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The association between self-regulation and self-insight to delinquency in mid-adolescence

Under review:

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*.

ABSTRACT

The prevalence of youth delinquency increases in mid-adolescence and declines in emerging adulthood. Skills in the domain of self-regulation and self-insight – which are important executive functions – could play a key role in this process. Both self-regulation and self-insight gradually improve over the course of adolescence. The levels of self-regulation and self-insight of individuals are thus lower in earlier adolescence than in later adolescence. This may explain why delinquency rates are higher in early and mid-adolescence than in late adolescence. The goal of this study was to evaluate the association between self-regulation and self-insight to delinquency amongst a group of 554 juveniles in mid-adolescence (aged 14–18 years). Self-regulation and self-insight were evaluated with a self-report questionnaire: The Amsterdam Executive Functioning Inventory (AEFI). This questionnaire consists of three subscales (1) self-control & self-monitoring, (2) attention, and (3) planning & initiative-taking. As the AEFI is used as self-report, it provides information on the self-insight of the responder. Moreover, as self-control and self-monitoring, attention and planning and initiative-taking are important executive functions for self-regulation, the sum of these three subscales is a robust proxy for self-regulation. Results revealed that self-regulation and self-insight were associated to delinquency, regardless of sex, own education, socio-economic status and ethnicity. Taking a closer look at this finding revealed that the subscales *self-control & self-monitoring* and *attention* were uniquely associated to delinquency. The lower individuals evaluated their self-control and self-monitoring and attention, the more likely they perceive themselves to participate in delinquent acts. These findings have important implications for improving best practices in risk assessment. They suggest that using self-reports to administer self-regulation is a valuable approach to detect adolescents at risk for participation in delinquency. They also suggest that mid-adolescent delinquents could benefit from interventions aimed at training self-regulatory skills and executive functions to reduce delinquent acts in this age group.

INTRODUCTION

The prevalence of youth delinquency increases from early to mid-adolescence until the age of 16–17 years and then declines throughout late-adolescence and emerging adulthood (Farrington, 1986; Loeber & Farrington, 2012; Moffitt, 1993; Sampson & Laub, 2005). Delinquent acts range from minor offenses such as petty theft, to serious offenses such as burglary or assaults. These acts have significant consequences and costs for society. Adolescents who persist in delinquency have, for example, higher risks of unemployment, and are less likely to participate fully in the civic aspects of societies. Delinquency also imposes high costs on public budgets for sanctions, including incarceration and correctional programs (McCollister, French & Fang, 2010). For all these reasons, understanding the increase in delinquency from early into mid-adolescence is of major societal interest. Skills in the domain of self-regulation and self-insight – which are important executive functions – may play key roles in this process (Diamond, 2013; Fine, Steinberg, Frick & Cauffman, 2016). Individuals have lower levels in earlier adolescence than in later adolescence, because self-regulation and self-insight gradually improve over the course of adolescence. This may explain why delinquency rates are higher in early and mid-adolescence than in late adolescence. The goal of this study is to evaluate this notion by investigating the association between self-regulation and self-insight to delinquency amongst more than 500 juveniles in mid-adolescence.

The period of adolescence is characterized by transitions that appeal to the self-regulation and self-insight of individuals. Important transitions are the change from primary to secondary school in early adolescence and the onset of employment in later adolescence (Uggen, 2000). Both transitions are characterized by changes in learning procedures (Baars, Bijvank, Tonnaers & Jolles, 2015), as well as by changing expectations of parents, teachers and employers. Whereas parents and teachers supervised children in the past, adolescents become increasingly responsible for arriving at work in time and for organising their own schoolwork in the future. Parents, teachers and employers thus expect increasing levels of interdependence with age. Their supervision gradually changes accordingly (Stattin & Kerr, 2000). Adolescents need to evaluate previous behavioural acts and habits as being inefficient or age-inappropriate, and adjust them to develop new (age-) appropriate ones. Self-regulation and self-insight are both needed to quickly shift thoughts, plans or behaviours. They are needed to adapt to the novel and diverse situations while simultaneously inhibiting inappropriate behavioural routines (Anderson, 2002; Diamond, 2013; Jolles, 2016).

Another important characteristic of the adolescent period is that individuals become increasingly oriented towards their peers (e.g., Cauffman et al., 2015; Steinberg, 2007). This is an important notion, because adolescents typically commit delinquent acts in peer groups (Weerman, 2001). Adolescents appear to be vulnerable to the short-term high intensity social rewards provided by the adolescent peer network, while having difficulties with keeping track of long-term goals (see Dishion, Bullock & Granic, 2004; Lam et al., 2014; Steinberg, 2007). High levels of self-regulation and self-insight are needed to suppress distraction of short-term rewards and to stay focused on long-term goals (Diamond, 2013; Jolles, 2016).

Self-regulation and self-insight are two executive functions that involve modulating systems of emotion, attention and behaviour in response to a given situation or stimulus (Carlson, 2003; Diamond, 2013; Eisenberg et al., 2004; Ferrier et al., 2014). This includes managing emotions and both the shifting and focusing of attention. It also includes inhibiting and planning behaviour, and initiative-taking (Smith-Donald et al., 2007). There are fundamental differences between self-regulation and self-insight. Self-insight refers to the way adolescents judge their own behaviour, whereas self-regulation contains an 'acting' or 'doing' component. Both abilities are often interrelated in daily life functioning: Individuals need to have the self-insight that their behaviour was in conflict to societal expectations to resolve discrepancies between their behaviour and these expectations. Self-regulation thus involves the behavioural response to the self-insight of that person (Jolles & Keizer, 2015).

Applied neuropsychological studies reported that self-regulation and self-insight continue to mature over the adolescent years until at least early adulthood (Anderson, 2002; Diamond, 2013; Jolles, 2016). It is of interest that recent new insights also revealed that other executive functions continue to mature until at least the mid-20s. This is of interest because other executive functions provide the cognitive foundation for self-regulation and self-insight (Diamond, 2013; Gunzenhauser, Saalbach & von Suchodoletz, 2017). "Executive functions" is an umbrella term that includes a broad variety of self-regulatory skills such as working memory, mental flexibility, planning, prioritizing, impulse regulation, assessing the consequences of actions, and attentional functions among others (Anderson, 2002; Diamond, 2013; Jolles, 2016). As executive functions improve with age, adolescents become better able to regulate and monitor their thoughts and behaviour, and also their self-insight improves (Anderson, 2002; Diamond, 2013; Jolles, 2016). The development of executive functions, and thus also that of self-regulation and self-insight, matches the maturational stages of complex brain areas and networks. Notable in this respect are networks which connect areas in the prefrontal cortex to many other cortical and subcortical areas, including the parietal cortex, the anterior cingulate,

and also other subcortical regions (Baars et al., 2015; Casey, Jones & Somerville, 2011; Steinberg & Morris, 2001). Maturation of these brain networks continue to occur well into the early 20s (e.g., Casey et al., 2011; Giedd & Denker, 2015; Giedd and Rapoport, 2010; Giedd, 2008).

There appear to be substantial individual differences in the pace at which neurocognitive development takes place. This may explain why some individuals are more likely to participate in delinquency than others (see also Monahan, Steinberg, Cauffman & Mulvey, 2013). Slower neurocognitive development may be disadvantageous, because these adolescents show lower levels of self-regulation and self-insight as compared to their peers with faster development. These adolescents may experience difficulties with reacting to the substantial changes in their social environment in adaptive ways. They experience difficulties with monitoring their own behaviour, with adjusting their behavioural planning to unexpected situations, and with inhibiting age-inappropriate desires and actions. They may also have difficulties with resisting the short-term rewards provided by their peer network, and are therefore increasingly vulnerable to negative peer influences. Conversely, youth with rapidly developing neurocognitive functions have higher levels of self-regulation and self-insight. For these individuals, self-regulation and self-insight may serve as resiliency factors in buffering them from influences of peer deviance. They are therefore better resistant to temptations of peers (see Gardner, Dishion & Connell, 2008). They are also better able to take all aspects of a situation into account, to adjust previous behaviours, to work at school, to do their homework, and to develop stable and healthy friendships. For all these reasons, it seems likely that higher levels of self-regulation and self-insight decrease the likelihood for participation in delinquency.

Results of neuroimaging studies provide circumstantial evidence for the association between self-regulation and self-insight to delinquency. These studies showed quite notable functional abnormalities in the prefrontal cortex of children, youth and adults who are aggressive and violent (see the literature review of Brower & Price, 2001; Meldrum, Trucco, Cope, Zucker & Heitzeg, 2017). Although the view that the prefrontal cortex is the primarily structure involved in self-regulation and self-insight is oversimplified, the point remains that significant abnormalities were reported in networks involving this brain area in violent and aggressive adolescents (Browder & Price, 2001; Meldrum et al., 2017).

In addition to neuroimaging studies, results of applied neuropsychological studies substantiate a possible association between self-regulation and self-insight to delinquency. These studies reported that low self-regulation and self-insight were related to violent offending (Parker, Morton, Lingefelt & Johnson, 2005) and reoffending (Bechtold, Cavanagh,

Shulman & Cauffman, 2013) in convicts. A notable characteristic of these previous studies is that they primarily focus on the impaired self-regulation and self-insight of convicts (e.g., Brower & Price, 2001; Cauffman et al., 2005; Steiner et al., 1999; Parker et al., 2005). These studies ignore that some form of delinquency can be considered as being normal part of adolescence for a majority of adolescents (Steinberg, 2008), as most mid-adolescents offend by committing non-serious crimes and most of them will not be arrested. The self-regulation and self-insight of convicts may, thus, not represent the abilities of mid-adolescents in a normal study population that commit non-serious crimes. This notion is substantiated by the findings of Cauffman, Steinberg and Piquero (2005). They showed substantial differences in the self-regulation and self-insight of offenders and non-offenders the same age. More pronounced problems are thus to be expected in self-regulatory abilities of convicts than of mid-adolescents in a normal population. This prompted the present study to investigate the association between self-regulation and self-insight to delinquency amongst a sample of adolescents from a normal population of mid-adolescents.

Another notable comment with respect to previous studies is that they only focus on the association between delinquency and one specific executive function (e.g., Fine, Mahler, Steinberg & Frick, 2017; Fine et al., 2016; Meldrum et al., 2015; Piquero, Jennings, Farrington, Diamond & Gonzalez, 2016). Cauffman and colleagues (2015) and Meldrum, Barnes and Hay (2015) for instance, reported on the relation between self-reported self-control and delinquency. In daily life, however, unexpected and changing situations not only appeal to one single executive function, such as self-control. Rather, these situations appeal to a broad variety of executive functions. For instance, they require adolescents to adjust a previously made behavioural plan, to reorganise and to restructure thoughts, to stay focused on long-term goals and to pay attention to all aspects of a new situation. The present study, therefore, investigates the association between self-regulation and self-insight to delinquency using a robust proxy of self-regulation and self-insight. Self-regulation and self-insight includes information on various perceived executive functions such as self-control, self-monitoring, as well as attention, planning ability and initiative-taking. Operationalising self-regulation and self-insight in this way represents both abilities as important for coping with unexpected or changing daily life situations.

Next to self-regulation and self-insight, this study investigates the unique association between self-control and self-monitoring, attention, and planning and initiative-taking to delinquency. These separate associations have only scarcely been considered in the previous literature, with few studies using objective neuropsychological tests providing circumstantial

evidence. Meijers, Harte, Meynen and Cuijpers (2017), for instance, reported associations between attention and reoffending using a choice reaction time task. In the same study, these authors showed that planning ability was related to an increased number of previous detentions using the Stockings of Cambridge Test (i.e., analogous to the tower of London task (Meijers et al., 2017)). Note that objective neuropsychological tests are not the method of choice for the assessment of self-insight and subjective functioning. Objective neuropsychological testing results in 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 judged by the adolescent (Baars et al., 2015; Guy et al., 2004; van der Elst et al., 2012; van Tetering & Jolles, 2017). It is of interest that findings of studies using self-reports are inconsistent to that of studies using behavioural measures (i.e., Meijers and colleagues, 2017). For instance, in contrast to the findings of Meijers and colleagues (2017), Nordvall and colleagues (2017) reported that delinquency was not associated with attention and planning ability as perceived by adolescents. Moreover, Fine and colleagues (2016) compared the association between self-control and delinquency using behavioural and self-report measures. They found that self-reports were more strongly associated to delinquency than behavioural measures (Fine et al., 2016). These findings indicate that objective neuropsychological tests and self-reports assess different abilities. These inconsistent findings prompted the present study to take a closer look at the unique contribution of self-insight with respect to self-control and self-monitoring, attention, and planning ability and initiative-taking to delinquency in adolescence.

In short, previous studies point to a possible association between self-regulation and self-insight. The central question of the present study is therefore: 'What is the association between self-regulation and self-insight with delinquency in a normal sample of mid-adolescents accounting for sex, own education, socioeconomic status (SES), and ethnicity?' We controlled for sex, own education, SES and ethnicity because quite some previous research reported on relations between these factors and participating in, or persistence into delinquency (e.g., Loeber, Slot, van der Laan & Hoeve, 2008; Wong et al., 2013). This study additionally investigated the unique contribution of self-insight with respect to self-control and self-monitoring, attention, and planning and initiative-taking to delinquency. The large sample size of this study ($N = 554$) allowed us to focus on a particular age-range (i.e., aged 14–18 years). This is an important characteristic of our study as delinquency rates are rising between these ages (Loeber & Farrington, 2014).

A final note should be made on the use of self-report measures (Baars et al., 2015; van der Elst et al., 2012; Nije Bijvank, Tonnaer & Jolles, 2017, van Tetering & Jolles, 2017). In daily life, youth may perceive their actual abilities incorrectly. Adolescents may lack self-insight and over- or underestimate their self-regulatory capacities. For instance, adolescents who overestimate their capacity to self-regulate may deny that they followed their peers without considering future consequences, because they are not aware of it: They do not recognize that their preferences were determined by others. Moreover, individuals with low confidence in their self-regulatory capacities may not even try to stand up for themselves or to go against negative peer influences. Studying the way adolescents perceive their executive functions and their self-regulation provides insight into this notion.

METHOD

Procedure

We used data from the WODC Youth Delinquency Survey (Van der Laan, Blom & Kleemans, 2009) wave 2015 (Van der Laan & Beerthuisen, 2016). The 2015 wave of this repeated cross-sectional survey is carried out in the Netherlands in the period of January till 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 of the home addresses of individuals from the Municipal Base Registry (GBA). This register contains all legally registered inhabitants in the Netherlands. Children aged 10–12 years old, and individuals with a Moroccan, Turks, Surinamese and Antillean or Aruban heritage were oversampled. A total of 5,266 individuals aged 10 till 23 were selected from the GBA and 3,188 agreed to be interviewed. The response rate was therefore 60.5%, which is acceptable (see Stoop, 2005).

Participants or parents (or caregivers, if participants were aged 15 years or below) gave informed consent. All participants were interviewed at home. 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; van Tetering, de Groot & Jolles, 2018). These items were administered by computer assisted self-interviewing (CASI). Basic demographic variables (e.g. sex, ethnicity, age or Social Economic Status [SES] 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. Ethnicity was indicated on a categorical scale (1= Antilleans/Arubans, 2 = Moroccans, 3 = Turkish, 4 = Surinamese 5 = Dutch, 6 = origin in another Western country, or 6 = origin in another non-Western country). The SES score was indicated on a 0 – 99 scale, representing the percentiles of the yearly income of a family as compared to all other registered families in the Netherlands. Moreover, participants were asked to indicate their educational levels at the moment of measurement on a 9-point scale ranging from primary school to university. They were also asked to indicated the highest educational levels of both parents/caregivers on an 8-point scale ranging from no education to university degree.

Participants

Of the $N = 3,188$ participants, $n = 855$ were aged between 14 and 18 years and selected for this study. The age of 14–18 was of major interest as delinquency rates are especially high and increasing in this age-period (Farrington, 1986; Loeber & Farrington, 2012; Moffitt, 1993; Sampson & Laub, 2005). Participants were excluded if they did not complete information about their own educational level ($n = 25$) or parental educational levels ($n = 132$), or if data was missing with respect to their SES ($n = 12$). In addition, participants with an ethnicity different from Dutch, Moroccan, Turkish, Surinamese, or Antillean/Aruban were excluded ($n = 132$). They were excluded because of our hypothesis that delinquency is associated to ethnicity. We therefore homogenize our study sample with regard to the ethnic background of participants.

The final sample consisted of $n = 554$ participants (48.6% boys), aged 14 to 18 years ($M = 15.5$, $SD = 0.5$). The ethnic background of the sample was diverse, including the five largest ethnic groups living in the Netherlands: Dutch (33.8 %), Moroccans (18.2%), Turkish (15.9 %), Surinamese (16.1%), and Antilleans and Arubans (16.1%).

Measures: the Amsterdam Executive Functioning Inventory

The Amsterdam Executive Functioning Inventory (AEFI) was developed as a self-report questionnaire to measure self-regulation and self-insight (van der Elst et al., 2012; Baars et al., 2015; Nije Bijvank et al., 2017; van Batenburg-Eddens & Jolles, 2013; van Tetering & Jolles, 2017). As the AEFI is a self-report measure, it provides insight into the self-insight of the respondee. The AEFI consists of 13 items. The total score of these items represents a robust proxy of self-regulation and self-insight, as it is a composite score of three subscales representing three dimensions of executive functioning that are important for self-regulation and self-insight: 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”). The 13 items in the original version of the AEFI were identical to those used in the present study for participants aged 13 to 19 years (see van der Elst et al., 2012). 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,’ 3 = ‘true’. Items 2, 3, 9 and 10 were reverse coded, and total score of all items was calculated so that lower 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), and they have been evaluated in another study on the same data as used in this study (see Van Tetering, M.A.J., van der Laan, A.M., de Kogel, K., de Groot, R.H.M., & Jolles., *in submission*). Results of these studies revealed that all Cronbach’s alphas were larger than 0.6 (which is the critical border). In addition, the corrected item-scale correlations were adequate as well (i.e., the correlations between items and scale scores that did not include the items being evaluated should be $\geq .30$; Ferketich, 1991). For shorter scales such as the AEFI subscales, 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). Together with the Cronbach alpha values, we therefore conclude that the inter-item correlations of the AEFI is acceptable.

Delinquency

Delinquency was measured using a self-report questionnaire concerning 27 offences, varying from minor offences to rare and serious offences (e.g. Van der Laan et al., 2009). The participants were asked how many times they had committed each offence during the previous 12 months. A delinquency scale was constructed based on the total sample, taking into account the seriousness, frequency and variety of offences. First, the offences were classified according to seriousness – based on the applicable legal penalty – as a minor offence (maximum custodial sentence of 48 months, e.g. vandalism; score 1) or a serious offence (minimum custodial sentence of 48 months, e.g. breaking and entering; score 2). Second, the offences were categorized according to the frequency. Minor offences were assigned code 0 (committed 0 times during the past 12 months), 1 (1–4 times) or 2 (5 times or more); serious offences were coded 0 (0 times), 1 (once), 2 (2–4 times), 3 (5–10 times) or 4 (11 times or more). Third, for

each offence the severity was multiplied by the frequency. Finally, the delinquency scale was the sum of these multiplicative scores with a low score indicating no delinquency and a high score serious delinquency (see for further Van der Laan et al., 2009).

Table 1. Descriptive statistics of all included variables measured at nominal or ordinal level

| | M | SE | Range |
|---|------|------|-------|
| <i>Demographics (N = 554)</i> | | | |
| Age of youth at baseline in years | 15.5 | 0.05 | 14-18 |
| % Boys | 48.6 | | |
| % Dutch | 33.8 | | |
| % Moroccan | 18.2 | | |
| % Turkish | 15.9 | | |
| % Surinamese | 16.1 | | |
| % Antilleans and Arubans | 16.1 | | |
| Own Education | 2.71 | 0.07 | 1-9 |
| Parental education | 4.3 | 0.08 | 0-7 |
| SES | 44.9 | 1.16 | 0-99 |
| <i>AEFI scales</i> | | | |
| Self-control & self-monitoring | 3.20 | 0.10 | 0-10 |
| Attention ^a | 2.87 | 0.07 | 0-6 |
| Planning & initiative-taking ^a | 2.88 | 0.08 | 0-9 |
| Self-regulation and Self-insight ^a | 8.96 | 0.19 | 0-21 |
| Delinquency ^b | 1.37 | 0.13 | 0-28 |

Note: ^aLower scores are indicative of better self-regulation/executive functions. ^bHigher score is indicative of more frequent and/or serious delinquent behaviours.

Statistical analyses

A substantial part of the participants (61.9%) reported no delinquency at all, or they obtained one score on the delinquency scale ('light offence'). A small proportion of the sample (38.1%) reported more delinquent behaviour, up to a score of 28. Thus, the distribution of the dependent variable was highly skewed and resembled a negative binomial distribution. Therefore, a negative binomial generalized linear regression was conducted. Negative binomial regression models are used to predict count outcomes because of their restricted distribution and over-dispersion. Incidence-rate ratios (IRRs) are presented for negative binomial regression models (Fine et al., 2016; Gijsselaers, Kirschner, Verboon & de Groot, 2014). IRRs can be interpreted as the effect of a one unit change in the independent variable on the odds of self-reported offending variety. Because IRRs are centered on 1, estimates larger than 1 indicate

that the variable is associated with a larger variety of self-reported delinquency. IRRs smaller than one indicate that the variable is related to the odds of a smaller variety of self-reported delinquency. For example, the IRR coefficient of 1.096 for self-regulation and self-insight indicates that every one unit increase on self-regulation and self-insight is associated with a 9.6 % increase on the delinquency scale.

We estimated four separate models to examine the association between self-regulation and self-insight [total AEFI score], and the AEFI subscales *self-control & self-monitoring*, *attention*, and *planning & initiative-taking* to delinquency, while accounting for the controls sex, own education, parental education, SES and ethnicity). In the first model, accounting for the controls, we included self-regulation and self-insight in order to examine the impact of all executive functions at once. In the following models, we examined the unique effect of the three subscales. In the second model, we investigated the effect of *self-control & self-monitoring*. In the third model, we investigated the effect of *attention*, and in the fourth model we investigated the effect of *planning & initiative-taking*. A *p*-value below .05 was considered to be significant. Analyses were performed in SPSS Statistics 24.

RESULTS

Correlations

Analyses revealed a number of significant correlations, which are presented in Table 2. Sex was negatively correlated to delinquency ($r = -.114, p < .01$), and the AEFI compound score self-regulation and self-insight was positively correlated to delinquency ($r = .148, p < .01$). A closer look at the AEFI subscales revealed that *self-control & self-monitoring* ($r = .156, p < .01$) and *attention* ($r = .213, p < .01$) were positively correlated with delinquency.

Control risk factors

In the first binomial regression model, the control risk factors, sex ($\chi^2(1) = 21.72, p < .01$), ethnicity ($\chi^2(4) = 29.37, p < .01$), own education ($\chi^2(1) = 14.88, p < .05$), and SES ($\chi^2(1) = 16.83, p < .01$) were significantly related to delinquency. These risk factors were therefore included in the prediction models. Parental education was not significantly associated to delinquency, $\chi^2(1) = 2.387, p = .12$. This risk factor was therefore excluded from the following four prediction models.

Model 1: Self-Regulation and Self-Insight

In the first model, the total AEFI score – as a proxy of self-regulation and self-insight - was used to predict self-reported delinquency. Chi-square comparisons revealed that the model was better at predicting delinquency than the null model (i.e., an intercept only model; $\chi^2(8) = 119.28, p < .01$), indicating that model 1 fits the data significantly better than the null model. When evaluating the regression weight of self-regulation and self-insight, the results in Table 3 show that this score (range 0-21) is significantly associated with a larger variety of self-reported delinquency. The IRR coefficient of 1.096 for total AEFI score indicates that every one unit increase self-regulation and self-insight variety was associated with a 9.6% increase in self-reported offending variety.

Table 2. Bivariate correlations between the primary variables in the analytic sample

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---------|--------|---------|-------|--------|--------|--------|--------|
| 1 Sex ^a | - | | | | | | | |
| 2 SES | -.014 | | | | | | | |
| 3 Own education | -.053 | .058 | | | | | | |
| 4 Parental Education | .019 | .429** | -.066** | | | | | |
| 5 Self-control & self-monitoring ^b | .056 | .033 | -.001 | -.025 | | | | |
| 6 Attention ^b | -.002 | .129** | -.008 | .067 | .599** | | | |
| 7 Planning & initiative-taking ^b | -.071 | -.056 | -.032** | -.069 | .168** | .207** | | |
| 8 Self-regulation and self-insight ^c | -.005 | .041 | -.017 | -.018 | .818** | .785** | .619** | |
| 9 Delinquency ^d | -.114** | -.051 | .080 | -.052 | .156** | .123** | .047 | .148** |

Note: ^aGirls is coded as 1, boys as 0; ^bSubscales of the AEFI; higher score indicates lower self-control & self-monitoring, attention and planning & initiative-taking; ^cCompound score consisting out of the three AEFI subscales; higher score indicates lower self-regulation and self-insight. ^dSelf-reported delinquency; * $p < .05$; ** $p < .01$.

Model 2: Self-Control & Self-Monitoring

In the second model, the AEFI subscale for *self-control & self-regulation* was used to predict self-reported delinquency. Chi-square comparisons revealed that model 2 was better than the null model in predicting delinquency (i.e., an intercept only model; $\chi^2(8) = 120.96, p < .01$), indicating that model 2 fits the data significantly better than the null model. When evaluating the regression weight of the score for self-control & self-regulation, the results in Table 3 show that this score (range 0-10) is significantly associated with a larger variety of self-reported delinquency. The IRR coefficient of 1.192 for the score of *self-control & self-monitoring*

indicates that every one unit increase in score of *self-control & self-monitoring* variety was associated with a 19.2% increase in self-reported offending variety (see Table 3).

Model 3: Attention

In the third model, the AEFI subscale *attention* was used to predict self-reported delinquency. Chi-square comparisons revealed that the model was better than the null model in predicting delinquency (i.e., an intercept only model; $\chi^2(8) = 112.20, p < .01$), indicating that model 3 fits the data significantly better than the null model. When evaluating the regression weight of the score for attention, the results of the third model indicate that this score (range 0-6) is associated with a larger variety of self-reported delinquency. The IRR coefficient of 1.252 for attention indicates that every one unit increase in self-reported *attention* variety was associated with a 25.2% increase in self-reported offending variety (see Table 3).

Table 3. Generalized linear regression of model 1, 2, 3 and 4.

| | <i>B</i> | SE | 95% CI (<i>B</i>) Lower - Upper | IRR ^a |
|--------------------------------|----------|------|--------------------------------------|------------------|
| Model 1 | 0.09 | 0.01 | 0.06 - 0.12 | 1.096** |
| Self-regulation & self-insight | 119.28** | | | |
| <i>Wald</i> χ^2 | 8 | | | |
| <i>df</i> | | | | |
| Model 2 | | | | |
| Self-control & self-monitoring | 0.18 | 0.03 | 0.12 - 0.23 | 1.192** |
| <i>Wald</i> χ^2 | 120.96** | | | |
| <i>df</i> | 8 | | | |
| Model 3 | | | | |
| Attention | 0.22 | 0.04 | 0.15 - 0.30 | 1.252** |
| <i>Wald</i> χ^2 | 112.20** | | | |
| <i>df</i> | 8 | | | |
| Model 4 | | | | |
| Planning & initiative-taking | 0.05 | 0.03 | -0.01 - 0.12 | 1.050 |
| <i>Wald</i> χ^2 | 76.36** | | | |
| <i>df</i> | 8 | | | |

Note: * $p < .05$, ** $p < .01$. ^aIRR: Incidence-rate ratio.

Model 4: Planning & Initiative-taking

In the final model, the AEFI subscale *planning & initiative-taking* was used to predict self-reported delinquency. Chi-square comparisons revealed that the model was better than the null model in predicting delinquency (i.e., an intercept only model; $\chi^2(8) = 76.36, p < .01$), indicating that model 4 fits the data significantly better than the null model. When evaluating the regression weight, the results of the fifth model indicate that *planning & initiative-taking* is not significantly associated to self-reported delinquency.

DISCUSSION

This study investigated the association between self-regulation and self-insight to delinquency in mid-adolescence. Self-regulation and self-insight were administered with a self-report measure; the AEFI. As the AEFI is used as self-report, it provides information on the self-insight of the responder. Moreover, as self-control and self-monitoring, attention and planning and initiative-taking are important executive functions for self-regulation, the sum of these three subscales is a robust proxy for self-regulation. Our results revealed a significant association between self-regulation and self-insight to delinquency, while controlling for sex, own education, SES, and ethnicity. Taking a closer look at the three AEFI subscales, *self-control & self-monitoring* and *attention* were significantly associated to delinquency, in contrast to the subscale *planning & initiative-taking*.

Our findings revealed that the lower mid-adolescents evaluate their self-control, self-monitoring and attention, the more likely they perceive themselves to engage in delinquent acts. Adolescents who reported to have lower levels of self-regulation experience problems with inhibiting behaviours and with organizing their thoughts. These abilities are important to adjust behavioural routines and thoughts to the rapidly changing psycho-social contexts in adolescence (Diamond, 2013). They are also needed to control the inclination which many adolescents have for novelty and risk seeking (Steinberg, 2007). Individuals that reported lower levels of self-regulation may, therefore, experience more difficulties with adjusting to the changing socio-environmental context during adolescence. They may also be more inclined towards risk-taking, and consequently to delinquency.

The findings of this study are in line with, and extend to those of previous studies on the association between self-control and delinquency in convicted adolescents (e.g., Brower & Price, 2001; Kaufmann et al., 2005; Monahan et al., 2013; Nordvall and colleagues, 2015; Parker et al., 2005; Steiner et al., 1999). For instance, Nordvall and colleagues (2015) showed that

interned adolescents reported difficulties with inhibiting and controlling undesirable behaviours, adapting to changing situations and remembering of and following through on everyday tasks (Nordvall et al., 2015). In line with their findings, our results suggest that normally developing adolescents that report to commit non-serious crimes, experience similar difficulties in daily life as convicts. In addition to the findings of Nordvall and colleagues (2015), we found that normally developing adolescents who report to engage in delinquency also experience difficulties with concentrating and focusing on tasks and situations. Our findings therefore show that – next to individuals that report lower levels of self-control – individuals that report lower levels of attention are also at increased risk for participation in delinquency. It is notable that our results showed a high correlation between the subscale *attention* and *self-control & self-monitoring*. In an attempt to make a distinction between *self-control & self-monitoring*, and *attention* in this study, it could thus be that both subscales give an indication of a similar underlying construct. Notwithstanding that fact, our results revealed a possible association between self-insight with respect to attentional functions and delinquency. This finding is substantiated by the results of a study by Cornet, van der Laan, Nijman, Tollenaar & De Kogel (2015) on the importance of attention to cognitive training programs in convicts. They reported that lower performance on attentional tasks was associated with early drop-out of interventions that aim to train cognitive functions. Taking into account the possible contribution of attentional functions to delinquency, it is striking that most previous studies using self-report measures primarily focus on the association between self-control and delinquency, while the possible contribution of attention has widely been ignored. Our findings highlight the importance of attentional functions to the abstinence of participation in delinquency.

In addition to the significant association between self-control and self-monitoring as well as attention to delinquency, our results also revealed that sex, own education, SES and ethnicity were significantly associated to delinquency. It appears that several subgroups of adolescents are more likely to engage in delinquent behaviours than others. These subgroups include adolescent boys, and adolescents at lower educational levels in addition to those who grow up in lower SES families, and the adolescents who belong to societies ethnic minority groups (Loeber et al., 2008). Although a bunch of previous research reported on these risk factors, the detection of these factors give no explanation about the underlying mechanism why some adolescents do participate in delinquency and others do not. Future research would benefit from investigating the interactions between these previous risk factors, and self-regulation and self-insight to delinquency. This is of particular relevance as there is circumstantial evidence

that self-regulation and self-insight plays an important role in all four risk factors (i.e., sex, own education, SES, and ethnicity). For instance, in one of our earlier studies we found that boys aged 14–17 years report lower levels of self-regulation and self-insight than girls the same age (see van Tetering et al., *in submission*). Other studies indicated that children with lower educational achievement have less well developed neurocognitive abilities than children at higher educational levels (see Chen, Cleary & Lui, 2015; Gerst, Cirino, Fletcher & Yoshida, 2015; van Tetering, de Groot & Jolles, 2018). Furthermore, the negative effects of growing up in low SES neighbourhoods and/or poverty of the family on brain maturation and cognitive development have extensively been reported (e.g., Beauregard, Dews-Botsch, Sales, Flanders & Kramer, 2018; Noble et al., 2015). These findings suggest a slower neurocognitive development in children growing up in disadvantageous families compared to children growing up in high SES/wealthy families. In addition to these studies, we found in one of our earlier studies that teachers reported lower levels of self-regulation for children of lower educated families than of children of higher educated families (van Tetering & Jolles, 2017). Finally, Steinberg (2016) reported on differences in the developmental trajectories of self-regulation amongst individuals with various ethnic backgrounds. Further investigation of the importance of self-regulation and self-insight to delinquency in relation to the control risk factors is of highly interest as this notion is very promising. It implies that adolescents at risk for participation in delinquency could benefit from interventions aimed at stimulating the development of self-regulation and self-insight.

A reflection on the study

The use of a short self-report to evaluate self-regulation and self-insight (i.e., the AEFI) is amongst the strengths of this study. This is a strength because self-report measures assess self-regulation and self-insight across multiple environmental contexts. Contexts such as those involving peers and emotional engagement affect adolescent risk taking (Lam et al., 2014; Monahan et al., 2013). Adolescents report on their behaviour in these contexts on self-report measures. For this reason, assessment that measure self-regulation and self-insight across multiple contexts can be considered of special relevance in predicting adolescent delinquency (Fine et al., 2017). Indeed, our study showed that self-perceptions of adolescents regarding their self-control and self-monitoring, as well as their attention are associated to delinquency. This finding suggests that the AEFI may be useful in detecting individuals at increased risk for the involvement of delinquent behaviour.

Other strengths of this study are the random selection of Dutch juveniles from the normal population, the choice and composition of the sample (homogeneous), and the large sample size of more than 550 adolescents. The large sample size of our study allowed us to select a homogeneous study population by including only those adolescents aged 14-18 years that belonged to the five largest ethnic groups in the Netherlands. As we homogenized our study sample to the five largest ethnic minority groups in the Netherlands, results with respect to delinquency rates of ethnic groups cannot directly be generalized to that of other countries with a different distribution of habitants. Yet, the findings do indicate that ethnic diversity is of importance in understanding selective prevalence of youth delinquency. We further homogenized our study sample by including a small age-range. All individuals within the age range of our study are considered to be in a similar phase of life with respect to cognitive development, social-emotional development, education and work (e.g., Curtis, 2015). We therefore reduced heterogeneity in our study sample with respect to individual differences in delinquency that are related to individual differences in cognitive development, social-emotional development or phase of life. The age of 14-18 was of major interest as delinquency rates are especially high and increasing in this age-period (Farrington, 1986; Loeber & Farrington, 2012; Moffitt, 1993; Sampson & Laub, 2005). We know now that self-regulation and self-insight have a significant contribution to these increased delinquency rates in this particular age-period.

Next to the strengths, elaboration on a few aspects of the study is needed to interpret the results correctly. One of the aspects of this study has to do with the subjective character of self-reports, such as the AEFI. It has been well established that self-report measures are acceptability valid and reliable (e.g., Farrington, Jolliffe, Loeber & Hornish, 2007; Payne & Piquero, 2016; Thornberry & Krohn, 2000). Nevertheless, it appears that individuals of particular cultures have the tendency to over-report or under-report on their cognitive abilities as well as on the frequency in which they commit delinquent acts. The same argument applies to the way delinquency was administered in our study, as we used self-reported delinquency assessed in a computerized interview. It is notable that this is not necessarily the same as the actual rate of delinquency committed by that person. An adolescent may, for example, give socially desirable answers and indicate a lower frequency of delinquent acts than the actual frequency. This is, however, not at relevance for our study as we were interested in the way adolescents perceive the association between self-regulation and delinquency. Our results suggest that adolescents who perceive their self-regulatory capacity lower, perceive themselves more likely to participate in delinquent behaviours. This could be a reason for

adolescents to actually start participating in delinquency: They do not believe that they are able to suppress negative peer pressure. It is of interest for future studies to elaborate on this notion as it could improve our understanding of adolescent risk-taking behaviour. Future studies could benefit from the use of the AEFI as a proxy of self-regulation and self-insight, and investigate whether these outcome measures are related to actual delinquency rates in 14–17 years. This is relevant for juvenile court, as the AEFI might be useful in predicting the adolescents' likelihood of future engagement in delinquency.

Conclusion

The findings of our large-scale study showed that the self-regulation and self-insight of an ethnic diverse sample of mid-adolescents is associated to their perceived likelihood to participate in delinquency. In fact, the lower mid-adolescents perceive their levels of self-control and self-monitoring as well as their and attention, the more likely they perceive themselves to engage in delinquent acts. Our findings imply that it is important to support the development of self-control and self-monitoring, and attention in order to reduce delinquency in the period of middle adolescence. It is likely that an intervention in this age period may be important in preventing future engagement in delinquency and possibly even in criminal acts. A direction for future research is to develop new interventions which are especially aimed at training self-control and self-monitoring, as well as attentional functions. Our findings are of applied value since they suggest that self-report measures regarding neuropsychological abilities may be highly valuable in juvenile risk-assessment.

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