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Sex differences in self-regulation and self-insight in early, middle and late adolescence: A cross-sectional study

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ABSTRACT

It has been well-established that adolescent boys and girls differ in academic achievements and in cognitive and behavioural development. Previous studies reported on the importance of self-regulation and self-insight for academic achievement and behavioural problems. The present study takes this notion one step further by evaluating differences in the self-regulation and self-insight of adolescent boys and girls, as this may contribute to sex differences in academic achievement and behavioural problems. A cross-sectional study was conducted, involving more than 450 adolescent boys and girls aged 10–19 years. Sex differences in these areas were investigated in three age ranges: young, middle and late adolescence. Self-regulation and self-insight were evaluated with a self-report questionnaire: The Amsterdam Executive Functioning Inventory. Results revealed sex differences in the period of middle adolescence (i.e., 13–16 years). Self-regulation and self-insight were higher amongst girls than boys. This finding is important for educational practice and policy because it offers explanations for the sex differences that exist in school performance and problem behaviour, especially in the period of middle adolescence. The findings suggest that boys could benefit from intervention programs which aim at stimulating the development of self-regulation and self-insight, as well as their attentional functions.

INTRODUCTION

Boys and girls appear to differ in academic achievement and in cognitive and behavioural development. This has been well-established in past years (e.g., Alst, 2010; Bos, Bremerich-Vos, Tarelli, & Valtin, 2012; Buchner, Smits, & Velden, 2012; Coenen, Meng, & van der Velden, 2011; Driessen & van Langen, 2011; Jarman, Blackburn & Racko, 2012; Miller & Halpern, 2014; Schaacke, 2014) and in many industrialised countries (Cotton, Joyner, George & Cotton, 2016; Legewie & Diprete, 2012). With respect to academic achievement, boys more often flow to lower educational tracks than girls and their school drop-out rates are higher. Next to differences in academic achievements, there are clear boy-girl differences in the occurrence of behavioural problems. For instance, boys outnumber girls in fatal accidents (Heron, 2012), gambling (Zuckerman & Kuhlman, 2000), and crime (Bertrand & Pan, 2011; Gottfredson & Hirschi; 1990; Lightdale & Prentice, 1994; Shulman, Harden, Chei n, & Steinberg, 2015; Wong, 2012). With respect to a possible cause of these sex differences, previous studies have reported on the importance of higher-level neuropsychological functions to school achievement and behavioural regulation. These functions include skills in the domain of self-regulation and self-insight (e.g., Baars, Nije Bijvank, Tonnaers, & Jolles, 2015; Best, Miller, & Naglieri, 2011; Knouse, Feldman, & Belvins, 2014; OECD, 2015). The current study takes this notion one step further by evaluating differences in the self-regulation and self-insight of adolescent boys and girls, as this may contribute to sex differences in academic achievement and behavioural problems. The present study therefore investigated differences in the self-regulation and self-insight of more than 450 adolescent boys and girls.

Self-insight is important for proper self-regulation. How well an adolescent is able to monitor his/her own behaviour, his cognitive acts and his feelings are regarded as important determinants of his/her present and future behaviour (Diamond, 2013). Both abilities are the basis for behavioural planning and coping with environmental demands. They are important for academic achievement and behavioural regulation. With respect to academic achievement, self-regulation and self-insight enable the adolescent to pay attention in the classroom, to engage in learning tasks and to cope with interactions with peers, teachers and parents. They are also needed to plan future homework, to prioritise between competing tasks and to complete them (Anderson, 2002; Diamond, 2013; Jolles, 2016). An example of a situation in which self-regulation and self-insight are involved in performance at school, is when adolescents fail for an exam because they were distracted by external stimuli such as hanging out with their peers when they actually needed to study. Adolescents need to have

the self-insight that they have spent too little time studying in the past, or that they were not very effective, before they can adjust their behaviour to become more efficient in learning in the present. With respect to behavioural regulation, adolescents with well-developed self-regulation and self-insight are better at evaluating the appropriateness of their behaviour against societal norms. They also are better at evaluating the intentions of other people, including their teachers and parents. Self-regulation and self-insight thus enable individuals to monitor their behaviour and thought processes, which is important for learning and achievement at school, as well as for behaviour in the society (e.g., Anderson, 2002; Diamond, 2013).

Self-regulation and self-insight develop over a long period from early childhood into at least emerging adulthood (i.e., the age of 25, Diamond, 2013; Harden & Tucker – Drob, 2011). They are regarded as two executive functions. Other executive functions include a set of higher-order abilities such as working memory, mental flexibility, planning, prioritising, impulse regulation, assessing the consequences of actions, and attentional functions. These abilities provide the cognitive foundation for self-regulation and self-insight (Diamond, 2013; Gunzenhauser et al., 2017). It is of interest that developmental changes in executive functions appear to be supported by the maturation of underlying brain networks and structures (Casey, Jones, & Hare, 2008; Casey, Jones & Sommerville, 2011; Steinberg & Morris, 2001). Notable are networks that connect areas in the prefrontal cortex to many other cortical and subcortical areas, including the parietal cortical and the anterior cingulate (Baars et al., 2015; Casey et al., 2008; Casey et al., 2011; Steinberg & Morris, 2001). Several studies in structural and functional brain imaging have shown that these brain regions are in a process of maturation until at least early adulthood (Baars et al., 2015; Giedd & Denker, 2015; Giedd and Rapoport, 2010; Shaw et al., 2008).

There appear to be notable differences between boys and girls in the onset and pace at which these brain maturational processes take place (e.g., Baars et al., 2015; Halpern, 2013; Lenroot & Giedd, 2010; Miller and Halpern, 2014; van Tetering & Jolles, 2017; Wieringa, Sexton, Laake, Giedd, & Tamnes, 2017). With respect to neuroanatomical differences, Lenroot and Giedd (2010) reported that girls and boys exhibit four years' difference in the age that the brain has its greatest volume (average age is 10.5 years for girls and 14.5 years for boys). Brain maturation of boys is thus lagging behind that of girls in the periods of early and middle adolescence; this developmental gap seems to decrease over the course of later adolescence (Lenroot & Giedd, 2010). These sex differences in brain maturational onset and pace suggest that sex should be regarded as a possible factor contributing to individual

differences in cognitive development of adolescents. Sex, therefore, may also contribute to individual differences in self-regulation and self-insight.

Applied neuropsychological investigations partly support the notion that sex could be a relevant factor contributing to individual differences in self-regulation and self-insight in adolescence (Berlin & Bohlin, 2002; Gioia, Isquith, Guy & Kenworthy, 2000; Huizinga & Smidts, 2010). Such studies reported sex differences on executive functions that are important for self-regulation and self-insight. For instance, several studies showed that girls outperform boys on tasks that evaluate inhibitory control (Berlin & Bohlin, 2010; Hyde & Linn, 1988). This sex difference has been found already from the age of 5 years onwards (e.g., Berlin & Bohlin, 2002; Hyde & Linn, 1988). Furthermore, a large study by Huizinga and Smidts (2010) found evidence that parents perceive boy-girl differences on various executive functions of 10- to 18–year-old adolescents. These authors used the well-established Behavioural Rating Inventory of Executive Functioning (BRIEF) (Gioia et al., 2000; Huizinga & Smidts, 2010). Their results showed that parents judged girls to be better than boys at initiating behaviour, planning and organising, as well as at monitoring their behaviour. Likewise, van Tetering and Jolles (2017) showed that teachers perceived the self-regulation in boys and girls aged 8–to–12 years differently. They evaluated the self-regulation of girls significantly higher than that of boys. Results of behavioural and observational studies thus suggest that sex could be a factor contributing to individual differences in the self-regulation of adolescents.

It is notable that these previous studies have used behavioural measures and observer-reports to evaluate the self-regulation of adolescents. Objective neuropsychological testing, however, results in the objective measurement of behaviour in a simulated context, whereas the present investigation focusses upon subjective behavioural measures such as self-regulation and self-insight as indicated by adolescents themselves (Baars et al., 2015; Guy et al., 2004; van der Elst et al., 2012; van Tetering & Jolles, 2017). Self-report measures are the instrument of choice to gain information in this area (Baars et al., 2015; Guy et al., 2004; van der Elst et al., 2012; van Tetering and Jolles, 2017). Boy-girl differences in self-regulation and self-insight have only scarcely been considered by previous studies, while it could enhance our understanding about adolescents' thought processes underlying their behaviours. The primary aim of this study therefore was to examine sex differences in the self-regulation and insight of adolescents. Sex differences were also evaluated in the self-insight of adolescents with respect to three specific executive functions important to self-regulation: (1) self-control and self-monitoring, (2) attentional functions and (3) planning and initiative-taking.

Investigating sex differences in the self-insight of adolescents in relation to their self-control and self-monitoring, attentional functions and planning and initiative-taking also allows examining whether possible sex differences in self-regulation and self-insight are specific, and thus only present in one particular cognitive domain, or whether they are also present on other related neuropsychological abilities which fall under the umbrella of the executive functions.

Sex differences were evaluated in the three age groups of early, middle and late adolescence. Adolescence is often divided into these sub stages because of the major changes in neuropsychological developmental over the long age period between 10 and 18 years. There are clear differences in the physical, cognitive, socio-emotional and cultural maturation of adolescents at each sub stage (see Curtis 2015; Steinberg, 2007, Steinberg, 2014). The importance of studying cognitive sex differences in narrow age groups is substantiated by the increasing amount of research showing that the magnitudes of sex differences in cognitive abilities is influenced by age. This is especially the case in the period of adolescence. For instance, Cross, Copping and Campbell (2011) reported that sex differences in impulse control were more pronounced in adolescence than in adulthood. The same was reported for other cognitive abilities such as information processing speed and mental rotation (Camarata & Woodcock, 2006; Voyer, Voyer & Bryden, 1995). The notion that sex differences in cognitive abilities change with age is further substantiated by findings of studies on sex differences in brain maturation. For instance, Lenroot and Giedd (2010) reported boy-girl differences in brain volume in the periods of early and middle adolescence (10–14 years), which declined over the period of late adolescence. Another notable point is that boy-girl differences in academic achievement and behaviour are especially reported in the periods of early and middle adolescence, and less frequently in the period of late adolescence (Coenen et al., 2011; Driessen & van Langen, 2011; Jolles & Keizer, 2015). Studying sex differences in three narrow age groups, therefore, has an important advantage compared to earlier studies that examined sex differences in cognitive abilities in age groups with broad age ranges (such as in Huizinga and Smidts (2010), who studied sex differences in 10–18 year olds; and Lee and colleagues (2013), who studied sex differences in 12–17 year olds). If sex differences are investigated in groups with an age range that is too broad, there is a good chance that sex differences present in a smaller age group will not be detected (i.e., the larger sex differences at particular ages will be reduced by the smaller differences at other ages). Another advantage of studying sex differences in three separate age ranges in adolescence is that it provides insight into the changing magnitude of sex differences in self-

regulation and self-insight over the course of adolescence. As self-regulation and self-insight have a central role in academic achievement and behavioural problems, any evidence for sex differences in the period of adolescence may offer important new insights in the underpinnings of adolescents' daily life decisions, academic achievements and behaviour.

METHODS

Procedure

We used data from the WODC Youth Delinquency Survey wave 2015 (Van der Laan & Beerthuizen, 2016). The 2015 wave of this repeated cross-sectional survey was carried out in the Netherlands between January and June 2015. A stratified random sampling method was used in which the strata were based on age and nationality. Within these strata, a random selection was made from the home addresses of adolescents from the Municipal Base Registry (GBA). This register contains all legally registered inhabitants in the Netherlands. Participants aged 10–12 years old, and individuals with a Moroccan, Turkish, Surinamese and Antillean or Aruban heritage were oversampled. A total of 5,266 individuals aged 10 to 23 were selected from the GBA, and 3,188 individuals agreed to be interviewed. The response rate was therefore 60,5%, which is acceptable (see Stoop, 2005). The questionnaire contained a broad range of items related to demographics (i.e., characteristics of the family) and risk factors for delinquency (e.g., regarding parenting styles, peer delinquency). These items were administered by means of computer assisted personal interviewing (CAPI). The questionnaire also contained items regarding self-regulation and self-insight (e.g., van der Elst et al., 2012; van Tetering & Jolles, 2017). These items were administered by computer assisted self-interviewing (CASI). Basic demographic variables (e.g. sex, ethnicity, age and social economic status of the family) were extracted from the System of Social Statistical datasets of Statistic Netherlands (Bakker, van Rooijen & Tor, 2014), and connected at the micro-level to the database.

Participants

Of the total study population (*N* = 3,188, aged between 10-23 years), only participants aged between 10–19 years old were selected for the investigation described in the present study (*n* = 2,356). Furthermore, only individuals with a Dutch heritage were selected in order to homogenise our study sample with respect to heritage (*n* = 593). Excluded from participation were those participants who were characterised by missing data on the questionnaire related

to self-regulation and self-insight (n = 2), or if they had repeated a grade (n = 138). The decision to exclude individuals who repeated a grade was based upon the consideration that the cognitive development of these individuals may lag behind that of others of the same age who have a regular academic performance (see also van Tetering & Jolles, 2017 and van Tetering, de Groot & Jolles, 2018). This notion was confirmed by post-hoc one-way analyses of variances (ANOVAs) showing lower self-evaluations of individuals who repeated a grade compared to those who did not repeated a grade on three of the outcome measures of our study: These results were registered on the total score of the three outcome measures for self-regulation and self-insight (F (1, 589) = 11.54, p < .01), on a subscale for self-control & self-monitoring (F (1, 589) = 3.89, p < .05), and on a subscale for attention (F (1, 589) = 20.26, p < 0.01). By excluding adolescents who had repeated a grade, we thus additionally homogenised the study sample with respect to individual differences in cognition within grades.

The remaining study sample consisted of n = 453 Dutch participants. Their average age was 14.1 years (SE = 0.13). 53.2% of the adolescents were female. ANOVAs revealed that the mean age of boys (M = 13.79, SE = 0.19) and that of girls (M = 14.27, SE = 0.18) in the total study population was the same, F (1, 451) = 3.34, p = .07, η_p < 0.01.

The participant's data were split into three age groups: one group with a mean age of 10.9 years (SE = 0.06) (n = 161; age range = 10–12 years; 48.5% girls), a second group with a mean age of 14.0 years (SE = 0.07) (n = 133; age range 13–15 years; 52.6% girls), and a third group with a mean age of 17.3 (SE = 0.07) (n = 159; age range = 16–18 years; 58.5% girls). Again, ANOVAs revealed that the average age of girls and boys did not significantly differ in the first (F (1,159) = 1.49; p = .22, η_p < 0.01), second (F (1, 131) = 1.40, p = .24, η_p = 0.01) or third group (F (1, 157) = 0.45, p = .50, η_p < 0.01). Table 1 gives an overview of the number of participants and the mean age for boys and girls per group.

Table 1. Number of participants and mean age for boys and girls per age group

	Age groups					
	1		2		3	
	Boys	Girls	Boys	Girls	Boys	Girls
N	83	78	63	70	66	93
Age *M(SE)*	11.0 (0.09)	10.9 (0.09)	13.9 (0.10)	14.06 (0.10)	17.20 (0.12)	17.29 (0.09)

Measure: the Amsterdam Executive Functioning Inventory (AEFI)

The Amsterdam Executive Functioning Inventory (AEFI) was developed as a self-report questionnaire to measure self-regulation (van der Elst et al., 2012). As the AEFI is a self-report instrument, it provides information about the self-insight of the responder (van der Elst et al., 2012; Baars et al., 2015; Nije Bijvank et al., 2017; van Batenburg-Eddens, & Jolles, 2013; van Tetering & Jolles, 2017). The AEFI consists of 13 items. The total score of these items represents a robust proxy of self-regulation and self-insight. It is a composite score of the three subscales which represent three dimensions of executive functioning, that is, (1) *self-control & self-monitoring* (e.g., "I often react too fast, I have done or said something before it is my turn"), (2) *attention* (e.g., "I am not able to focus on the same topic for a long period of time"), and (3) *planning & initiative-taking* (e.g., "I am good at planning what I need to do during a day"). In the present study, there were minor differences in the versions of the AEFI used for 10- to 12–year-old individuals, and the one for 13- to 19–year-old individuals. These differences pertained to some examples given to explain the items to individuals aged 10- to 12–years old (in primary school). This was done to make the items age appropriate (see van Tetering & Jolles, 2017). All participants were asked to indicate how well each item of the AEFI suited them by endorsing one of three responses on a 3-point Likert scale: 1 = 'not true,' 2 = 'partly true,' or 3 = 'true'. Items 1,4,5,6,7,8,11,12, and 13 were-reverse coded, and the total score of all items was calculated so that higher scores were indicative of better self-regulation and self-insight.

Validity and reliability of the AEFI were evaluated in multiple large-scale studies (see van Tetering & Jolles, 2017; Van der Elst et al., 2012). The reliability and internal consistency of the AEFI were examined to ensure that both were acceptable in the present study population as well. Results revealed that the Cronbach's alphas in the present study sample (ranging between 0.4 and 0.7) were essentially the same as in van der Elst and colleagues (2012) and in van Tetering and Jolles (2017). In addition, the corrected item-scale correlations (i.e., the correlations between items and scale scores that did not include the items being evaluated), were calculated. These correlations should be ≥ .30 (Ferketich, 1991). For shorter scales, the corrected item-scale values provide a better index of internal consistency and reliability than Cronbach's alpha, because Cronbach's alpha values are not only a function of the height of the inter-correlations between the items of a scale, but also a function of the number of items on that scale (Clark & Watson, 1995). Again, the inter-item correlations in the present study were essentially the same as those in Van der Elst and colleagues (2012) and in van

Tetering & Jolles (2017). Together with the Cronbach alpha values, we therefore conclude that the inter-item correlations were acceptable (see Table 3 in the Appendix).

Statistical analyses

Normality distributions were investigated by visual inspection of the histograms and the normal probability plots. Both were adequate. Partial eta squared (η_p^2) was calculated as a measure of effect-size.

Univariate Analyses of Variances (ANOVAs) were performed with age group (age groups 1, 2 and 3) and sex (boys versus girls) as independent variables and the four outcome measures of the AEFI *(self-regulation and self-insight* [i.e., total AEFI score], *self-control & self-monitoring, attention, and planning & initiative taking*) as dependent variables. *P*-values $\leq$ .05 were considered statistically significant. If the analyses revealed a significant main effect of age group on any of the outcome measures, additional one-way ANOVAs were performed to investigate the differences between the three age groups more specifically: Mean of age group 1 was compared to mean of age group 2, and mean of age group 2 was compared to mean of age group 3. Only the consecutive classes were compared to investigate whether self-evaluations changed with age. For these additional analyses, Modified Hochberg correction was used to control for multiple testing issues. Because of the correction, *p*-values of $\leq$ .03 were considered statistically significant (Rom, 2013).

Finally, post-hoc analyses were performed to investigate sex differences in the three age groups separately. This was done since earlier literature suggested that cognitive sex differences in adolescence should be tested in groups with narrow age ranges. Accordingly, one-way ANOVAs were performed with sex as independent variable and the four outcome measures of the AEFI as depended variables, per age group. For these analyses, Modified Hochberg correction was used to control for multiple testing issues. Because of the correction, *p*-values of $\leq$ .03 were considered statistically significant (Rom, 2013). Analyses were performed in SPSS Statistics 24.

RESULTS

Age and Sex Differences on the AEFI

Self-regulation and self-insight (Total AEFI score). Analyses were performed to investigate the main effects of age group and sex, and the interaction between age group and sex on *self-regulation and self-insight* (i.e., the total AEFI score). Results revealed a significant

interaction between age group and sex, F (2, 447) = 4.12, p = .02, η_p^2 = 0.02). Main effects of age group (F (2, 447) = 0.02, p = .98, η_p^2 = 0.00) and sex (F (1, 477) = 3.59, p = .68, η_p^2 = 0.00) were not statistically significant. Mean and standard errors for boys and girls in each age group are presented in Table 2.

Post-hoc analyses in which sex differences were investigated in each of the three age groups allowed a further exploration of the significant interaction effect on *self-regulation and self-insight.* The sex difference was statistically significant in the second age group, F (1, 132) = 7.46, p < .01, η_p^2 = 0.05. *Self-regulation and self-insight* of girls (M = 17.67, SE = 0.51) was higher than that of boys (M = 15.76, SE = 0.48). The sex differences in the first (F (1, 159) = 0.16, p = .69) and third (F (1, 157) = 1.96, p = .16) age groups were not statistically significant. Accordingly, the statistically significant sex-effect found on the total group was due to a large difference between boys and girls in middle adolescence.

Self-control & self-monitoring. Analyses were performed to investigate the main effects of age group and sex, and the interaction between age group and sex on the AEFI subscale *self-control & self-monitoring.* Results revealed a significant interaction between age group and sex, F (2,447) = 3.45, p = .03, η_p^2 = 0.02. The main effects of age group (F (2, 447) = 0.89, p = .12) and sex (F (1, 447) = 3.45, p = .66) were not statistically significant. Mean and standard errors for boys and girls in each age group are presented in Table 2.

Post-hoc analyses in which sex differences were investigated in each of the three age groups separately allowed us to further explore the significant interaction effect on the subscale *self-control & self-monitoring.* Results revealed a significant sex difference in the second age group, F (1, 131) = 4.67, p = .03, η_p^2 = 0.03. Girls (M = 7.01, SE = 0.24) evaluated their self-control & self-monitoring higher than boys (M = 6.22, SE = 0.28). The sex differences in the first (F (1, 159) = 0.04, p = .85) and third (F (1, 157) = 2.65, p = .11) age groups were not statistically significant.

Attention. Analyses were performed to investigate the main effects of age group and sex, and the interaction between age group and sex on the AEFI subscale *attention*. Results revealed a significant main effect of age group, F (2, 447) = 3.700, p = .03, η_p^2 = 0.02. The sex difference approaches significance, F (1, 447) = 3.103, p = .08, η_p^2 < 0.01. Girls (M = 3.19, SE = 0.11) evaluated their attention higher than boys (M = 2.96, SE = 0.12). The interaction between age group and sex was not significant, F (2, 447) = 2.10, p = .12. Mean and standard errors for boys and girls in each age group are presented in Table 2.

Additional analyses were performed to investigate differences on the AEFI subscale *attention* between age groups 1 and 2, and between age groups 2 and 3. There was a significant difference between age groups 1 and 2, F (1,292) = 5.14, p = .02, η_p^2 = 0.02. Mean of age group 1 (M = 3.37, SE = 0.13) was higher than that of age group 2 (M = 2.92, SE = 0.14). The difference between age groups 2 and 3 was not statistically significant, F (1, 290) = 0.00, p > .99.

Finally, post-hoc analyses were performed to investigate sex differences on the AEFI subscale *attention* in the three age groups separately. Results revealed a significant sex difference in the second age group, F (1,131) = 7.42, p < .01, η_p^2 = 0.05). Girls (M = 3.29, SE = 0.19) evaluated their attention higher than boys (M = 2.52, SE = 0.21). The sex differences in the first (F (1, 159) = 0.02, p = .89) and third (F (1, 157) = 0.00, p = .86) age groups were not statistically significant.

Table 2. Mean and standard errors of boys and girls in early, middle and late adolescence on the AEFI scales.

	Age groups					
	10-12 years		13-15 years		16-18 years	
	Boys *n* = 83 M (SE)	Girls *n* = 78 M (SE)	Boys *n* = 63 M (SE)	Girls *n* = 70 M (SE)	Boys *n* = 66 M (SE)	Girls *n* = 93 M (SE)
Total AEFI score	16.78 (0.49)	16.49 (0.55)	15.76 (0.48)	17.67 (0.51)*	17.26 (0.55)	16.18 (0.52)
AEFI subscales						
Self-control & self-monitoring	6.46 (0.24)	6.53 (0.27)	6.22 (0.28)	7.01 (0.24)*	6.83 (0.24)	6.25 (0.25)
Attention	3.35 (0.19)	3.39 (0.19)	2.52 (0.21)	3.29 (0.19)*	2.89 (0.20)	2.95 (0.20)
Planning & initiative-taking	6.98 (0.22)	6.58 (0.21)	7.02 (0.20)	7.37 (0.23)	7.53 (0.24)	6.99 (0.22)

Note: *$p \leq .03$

Planning & initiative-taking. Analyses were performed to investigate the main effects of age group and sex, and an interaction between age group and sex on the AEFI subscale *planning & initiative-taking.* Results revealed that the main effect of age group approaches significance, F (2, 447) = 2.84, p = .06, η_p^2 = 0.01. The main effect of sex (F (1, 447) = 1.12, p = .29, η_p^2 < 0.01) and the interaction between sex and age group were not statistically

significant (F (2, 447) = 2.15, p = .12). Mean and standard errors for boys and girls in each age group are presented in Table 2.

Post-hoc analyses were performed to investigate sex differences on the AEFI subscale *planning* in the three age groups separately. No significant differences between boys and girls were found in any of the three age groups (age group 1: F (1, 131) = 1.36, p = .25); age group 2: (1, 157) = 2.60, p = .11; age group 3: F (1, 159) = 0.04, p = .85).

DISCUSSION

This cross-sectional study examined whether there were sex differences in the self-regulation and self-insight of adolescents. Self-regulation and self-insight were evaluated with a self-report questionnaire: the AEFI. As the AEFI is a self-report instrument, it provides information on the self-insight of the responder. Moreover, as the AEFI evaluates on three subscales representing important executive functions for self-regulation, the total AEFI score is a robust proxy for self-regulation. Results revealed sex differences in self-regulation and self-insight in 13- to 15–year–old adolescents, and not in the younger and older age groups. Taking a closer look at this significant sex difference, it was found that the difference could be attributed to the AEFI subscales *self-control & self-monitoring* and *attention*. Girls appeared to report higher levels of *self-control & self-monitoring* and *attention* than boys in middle adolescence.

Our findings are supported by results of studies that have evaluated self-regulation by behavioural measures (e.g., Berlin & Bohlin, 2002; Hyde & Linn, 1988) and observer-reports (Huizinga & Smidts, 2010; van Tetering & Jolles, 2017). Specifically, the results of these studies revealed sex differences on behavioural measures of impulse inhibition (Berlin & Bohlin, 2002; Hyde & Linn, 1988), as well as on teacher-perceived self-regulation (van Tetering & Jolles, 2017) and on various parental-observed executive functions that are important to self-regulation (Huizinga & Smidts, 2010). It therefore seems that the sex differences in self-control and self-monitoring, and attention that mid-adolescent boys and girls experience are also observed by parents and teachers; further, they are established on behavioural tasks. An advantage of using self-report measures compared to behavioural measures and observer reports is that they provide information on self-regulation across multiple environmental contexts (Dekker et al., 2017; Fine et al., 2016). This is advantageous because contexts, particularly those involving peers and emotional engagement, affect adolescent behaviour including risk-taking (Blakemore and Mills, 2014; Cauffman, Cavanagh, Donley & Thomas, 2015). Self-assessments can therefore be considered as highly valuable

tools that take into account the context in which the adolescent behaves. It is of special interest that our results show that mid-adolescent boys reported more difficulties with the regulation of their behaviour and attention in various contexts than did girls of the same age.

The finding that sex differences in self-regulation and self-insight were only reported in middle adolescence, and not in early and late adolescence, is notable. Interestingly, this finding is supported by neuroimaging studies. These studies have shown boy-girl differences in brain maturational processes, which were also most pronounced in middle adolescence (Giedd, 2008; Giedd & Denker, 2015; Lenroot & Giedd; 2010; Wierenga et al., 2017). Cerebral volume and gray matter volumes peaked at a later age in boys (14.5 years) than in girls (10.5 years, Lenroot & Giedd, 2011). The boy-girl differences in self-regulation and self-insight as found in the present study, may therefore be the consequence of the fact that brain maturation in mid-adolescent boys follows another time trajectory compared to girls of the same age. Accordingly, our results may not have revealed sex differences in early adolescence because the differences in brain maturation as described by Giedd and colleagues (2011), have not yet been well-established. Giedd and colleagues (2011) also have shown that the sex gap diminishes as boys and girls grow older. This is in line with our findings, as we did not observe sex differences in the group of late adolescents. Sex differences in brain maturation in middle adolescence may thus contribute to the variations in self-regulation and self-insight as reported in this study.

Applied neuropsychological studies also reported the largest sex differences on various cognitive tasks in the period of middle adolescence (e.g, for gender differences in information processing speed see Camarata & Woodcock, 2006; and for sex differences in impulse regulation see Cross et al., 2011). In addition to these studies, our findings uphold the notion that it is important to investigate sex differences in cognitive abilities in adolescence over narrow age classes. In fact, the present findings show that if sex differences are investigated in groups with large age ranges (e.g., in 10-to 19-year-olds), the large difference in middle adolescence will remain unnoticed because of a ‘dilution-effect’ which is caused by the smaller differences in earlier and later adolescence. This will result in average evaluations of boys and girls over the total age range to be almost equal. This would not do justice to the large differences in behaviour, cognition and academic performance in boys versus girls that are especially reported in the age period of middle adolescence (see also Kingdon, Serbin, & Stack, 2017; OECD, 2015; Steinberg, 2007).

There is circumstantial evidence that sex differences in behaviour and academic performance in middle adolescence could be the consequence of differences in the self-

regulation and self-insight of mid-adolescent boys and girls. For instance, previous studies reported that self-regulation and self-insight are related to risk-taking behaviours such as delinquency in adolescence (e.g., Cauffmann et al., 2015; Meldrum et al., 2015; van Tetering et al., *in submission*). The substantially lower levels of self-regulation and attention, as indicated by the self-insight of boys in early and middle adolescence, may place them at higher risk for engagement in impulsive and delinquent behaviours than girls. Furthermore, the importance of self-regulation to academic achievement is substantiated by our finding that individuals who repeated a grade (and were therefore excluded from our study sample) reported significantly lower levels of *self-monitoring & self-control* and *attention* than individuals who did not repeat a grade. As our results revealed that boys reported lower levels of attention than girls, the majority of boys may suffer more than the majority of girls from the distraction that goes with assessment in a classroom setting. This may negatively affect their school performance. Our findings, therefore, indicate that sex differences in self-control and self-monitoring, and attention as indicated by the adolescents' self-insight may have far-reaching consequences for academic achievement and behaviour. It is relevant for future research to investigate this notion because it is promising with respect to application in practice. It implies that boys could benefit from intervention programs which stimulate the development of self-regulation and self-insight in order to improve academic achievement and reduce behavioural problems.

The present study had a second focus, namely the evaluation of age differences in self-regulation and self-insight. Our findings revealed that the self-regulation and self-insight of adolescents did not necessarily improve with age. This seems to be in contrast to reported changes in the maturation of brain networks, and observations in several cognitive domains which show improvements in the expression of general cognitive skills as children and adolescents get older (e.g., Fry & Hale, 2000; Raghubar et al., 2010). The explanation for this finding is that when evaluating one's own behaviour, the individual compares himself with his or her peers (e.g., classmates, friends) at each time point. In consequence, the norms are different for the three age groups. Thus, the actual self-regulation and self-insight of older individuals will actually be higher than that of younger individuals. Their self-assessed self-regulation, on the other hand, is not well established on self-report measures because individuals maintain a relative position to their peers with respect to their own abilities. A related explanation is the possible lack of self-insight in 10- to 12–year-old adolescents. Self-insight is an ability that develops over the period of childhood up into adolescence and early adulthood (Diamond, 2013; Weil et al., 2013). It is therefore possible that young adolescents

cannot yet adequately evaluate and reflect on their own abilities yet. For the present study, it is not relevant whether evaluations were adequate to the actual levels of self-regulation and self-insight of adolescents because of our focus on self-perceived functioning.

Several aspects of the study need to be addressed in order to interpret the results correctly. First, among the strengths of this study are the composition of the sample and the large sample size of more than 450 adolescents (selected from a large-scale study of Dutch juveniles). A homogeneous study population was selected by excluding those individuals that repeated a class. The decision to exclude these participants was based upon the consideration that the cognitive development of these individuals may lag behind that of individuals the same age who have a regular academic performance (see also van Tetering & Jolles, 2017). As a consequence of this procedure, our findings probably became more conservative; adolescents who repeated a grade have lower levels of self-regulation and self-insight as indicated by our post-hoc analyses comparing the self-regulation and self-insight of individuals that repeated a grade with that of regular students. Another aspect of our study that needs to be addressed is that we additionally homogenised the study sample by including only individuals of Dutch origin. Many studies report that the development of self-regulation and self-insight is influenced by the cultural background of individuals (Steinberg et al., 2017; Miller & Halpern, 2014). Miller and Halpern (2014), for instance, reported that sex differences on cognitive abilities are culture-specific. They are present in some cultures, but absent or reversed in others (Miller and Halpern, 2014). It is therefore important to note that the findings of the present study cannot directly be generalised towards adolescents from immigrant groups or second-generation ethic minority groups. It is relevant to know whether sex differences in self-regulation and self-insight are also present in adolescents from other heritages, given the central role of self-regulation and self-insight to academic achievement and behavioural problems. Any evidence for sex differences in the various cultures in the period of adolescence may offer important new insights in the underpinnings of adolescents' daily life decisions, behaviour, social performance and academic achievements.

In conclusion, our study revealed differences between boys and girls in their self-regulation and self-insight, as well as in their self-perceived attention in the period of middle adolescence. It appears that amongst adolescent boys the development of self-regulation and attention, as indicated by their self-insight, lags behind compared to that of girls. This is important for educational practice and policy since it offers explanations for the sex differences that exist in school performances and problem behaviour, especially in middle adolescence. The findings suggest that boys need special attention in this age period, because

they are at risk for poor school performances and behavioural problems. The implication is that boys may benefit from intervention programs which stimulate the development of self-regulation and self-insight, as well as their attentional functions. These intervention programs could be developed and offered at school, and also in mental health care settings. This approach may bear the promise that sex differences in academic achievement and behavioural problems could be reduced by stimulating the development of self-regulation and self-insight in adolescent boys.

REFERENCES

Alst, J. V. (2010). Zicht op sekseverschillen in studiesucces. Een verkenning met aanbevelingen voor de Radboud Universiteit. Retrieved from: http://www.iowo.nl/icto/kunweb/IOWO_vanAlst_ZichtOpSexeverschillen.pdf

Anderson, P. (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology*, *8*(2), 71-82. doi:10.1207/S15326942DN2001_5

Baars, M. A., Bijvank, M. N., Tonnaer, G. H., & Jolles, J. (2015). Self-report measures of executive functioning are a determinant of academic performance in first-year students at university of applied sciences. *Frontiers in Psychology*, *6*. doi:10.3389/fpsyg.2015.01131

Bakker, B. F. M., van Rooijen, J., & van Tor, L. (2014). The System of social statistical datasets of Statistics Netherlands: An integral approach to the production of register-based social statistics. *Statistical Journal of the IAOS, 30,* 411-424.

Berlin, L., & Bohlin, G. (2002). Response inhibition, hyperactivity, and conduct problems among preschool children. *Journal of Clinical Child and Adolescent Psychology*, *31*(2), 242-251. doi:0.1207/S15374424JCCP3102_09

Bertrand, M., & Pan, J. (2011). *The trouble with boys: Social influences and the gender gap in disruptive behavior* (NBER Working Paper No. 17541). Retrieved from National Bureau of Economic Research website: http://www.nber.org/papers/w17541

Best, J. R., Miller, P. H., & Naglieri, J. A. (2011). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. *Learning and individual differences*, *21*(4), 327-336. doi: 10.1016/j.lindif.2011.01.007

Blakemore, S. J., & Mills, K. L. (2014). Is adolescence a sensitive period for sociocultural processing? *Annual review of psychology*, *65*, 187-207. doi:10.1146/annurev-psych-010213-115202

Bos, W., Bremerich-Vos, A., Tarelli, I., & Valtin, R. (2012). Lesekompetenzen im internationalen Vergleich [Reading competence in international comparison]. In W. Bos, I. Tarelli, A. Bremerich-Vos, & K. Schwippert (Eds.), *IGLU 2011: Lesekompetenzen von Grundschulkindern in Deutschland im internationalen Vergleich* [Reading competence of elementary students in German in international comparison]. Retrieved from https://www.waxmann.com/fileadmin/media/ zusatztexte/2828Volltext. Pdf

Buchner, C., Smits, W., & Velden, R. K. W. (2012). *Education, cognitive skills and earnings of males and females*. ROA, Maastricht University School of Business 8203and Economics. Retrieved from: https://cris.maastrichtuniversity.nl/portal/files/1701917/content

Camarata, S., & Woodcock, R. (2006). Sex differences in processing speed: Developmental effects in males and females. *Intelligence*, *34*(3), 231-252. doi: 10.1016/j.intell.2005.12.001

Casey, B. J., Jones, R. M., & Hare, T. A. (2008). The adolescent brain. *Annals of the New York Academy of Sciences 1124*(1), 111-126. doi:10.1016/j.dr.2007.08.003

Casey, B., Jones, R.M., & Somerville, L.H. (2011). Braking and accelerating of the adolescent brain. *Journal of Research on Adolescence, 21,* 21–33. doi:10.1111/j.1532- 7795.2010.00712.x

Cauffman, E., Cavanagh, C., Donley, S., & Thomas, A. G. (2015). A developmental perspective on adolescent risk-taking and criminal behavior. In A. R. Piquero (Ed.) The handbook of criminological theory (pp. 100–120). New York, NY: John Wiley & Sons, Inc.

Chen, P. P., Cleary, T. J., & Lui, A. M. (2015). Examining parents' ratings of middle-school students' academic self-regulation using principal axis factoring analysis. *School Psychology Quarterly*, *30*(3), 385. doi:10.1037/spq0000098

Clark, L. A., & Watson, D. (1995). Constructing validity: Basic issues in objective scale development. *Psychological Assessment*, *7*, 309–319.

Coenen, J., Meng, C., & van der Velden, R. (2011). Schoolsucces van jongens en meisjes in het HAVO en VWO: waarom meisjes het beter doen. ROA Report 002, Maastricht University, Research Centre for Education and the Labour Market (ROA).

Cotton, D. R. E., Joyner, M., George, R., & Cotton, P. A. (2016). Understanding the gender and ethnicity attainment gap in UK higher education. *Innovations in Education and Teaching International*, *53*(5), 475-486. doi:10.1080/14703297.2015.1013145

Cross, C. P., Copping, L. T., & Campbell, A. (2011). Sex differences in impulsivity: a meta- analysis. *Psychological bulletin*, *137*(1), 97. doi:10.1037/a0021591

Curtis, Alexa C. (2015). Defining Adolescence. *Journal of Adolescent and Family Health, 7*, 2. Available at: http://scholar.utc. edu/jafh/vol7/iss2/2

Dekker, S., Krabbendam, L., Aben, A., de Groot, R., & Jolles, J. (2013). Coding task performance in early adolescence: a large-scale controlled study into boy-girl differences. *Frontiers in psychology, 4.* doi:10.3389/ fpsyg.2013.00550

Dekker, M. C., Ziermans, T. B., Spruijt, A. M., & Swaab, H. (2017). Cognitive, parent and teacher rating measures of executive functioning: Shared and unique influences on school achievement. *Frontiers in psychology*, *8*. doi:10.3389/fpsyg.2017.00048

Diamond, A. (2013). Executive functions. *Annual review of psychology*, *64*, 135-168.

Driessen, G., & van Langen, A. (2011). Mogelijke verklaringen voor onderwijsachterstanden van jongens. *Pedagogiek*, *31*(2), 155-171. doi:10.5117/PED2011.2.DRIE

Ferketich, S. (1991). Focus on psychometrics. Aspects of item analysis. *Research in Nursing & Health, 14*, 16-168. doi:10.1002/nur.4770140211

Fine, A., Steinberg, L., Frick, P. J., & Cauffman, E. (2016). Self-control assessments and implications for predicting adolescent offending. *Journal of youth and adolescence*, *45*(4), 701-712. doi:10.1007/s10964 -016-0425-2

Fry, A. F., & Hale, S. (2000). Relationships among processing speed, working memory, and fluid intelligence in children. *Biological Psychology, 54*(1-3), 1-34. doi:10.1016/S0301-0511(00)00051-X

Gerst E. H., Cirino P. T., Fletcher J. M., & Yoshida H. (2015). Cognitive and behavioral rating measures of executive function as predictors of academic outcomes in children. *Child Neuropsychology, 23*(4), 381-407. doi:10.1080/09297049.2015.1120860

Giedd, J. N. (2008). The teen brain: insights from neuroimaging. *Journal of Adolescent Health, 42*(4), 335–343. doi:10.1016/j.jadohealth.2008.01.007

Giedd, J. N., & Denker, A. H. (2015). The adolescent brain: insights from neuroimaging. In *Brain Crosstalk in Puberty and Adolescence* (pp. 85-96). Springer, Cham. doi:10.1007/978-3-319-09168-6_7

Giedd, J. N., & Rapoport, J. L. (2010). Structural MRI of pediatric brain development: what have we learned and where are we going? *Neuron*, *67*(5), 728-734. doi:10.1016/j.neuron.2010.08.040.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). *Behavior Rating Inventory of Executive Function: BRIEF*. Odessa, FL: Psychological Assessment Resources.

Gottfredson, M. R., & Hirschi, T. (1990). *A general theory of crime*. Stanford University Press.

Gunzenhauser, C., Saalbach, H., & von Suchodoletz, A. (2017). Boys have caught up, family influences still continue: Influences on executive functioning and behavioral self-regulation in elementary students in Germany. *PsyCh Journal*, *6*(1), 29-42. doi: 10.1002/pchj.157

Guy, C. (2004). Neighbourhood retailing and food poverty: a case study in Cardiff. *International Journal of Retail & Distribution Management*, *32*(12), 577-581. doi: 10.1108/09590550410570064

Harden, K.P., & Tucker-Drob, E.M. (2011). Individual differences in the development of sensation seeking and impulsivity during adolescence: Further evidence for a dual systems model. *Developmental Psychology*,*47*, 739–746. doi:10.1037/a0023279

Heron, M. P. (2015). Deaths: leading causes for 2012.

Huizinga, M., and Smidts, D.P. (2010). Age-related changes in executive function: A normative study with the Dutch version of the Behavior Rating Inventory of Executive Function (BRIEF). *Child neuropsychology, 17,* 51-66. doi:10.1080/09297049.2010.509715.

Hyde, J. S., & Linn, M. C. (1988). Gender differences in verbal ability: A meta-analysis. *Psychological Bulletin, 104*(1), 53-69. doi:10.1037/0033-2909.104.1.53

Jarman, J., Blackburn, R. M., & Racko, G. (2012). The dimensions of occupational gender segregation in industrial countries. *Sociology*, *46*(6), 1003-1019. doi: 10.1177/0038038511435063

Jolles, J. (2016). *Het tienerbrein: over de adolescent tussen biologie en omgeving*. Amsterdam University Press.

Kingdon, D., Serbin, L. A., & Stack, D. M. (2017). Understanding the gender gap in school performance among low-income children: A developmental trajectory analysis. *International Journal of Behavioral Development*, *41*(2), 265-274. doi: 10.1177/0165025416631836

Knouse, L. E., Feldman, G., & Blevins, E. J. (2014). Executive functioning difficulties as predictors of academic performance: examining the role of grade goals. *Learning and Individual Differences*, *36*, 19-26. doi:10.1016/j.lindif.2014.07.001

Lee, N. C., Groot, R. H. M., Boschloo, A. M., Dekker, S. J., Krabbendam, L., & Jolles, J. (2013). Age and educational track influence adolescent discounting of delayed rewards. *Frontiers in Psychology*, *2013*(4), [993]. doi:10.3389 /fpsyg.2014.00993

Legewie, J., & DiPrete, T. A. (2012). High school environments, STEM orientations, and the gender gap in science and engineering degrees. Retrieved from: http://dx.doi.org/10.2139/ssrn.2008733

Lenroot, R. K., & Giedd, J. N. (2010). Sex differences in the adolescent brain. *Brain And cognition*, *72*(1), 46-55. doi:10.1016/j.bandc.2009.10.00

Lightdale, J. R., & Prentice, D. A. (1994). Rethinking sex differences in aggression: Aggressive behavior in the absence of social roles. *Personality and Social Psychology Bulletin*, *20*(1), 34-44. doi:10.1177/0146167294 201003

Miller, D. I., & Halpern, D. F. (2014). The new science of cognitive sex differences. *Trends in cognitive sciences*, *18*(1), 37-45. doi:10.1016/j.tics.2013.10.011F

Neinstein, L. S. (2002). Adolescent health care: A practical guide (4th ed.). Philadelphia: Lippincott.

Jolles, J. en Keizer J. (2015). Cognitief en non-cognitief presteren van jongens en meisjes in mbo en ho: een neuropsychologisch perspectief. In: De jongens tegen de meisjes. Een onderzoek naar verklaringen voor verschillen in studiesucces van jongens en meisjes in mbo, hbo en wo (Belfi, B., Levels, M., & van der Velden, R, redactie). Rapport voor het ministerie van OCW, 19 november 2015, ISBN 978-90-5321-542-5.

OECD Organisation for Economic Cooperation and Development. (2015). The ABC of gender equality in education: Aptitude, behaviour, confidence. Paris, France: PISA, OECD Publishing. Retrieved from http://dx.doi.org/10.1787/ 9789264229945-en

Raghubar, K. P., Barnes, M. A., & Hecht, S. A. (2010). Working memory and mathematics: A review of developmental, individual difference, and cognitive approaches. *Learning and individual differences*, *20*(2), 110-122. doi:10.1016/j.lindif.2009.10.005

Rom, D. M. (2013). An improved Hochberg procedure for multiple tests of significance. *British Journal of Mathematical and Statistical Psychology*, *66*(1), 189-196. doi:10.1111/j.2044-8317.2012.02042.x

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

Schaacke, J. (2014). Onderwijsongelijkheid tussen jongens en meisjes; bijeenkomst Platform Beleidsinformatie. *Dienst Uitvoering Onderwijs (DUO)*.

Sharma, L., Markon, K. E., & Clark, L. A. (2014). Toward a theory of distinct types of "impulsive" behaviors: A meta-analysis of self-report and behavioral measures. Psychological Bulletin, 140(2), 374. doi:10.1037/a0034418

Shaw, P., Kabani, N. J., Lerch, J. P., Eckstrand, K., Lenroot, R., Gogtay, N., Greenstein, D., Clasen, L., Evans, A., Rapoport, J.L., Giedd, J.N., Wise, S.P. (2008). Neurodevelopmental trajectories of the human cerebral cortex. *The Journal of Neuroscience*, *28*(14), 3586-3594. doi:10.1523/JNEUROSCI.5309-07.2008.

Shulman, E. P., Harden, K. P., Chein, J. M., & Steinberg, L. (2015). Sex differences in the developmental trajectories of impulse control and sensation-seeking from early adolescence to early adulthood. *Journal of Youth and Adolescence, 44*(1), 1–17. doi:10.1007/s10964-014-0116-9

Steinberg, L., & Morris, A. S. (2001). Adolescent development. *Journal of Cognitive Education and Psychology*, *2*(1), 55-87.

Steinberg, L. (2007). Risk taking in adolescence: New perspectives from brain and behavioral science. *Current directions in psychological science*, *16*(2), 55-59. doi:10.1111/j.1467-8721.2007.00475.x

Steinberg, L. (2014). *Age of opportunity: Lessons from the new science of adolescence*. Houghton Mifflin Harcourt.

Steinberg, L., Icenogle, G., Shulman, E. P., Breiner, K., Chein, J., Bacchini, D., Chang, L., Chaudhary, N., Giunta, L. D., Dodge, K. A., Fanti, K. A., Lansford, J. E., Malone, P.S., Oburu, P., Pastorelli, C., Skinner, A. T., Sorbring, E., Tapanya, S., Tirado, L. M., Alampay, L. P., Al-Hassan, S. M., & Takash, H. M. (2017). Around the world, adolescence is a time of heightened sensation seeking and immature self-regulation. *Developmental science*. doi: 10.1111/desc.12532

Stoop, I. A. (2005). *The hunt for the last respondent: Nonresponse in sample surveys*. Sociaal en Cultureel Planbureau.

Van Batenburg-Eddes, T., & Jolles, J. (2013). How does emotional wellbeing relate to underachievement in a general population sample of young adolescents: a neurocognitive perspective. *Frontiers in psychology*, *4*. doi:10.1080/092970410036 71184

Van der Elst, W., Ouwehand, C., van der Werf, G., Kuyper, H., Lee, N., and Jolles, J. (2012). The Amsterdam Executive Function Inventory (AEFI): psychometric properties and demographically corrected normative data for adolescents aged between 15 and 18 years. *Journal of Clinical and Experimental Neuropsychology. 34*, 160–171. doi:10.1080/13803395.2011.625353

Van der Laan, A. M. and M. G. C. J. Beerthuizen (2016). Jeugdige zelfgerapporteerde daders. Monitor Jeugdcriminaliteit. Ontwikkelingen in de jeugdcriminaliteit 1997 tot 2015. A. M. Van der Laan and H. Goudriaan. Den Haag, WODC/CBS**:** 23-50.

Van der Laan, A. M., Blom, M., & Kleemans, E. R. (2009). Exploring long-term and short-term risk factors for serious delinquency. *European Journal of Criminology*, *6*(5), 419-438. doi: 10.1177/1477370809337882

Van Tetering, M. A., & Jolles, J. (2017). Teacher Evaluations of Executive Functioning in Schoolchildren Aged 9–12 and the Influence of Age, Sex, Level of Parental Education. *Frontiers in Psychology*, *8*. doi:10.3389/fpsyg.2017.00481

Van Tetering, M.A.J., van der Laan, A.M., Willemen, A., de Kogel, K., de Groot, R.H.M., & Jolles, J. The Association Between Self-regulation and Self-insight to Delinquency in Mid-adolescence. *PlosOne.*

Voyer, D., Voyer, S., & Bryden, M. P. (1995). Magnitude of sex differences in spatial abilities: A meta-analysis and consideration of critical variables. *Psychological Bulletin, 117*(2), 250–270. doi:10.1037/0033-2909.117.2.250

Weil, L. G., Fleming, S. M., Dumontheil, I., Kilford, E. J., Weil, R. S., Rees, G., Dolan, R.J., & Blakemore, S. J. (2013). The development of metacognitive ability in adolescence. *Consciousness and Cognition*, *22*(1), 264-271.

Wierenga, L. M., Sexton, J. A., Laake, P., Giedd, J. N., & Tamnes, C. K. (2017). A key characteristic of sex differences in the developing brain: greater variability in brain structure of boys than girls. *Cerebral Cortex*, 1-11.

Wong, T. (2012). *Girl delinquency. A study on sex differences in (risk factors for) delinquency*. Oisterwijk: BOXPress / Dissertation VU.

Zuckerman, M., & Kuhlman, D. M. (2000). Personality and risktaking: Common biosocial factors. Journal of Personality, 68, 999–1029. doi:10.1111/1467-6494.00124.

APPENDIX

Table 3. Reliability statistics of the Amsterdam Executive Functioning Inventory

	10–12 years old		13–15 years old		16–18 years old	
AEFI items	Cronbach's Alpha	r_{is}	Cronbach's Alpha	r_{is}	Cronbach's Alpha	r_{is}
Attention	0.66		0.69		0.76	
1. I am not able to focus on the same topic for a long period of time		0.49		0.39		0.53
4. I am easily distracted		0.54		0.60		0.66
6. My thoughts easily wander		0.38		0.54		0.58
Self-control & self-monitoring	0.62		0.58		0.61	
5. I often reacts too fast. I've done or said something before it is my turn.		0.39		0.30		0.28
7. It is difficult for me to sit still		0.47		0.42		0.40
10. It takes a lot of effort for me to remember things		0.33		0.40		0.43
11. I often forgets what I have done yesterday		0.27		0.31		0.40
12. I often lose things		0.41		0.31		0.31
Planning & initiative taking	0.55		0.43		0.66	
2. I can make fast decisions (e.g., in lesson)		0.25		0.19		0.48
3. I am well-organized. For example, I am good at planning what I needs to do during a day		0.29		0.27		0.32
8. It is easy for me to come up with a different solution if I get stuck when solving a problem		0.42		0.32		0.51
9. I am full of new ideas		0.35		0.31		0.51
13. I am curious, I want to know how things work.		0.26		0.06		0.29

Note: AEFI = Amsterdam Executive Function Inventory; r_{is} = corrected item–scale correlation.