADHD inte får liknande resultat på prestationsbaserade test och skattningsbaserade test av EF. Ackerman (1994) har också skiljt på optimal/maximal prestation (situation där uppgiften är precist förklarad och där deltagaren skall maximera prestationen) och typisk prestation (situation där tolkningen av uppgiften är lämnad öppen och måste tolkas av deltagaren). Toplak, West och Stanovich (2013) argumenterar för att prestationsbaserade test görs under optimala betingelser och fångar deltagarens optimala/maximala prestation, medan skattningar av EF igen kräver en tolkning av deltagarens beteende (av endera deltagaren själv eller en närstående) och fångar deltagarens typiska prestation.

De flesta av studierna inom fältet har gjorts med prestationsbaserade mått på EF. Endast ett fåtal studier har undersökt sambandet mellan tvåspråkighet och skattningsbaserade EF och resultaten och metoderna är spretiga. Moore (2010) har undersökt självskattningar bland icke-kliniska unga vuxna och fann ingen skillnad mellan språkgrupperna medan Weber, Johnson och Wiley (2011) studerat föräldraskattningar bland 4–7 åriga icke-kliniska barn och fann en tvåspråkig fördel på organisering av material, arbetsminne och metakognition. Hermodson-Olsen (2010) har undersökt lärar- och föräldraskattningar samt prestationstest på 3–19 åriga kliniska barn och fann en tvåspråkig fördel på lärarskattade generella EF men ingen skillnad mellan språkgrupperna på föräldraskattningen och prestationstesten. Loe och Feldman (2016) igen, fann ingen skillnad bland språkgrupperna på lärarskattade och prestationsbaserade test av EF inom ett sampel med kliniska och icke-kliniska 3–5 åringar. Studierna jämför olika aspekter av EF, olika grupper (kliniska, icke-kliniska), olika åldrar (förskolebarn, skolbarn och unga vuxna) samt olika skattare (själv, förälder, lärare) och är således inte direkt jämförbara. Detta belyser vikten av att lyfta olika mätningstraditioner i forskningen kring tvåspråkighet och EF.

Även tvåspråkighet kan definieras på många olika sätt och varierar ofta mellan studier vilket försvårar jämförandet. Ofta baseras definitionerna på endera färdighet eller ålder (Kohnert, 2013). Färdighetsbaserade definitioner gäller 1. det tvåspråkiga barnets nivåer på språken jämfört med jämngamla enspråkigas nivåer 2. det tvåspråkiga barnets nivå etta språket jämfört med nivån på det andra språket (balanserad tvåspråkighet eller dominant språk) eller 3. det tvåspråkiga barnets nivåer på språken jämfört med andra tvåspråkiga barns nivåer, när de är matchade med ålder och erfarenhet. Det andra sättet att definiera tvåspråkighet innefattar ålder. När föräldrarna pratar olika språk till barnet direkt från födseln kallas det *samtidig tvåspråkighet*. Om barnet lär sig ett språk först och det andra språket senare i livet kallas det *sekventiell/successiv tvåspråkighet.* Ifall det andra språket introduceras efter födseln men före tre års ålder används ofta termen *tidig successiv tvåspråkighet* och om språk två introducerats efter tre, används termen *sen successiv tvåspråkighet*. (Kohnert, 2013). I vissa studier (Green & Abutalebi, 2013) har man också definierat tvåspråkighet enligt olika interaktionsmönster.

Studiens syfte

Sammanfattningsvis har tidigare studier inom fältet tvåspråkighet och EF främst studerat EF under optimala och kontrollerade omständigheter (s.k. prestationsbaserade EF). Få studier har undersökt effekten av tvåspråkighet i ”verkliga livet”, under mindre kontrollerade betingelser (s.k. skattningsbaserade EF) och i icke-kliniska sampel med barn. Syftet med studien var tvådelad. Bisyftet var att undersöka den latenta strukturen i lärarskattningsformuläret Kesky (Klenberg, Jämsä, Häyrinen & Korkman, 2010) för att kunna sammanställa adekvata faktorer som sedan i huvudanalyserna kunde användas som beroendevariabler. Huvudsyftet med studien var att undersöka effekten av tvåspråkighet, kön och klass på lärarskattade EF i ett icke-kliniskt sampel med finländska svensk- och svensk-finskspråkiga elever i grundskolan. Kön inkluderades eftersom pojkar tidigare visat sig ha signifikant sämre EF än flickor mätt med Kesky (Klenberg, Jämsä, Häyrinen & Korkman, 2010). Ålder inkluderades för att undersöka en möjlig utvecklingskurva av EF bland barn på lärarskattningsformuläret Kesky.

Metod

Denna studie var en del av ett omfattande forskningsprojekt arrangerat av Niilo Mäki Institutet som är en finsk enhet för tvärvetenskaplig forskning och utvecklingsarbete kring inlärningssvårigheter. Projektet i fråga (*InLärning och Stöd, ILS-projekt 2015–2018. Utvecklingsprojekt om utvärdering av och stödåtgärder vid inlärningssvårigheter i finlandssvenska skolor och daghem*) strävar efter att utveckla forsknings- och evidensbaserad kunskap om inlärningssvårigheter bland barn, främst inom svenskspråkiga skolor och daghem i Finland. Studien beviljades etiskt tillstånd av de kommunala utbildningsnämnderna samt av de 28 skolorna som deltog.

Datat till denna studie har samlats in med ett omfattande bakgrundsformulär ifyllt av föräldrarna till barnen samt med lärarskattningsformuläret *Kesky – frågeformulär om koncentrationsförmåga*. Insamlingen var stratifierad och bestod av fyra geografiskt separata regioner: Österbotten, huvudstadsregionen, Åland och övriga svenskspråkiga områden. Från de 28 skolorna som deltog, valdes var fjärde elev i alfabetisk ordning. Datainsamlingen genomfördes under skolåret 2015–2016. Det ursprungliga samplet bestod av 522 barn i åldern 6–16 år. Totalt exkluderades 45 deltagare vars föräldrar inte fyllt i bakgrundsformuläret, 27 deltagare som inte hade den språkbakgrund som krävdes (svenskspråkig eller svensk- och finskspråkig) och 18 elever som hade en neurologisk diagnos som kunde tänkas påverka de beroendevariablerna studien undersökte (ADHD/ADD, epilepsi, dyslexi). Det slutgiltiga samplet bestod av 432 deltagare, varav 51.6 % var flickor och 48.4 % var pojkar, och varav 53.2 % var tvåspråkiga och 46.8 % var enspråkiga. Tvåspråkighet i denna studie baserades på definitionen för *samtidig tvåspråkighet* (Kohnert, 2013), dvs. föräldrarna har pratat varsitt språk konsekvent med barnet och därmed har hen lärt sig båda språken (svenska och finska) direkt från födseln.

Bakgrundsformuläret som användes i studien innefattade demografisk information, familjebild, språkbakgrund och språkbeteende, föräldrarnas utbildningsnivå och yrke, hälsotillstånd, ärftlighet, språkutvecklingssvårigheter, neurologiska utvecklingsavvikelser, medicinering och slutligen media- och läsvanor. Det andra instrumentet som användes i studien, Kesky, var ett lärarskattningsformulär som mäter EF, uppmärksamhet- och koncentrationsförmåga hos barn i grundskolan. Kesky utvecklades som en finsk motsvarighet till BRIEF, *Behavior Rating Inventory of Executive Functioning* (Gioia, Isquith, Guy & Kenworthy, 2000) och kan användas till exempel i skolmiljöer, som stöd i

diagnostiska processer och i rehabiliteringsplanering. Skattningsprocessen i Kesky görs av barnets lärare och är tredelad (skattning av EF, bedömning av styrkor och stödåtgärder). Endast den första delen användes i denna studie och består av 55 frågor som skattas på en tregradig skala. Frågorna delas i manualen (Klenberg, Jämsä, Häyrinen & Korkman, 2010) vidare in i 10 delfunktioner (distraherbarhet, impulsivitet, motorisk oro, riktande, upprätthållande, växling, initiering, planering, utförande och bedömning). Klenberg, Jämsä, Häyrinen och Korkman (2010) genomförde en faktoranalys på samtliga frågor och gjorde då bedömningen att formuläret var relativt endimensionellt. Manualens indelning i 10 delfunktioner kan därför statistiskt ses som tämligen ogrundad och belyser vikten av vidare analyser.

De statistiska analyserna genomfördes med programmet IBM SPSS Statistics 24.0 för Windows (IBM Corp., 2016). För bisyftet genomfördes inledningsvis en explorativ faktoranalys för att undersöka den latenta strukturen i Kesky för att därefter kunna sammanställa faktorer att använda som beroendevariabler i huvudanalyserna. För huvudanalyserna genomfördes två kovariansanalyser (ANCOVA) för att bedöma möjliga effekter av språkighet, kön och årskurs separat för Kesky totalpoäng och den första faktorn från den tidigare faktoranalysen. Moderns utbildningsnivå användes som kovariat. Ytterligare genomfördes en faktoriell variansanalys (ANOVA) för att undersöka effekten av samma oberoende variabler men med den andra faktorn som beroendevariabel och utan moderns utbildningnivå som kovariat. Samtliga antaganden för faktoranalys och variansanalys kontrollerades innan huvudanalyserna.

Resultat

I den explorativa faktoranalysen framkom inledningsvis åtta faktorer varav en tvåfaktorlösning bedömdes som mest adekvat. Dessa gavs namnen ”uppmärksamhet & exekutiv funktion” samt ”motorisk rastlöshet” och analyserades som separata beroendevariabler i huvudanalyserna. Ytterligare analyserades Kesky totalpoäng som en tredje beroendevariabel.

Resultaten från huvudanalyserna antyder att pojkarna generellt skattades med högre poäng (vilket indikerar mera problem) än flickorna på samtliga tre beroendevariabler. Det fanns även en interaktionseffekt mellan kön och språk där tvåspråkiga pojkar skattades med mera exekutiva problem än enspråkiga pojkar på samtliga beroendevariabler, även då man tagit moderns utbildningsnivå i beaktande.

Ingen liknande skillnad mellan språkgrupperna fanns bland flickorna. Endast på variabeln ”uppmärksamhet & exekutiv funktion” fanns en effekt av årskurs, där barnen på årskurs 1 skattades med signifikant sämre exekutiva funktioner än barnen i högstadiet, där årskurs 7 och 9 adderats ihop för att säkerställa tillräcklig gruppstorlek. Ingen interaktionseffekt fanns mellan språkighet, kön och årskurs. Preanalyser avslöjade en signifikant skillnad mellan språkbakgrund och geografisk region där en större andel av de svenskspråkiga deltagarna härstammade från landsbygdsorter (Åland och Österbotten) och en större andel av de tvåspråkiga deltagarna härstammade från stadsmiljöer. Detta måste belysas i tolkningen av resultaten eftersom en del av skillnaderna mellan språkgrupperna således kan bero på faktorer relaterade till olikheter mellan stads- och landsbygd (ex. stressnivå, klasstorlek).

Diskussion

Bisyftet med denna studie var att undersöka den latenta strukturen i lärarskattningsformuläret Kesky samt att sammanställa faktorer som kunde användas i huvudanalyserna. Huvudsyftet var att undersöka hur tvåspråkighet, kön och årskurs påverkar lärarskattade exekutiva funktioner hos barn i grundskolan. Resultaten antydde, i likhet med tidigare studier (ex. Klenberg, Jämsä, Häyrinen & Korkman, 2010), att pojkar generellt hade sämre EF än flickor. Dock framgick i denna studie att tvåspråkiga pojkar överlag hade sämre EF än enspråkiga pojkar i motsats till några tidigare studier som också på olika sätt undersökt skattningsbaserade EF (Hermodson-Olsen, 2012; Loe & Feldman, 2016; Moore, 2010; Weber, Johnson & Wiley, 2011). Denna skillnad mellan språkgrupperna fanns inte bland flickorna. I normeringen av Kesky (Klenberg, Jämsä, Häyrinen & Korkman, 2010) har man inte undersökt effekten av språkighet men resultaten från denna studie visar att det är en faktor som är viktig att ta i beaktande vid kartläggning av EF hos barn. Vidare fann Klenberg, Jämsä, Häyrinen och Korkman (2010) ingen åldereffekt i normeringsprocessen, bortsett från i delfunktionen ”motorisk oro”, där de 7-åriga barnen hade signifikant mera problem än 14-åriga barn. Denna studie analyserade inte de 10 olika delfunktionerna separat i och med att den inledande faktoranalysen enbart föreslagit en tvåfaktorlösning. I denna studie fanns ingen effekt av årskurs på Kesky totalpoäng eller på ”rastlöshet & impulsivitet”. Endast på ”uppmärksamhet &

exekutiv funktion" fanns en huvudeffekt av årskurs där deltagarna i högstadiet hade signifikant bättre EF än deltagarna i årskurs 1.

Resultaten väcker frågor om vad som möjligtvis händer i klassrumsmiljön som gör tvåspråkighet till en nackdel, speciellt för pojkar. Möjligtvis kan resultaten vara lärarrelaterade, där lärarna av någon orsak är mera benägna att tolka att tvåspråkiga pojkar har mera EF relaterade problem. En annan möjlig förklaring är att en del av tvåspråkiga pojkars verbala förmågor kan vara sämre (t.ex. Lehtonen et al., 2018) och att detta kunde leda till svårigheter som påminner om EF problem. Dessa problem kan bli synliga i klassrumsmiljön var majoriteten av uppgifterna är baserade på verbala instruktioner, förståelse och uttryck. En tredje förklaring kan bero på en ojämn geografiska fördelningen av språkgrupperna där en större andel av de enspråkiga härstammade från landsbygdsmiljöer och en större andel av de tvåspråkiga härstammade från stadsmiljöer. Skillnaderna mellan språkgrupperna kan således bero på olikheter mellan stad- och landsbygdsmiljö (ex. stressnivå, klasstorlek). Detta förklarar dock inte varför det enbart fanns en skillnad mellan språkgrupperna bland pojkarna.

Styrkan i denna studie ligger i att urvalet av deltagarna var stratifierat och representerar både stadsmiljön och landsbygden samt att skolorna och deltagarna var slumpmässigt utvalda. Ytterligare hade studien ett stort sampel vilket stöder de statistiska analyserna. Dessa faktorer tillsammans stärker generaliserbarheten av resultaten till den svenskspråkiga och svensk-finskspråkiga populationen i Finland. Till begränsningarna i denna studie hör dels operationaliseringen av EF som i denna studie mättes enbart med ett lärarskattningsformulär, vilket inte är direkt jämförbart med andra skattningsformer (självskattning, föräldraskattning) eller med prestationsbaserade test. Språkdefinitionen kan även ses som en begränsning i studien, där definitionen baseras på tidig samtidig tvåspråkighet som inte tar varken språkvanor eller kunskapsnivå i beaktande. Dels finns det även begränsningar relaterade till de statistiska analyserna där antagandet om normalitet av residualerna inte uppfylldes. En robust analysmetod hade möjligen varit mera adekvat och resultaten måste därmed tolkas försiktigt. Ytterligare fanns en begränsning beträffande fördelningen av språkgrupperna där en signifikant andel av de svenskspråkiga var från mindre landsbygdsorter såsom Åland och Österbotten medan en större andel av de tvåspråkiga var från stadsmiljöer. Därmed kan skillnaderna mellan språkgrupperna också påverkas av skillnader mellan landsbygds- och

stadsmiljön och måste beaktas i tolkningen av resultaten. Slutligen är forskningen, likt de flesta inom fältet, en tvärsnittsstudie. Detta belyser frågan om kausalitet som inte kan garanteras med denna studiedesign. En longitudinell studiedesign med kontrollgrupp krävs för att göra kausala slutsatser.

Resultaten, speciellt beträffande effekten av språkbakgrund, är avvikande från tidigare fynd och belyser därmed vikten av replikering och genomförande av större, mera omfattande studier gällande effekten av tvåspråkighet på skattningsbaserade exekutiva funktioner hos barn. Resultaten är kliniskt viktiga och argumenterar för ett behov att ta språkbakgrund i beaktande vid kartläggning av EF samt i normeringsprocessen av de skattningsskalor som används.

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Appendix

List of Diagnoses Mentioned in the Questionnaires

All cases diagnosed by a professional with any of the bolded disorders/diseases were excluded

ADHD/ADD
Allergies (pollen, dust, food)
Aspergers
Asthma
Celiac disease
Cleft palate
Deafness
Decreased muscle strength
Delayed langugage disorder
Dyscalculia
Dyslexia
Encephalitis
Epilepsy
Hypothyreosis
Irritable bowel syndrome
Learning disability
Migraine
Stuttering

Lea Gädda

PRESSMEDDELANDE

Tvåspråkiga pojkar har mera exekutiva problem än enspråkiga pojkar i grundskolan

Pro gradu-avhandling i psykologi
Fakulteten för humaniora, psykologi och teologi, Åbo Akademi

Resultaten från en pro-gradu avhandling vid Åbo Akademi tyder på att tvåspråkiga pojkar har mera exekutiva problem än enspråkiga pojkar i grundskolan, även när man tagit moderns utbildningsnivå i beaktande. Avhandlingen undersökte effekten av kön, språkbakgrund och årskurs på exekutiva funktioner mätt med lärarskattningsformuläret *Kesky – frågeformulär om koncentrationsförmåga*. Ingen liknande skillnad mellan språkgrupperna fanns bland flickor. Vidare tyder resultaten på att pojkar i grundskoleåldern även rent generellt har sämre exekutiva funktioner än flickor, ett resultat som också stöds av tidigare studier. Man fann ingen enhetlig utvecklingseffekt av exekutiva funktioner under grundskoletiden, varken hos pojkar eller flickor.

Exekutiva funktioner, dvs. kognitiva kontrollfunktioner som riktande och upprätthållande av uppmärksamhet och impulskontroll, har visat sig ha samband med bland annat studie-, och arbetsförmåga. Effekten av flerspråkighet på dessa funktioner har varit ett aktuellt forskningsområde ända sedan 60-talet och fullständig konsensus har fortfarande inte uppnåtts.

Pro-gradu avhandlingen var en del av Niilo Mäki Institutets ILS-projekt 2015–2018 (InLärning och Stöd i Finlandssvenska skolor) vars målsättning är att utveckla och stärka forskningsbaserad kunskap om inlärningssvårigheter i finlandssvenska skolor och daghem. I föreliggande studie deltog sammanlagt 432 barn i åldern 6–16 år. Datat till studien är insamlat via ett bakgrundformulär ifyllt av föräldrarna och ett skattningsformulär ifyllt av lärare.

Avhandlingen utfördes av Lea Gädda under handledning av professor Matti Laine och docent Vesa Närhi.

Ytterligare information fås av:

Lea Gädda
Tel. 044-0541990
E-post: lea.gadda@abo.fi