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Neuropsychological precursors of psychopathology and the moderating/mediating effect of social skills in 4-to-7-year-old children

Shivanie Schoorl

Leiden University

Department of Clinical Child and Adolescent Studies

Universiteit Leiden

Student:	Shivanie Schoorl
Student ID:	S0532657
University:	Leiden University
Department:	Department of Clinical Child and Adolescent Studies
Research Master:	Developmental Psychopathology in Education and Child Studies
Supervisor:	Dr. S.C.J. Huijbregts
Second reader:	Prof. Dr. J.T. Swaab-Barneveld
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Preface

The current study was conducted under supervision of Dr. S.C.J. Huijbregts and Prof. dr. J. T. Swaab-Barneveld at the Department of Clinical Child and Adolescent studies at University of Leiden. The study was part of the Curious Minds-study which focuses on relationships between explorative behaviour, social functioning, neuropsychological functioning and mathematical abilities in kindergarten children.

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Abstract

The current study examined the predictive interrelations between social cognition, executive functioning, social skills, and psychopathology in 4-to-7-year-old typically developing children. Furthermore, the moderating and mediating effects of social skills on the relationships between social cognition, executive functioning and internalizing/externalizing behaviour were examined. The sample consisted of 286 children from regular primary schools in the Netherlands. Both direct and indirect measures of social cognition (Theory of Mind, emotion recognition and social cognitive skills in daily life) and executive functioning (inhibitory control, visual spatial working memory, verbal fluency, planning abilities and EF in daily life) were used in the study. Social skills and psychopathology were measured using parent-rating scales (SSRS and CBCL respectively). Problems in the domain of social cognition and executive functioning, as well as internalizing and externalizing behaviour problems were highly correlated. Also, social skills were highly correlated with psychopathology. Social cognition only predicted internalizing behaviour, whereas executive functioning only appeared to be a unique predictor of externalizing behaviour. Moderation and mediation models demonstrated social skills to be a moderator and partial mediator in the relationship between executive functioning and externalizing behaviour problems. Mediation analyses indicated the relationship between social cognition and externalizing behaviour to be fully mediated by executive functioning. The results of this study suggest that training social skills may be important for children who show deficits in executive functioning and who are at risk for developing externalizing behaviour problems. Furthermore, the mediating role of executive functioning on the relationship between social cognition and externalizing behaviour possibly explains the absence of a moderating/mediating effect of social skills on the relationship between social cognition and externalizing behaviour problems. For more knowledge on precursors of psychopathology, future studies should focus on atypically developing children, should examine the prediction of specific psychiatric disorders, examine the possible differential results from direct and indirect measures and examine the development of the social cognition, executive functions, social skills and psychopathology in middle and late childhood, and during adolescence.

Keywords: social cognition, executive functioning, social skills, internalizing/externalizing behaviour, typically developing children

Introduction

Both internalizing and externalizing behaviour problems during the preschool and early school years could have serious consequences for the child's later development and its environment. For years practitioners have been trying to describe the presentation and epidemiology of behavioural and emotional psychiatric disorders in preschool and grade 1 children (children aged 2-to-7 years). But next to classifying behavioural and emotional dysregulation in young children, it seems important to identify underlying factors and correlates which could possibly be associated with or could explain the presence of internalizing and externalizing behaviour problems in young children. Despite the continued growth of literature on causal factors and correlates of internalizing and externalizing behaviour problems, researchers and practitioners still need a more complete and comprehensive view of the developmental pathway towards psychopathology. A more complete view of underlying factors could also possibly identify the factors which could be targeted in early interventions.

To enhance understanding of the correlates of behaviour problems, the current study focuses on several neuropsychological factors (social cognition and executive functioning) in relation to internalizing and externalizing behaviour problems. Furthermore, the mediating and/or moderating influence of social skills on the relationship between the neuropsychological indicators and psychopathology will be examined.

Childhood psychopathology

There seems to be little consensus about the criteria for classifying psychiatric disorders in young children (Verhulst & Verheij, 2006). Clinicians and researchers are often concerned with the question how to distinguish between normative individual differences (typical development) and clinically significant behaviours (atypical development). This issue greatly influences the view of psychopathology but also the implementation of interventions or treatment programs (Egger & Angold, 2006).

'At risk'- children of 'clinically significant' emotions and behaviours can be defined using several approaches or taxonomies. Whether psychopathology in children should be defined 'dimensionally' with clinically significant problems representing the extreme end of a continuum or 'categorically' with children either meeting criteria or not meeting criteria for a specific disorder is still a matter of debate (Egger & Angold, 2006; Verhulst & Verheij,

2006). The DSM-IV TR (American Psychiatric Association, 2000) and the ICD-10 (World Health Organization, 1992) are the most commonly used psychiatric classification systems using the categorical approach. The DSM-IV TR does not make a clear distinction between internalizing and externalizing disorders. However, anxiety disorders, mood disorders and somatoform disorders could be named internalizing disorders and disruptive behaviour disorders and attention-deficit-hyperactivity disorders are captured by the overall term of externalizing disorders. Only recently the DSM-versions pay closer attention to the emotional and behavioural problems in preschoolers. Several DSM disorders have included criteria specific to children. However, the DSM does not define clearly developmentally appropriate criteria for preschool psychopathology. The diagnostic validity and reliability of psychiatric disorders in preschoolers is diminished in most classification systems using the categorical approach. Due to the rapid and continued physical, neural, emotional and cognitive development of children, behaviour problems are not consistently present during different developmental phases, which calls for the need of developmentally and environmentally appropriate criteria (Egger & Angold, 2006; Bell, 2011). Therefore, consensus grows that the fifth edition of the DSM should adopt a more dimensional perspective (Luyten & Blatt, 2011; Kendler & First, 2010). In dimensional approaches (or psychometric approaches) empirical data is collected from which associations among behaviours/symptoms can be examined. Cut points are set in order to characterize groups of children at the extremes of the distribution indicating normative behaviours or clinical behaviours. Dimensional approaches ensure that researchers and practitioners can differentiate between forms of problem behaviours on a continuum and therefore in the current study a more dimensional approach to problem behaviours was adopted. An example of an 'empirically-derived' checklist is the Child Behaviour Checklist which is one of the Achenbach System of Empirically Based Assessment questionnaires (CBCL, ASEBA, Stanger, Achenbach & McConaughy, 1993). This questionnaire for parents assesses emotional and behavioural problems in boys and girls aged 1,5 to 18 years. The CBCL provides a total score, a general score on internalizing behaviour problems, a general score on externalizing behaviour problems (the latter two refer to the two broad-band syndromes which represent the two global dimensions within psychopathology), eight syndrome scales (small-band syndromes) which can also be converted into six DSM-scales (Affective problems, Anxieties, Physical problems or Somatic complaints, Attention-Deficit Hyperactivity problems, Oppositional problems and Behavioural problems) (Kievit,

Tak & Bosch, 2008; Verhulst & Verheij, 2006). In the current study only the scores on the internalizing and externalizing scales are used in the analyses.

Internalizing and externalizing psychopathology: causes and correlates

Internalizing and externalizing behaviour problems are prevalent in young children and in the majority of cases the health impact of psychiatric disorders remains significant throughout development (Bilancia & Rescorla, 2010; Verhulst & Verheij, 2006; Slemming, Sørensen, Thomsen, Obel, Henriksen et al., 2010). Externalizing behaviour (behaviours characterized by an undercontrol of emotions) refers to behaviours such as aggressiveness, antisocial behaviour, rule-breaking behaviour or impulsive behaviour, whereas internalizing behaviour (behaviours characterized by an overcontrol of emotions) refers to behaviours such a anxious, social withdrawn behaviour, temperamental fearfulness, somatic complaints, feelings of worthlessness or depressive symptoms (Verhulst & Verheij, 2006; Guttmannova, Szanyi & Cali, 2008). Stability of behavioural and emotional problems throughout childhood and adolescence has been demonstrated by several studies (Bilancia & Rescorla, 2010; Egger & Angold, 2006).

Externalizing behaviour problems are the most common psychiatric disorders diagnosed in children (Nock, Kazdin, Hiripi & Kessler, 2007; Egger and Angold, 2006). Disruptive behaviour disorders such as Oppositional Defiant Disorder or Conduct Disorder are possible precursors for delinquency, criminology and the development of psychopathic features (Loeber, Burke & Pardini, 2009). These behaviours are also associated with later substance abuse, underachievement, rejection by peers (Guttmannova, 2008) and also with internalizing disorders such as mood disorders of anxieties (Nock et al., 2007). An opinion shared by many researchers is that when externalizing problems have an early onset (in early or middle childhood) there is a higher change of persistence of behaviour problems and that the problems will be more serious (Wenar & Kerig, 2006; Loeber & Hay, 1997).

Also the stability and consequences of internalizing symptoms throughout childhood and adolescence have been well documented (Egger & Angold, 2006; Bilancia & Rescorla, Slemming et al., 2010). Research consistently links childhood internalizing behaviours problems to for example the development of anxieties and depression in adolescence (Guttamannova, 2008: Findlay, Coplan & Bowker, 2009) or higher risk of high-school drop-out (Zahn-Waxler, Klimes-Dougan & Slattery, 2000). According to Rydell, Diamantopoulou, Thorell and Bohlin (2009) shyness in preschool children remains stable to age 9 for both boys

and girls and high shyness levels appeared to be related to low social preference (social acceptance) at age 9. Findlay and colleagues (2009) demonstrated that children 9 to 11 years old who scored high on shyness showed greater internalizing difficulties and lower well-being. Also these children tend to use internalizing coping strategies to deal with stress more often (this refers to strategies as avoidance and distancing) which appeared to partially mediate the relationship between shyness and internalizing behaviour problems. The developmental pathway of internalizing disorders was also studied by Slemming et al. (2010). The researchers found that anxious-fearful behaviour and hostile-aggressive behaviour as measured during preschool was associated with emotional difficulties during the school-age period. The fact that anxious-fearful behaviour was associated with emotional difficulties at age 10-12 could refer to stability of internalizing symptoms from early childhood onwards. The fact that preschool hostile-aggressive behaviour was associated with emotional difficulties during school-age provides evidence for transformation of one behavioural dimension into another throughout childhood en that both internalizing difficulties and hostile-aggressive behaviours are risk factors for later internalizing disorders.

Childhood and adolescent internalizing and externalizing disorders are distinct classes of disorders, but they are also significantly intercorrelated: internalizing and externalizing disorders often co-occur (Egger & Angold, 2006; Zahn-Waxler et al., 2000). During preschool the percentages of comorbidity of internalizing and externalizing disorders appears to vary from 5.4 to 51.6 percent (Egger & Angold, 2006), which is a large percentage-range. The results of the study conducted by Rydell et al. (2009) indicated comorbidity of hyperactivity, shyness and aggression. Furthermore, the researchers also demonstrated a moderating effect of gender: for boys there seemed to be a protective effect of shyness with regard to aggression at high hyperactivity levels, i.e. at high hyperactivity levels boys with high shyness levels were less aggressive than boys with low shyness levels. Zahn-Waxler et al. (2000) examined the development of internalizing disorders and the comorbidity of depression and anxiety and externalizing disorders. The authors state that there is growing evidence that different constellations of problem behaviours (different ‘subtypes’ or combinations of internalizing and externalizing behaviours) may reflect different correlates and developmental pathways. For example, children with conduct problems and depression or anxiety were less likely to show conduct problems in adulthood, which means that depression or anxieties may function as a protective factor (Zahn-Waxler et al. 2000).

For complete understanding of developmental pathways of internalizing and externalizing behaviour problems, causes (e.g. biological, environmental or neuropsychological) of psychopathological behaviours should be uncovered. Causes/correlates of psychopathology are different for different kinds of trajectories and subsequent ages of development (Loeber & Hay, 1997; Maughan, 2005). The existence of multiple risk factors constitutes an important risk factor for more severe and more varied problems in children. Zahn-Waxler and colleagues (2000) name several adverse environmental factors which often contribute to the development of both internalizing and externalizing behaviours: parental marital discord, maltreatment, psychosocial stress, poverty, parental psychopathology and parental emotional unavailability. With regard to aggression Loeber and Hay (1997) indicate that less advantaged neighborhoods and repeated exposure to violence on television facilitates aggression and violence in children. Child factors that are possible predictors of poor behavioural and emotional outcomes include poor regulation of emotions (especially with regard to externalizing behaviours; Eisenberg, Spinrad & Eggum, 2010), inaccurate, biased or incomplete processing of social information (Izard, Fine, Mostow, Trentacosta & Campbell, 2002; Wenar & Kerig, 2006) and temperament (for example withdrawn or inhibited behaviour are predictors for fearfulness and anxieties; Zahn-Waxler et al. 2000). In recent years, literature on clarifying neuropsychological profiles of different internalizing and externalizing trajectories has been growing (Wenar & Kerig, 2006).

Social cognition and psychopathology

Social cognition refers to cognitive abilities that enable the child to understand its social world (Sroufe, DeHart & Cooper, 2004). By interpreting social cues and planning appropriate responses to others, children learn what other people think, feel and what their motives and intentions are (Scourfield, Martin, Eley & McGuffin, 2004). In preschool children begin to understand that other people's perspective sometimes differ from their own which helps them to communicate more effectively (Sroufe, et al., 2004). Theory of Mind (ToM) is the understanding of the mind and mental operations, this occurs around the age of 5. The development of ToM is considered to be a major change in social cognitive development: it means increased comprehension in understanding not only one's own but also others' thoughts, feelings, desires and intentions (Melot & Angeard, 2003). Like ToM, recognition of emotions in facial expressions constitutes an important part of social cognitive development. The effective decoding of others' facial expressions aids in understanding the emotions

experienced by others and thus in producing more accurate cognitive representations of social situations, which in turn may potentially lead to more effective social interaction (Grinspan, Hemphill & Nowicki, 2003). Research on neural systems for social cognition indicates that several brain structures are involved in processing social and emotional information. Aleman, Bermond and de Haan (2009) indicate that the amygdala (part of the limbic system which is often denoted as 'the emotional brain'), the orbitofrontal cortex, the ventral striatum, the insula, the anterior cingulate and the medial frontal cortex are the most important brain structures involved in processing social and emotional information. To further support this claim, Hill and Frith (2003) demonstrated in their study that children with Asperger Syndrome (who fail to develop an adequate Theory of Mind) showed less activation in the medial prefrontal region than did the normal controls. Adolphs (2002) reports on the same brain structures which are the foundation for recognition of emotions, namely: the occipitotemporal neocortex, the amygdala, orbitofrontal cortex and right frontoparietal corticies. The recognition of fear may draw especially on the amygdala (Adolphs, 2003).

Externalizing disorders (especially disorders such as ODD or CD) are frequently associated with deficient social-cognitive skills (Loeber & Hay, 1997; Blair & Coles, 2000; Zadeh, Im-Bolter & Cohen, 2007). Specific social cognitive factors make aggression more likely. Social cognitive deficiencies might make it difficult for some children to find diverse (nonaggressive) solutions to problems. Also, children with disruptive behaviour disorders frequently tend to misunderstand or misinterpret others' intentions: they tend to think that other have aggressive intent and react accordingly (Loeber & Hay, 1997). The tendency to assign negative attributions may lead to conflict with parents and rejection by peers (Loeber & Hay, 1997). Scourfield and colleagues (2004) examined the genetic relationship between conduct problems and social cognition in a sample of monozygotic and dizygotic twins. They reported high significant correlation between poor social cognitive skills and conduct problems (r=.60) and also demonstrated the genetic effects acting on covariation of poor social cognitive skills and conduct problems (comparing the cross-twin cross-trait correlations of MZ and DZ twins). Conduct problems and social cognition appeared to share common genetic influences that accounted for about half of the covariance in the data. Deficiencies in social cognitive information processing have also been related to internalizing problems. Luebbe, Bell, Allwood, Swenson and Early (2010) found in their study with 215 typically developing children in the age of 8 to 13 years that children with anxiety or depression traits had a more negative information processing style. Depression appeared to be uniquely

characterized by experiencing less positive affect. In their second study the researchers demonstrated that negative social cognitive information processing predicted both anxiety and depression. It is likely that maladaptive social information processing has an influence on emotion regulation which in turn contributes to the development and maintenance of internalizing symptoms. Several studies have documented the influences of deficiencies in ToM on psychopathology (Brüne & Brüne-Cohrs, 2006). Hughes and Ensor (2007) demonstrated that ToM was a significant predictor of problem behaviour scores in a sample of 120 children who were followed from age 2 to age 4. Furthermore, Zobel and colleagues (2010) demonstrated that chronically depressed patients were markedly impaired on several neuropsychological tasks measuring ToM and several executive functions (which are highly relevant to social cognitive development). With regard to recognition of facial emotions, it appears that the ability to recognize emotions accurately is associated with high scores on social competence (Custrini & Feldman, 1989) and predicts prosocial behaviour (Marsh, Kozak & Ambady, 2007). However, the positive association between emotion recognition and social adjustment appeared to be moderated by gender of the child and the emotion category in the study conducted by Leppänen and Hietanen (2001) (the recognition of surprise in particular was related to social adjustment). Blair and Coles (2000) also indicated that high scores on emotion recognition tasks were inversely related to both level of affective-interpersonal disturbance and impulsive-conduct problems, again indicating the influence of social cognitive skills on psychopathological traits.

Executive functioning and psychopathology

Ever since Luria first introduced the term ‘executive functions’ in 1973, more and more researchers have tried to define the concept (van Zomeren & Eling, 2008). *Executive functions* (EF) include several cognitive processes that are integral to emerging self-regulation of behaviour and developing social and cognitive competence in children (Blair, Zelazo & Green, 2005). Executive functions include inhibition of prepotent responding, the maintenance of information in working memory and the appropriate shifting and sustaining of attention for the purposes of goal-directed action (Blair, Zelazo & Green, 2005). The executive functions have long been associated with different parts of the prefrontal cortex (Zelazo & Müller, 2002). Research has shown that EF expands rapidly during early childhood simultaneously with the rapid development of cortical structures in the prefrontal cortex (Blair, Zelazo & Green, 2005). This had led many researchers to investigate the nature and

development of executive functions further. In recent years the literature on the role of executive functions in a variety of psychopathologies has increased (Blair, Zelazo & Green, 2005; Séquin, Parent, Tremblay & Zelazo, 2009). And furthermore, EF appeared to have a relation with social competence which has also been subject of many studies (Hughes, Dunn and White, 1998).

Several developmental disorders and psychopathological traits have been associated with deficiencies in executive functioning. Children diagnosed with disruptive behaviour disorders (ODD/CD or ADHD) have got major difficulty in regulating their emotions and controlling their impulses (Loeber & Hay, 1997). Ellis, Weiss and Lochman (2009) examined 85 typically developing boys on executive functioning and appraisal processing in relation to several types of aggression. The researchers demonstrated that response inhibition and planning ability were related to reactive aggression. Furthermore, the tendency of attributing hostile intent to others moderated the relations between planning ability and proactive and reactive aggression. As the level of hostile attributional bias increased, the relation between planning deficits and reactive aggression became increasingly positive whereas the relation with proactive aggression became increasingly negative. This could mean that high levels of hostile attributional biases increases the planning demands required to be successful with proactive aggression which makes it unlikely for children with poor planning abilities and high levels of hostile attributional biases to be successful at proactive aggression. As a result, they may show less proactive aggression since proactive aggression is controlled by it consequences. Campell and von Stauffenberg (2009) report results from their study with data from the NICHD Study of Early Child Care and Youth Development. In their sample consisting of 1,082 children, measures of delay capacity, inhibitory control, planning and attention were administered. Poor performance on measures of resistance to temptation, delay of gratification, response inhibition, attention and planning measured between 36 months of age and first grade, predicted hyperactivity-impulsivity and inattention (measured during third grade). Rhoades, Greenberg and Domitrovich (2009) indicated a significant relation between inhibitory control, social skills and internalizing problem behaviours: children who demonstrated better inhibitory control were more likely to be rated higher on social-emotional competence and scored lower on measures of internalizing behaviours. Hughes and Ensor have conducted many studies on the association of EF with psychopathology in preschoolers. They reported on strong and specific associations between EF and problem behaviours in four-year-olds (Hughes & Ensor, 2008). In a study conducted by Hughes, Dunn and White

(1998) it appeared that hard-to-manage preschoolers showed poor executive control. In the same study measures of Theory of Mind were administered: the researchers demonstrated that executive function was associated with performance on the Theory of Mind tasks for the hard-to-manage group alone, indicating both direct and indirect links between executive dysfunction and disruptive behaviour.

Social cognition and executive functioning

Interrelations between aspects of social cognition and executive functioning have been demonstrated by many studies (Carlson, Mandell, Williams, 2004; Carlson, Moses and Breton, 2002; Hughes and Ensor, 2005). Especially the interrelation between Theory of Mind and executive functioning has been examined thoroughly both in clinical and non-clinical samples. Hughes and Ensor (2005) examined a sample of 140 two-year-olds and reported strong associations between EF en ToM even after controlling for verbal ability. Longitudinal research conducted by Carlson et al., (2004) with children in the age of 24 to 39 months demonstrated that EF and ToM were not yet related at age 2: when the children were 3 years of age there were significant relations between EF and ToM. Furthermore, EF (as measured at Time 1 when the children were 2) appeared to be a significant predictor for Time 2 ToM measures (when the children were 3 years of age). These results indicate that the ability to reflect on mental states of others is highly relevant to the organization of self-control. In the study conducted by Carlson, Moses and Breton (2002) inhibitory control was strongly related to false belief performance (ToM), even when controlling for general cognitive abilities.

The key aim of the study conducted by Hughes (1998) was to identify which components of EF were most likely to be linked to children's developing ToM. The author states that for successfully completing ToM tasks a minimum of working-memory capacity is needed. This would explain why EF at Time 1 (mean age of the children was 3 years and 11 months) was predictive for ToM at Time 2 (children were about 5 years of age). But Hughes also states (with regard to inhibitory control) that high inhibitory control may have both a direct effect and indirect effect on ToM. On the one hand it enables children to override prepotent responses and on the other it maximizes the efficiency of working memory by reducing the mental resources used for processing task-irrelevant information during the ToM tasks. Planning abilities and ToM are not found to be related according to Carlson, Moses and Claxton (2004). Dennis, Agostino, Roncandin and Levin (2009) examined ToM, working memory and inhibition in children with traumatic brain injury. Children in the sample had

diffuse axonal injury or frontal lesions. Inhibition appeared to be predictive of ToM through working memory (working memory was a mediator). Frontal injury directly influenced working memory, which accounted for the relationship between frontal injury and ToM. The researchers conclude by indicating that for the emergence of ToM skills several specific executive functions (working memory and inhibitory control) are important.

Social cognition and executive functioning and their relationship with social skills

The association between social cognition and executive function is often examined in relation to social skills. Social skills are defined by Yager and Ehmann (2006) as the cognitive, verbal and nonverbal behaviours necessary to interact appropriately with other people. Social skills emerge throughout childhood and adolescence and reflect a dynamic interplay between the child and its environment (Beauchamp & Anderson, 2010). Beauchamp and Anderson (2010) indicate that several cognitive functions including social cognition (or socio-emotional processes), executive functions (attention executive processes) and communicative functions determine the presence and integration of social skills. For example, accurately identifying and interpreting emotions or facial expressions is essential for processing social cues and influences how an individual acts and reacts in social situations (Beauchamp & Anderson, 2010). Also, Theory of Mind appears to be positively related to social skills such as social problem solving, judging and planning (Sokol, Chandler & Jones, 2004). Fenning, Baker and Juvonen (2011) examined parent-child emotion discourse, children's social information processing and social skills in 8-year-olds with and without developmental delays. Social cognition was measured using an observation system in which parent-child interactions, that provided opportunities for discussing topics relevant to social-cognitive development, were coded. Children (both typically and atypically developing) who engaged more in complex emotion discourses with their parents (and thus have more discussions relevant to social-cognitive development), produced a greater number of prosocial problem-solving strategies which in turn were associated with more adaptive social skills outcomes. Kiley-Brabeck and Sobin (2006) demonstrated a executive dysfunction related to lower social skills in children with the 22q11 deletion syndrome (children with this deletion are found to have marked social difficulties). Children had scores approaching the clinical range on the overall executive functioning scale as well as on several subscales measuring initiation, working memory, planning and monitoring. This finding suggests that children with observable deficits in social skills also exhibit deficits in executive functions.

Several studies have also demonstrated that disruptions to social skills can contribute to psychopathological symptoms including psychological distress, social isolation and reduced self-esteem (Beauchamp & Anderson, 2010). Beidel, Rao, Scharfstein, Wong and Alfano (2010) demonstrated that adults with social phobia showed impaired social skills. Adults with generalized social phobia showed more deficits in social skills compared to the patients with non-generalized social phobia. Petermann and Petermann (2010) indicate that children with different forms of school anxiety or school phobia often show poor social skills and state that social skills of children who have school phobia should be targeted in during treatment programs. Groeben, Perren, Stadelmann and Klitzing (2011) examined the interactive influence of self-oriented and other-oriented social skills on children's emotional symptoms and conduct problems in children aged 5-to-9 years. Self-oriented social skills were defined as skills that are based on the consideration of one's own interests and benefits and include measures of social participation and assertiveness. Other-oriented social skills refer to social behaviours that are based on consideration of interests and benefits of others in social interactions. This included measures of pro-social and cooperative behaviour. The researchers demonstrated that children aged 5-6 years showing low self-oriented social skills (social participation and assertiveness) were associated with more emotional symptoms. Furthermore, low other-oriented social skills (pro-social and cooperative behaviour) were also negatively and significantly correlated with emotional and conduct problems. With regard to pro-social behaviour and social participation, the researchers found that children with high levels of pro-social behaviour and low levels of social participation showed significantly higher levels of emotional symptoms. The researchers also predicted psychopathology from social skills over time. Analyses indicated that children at age 5 with low pro-social behaviour and low assertiveness showed higher levels of emotional symptoms at age 6 compared to low pro-social and highly assertive children. And high levels of pro-social behaviour predicted increases in emotional symptoms from age 6 to age 9, especially if children also showed low levels of social participation.

The results from previous studies have demonstrated the associations between executive functioning, social cognition and social skills and have highlighted the relevance of social skills for the emergence of psychopathology. It seem plausible that highly developed social skills have a protective effect on for example the regulation of emotions and therefore act as a mediator or moderator within the relation between executive functioning, social

cognition and psychopathology. Therefore, in the current study social skills of children will be taken into account.

Interrelations between EF, social cognition, social skills and psychopathology

The nature of the association between EF and social cognition and its impact on internalizing and externalizing behaviour problems continues to be explored. Also, the association between EF, social cognition and social skills remains to be investigated further. It is still not very clear whether EF and social cognition have independent contributions to internalizing and externalizing psychopathology (considering the strong associations between them). Also, it remains to be investigated whether social skills play a mediating or moderating role in predictive associations between EF and social cognition on the one hand and psychopathology on the other. Considering the association between EF and social cognition as found in previous studies, it also seems interesting to examine whether EF might be a mediating/moderating factor in the prediction of psychopathology from social cognition and vice versa. It is very likely that EF and social cognition are predictive of internalizing and externalizing behaviour problems. Hughes and Ensor (2008) indicate that ToM and EF are intercorrelated with regard to the influence on psychopathology. And according to Hughes and colleagues (1998) the association between EF and ToM is larger in children with externalizing behaviour problems compared with typically developing children. Furthermore, social skills appears to be related to EF and social cognition as examined by several studies. And also impaired social skills have been linked to several developmental psychopathological disorders as well. Because social skills seem relevant to the development of social cognitive and executive functioning skills, it seems plausible that social skills is a moderator/mediator in the relationship between EF, social cognition and psychopathology. Therefore, in the current study the following model is proposed (Figure 1). In this model social cognition and EF are expected to have bidirectional relationships. EF and social cognition are expected to be predictive for psychopathology. Social skills are expected to be related to social cognition, executive functioning and internalizing and externalizing behaviour problems and is therefore expected to influence the predictive relation between EF, social cognition on the one hand and psychopathology on the other. As far as known, this model has not been evaluated systematically yet and the current study makes a contribution by integrating two neuropsychological constructs, a behavioural-level construct with measures of

psychopathology. Also, the mediating/moderating influence of specifically social skills between EF, social cognition and psychopathology has not been examined thus far.

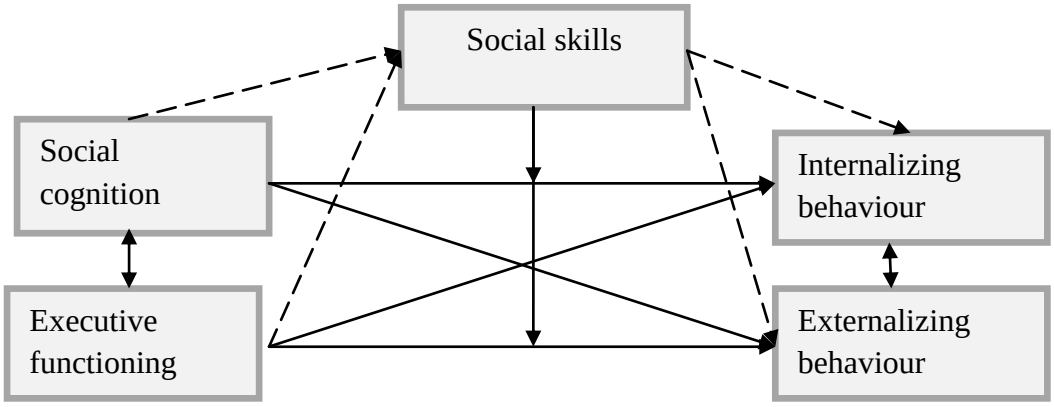

Figure 1: proposed theoretical model of interrelations between social cognition, executive functioning, social skills and psychopathology

Research questions and hypotheses

The aim of the current study is to examine the way in which internalizing and externalizing are predicted by executive functioning, social cognition and social skills. Based on previous studies the following hypotheses were generated:

(1) Social cognition and executive functioning are expected to be highly correlated and to be independently related to social skills. Social cognition and executive functioning are also expected to be associated with psychopathology in which low levels of social cognition and executive functioning are associated with high levels of internalizing and externalizing behaviour problems. Social skills are expected to be negatively correlated with psychopathology.

(2) Social cognition, executive functioning and social skills are expected to be significant predictors in several domains of psychopathology (internalizing and externalizing behaviour problems) and thus explain unique proportions of the variance in both internalizing and externalizing behaviour problems.

(3) The main effects of social cognition and EF are examined with regard to several dimensions of psychopathology (internalizing and externalizing behaviour problems). The possible moderating (interactive effect) or mediating (additive effect) influence of social skills on the relationship between EF, social cognition and psychopathology is examined.

With regard to the interactive model (moderation analyses), social skills are expected to modify the relation between EF, social cognition and internalizing and externalizing behaviour in which the effects of EF and social cognition on psychopathology are stronger when children have low social skills than when children have high social skills. It is expected that the regression weights in the regression model for both social cognition and executive functions are negative and significant when social skills (the interaction) is added to the model. With regard to the additive model (mediation analyses), EF and social cognition might predict social skills which in turn predict psychopathology (indirect effect of EF/social cognition through social skills). This would refer to full mediation. However, when there also appears to be a direct effect of EF/social cognition on psychopathology, partial mediation is demonstrated. If social skills indeed appear to be a mediator, the Sobel test (a test for the indirect effect) will be significant. EF and social cognition are expected to be partially mediated by social skills in their prediction of internalizing and externalizing psychopathology. Finally, mediation and moderation analyses will be conducted to examine the role of executive functioning in the relationship between social cognition and psychopathology and to examine the role of social cognition in the relation between executive functioning and psychopathology.

Methods

Participants

The current study is part of the longitudinal Curious Minds-study, which examines the relationships between explorative behaviour, social skills, neuropsychological functioning and mathematical abilities in young children. In this study the participants were assessed twice: the first assessment took place between February and March 2009 (Time 1) and the second assessment took place between February and March 2010 (Time 2). For the current study only data from Time 2 were used for the analyses. A total of 409 children participated at Time 2 (mean age at Time 2 = 6.37, *SD*= 0.60). The children were recruited from 33 regular primary schools in the province of South Holland (The Netherlands). The sample consisted of 190 girls (mean age at time 2= 6.33, *SD*= 0.60) and 219 boys (mean age at time 2= 6.43, *SD*= 0.61).

In 2008, schools were contacted and invited to participate in the research project. After permission of the schools, they were sent informative letters for parents who had children in the age range of 4 to 6 (kindergarten). Children who attended school for at least two months,

who were native speakers of Dutch and whose parents understood Dutch writings, were eligible for participation in the study. After informed consent by parents, they were given questionnaires and the children were assessed twice by bachelor students in Education and Child studies (Leiden University).

Procedure

In the Curious Minds-study a broad range of neuropsychological tests and behavioural questionnaires were administered. The complete test battery consisted of ten computerized neuropsychological tasks and eight paper-and-pencil tasks which were administered during three assessments moments for each child. Each assessment took about one hour (three hours in total for the complete test battery). Parents completed nine questionnaires. Because completing the questionnaires and taking part in the study demanded a considerable amount of effort and time from children, parents and schools, families and schools were rewarded. Children were given a domino-game, parents received several coupons for museums and a gift coupon worth €20 and schools were given a gift worth €25.

At the first assessment (February- March 2009) 33 regular primary schools (472 children) were recruited. After informed consent of the schools, parents with children in kindergarten were recruited. The second assessment took place in February to March 2010 (including 32 schools, 409 children, one school had indicated not to continue participation and several participants from other schools also indicated not to continue participation). There was approximately one year between the two assessments. At both assessments, the tests were administered by trained bachelor and master students from the Department of Clinical Child and Adolescent Studies.

Measurement instruments

The constructs (social cognition, social skills, executive functioning and psychopathology) were assessed using several computerized tasks, paper-and-pencil tasks and behavioural questionnaires. The measurement of each construct will be described in the following section.

Social cognition

Social cognition was measured using the Dutch version of the Social Cognition Skills Test (Sociaal Cognitieve Vaardigheden Test, SCVT), the IFE (Identification of Facial Emotions) task of the ANT test battery (Amsterdam Neuropsychological Tasks) and the Social Cognition

subscale of the Social Responsiveness Scale. The first two measurements are direct measurements of social cognition and the social cognition subscale of the SRS is a daily life measurement.

The Social Cognitive Skills Test is test for assessing social-cognitive skills (more specifically: Theory of Mind) in children aged 4 to 12 years old (van Manen, Prins & Emmelkamp, 2007). The instrument consists of seven short stories with matching pictures. After each story, children are asked to answer eight questions which represent eight social-cognitive skills: *to identify* (the ability to discern the existence of perspectives of others and to recognize and label these observable perspectives), *to discriminate* (the ability to indicate differences and similarities between two observable perspectives), *to differentiate* (ability to deduce that two or more persons in similar or dissimilar situations do not necessarily have similar perspectives), *to compare* (the ability to deduce and label differences/similarities between observable perspectives of persons in the same situation), *to take another person's perspective* (to take the position or role of another person and to infer the perspective of that person), *to relate* (making causal inferences between perspectives and their causes and vice versa), *to coordinate* (view of perspectives from a 'third persons-perspective') and *to take into account* (the ability to take perspectives of others and oneself into account at the same time) (van Manen, et al., 2007). Van Manen et al. (2007) reported on the psychometric properties of the instrument. Tested in a Dutch population, the researchers report good internal consistency (Cronbach's Alpha = .96) for the test as a whole. The test-retest reliability is r=.82-.85 (p<.001). However, the reliability and validity of the instrument in other populations still has to be examined. Van Manen, Prins and Emmelkamp (2001) demonstrated in one of their studies that chronological age of both non-aggressive as well as aggressive children was positively related to scores on the SCST. A MANOVA indicated significant differences between the age- group of 6,- 7,- and 8-year-olds, the group of 9,- and 10-year-olds and the group of 11- and 12-year-olds. The group of 6-, 7- and 8-year-olds scored significantly lower than the group of 9- and 10-year-olds and the group of 11- and 12-year-olds. For this reason, all the analyses including the SCST will also include the covariate age. Furthermore, the researchers demonstrated that the SCST can correctly differentiate between aggressive and non-aggressive children: results showed that aggressive children function on a lower social-cognitive level compared to non-aggressive children of the same age. The SCST gives a subscale score for each of the skills. Summing these scores gives the total (raw) SCST score, which will be used in the analyses in the current study. Administering the total test took about

30 minutes, depending on the amount of errors made by the child. When the child made two or more errors in one story, the story was terminated and the next story was read to the child.

The Amsterdam Neuropsychological Tasks is a computerized neuropsychological test battery consisting of 33 subtests (De Sonneville, 2005). The test battery is developed to systematically asses more complex cognitive processes such as focused and sustained attention, working memory, executive and psychomotor functions and social information processing. The ANT is suitable for young children (from the age of 4), older children, adolescents and adults. Performances on the subtests are registered in standardized scores, in the current study raw scores were used. Reaction time, accuracy (percentage of errors) of response are registered as well as stability of responding. The psychometric properties of the ANT have been examined by several studies in both non-clinical (Brunnekreef, Althaus, De Sonneville, Verhulst, Minderaa et al., 2003) and clinical samples (Kalff, De Sonneville, Hurks, Hendriksen, Kroes et al., 2005). The subtest Identification of Facial Emotions of the ANT was used to assess emotion recognition. The ability to recognize happy, sad, angry and fearful faces was tested. Each of the four parts included an instruction trial, a practice trial and the actual test trial. In each part twenty pictures with the target emotion and twenty pictures with another emotion were shown (one at the time). The child was instructed to indicate whether he/she recognized the target emotion or not by pressing a mouse button (a 'yes-or-no'- button). Because in the current study the focus is on the ability to recognize or identify emotions in general, the accuracy scores (the amount of errors made by the children) of all four parts were taken together in the analyses. However, it should be noted that several primary emotions are more difficult to decode than other primary emotions. For example, Crustini and Feldman (1989) indicated that the 9- to 12-year old children in their sample performed most accurately when happy faces had to be recognized and least accurately when angry faces had to be recognized.

The Social Responsiveness Scale is a questionnaire for parents or teachers. It assesses autistic symptoms in children (SRS, Constantino, Davids, Todds, Schlinder, Gross, et al. 2003). It is a brief measure (it takes about 15 to 20 minutes to complete) and it obtains 'first-hand' ratings from parents or teachers who have experienced the child in natural social settings. The questionnaire contains 65 items which are divided over five subscales: Social Awareness, Social Cognition, Social Communication, Social Motivation and Autistic Mannerisms. For this study only the Social Cognition subscale is of importance. The subscale contains items such as 'takes things literally and does not understand the true content of a

conversation' (item 10) or 'is capable of interpreting tone of voice and facial expressions in a correct way' (item 15, this items refers to emotion recognition). Parents rated the behaviour of their child during the past six months on a four-point scale (from 1= not true to 4= almost always true). A high score on the subscales or total scale indicates more difficulties in social situations. With regard to the psychometric properties of the SRS, Constantino and colleagues (2003) report inter-rater-reliability ranging from 0.75 (for the correlation between teachers and fathers) to 0.91 (for the correlation between mothers and fathers). Bölte, Poustka and Constantino (2008) report internal consistency ranging between .91 to. 97 for normative and clinical samples and for mothers' and fathers' ratings. The test-retest reliability ranged between .72 and .97 for normative and clinical samples and for mothers' and fathers' ratings. Validity measures were satisfactory (Bölte, Poustka and Constantino, 2008).

Executive functioning

Executive functioning was examined using several tasks and a questionnaire: the Go-no-Go task (GNG, inhibition) of the ANT programme was used as well as the Spatial Temporal Span task (STS, visuospatial working memory) (De Sonneville, 2005); the Word Fluency Test (WFT); the Zoo Map Test of the Behavioural Assessment of the Dysexecutive Syndrome for Children (BADS-C) and the Dysexecutive Questionnaire for Children of the BADS-C (DEX-C).

The Go-no-Go task has two parts, in this study only the second part was administered which took about four minutes to complete. On the computer screen an open square could be presented (the Go-stimulus or target stimulus) or a closed squared could be presented (No-Go stimulus or non-target stimulus). The children were asked to press the Yes-button of the mouse when the Go-stimulus was shown (which mouse button was labelled as the 'yes'-button was in concordance to the hand preference, for example a right-handed child had to press the right button if the Go-stimulus was shown). Children were told not to respond when the No-Go stimulus was shown. This part of the GNG task was biased referring to the fact that an unequal amount of target and non-target stimuli were shown: more target stimuli were shown so that children with inhibition problems could be detected easier. The percentage of false alarms (pressing the mouse button when no stimulus was shown yet) was used as an indicator of a lack of inhibitory control.

The Spatial Temporal Span took 16-20 minutes to complete and had a 'forward' and 'backward' part. During the first part of the task, the mouse cursor (in the shape of a pointing

finger) indicated three out of nine squares in a given order. Next, children were asked to press the same squares in the same order. Depending on the working memory abilities of the child, the amount of squares to be pointed out could increase to five out of nine squares. In the second part of the task, children were asked to start press the squares that had been pointed out in reverse order (i.e. the backward condition). When five consecutive errors were made, the task was automatically aborted. Hits in the correct order of the two trials (forward and backward) represented the quality of children's visuospatial working memory.

The Word Fluency Test (WFT) assesses verbal memory and fluency and the ability of generating ideas. The test consisted of two parts: one in which the child has to name as many animals as possible within one minute and one in which the child has to name things to eat. The total score of the two parts was used to indicate verbal fluency. The WFT is derived from the Thurstone Word Fluency Task (TWFT, Thurstone, 1938) and has been used to assess neuropsychological functioning (Cohen and Stanczak, 2000). Cohen and Stanczak (2000) reported a TWFT test-retest reliability of .79. Furthermore, the TWFT differentiated between normal controls, psychiatric patients, left anterior and generalized lesioned participants. The authors also report good construct validity of the TWFT: correlations between the TWFT, the Controlled Oral Word Association Test (COWA) and the FAS ranged between .49 and .82 which indicate moderate to good construct validity. Finally, the researchers demonstrated that for successful TWFT performance several cognitive abilities are of importance such as psychomotor speed, attention and memory skills.

The Behavioural Assessment of the Dysexecutive Syndrome for Children (BADS-C) is a standardized neuropsychological test battery to assess executive functioning in 8-15 year old children. The battery consists of two parts: five performance-based tests (including the Zoo Map Test) and a 20-item questionnaire for caregivers (Dysexecutive Questionnaire for Children, DEX-C). The Zoo Map Test intends to measure planning abilities. In the current study only the second Zoo Map Test was administered to children because the second test provided more structure to children compared to the first Zoo Map Test. Children were asked to plan a route through a zoo. While doing so they had to visit specific animals and they were asked to take into account several rules (for example: "don't use the same path twice", "the camel-pathway may only be used once"). The children received a point for each animal that was visited in the correct order. Errors were subtracted from the total score. When the children would plan a route through the zoo without any errors a total score of 8 was given. Originally this test was validated for children from age 8 onwards, but it was expected that

this task would be an indicator of planning abilities in children 4 to 7 years as well. The DEX-C was meant as a supplementary (daily-life) measure of executive functioning to the five performance-based subtests. Parents could rate the executive functioning of the child during the last six months on a five-point scale (ranging from 0= never to 4= a lot). A total score could be calculated from the 20 items: a high total score is indicative of more problems in executive functioning. Engel-Yenger, Josman and Rosenblum (2009) demonstrated satisfactory construct validity (by demonstrating an age-related development and specific profiles for age groups and by demonstrating that the Water Test, Key Search Test and Zoo Map Test 1 contributed the most to the sensitivity of the test), but indicate that the validity and reliability should be examined further in future studies.

Social skills

Social skills were assessed using the Social Skills Rating System (Gresham & Elliot, 1990). This questionnaire measures social skills and problem behaviours. The social skills items can be divided into four subscales: Cooperation, Assertion, Self-Control and Responsibility. Studies into the psychometric properties of the SSRS indicate that the questionnaire is a valid and reliable tool (Gresham & Elliot, 1990; van der Oord, Van der Meulen, Prins, Oosterlaan, Buitelaar et al., 2005). Gresham and Elliot (1990) report a mean internal consistency of .75. Flanagan and Alfonso (1996) report good concurrent validity of the SSRS social skills domain with the Behaviour Assessment System for Children (BASC) with correlations of about .54 for the parent versions. The total SSRS score was used as an indicator of social skills: the higher the score the better the social skills.

Psychopathology

The Child Behaviour Checklist is a questionnaire with the aim to capture children's and adolescent's behavioural, emotional and social problems as rated by parents (Ivanova, Achenbach, Rescorla, Harder, Ang et al., 2010). This 'empirically-derived' checklist evolved from the psychometric approach to classifying psychiatric symptoms in children and adolescents. Parents rate 99 social, emotional and behaviour problems of their child during the last two months on a three-point scale (0= not present, 1= sometimes present and 2= clearly present or often present). Scores on the 99 items can be converted into T-scores which indicate whether the child scores in the normal, subclinical or clinical area. Scores in the subclinical area indicate problems that are not yet of clinical relevance but have the potential

of becoming clinical problem behaviours. When children have T-score of 65 or higher, these behaviours can be defined as clinically significant problem behaviours. The total score of all the 99 items can be divided into the two broad band syndromes: the internalizing and externalizing behaviour scale. The two broad band syndromes can be divided into seven small band syndromes which are Anxious/Depressed Behaviour, Withdrawn/Depressed Behaviour, Somatic Complaints, Social Problems, Thought Problems, Attention Problems, Rule-Breaking Behaviour and Aggressive Behaviour. Ivanova, Achenbach, Dumenci, Rescorla, Almqvist et al. (2007) found strong support for this 8-syndrome structure using factor analysis in 30 different societies. In the current study only the internalizing scale (composed out of the first three syndrome scales) and externalizing scale (composed out of the last two syndrome scales) are used in the analyses. The CBCL is used frequently by researchers and clinicians and has been proven to be a reliable and valid tool in identifying behavioural, social and emotional problems in children (Ivanova et al., 2010; Ivanova et al., 2007; Stanger, Achenbach, McConaughy, 1993).

Statistical analyses

All analyses were conducted with Predictive Analytic SoftWare version 18.0 (PASW 18.0). First several descriptive analyses were performed for data inspection, including a check for normality of distributions, and a check for outliers and missing values. Extreme outliers (scores more than three standard deviations from the mean) were removed from the data. Listwise deletion was therefore used in order to obtain complete data (N=286). Variables that did not fulfil statistical assumptions for normality were log transformed (Kinnear & Gray, 2010). All analyses were conducted using both the log transformed variables and the original variables. Once the results between log transformed and non-transformed differed, the log transformed results were presented, when the results were similar the results from the original data were presented. If the variables contained 0-values or negative values, a log transformations cannot be defined. This was overcome by adding a constant to all scores of a variable before transforming the variable. The constant had to be large enough to ensure positive values.

Next, Pearson's product-moment correlations were calculated for assessing multicollinearity among the predictor variables, for assessing associations between the several EF and social cognition measures (in order to obtain a total EF and social cognition score) and to assess the relationship between the predictor and outcome variables. To assess the

independent influence of the predictor variables (executive functioning and social cognition) on the outcome variables (internalizing and externalizing behaviour problems) several simple linear regression analyses were conducted.

In order to examine the combined influence of social cognition and executive functioning on psychopathology, hierarchical multiple regression analyses were conducted. To examine the unique contribution of each of the predictors to internalizing behaviour problems, externalizing behaviour problems was forced into the first block of the hierarchical regression analysis, after which the predictors were added in the following blocks of the model. And to assess the unique contribution of each of the predictors to externalizing behaviour problems, internalizing behaviour problems was forced into the first block of the hierarchical regression analysis, after which the predictors were added to the model.

Moderation analyses were used to test several hypotheses. First, it was assumed that children with behaviour problems would score low on social cognition and executive functioning due to low social skills, whereas children with low or no behaviour problems would have well developed social cognition and executive functions and will show high levels of social skills. Moderation analyses were conducted when at least a trend was found in the simple linear and hierarchical multiple regression analyses between the predictor variables (social cognition and executive functions), the outcome variables (internalizing and externalizing behaviour problems) and the third variable (social skills). Testing the interactive (moderation effect) is done using centered variables in hierarchical regression analyses. After centering, an interaction term is calculated from the centered predictors (EF*Social Cognition* Social Skills). In the first block of the hierarchical regression analysis the predictors are included and in the second block the interaction term is added. Also, moderation analyses were conducted to assess the moderating effect of EF on the relationship between SC and psychopathology and the moderating effect of SC on the relationship between EF and psychopathology.

Finally, mediation analysis was used to examine whether the relationship between EF/SC and psychopathology is mediated by social skills. Within mediation analysis three subsequent regression analyses are necessary. First, regression analysis should indicate whether there is a direct effect between EF, SC and psychopathology (X→Y). Here, psychopathology is ‘Y’, EF and SC are the predictors ‘X’ and social skills is the third variable ‘Z’. The next step included predicting social skills from EF and SC (X → Z), for assessing the relationship between the predictors and the possible mediator. In this analysis social

functioning (which is the possible mediator 'Z') is predicted from predictors EF and SC ('X'). The third step includes predicting psychopathology from EF and SC and social skills in the same analysis. The third step contains two smaller steps (1) is social skills related to psychopathology (controlling for EF and SC)? and (2) are EF and SC still related to psychopathology controlling for social skills? This refers to testing the direct and indirect effects between the predictors X and the outcome variables Y. If significant effects are found in step 1, 2 and 3 there is evidence for a mediating effect of social skills. Depending on the results from the two steps from step 3, this could refer to complete or partial mediation. Because testing mediation with these subsequent steps results in a relatively low power, mediation should also be tested using a direct test of mediation. Therefore, the Sobel-test is conducted (Sobel, 1982). In the current study the Aroian version of the Sobel test is used:

Mediation analyses will be conducted separately for the two predictors EF and SC and for internalizing and externalizing behaviour problems. Similar mediation analyses were conducted to test the mediating effect of SC on EF and psychopathology and of EF on SC and psychopathology.

Results

Descriptive and preliminary results

Exploration of the data first indicated outliers in Word Fluency , SRS social cognition and Emotion Recognition (IFE). After removal of the outliers, Emotion Recognition became normally distributed.

Table 1 presents descriptives of all the dependent and independent variables (mean, *SD*, range, skewness, standard error of skewness, kurtosis and standard error of kurtosis). The variable 'Inhibition' was positively skewed (standardized skewness: 10.7; standardized kurtosis: 10.9). Word Fluency ('WFT') was also positively skewed (standardized skewness: 7.2; standardized kurtosis: 5.7), just as Internalizing behaviour (CBCLint) (standardized skewness: 14.3; standardized kurtosis: 16.3) and social cognition (SRS social cognition subscale) (standardized skewness: 7.3; standardized kurtosis: 3.9). Planning (BADS-C) was negatively skewed (standardized skewness: 10,6; standardized kurtosis: 6.7). And Emotion Recognition (IFE) had a standardized skewness of 9.4 and a standardized kurtosis of 24.0.

After removing an extreme outlier from this distribution, the variable IFE became normally distributed. Next, the variables Inhibition, Word Fluency, Planning (BADS-C), SRS social cognition and CBCL Internalizing behaviour were log transformed (to the variables Word Fluency, Inhibition, Planning and Internalizing behaviour a constant was added first due to the presence of negative or 0-values in order to obtain only positive values).

Associations among social cognition, executive functioning, social skills and psychopathology

Table 2 presents correlations among all the predictors, outcome variables, age and IQ. Because the correlations obtained with the original variables differed from those obtained with the transformed variables, the results from the analysis conducted with the transformed variables are presented. As shown in the table, internalizing and externalizing behaviour are significantly correlated (r=.696, p <.005).

Table 1: Descriptive statistics

		Mean	*SD*	Min	Max	Skewness	SE	Kurtosis	SE
1	Inhibition	24,73	17,59	.00	100.00	1.336	.124	2,702	.247
2	Spatial Temporal Span	47.82	21.93	2.00	131.0	.467	.124	-.135	.247
3	Word Fluency	18.1	5.82	6	43	.875	.121	1.37	.241
4	Planning	-.98	7.86	-.35	8	-1.291	.122	1.62	.243
5	EF DEX (daily life)	18.60	9.97	.00	51.0	63.2	.134	.079	.268
6	Emotion recognition	19,47	8.72	2.50	82.50	1.149	.122	5.835	.243
7	SCST	79.83	26.81	14	159	.168	.122	-.012	.243
8	SG SRS (daily life)	1.37	.287	1.00	2.50	.985	.134	1.064	.267
9	Social skills	100,05	8.68	74.0	120.0	-.338	.134	.119	.268
10	Externalizing behaviour	8,37	6.81	.00	31.00	.98	.134	.544	.268
11	Internalizing behaviour	5.91	6.12	.00	37.00	1.91	.134	4.37	.268

This indicates the importance of controlling for externalizing behaviour when conducting further analyses for internalizing behaviour and vice versa. As expected, both problems in the domains of EF and social cognition (as measured by the daily life tasks) are significantly correlated with both internalizing and externalizing behaviour (DEX-C- internalizing behaviour: r=.546, p<.05; DEX-C-externalizing behaviour: r=.749, p<.05; SRS social cognition – internalizing behaviour: r=.438, p<.05; SRS social cognition- externalizing behaviour: r=.446, p<.05). It is notable that among the direct measures of EF and social cognition there are hardly significant correlations and if they are present, they are generally weak. Also, the direct measures and the daily life measures appeared not to be correlated in general or to have quite low correlations (for the EF measures only Word Fluency and

Inhibition were significantly related to DEX-C with correlations of respectively *r*=-.125 and *r*= .164; for the social cognition measures there were significant but low correlations among SCST, emotion recognition and SRS social cognition scale). Therefore, it did not seem possible to generate a total EF or social cognition score composed out of the direct and daily life measures. Social skills were, as expected significantly related to both EF and social cognition (daily life measures): social skills were negatively significantly correlated with DEX-C (*r*=-.557, *p*<.05) and negatively and significantly correlated with SRS social cognition scale (*r*=-.477, *p*<.05) indicating that children with high social skills were rated by their parents as having more problems in the domains of EF and social cognition. Social skills also showed positive significant but low correlations with some of the direct measures of EF and social cognition: *r*=.126 (Word Fluency), *r*=-.100 (Emotion recognition) and *r*=.125 (SCST).

Table 2: Correlations among predictors, outcome variables, age and IQ

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1	Inhibition	-												
2	Spatial Temporal Span	-.125**	-											
3	Planning	-.081	.201**	-										
4	Word Fluency	-.055	.189**	.076	-									
5	EF DEX (daily life)	.164**	-.029	-.088	-.125*	-								
6	Emotion recognition	.166**	-.235**	-.046	-.115*	.086	-							
7	SCST	-.097	.286**	.168**	.408**	-.089	-.244**	-						
8	SC SRS (daily life)	.096	-.068	-.059	-.094	.584**	.156*	-.112*	-					
9	Social skills	-.061	.040	.036	.126*	-.557**	-.100*	.125*	-.477**	-				
10	Internalizing behaviour	.082	.058	-.064	-.104*	.546**	-.006	.017	.438**	-.438**	-			
11	Externalizing behaviour	.106*	-.036	-.116*	-.102*	.749**	.073	-.051	.446**	-.539**	.696**	-		
12	Age	-.099*	.486**	.140**	.335**	.031	-.217**	.321**	.059	.088	.066	.042	-	
13	IQ	-.027	.413**	.175**	.230**	-.050	-.172**	.408**	-.082	.076	.016	-.063	.391**	-

** Correlation is significant at the 0.01 level (one-tailed) * Correlation is significant at the 0.05 level (one-tailed)
Listwise deletion: *N*=286

High and significant correlations were obtained between social skills and psychopathology: *r*=-.438, *p*<.05 for internalizing behaviour and *r*=-.539, *p*<.05 for externalizing behaviour, indicating that children rated with more behaviour problems had lower social skills.

Due to some significant correlations among predictors, there is an indication of multicollinearity. However, collinearity statistics (Tolerance and VIF, Variance Inflation

Factor) indicated no multicollinearity. Tolerances values of all the predictors (Tolerance values demonstrate which amount of tolerance a predictor has to the variance in the set of predictors and is defined as 1- R^2) ranged between .533 and .915 where values of below 0.1 indicate multicollinearity. The Variance Inflation Factor is the number of times the variance of the parameter estimate (regression weights of the predictor variables) is increased due to multicollinearity. This is then compared to the situation when there would be no multicollinearity. High VIF values (which would be values between 2,5 and 10) indicate multicollinearity. A VIF value around 1 indicates no multicollinearity. The VIF values of all the predictors in this case range between 1.093 and 1.875, indicating no multicollinearity.

Because some predictors are significantly correlated with age and IQ (intelligence was measured using the scores on the Block Design subtest and the Vocabulary subtest of the WISC-III), the subsequent analyses were also conducted with age and IQ as covariates. Results from these analyses were only reported once they differed from the analyses without covariates.

Predictive relationships among social cognition, executive functioning, social skills and psychopathology

To examine the predictive relationships of social cognition, executive functioning, social skills to psychopathology, hierarchical multiples regression analyses were conducted.

Because internalizing and externalizing behaviour were highly correlated, externalizing behaviour was forced into the first block of the hierarchical regression analyses (when predicting internalizing behaviour) after which the predictors were added into the second block and vice versa. Due to correlations between the EF and social cognition measures (especially the daily life measures DEX-C and SRS social cognition), EF was controlled for during the analyses for predicting psychopathology out of social cognition by forcing the EF measures into the first block as well. The reverse was done for the analyses in which psychopathology was predicted out of EF. In the hierarchical multiple regressions only the predictor variables were used that were significantly correlated with internalizing and externalizing behaviour (with regard to the EF measures only DEX-C and Word Fluency correlated with internalizing behaviour and Inhibition, Planning, Word Fluency and DEX-C correlated with externalizing behaviour problems; with regard to SC measures only SRS social cognition correlated significantly with psychopathology and was therefore used as a predictor in the hierarchical multiple regression analyses). Table 3 presents results from a

hierarchical multiple regression analysis conducted with social cognition as predictor and internalizing behaviour as outcome variable (only the social cognition and EF measures that had significant correlations with internalizing behaviour were used). As shown, social cognition (SRS social cognition scale) significantly predicted internalizing behaviour (β= .212, p< .001) above and beyond the effect of externalizing behaviour: β= .617, p < .001. The introduction of social cognition to the model significantly increased the explained variance (R^2-*change*= .029, p<.001).

Table 3: Hierarchical multiple regression analysis: SC- internalizing behaviour

Predictor(s)			**Internalizing behaviour**				
			B	***SE***	***Beta***	***p***	***R^2***
SC (SRS)	Model 1	Constant	1.231	.978		.209	
		Word Fluency	.031	.038	.051	.405	
		DEX total score	-.039	.042	-.038	.352	
		CBCL externalizing	.572	.055	.636	.000	.464
	Model 2	Constant	-3.828	1.516		.012	
		Word Fluency	-.036	.040	-.058	.373	
		DEX total score	-.025	.041	-.025	.541	
		CBCL externalizing	.555	.054	.617	.000	
		SRS social cognition	4.520	1.054	.212	.000	.493

Table 4 presents results from a multiple hierarchical multiple regression analysis with EF measures as predictors and internalizing behaviour as outcome variable. Neither of the EF measures appeared to be significant predictors in the model for internalizing behaviour. SRS social cognition and externalizing behaviour explain 49.1% of the variance and adding the EF measures did not significantly improve the explained variance (R^2-*change*= .002 p =.565).

Table 4: Hierarchical multiple regression analysis: EF- internalizing behaviour

Predictor(s)			**Internalizing behaviour**				
			B	***SE***	***Beta***	***p***	***R^2***
EF (Word Fluency, DEX total score)	Model 1	Constant	-4.267	1.221		.001	
		SRS social cognition	4.207	.964	.197	.000	
		CBCL externalizing	.525	.041	.584	.000	.491
	Model 2	Constant	-3.828	1.516		.012	
		SRS social cognition	4.520	1.054	.212	.000	
		CBCL externalizing	.555	.054	.617	.000	
		Word Fluency	-.025	.041	.-025	.541	
		Dex total score	-.036	.040	-.058	.373	.493

In table 5 the results are presented from a hierarchical multiple regression analysis with SC as predictor and externalizing behaviour as outcome variable. Social cognition did not predict externalizing behaviour (β= .038, p=.377). In the analysis, DEX-C total score and internalizing behaviour were significant predictors and explained about 66% of the variance (R^2= .667).

Table 5: Hierarchical multiple regression analysis: SC- externalizing

Predictor(s)			**Externalizing behaviour**				
			B	***SE***	***Beta***	***p***	***R^2***
SC (SRS)	Model 1	Constant	-1.178	.934		.208	
		Inhibition	.001	.013	.003	.940	
		Planning	-.038	.029	.044	.199	
		Word Fluency	.006	.038	.005	.871	
		DEX total score	.366	.027	.538	.000	
		CBCL internalizing	.434	.044	.387	.000	.667
	Model 2	Constant	-.209	1.439		.885	
		Inhibition	.001	.013	.003	.921	
		Planning	-.037	.029	.043	.203	
		Word Fluency	.004	.039	.004	.915	
		DEX total score	.377	.030	.555	.000	
		CBCL internalizing	.443	.045	.396	.000	
		SRS social cognition	-.883	.998	.038	.377	.668

In table 6 the results are presented from a hierarchical multiple regression analysis with EF measures as predictors and externalizing behaviour as outcome variable. With regard to

externalizing behaviour SRS social cognition and internalizing behaviour were significant predictors in the first step: β= .205, p<.001 and β= .575, p< .001 respectively. When introducing the EF measures to the model DEX-C appeared to be a significant predictor of externalizing behaviour (β= .555, p< .001) above and beyond the effect of internalizing behaviour (β= .396, p<.001). Adding the EF measures to the model and controlling for social cognition and internalizing behaviour, resulted in SRS social cognition not to be a significant predictor any more. Introduction of the EF measures resulted in a R^2-*change* of .182, p<.001 indicating a significant increase in explained variance. Analyses conducted with the transformed variables and with inclusion of covariates ages and IQ, only slightly changed the R^2 of the regression models with none of the R^2- *change* values to be significant.

Table 6: Hierarchical multiple regression analysis: EF- externalizing

Predictor(s)			**Externalizing behaviour**				
			B	***SE***	***Beta***	***p***	***R^2***
EF (inhibition, planning, word fluency, DEX total score	Model 1	Constant	-2.702	1.416		.144	
		SRS social cognition	4.824	1.100	.205	.000	
		CBCL internalizing	.645	.052	.575	.000	.486
	Model 2	Constant	-.209	1.439		.885	
		SRS social cognition	-.883	.998	-.038	.377	
		CBCL internalizing	.443	.045	.396	.000	
		Inhibition	.001	.013	.003	.921	
		Planning	-.037	.029	-.043	.203	
		Word Fluency	.004	.039	.004	.915	
		DEX total score	.377	0,03	.555	.000	.668

Moderating role of social skills on the relation between social cognition, executive functioning and psychopathology

For the interpretation of main and interaction effects in moderation analyses, variables were centered first (variables were transformed into deviations from their own mean). Also, with regard to the several EF measures only the DEX-C total score was used as an EF-predictor in the moderation and mediation analyses because the direct EF-measures appeared to be non-significant predictors in the preliminary analyses. As can be seen in table 7, no moderation effects were found for social skills on the relationship between social cognition and internalizing and externalizing behaviour problems. Both models for both internalizing and

externalizing behaviour are non-significant and the interaction terms are also non-significant (internalizing behaviour: R^2-*change*=.000, *p*=.827, *F*(4,322)=80,147, β= -.009, $p > .05$ and externalizing behaviour: R^2-*change*=.001, *p*=.360, *F*(4.322)= 98,515, β= -.035, $p > .05$. As shown in table 8, no moderating role was found for social skills in the relationship between executive functioning and internalizing behaviour (R^2-*change*=.000, *p*=.807, *F* (4,320)= 73,889, interaction term: β=.010, *p*=.807). However, social skills were found to have a moderating role in the relationship between executive functioning and externalizing behaviour (R^2-*change*=.005, *p*=.026, *F*(4,320)=173,669, interaction term: β= .002, *p*=.026).

Table 7: Moderation analysis: social skills as a moderator in the relationship between social cognition and internalizing and externalizing behaviour.

			Internalizing behaviour					
		Predictor	***F (df, df)***	***B***	***SE***	***β***	***p***	***R^2***
Social cognition	Model 1	(constant)	107163 (3,323)**	1.931	.034		.000	
		Externalizing behaviour		.040	.003	.583	.000	
		Social cognition		.293	.078	.176	.000	
		Social skills		-.002	.003	-.035	.478	.499
	Model 2	(constant)	80.147 (4, 322)**	1.930	.034		.000	
		Externalizing behaviour		.040	.003	.581	.000	
		Social cognition		.292	.078	.176	.000	
		Social skills		-.002	.003	-.035	.478	
		Social cognition * social skills		-.001	.006	-.009	.827	.499
			Externalizing behaviour					
		Predictor	***F (df, df)***	***B***	***SE***	***β***	***p***	***R^2***
	Model 1	(constant)	131.139 (3, 323)**	5.075	.385		.000	
		Internalizing behaviour		.556	.049	.501	.000	
		Social cognition		2.667	1.081	.111	.014	
		Social skills		-.223	.034	-.285	.000	.549
	Model 2	(constant)	98.515 (4, 322)**	5.031	.388		.000	
		Internalizing behaviour		.548	.050	.494	.000	
		Social cognition		2.621	1.082	.109	.016	
		Social skills		-.223	.034	-.285	.000	
		Social cognition * social skills		-.081	.089	-.035	.360	.550

The negative interaction regression weight (*b*= -.005) indicates that the positive relationship between executive functioning and externalizing behaviour problems (more problems in executive functioning predicts more externalizing problems) becomes weaker with higher levels of social skills. As depicted in Figure 2, the interaction effect indicates that the positive relation between executive dysfunctioning and externalizing behaviour becomes more positive with lower levels of social skills. Thus, low social skills is associated with high executive dysfunctioning and externalizing behaviour problems and high levels of social skills is associated with lower levels of executive dysfunctioning and externalizing behaviour problems.

Table 8: Moderation analysis: social skills as a moderator in the relationship between executive functioning and internalizing and externalizing behaviour.

			Internalizing behaviour					
		Predictor	***F (df, df)***	***B***	***SE***	***β***	***p***	***R^2***
EF	Model 1	(constant)	98,788 (3, 321)**	1.913	.041		.000	
		Externalizing behaviour		.042	.004	.610	.000	
		EF (DEX-C)		.003	.003	.055	.376	
		Social skills		-.004	.003	-.068	.170	.4800
	Model 2	(constant)	73,889 (4,320)**	1.914	.041		.000	
		Externalizing behaviour		.042	.003	.613	.000	
		EF (DEX-C)		.003	.003	.066	.373	
		Social skills		-.004	.003	-.068	.176	
		EF*Social skills		.000005	.000	.010	.807	.480
			Externalizing behaviour					
		Predictor	***F (df, df)***	***B***	***SE***	***β***	***p***	***R^2***
	Model 1	(constant)	227,080 (3,321)**	5.991	.329		.000	
		Internalizing behaviour		.405	.042	.365	.000	
		EF (DEX-C)		.326	.028	.478	.000	
		Social skills		-.108	.030	-.137	.000	0,68
	Model 2	(constant)	173,669 (4,320)**	5.856	.333		.000	
		Internalizing behaviour		.387	.043	.349	.000	
		EF (DEX-C)		.319	.028	.467	.000	
		Social skills		-.111	.030	-.141	.000	
		EF*Social skills		-.005	.002	-.073	.026	.685

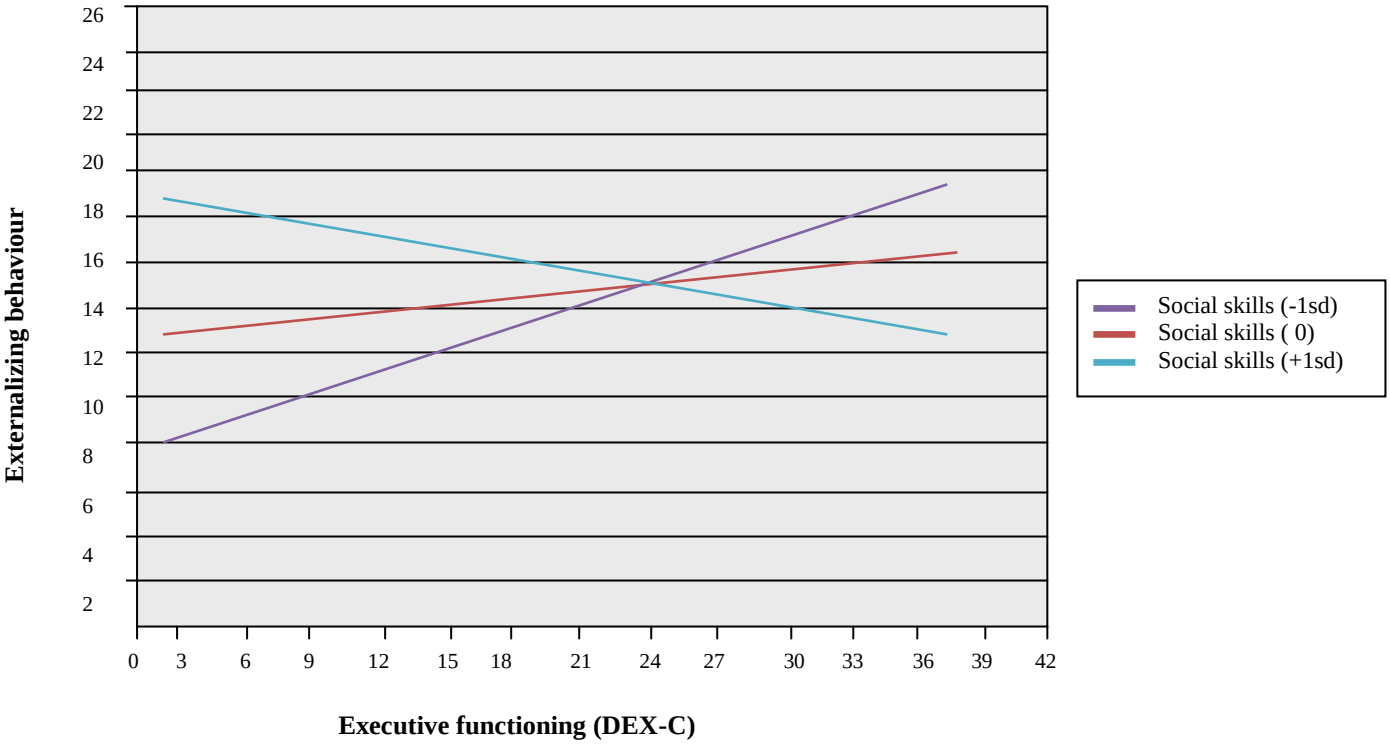

Figure 2: Interaction effect of social skills * executive functioning in externalizing behaviour

When examining the moderating role of executive functioning on the relationship between social cognition and psychopathology or the moderating role of social cognition on the relationship between executive functioning and internalizing and externalizing behaviour problems, the same model was specified (the same hierarchical multiple regression analysis was conducted). This is because moderation effects indicate that if a third variable 'Z' (social skills) moderates the X-Y relationship (for example social cognition-internalizing behaviours) that this is equivalent to X moderates Z-Y relationship. As can be seen in table 9, no moderation effects were found for social cognition/executive functioning on the relationship between executive functioning/social cognition and internalizing and externalizing behaviour problems: internalizing behaviour: R^2-*change*=.002, *p*=.354, *F*(3,324)=54,837, *β*= .047, *p* > .05 and externalizing behaviour: R^2-*change*=.002 *p*=.253, *F*(3,324)= 137,857, *β*= -.047, *p* > .05.

Table 9: moderating role of social cognition/executive functioning

			Internalizing behaviour					
		Predictor	***F (df, df)***	***B***	***SE***	***β***	***p***	***R^2***
EF-SC	Model 1	(constant)	81,860 (2,325)**	2,267	.021		.000	
		Social cognition (SRS)		.378	.092	.230	.000	
		EF (DEX-C)		.020	.003	.412	.000	.335
	Model 2	(constant)	54,837 (3,324)**	2.256	.024		.000	
		Social cognition (SRS)		.356	.095	.217	.000	
		EF (DEX-C)		.019	.003	.402	.000	
		EF*Social cognition		.006	.007	.047	.354	.337
			Externalizing behaviour					
		Predictor	***F (df, df)***	***B***	***SE***	***β***	***p***	***R^2***
	Model 1	(constant)	205,933 (2,325)**	8.378	.251		.000	
		Social cognition (SRS)		1.533	1.082	.065	.157	
		EF (DEX-C)		.485	.031	.708	.000	.559
	Model 2	(constant)	137,857 (3,324)**	8.228	.283		.000	
		Social cognition (SRS)		1.206	1.119	.051	.282	
		EF (DEX-C)		.478	.032	.698	.000	
		EF*Social cognition		.089	.078	.047	.253	.561

Mediating role of social skills

The mediating role of social skills has been examined separately for the relationships between social cognition- internalizing and externalizing behaviour and executive functioning and internalizing and externalizing behaviour. In the analyses for internalizing behaviour, externalizing behaviour was controlled for and vice versa. Also, in the analyses for social cognition, EF was controlled for and vice versa. Analyses with internalizing behaviour were conducted with the transformed variable. In table 10 and 11 results are presented from several linear regressions to examine the mediating role of social skills. As shown, the mediating role of social skills in the relation between social cognition and internalizing behaviour could not be demonstrated. Social skills appeared not to be related to internalizing behaviour (when controlling for social cognition and when forcing externalizing behaviour and EF in the first step): (β=-.032, p=.521). Therefore, no evidence exists for an indirect effect (*Sobel test statistic*: 0.660685, p=.251).

Table 10: Mediation analysis: social skills as a mediator in the relationship between social cognition and internalizing behaviour

Outcome variable		**Predictor**	***F (df,df)***	***B***	***SE***	***β***	***p***	R^2
Internalizing behaviour	X → Y	(constant)	104.979 (3, 324) **	-4.386	1.225		.000	
		Externalizing		.556	.054	.618	.000	
		EF		-.035	.040	-.057	.379	
		SC		4.577	1.049	.215	.000	.493
Social skills	X → Z	(constant)	62.475 (3, 321) **	114.546	1.968		.000	
		Externalizing		-.405	.085	-.319	.000	
		EF		-.167	.063	-.193	.009	
		SC		-5.810	1.689	-.190	.001	.369
Internalizing behaviour		(constant)	77.621 (4,320) **	-2.015	4.622		.637	
		Externalizing		.547	.056	.606	.000	
		EF		-.042	.041	-.069	.300	
Control for X	Z → Y	Social skills		-.023	.036	-.032	.521	
Control for Z	X → Y	SC		4.672	1.096	.216	.000	.492

** Correlation is significant at the 0.01 level (two-tailed) * Correlation is significant at the 0.05 level (two-tailed)

Results from mediation analyses as presented in Table 11 indicate no evidence for social skills to be a (partial) mediator in the relation between social cognition and externalizing behaviour problems. When forcing EF and internalizing behaviour in the first step, social cognition appeared not to be related to externalizing behaviour (β=-.038, p=.351). Social cognition did significantly predict social skills (β=-.168, p=.004) and when controlling for social cognition, social skills appeared to be a significant predictor of externalizing behaviour (β=-.148, p <.001). However, in the final step when controlling for social skills, social cognition still was not a significant predictor: β=-.069, p=.092). Therefore, no evidence exists for an indirect effect (*Sobel test statistic*: 2.289866, p=.220).

Table 11:Mediation analysis: social skills as a mediator in the relationship between social cognition and externalizing behaviour

Outcome variable		**Predictor**	***F (df,df)***	***B***	***SE***	***β***	***p***	R^2
Externalizing behaviour	X → Y	(constant)	218.332 (3,324) **	-.090	1.121		.936	
		Internalizing		.449	.043	.404	.000	
		EF		.379	.029	.554	.000	
		SC		-.903	.968	-.038	.351	.669
Social skills	X → Z	(constant)	55.315 (3,321)**	114.246	2.053		.000	
		Internalizing		-.223	.078	-.158	.004	
		EF		-.311	.052	-.359	.000	
		SC		-5.142	1.776	-.168	.004	.341
Externalizing behaviour		(constant)	172.012 (4,320) **	13.410	3.665		.000	
		Internalizing		.421	.043	.379	.000	
		EF		.345	.030	.506	.000	
Control for X	Z → Y	Social skills		-.116	.031	-.148	.000	
Control for Z	X → Y	SC		-1.664	.984	-.069	.092	.683

** Correlation is significant at the 0.01 level (two-tailed) * Correlation is significant at the 0.05 level (two-tailed)

Results presented in table 12 indicate that social skills have no mediating role in the relation between executive functioning and internalizing problems. Executive functioning was not related to internalizing problems (β=.057,p=.379) but was related to social skills (β= -.193, p=.009). However, social skills were not related to internalizing problems (controlling for EF and when forcing externalizing behaviour and social cognition in the first step): β=-.032, p=.521. EF was no significant predictor of internalizing problems when controlling for social skills. The Sobel test indicated no indirect effect: *Sobel test statistic*= 1.274084, p= .206). As shown in table 13, the relation between executive functioning and externalizing behaviour is partially mediated by social skills. The indirect effect was demonstrated by the relation between EF and externalizing behaviour (β=-.554, p<.001), the relation between EF and social skills (β=-.359, p<.001) and the relation between social skills and externalizing behaviour (when controlling for EF and when forcing internalizing problems and social cognition in the first step). The partial mediation is demonstrated by the relation between executive functioning and externalizing problems when controlling for social skills (β=-.506, p<.001). The indirect effect is significant (*Sobel test statistic:* -6.652695, p<.001). Of the total

effect, 11,1% is due to the indirect effect of executive functioning via social skills on externalizing behaviour problems.

Table 12: Mediating role of social skills in the relation between executive functioning and internalizing behaviour problems

Outcome variable		**Predictor**	***F (df,df)***	***B***	***SE***	***β***	***p***	***R^2***
Internalizing behaviour	X → Y	(constant)	104.979 (3,324) **	-4.386	1.225		.000	
		Externalizing		.556	.054	.618	.000	
		SC		4.577	1.049	.215	.000	
		EF		-.035	.040	-.057	.379	.493
Social skills	X → Z	(constant)	62,475 (3,321) **	114.546	1.968		.000	
		Externalizing		-.405	.085	-.319	.000	
		SC		-5.810	1.689	-.190	.001	
		EF		-.167	.063	-.193	.009	.369
Internalizing behaviour		(constant)	77, 621 (4,320)**	-2.015	4.662		.637	
		Externalizing		.547	.056	.606	.000	
		SC		4.672	1.096	.216	.000	
Control for X	Z → Y	Social skills		-.023	.036	-.032	.521	
Control for Z	X → Y	EF		-.042	.041	-.069	.300	.492

** Correlation is significant at the 0.01 level (two-tailed) * Correlation is significant at the 0.05 level (two-tailed)

Table 13: Mediating role of social skills in the relation between executive functioning and externalizing behaviour problems

Outcome variable		**Predictor**	***F (df,df)***	***B***	***SE***	***β***	***p***	***R^2***
Exernalizing behaviour	X → Y	(constant)	218. 332 (3,324) **	-.090	1.121		.936	
		Internalizing		.449	.043	.404	.000	
		SC		-.903	.968	-.038	.351	
		EF		.379	.029	.554	.000	.669
Social skills	X → Z	(constant)	55.315 (3,321) **	114.246	2.053		.000	
		Internalizing		-.223	.078	-.158	.004	
		SC		-5.142	1.776	-.168	.004	
		EF		-.311	.052	-.359	.000	.341
Externalizing behaviour		(constant)	172.012 (4,320) **	13.410	3.665		.000	
		Internalizing		.421	.043	.379	.000	
		SC		-1.664	.984	-.069	.092	
Control for X	Z → Y	Social skills		-.116	.031	-.148	.000	
Control for Z	X → Y	EF		.345	.030	.506	.000	.683

** Correlation is significant at the 0.01 level (two-tailed) * Correlation is significant at the 0.05 level (two-tailed)

Mediating role of executive functioning

As can be seen in table 14, there are no indications of executive functioning to mediate the relation between social cognition and internalizing problems. In table 15 the results from mediation analysis are demonstrated which indicate that the relation between social cognition and externalizing behaviour problems is completely mediated by executive functioning. The indirect effect was demonstrated by the relation between social cognition and externalizing behaviour (β=-.205, p<.001), by the relation between social cognition and executive functioning (β=-.436, p<.001) and by the relation between executive functioning and externalizing behaviour when controlling for social cognition (β=-.554, p<.001). In the last step of the mediation analysis, social cognition appears not to be related to externalizing when controlling for executive functioning (β=-.038, p=.351) indicating full mediation.

Table 14: Mediating role of executive functioning in the relation between social cognition and internalizing behaviour problems

Outcome variable		**Predictor**	***F (df,df)***	***B***	***SE***	***β***	***p***	***R^2***
Internalizing behaviour	X → Y	(constant)	157,193 (2,327)**	-4.245	1.216		.001	
		Externalizing		.524	.041	.583	.000	
		Social cognition		4.203	.961	.197	.000	.490
EF	X → Z	(constant)	271,455 (2,325)**	-3.011	1.698		.077	
		Externalizing		.877	.057	.601	.000	
		Social cognition		10.406	1.342	.301	.000	.626
Externalizing behaviour		(constant)	104,979 (3,324)**	-4.386	1.225		.000	
		Externalizing		.556	.054	.618	.000	
Control for X	Z → Y	EF		-.035	.040	-.057	.379	
Control for Z	X →Y	Social cognition		4.577	1.049	.215	.000	.493

** Correlation is significant at the 0.01 level (two-tailed) * Correlation is significant at the 0.05 level (two-tailed)

Table 15: Mediating role of executive functioning in the relation between social cognition and externalizing behaviour problems

Outcome variable		**Predictor**	***F (df,df)***	***B***	***SE***	***β***	***p***	***R^2***
Externalizing behaviour	X → Y	(constant)	158,819 (2,327)**	-2.115	1.369		.123	
		Internalizing		.646	.050	.580	.000	
		Social cognition		4.862	1.064	.205	.000	.493
EF	X → Z	(constant)	121,825 (2,325)**	-5,178	2.129		.016	
		Internalizing		.523	.078	.322	.000	
		Social cognition		15.98	1.654	.436	.000	.428
Externalizing behaviour		(constant)	218,332 (3,324)**	-.090	1.121		.936	
		Internalizing		.449	.043	.404	.000	
Control for X	Z → Y	EF		.379	.029	.554	.000	
Control for Z	X →Y	Social cognition		-.903	.968	-.038	.351	.669

** Correlation is significant at the 0.01 level (two-tailed) * Correlation is significant at the 0.05 level (two-tailed)

Mediating role of social cognition

As shown in Table 16 and 17, no mediation effects were found for social cognition on the relation between executive functioning and psychopathology.

Table 16: Mediation analysis: social cognition as a mediator in the relation between executive functioning and internalizing problems.

Outcome variable		**Predictor**	***F (df,df)***	***B***	***SE***	***β***	***p***	***R^2***
Internalizing behaviour	X → Y	(constant)	140,162 (2,325)**	.459	.532		.389	
		Externalizing		.575	.055	.639	.000	
		EF		.034	.038	.055	.372	.463
Social cognition	X → Z	(constant)	88,519 (2,325)**	1.058	.027		.000	
		Externalizing		.004	.003	.095	.157	
		EF		.015	.002	.520	.000	.353
Externalizing behaviour		(constant)	104,979 (3,324)**	-4.386	1.225		.000	
		Externalizing		.556	.054	.618	.000	
Control for X	Z → Y	Social cognition		4.577	1.049	.215	.000	
Control for Z	X →Y	EF		-.035	.040	-.057	.379	.493

** Correlation is significant at the 0.01 level (two-tailed) * Correlation is significant at the 0.05 level (two-tailed)

Table 17: Mediation analysis: social cognition as a mediator in the relation between executive functioning and externalizing behaviour.

Outcome variable		**Predictor**	***F (df,df)***	***B***	***SE***	***β***	***p***	***R^2***
Externalizing behaviour	X → Y	(constant)	327,193 (2,325)**	-1.043	.462		.025	
		Internalizing		.439	.042	.395	.000	
		EF		.367	.026	.536	.000	.668
Social cognition	X → Z	(constant)	102,564(2,325)**	1.056	.026		.000	
		Internalizing		.011	.002	.231	.000	
		EF		.014	.001	.468	.000	.387
Externalizing behaviour		(constant)	218,332 (3,324) **	-.090	1.121		.936	
		Internalizing		.449	.043	.404	.000	
Control for X	Z → Y	Social cognition		.903	.968	-.038	.351	
Control for Z	X →Y	EF		.379	.029	.554	.000	.669

** Correlation is significant at the 0.01 level (two-tailed) * Correlation is significant at the 0.05 level (two-tailed)

Discussion

The aim of the present study was to examine the neuropsychological correlates of psychopathology and the moderating and mediating influence of social skills in a sample of typically developing children aged 5-to-7 years. First, it was hypothesized that social cognition and executive functioning would be highly correlated with and independently predictive to social skills. Social cognition, executive functioning and social skills were expected to correlate negatively with both internalizing and externalizing behaviour problems. Next, it was hypothesized that social cognition, executive functioning and social skills were significant predictors of psychopathology. The third hypothesis applied to the possible moderating and/or mediating role of social skills in the relationships between social cognition, executive functioning and psychopathology and the possible moderating and/or mediating role of executive functioning in the relation between social cognition and psychopathology and vice versa. It was expected that the level of social skills determines the strength of the relation between social cognition, executive function and psychopathology (interaction effect). Social cognition and executive functioning were also expected to predict social skills, which in turn would predict psychopathology (additive effect). Finally, the level of social cognition was expected to influence the relation between executive functioning and psychopathology and social cognition was expected to function as a mediator in the relation between executive functioning and psychopathology. Relations between neuropsychological

functioning, social skills and psychopathology have not been clearly demonstrated empirically in previous studies.

Relationships among social cognition, executive functioning, social skills and psychopathology

The relationship between social cognition and executive functioning has been demonstrated by many studies. The current study also indicated that social cognition and executive functioning are associated. This is in concordance with results from previous studies (Carlson, Moses & Breton, 2002; Carlson, Mandell & Williams, 2004; Hughes & Ensor, 2005). Some of the direct (empirical) measurements were related but especially the daily life measures indicated the relationship between social cognition and executive functioning. BADS-C zoo (planning) and word fluency were negatively correlated with externalizing problems whereas inhibition was positively correlated with externalizing problems. Low scores on planning are linked to externalizing behaviour problems, probably because poor planning abilities negatively influence strategy selection and make it difficult for children to generate prosocial solutions to problems (Ellis et al., 2009). Inhibition was positively associated with externalizing problems, a result that is consistent with previous findings showing that low levels of regulation are associated with and predictive of externalizing problem behaviours (Martel, Nigg, Wong, Fitzgerald, Jester, et al., 2007; Ellis et al., 2009; Blair, Zelazo & Greenberg, 2005). When children in the current sample had low word fluency skills (indicating low verbal memory skills and low ability of generating ideas), they showed significantly more externalizing and internalizing problems. Low verbal skills and difficulties with (cognitive) flexibility and generating ideas are associated with problems in the social domain (Wenar & Kerig, 2006). Also, Corbett, Constantine, Hendren, Rocke & Ozonoff (2009) report in their study that children with autism spectrum disorders showed profound deficits in cognitive flexibility next to deficits in inhibition and working memory. The association found between word fluency and psychopathology is, however, in contrast with the findings of Tacher and Readdick (2006) who indicated possible associations between verbal fluency, flexibility and originality with aggression. The children in their sample appeared to show verbal and postural aggressive behaviour to cope with difficult situations. To fend off a perceived interloper, children tended to utilize their verbal fluency and flexibility. Problems in the domain of executive functioning in daily life as reported by parents (DEX-C) appeared to be positively related to both internalizing and externalizing

behaviour and thereby demonstrating that executive dysfunctioning co-occurs with behaviour problems. This results is in concordance with previous studies (Ellis, et al., 2009; Martel, et al., 2007; Blair, Zelazo & Greenberg, 2006). However, the current study is one of the few in which an indirect measure of executive functioning was included.

Social skills were negatively correlated to DEX-C and SRS social cognition indicating that children with poor social skills exhibited more problems in executive functioning and social cognition as rated by their parents. Social skills showed significant positive relationships with some of the direct measures (Word Fluency, Emotion recognition and SCST) indicating that when children have adequately developed social skills they also tend to have better verbal memory, emotion recognition and ToM skills. Finally, social skills were shown to be negatively associated with both internalizing and externalizing psychopathology which is in concordance with previous studies (Beauchamp & Anderson, 2010; Beidel et al., 2010).

Predictive relations among social cognition, executive functioning, social skills and psychopathology

Results indicated that social cognition predicted internalizing behaviour above and beyond the effect of externalizing behaviour. Because internalizing and externalizing were simultaneously examined in the current study, this result expands on the results of Zobel and colleagues (2010) and Luebbe and colleagues (2010). The result suggests the unique contribution of social cognition to the development of internalizing behaviour problems (despite the high associations of social cognition with EF and the high associations of internalizing problems with externalizing problems). No predictive effect was found for one of the (direct or indirect) EF measures which is in contrast with the hypothesis and with previous studies (Rhoades, Greenberg & Domitrovich, 2009; Beauchamp & Anderson, 2010; Beidel et al., 2010). With regard to externalizing behaviour, social cognition (SRS social cognition) and executive functioning (DEX-C) were found to be significant predictors, which is in line with the literature (Zadeh et al., 2007; Loeber & Hay, 1997; Groeben et al., 2011). Further analyses indicated that, whereas executive functioning predicted externalizing behaviour above and beyond the effect of internalizing behaviour and when controlling for social cognition, the predictive effect of SRS social cognition disappeared. The last results suggest a non-specific, possibly indirect effect of social cognition on externalizing problems.

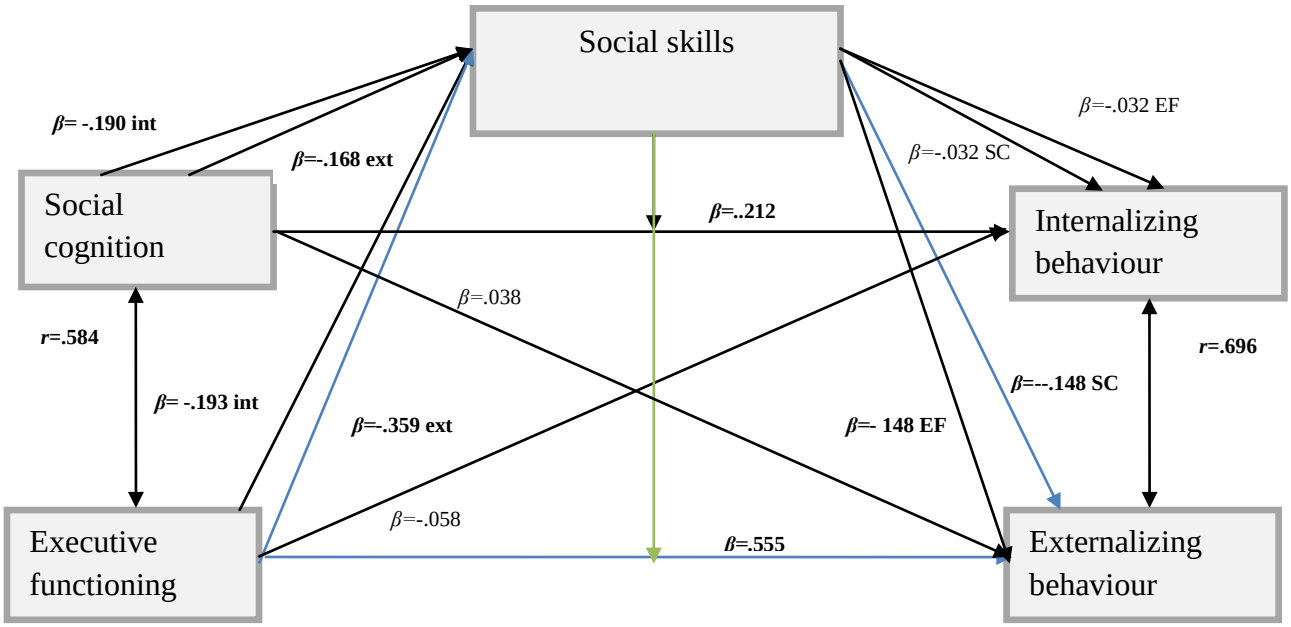

Figure 3: Predictive relationships between executive functioning, social cognition, internalizing and externalizing behaviour and the moderating/mediating role of social skills (results from correlations, hierarchical multiple regression analyses and mediation analyses). Bold results are significant.

Moderating and partial mediating role of social skills on EF and psychopathology

In contrast with the hypotheses, social skills also did not function as a moderator in the relationship between executive functioning and internalizing behaviour problems. In this model (when controlling for externalizing behaviour), executive functioning appeared not to be a significant predictor of internalizing behaviour, a result which is in contrast with previous studies (Hirshfeld-Becker, Biederman, Henin, Faraone, Davis et al., 2007; Rhoades, Greenberg & Domitrovich, 2009).

However, a moderation effect was found for social skills on the relationship between executive functioning and externalizing behaviour (depicted by the green line in Figure 3). In concordance with previous studies, the direct relationship of executive functioning and externalizing behaviour (Loeber & Hay, 1997; Ellis, Weiss & Lochman, 2009) and of social skills and externalizing behaviour was demonstrated (Groeben et al., 2011) as well. The

moderation effect indicates that children with inadequately developed EF and who are thus at risk for developing externalizing behaviour problems, will be even more vulnerable to deviant behaviour outcomes if they have low social skills. Social skills could function as a 'buffer' indicating that when children are trained in social skills, this could positively influence behavioural outcome if children experience deficits in executive functioning. Social skills should therefore be targeted in for interventions for children who experience problems in executive functioning and who are at risk for developing externalizing behaviour problems. Several studies have already reported on the effects of social skills training for children with psychiatric disorders characterized by deficits in executive functioning. Antshel and Remer (2003) evaluated the efficacy of a social skills training for children diagnosed with ADHD-Inattentive type and ADHD-Combined type. Compared to the typically developing children in the control group, the children diagnosed with both types of ADHD significantly improved in social skills, specifically in assertion skills. Haas, Waschbusch, Pelham, King, Andrade et al. (2011) also found that social skills training helped reducing conduct problems and ADHD, with children who also had callous-unemotional traits showing poorer treatment response compared to children without callous-unemotional traits. This study also indicated the influence of social skills training in children diagnosed with psychiatric disorders with deficits in executive functioning (conduct problems and ADHD).

In the present study, a partial mediation effect was found for social skills on the relationship between executive functioning and externalizing behaviour, which was in concordance with the hypothesis. With regard to internalizing behaviour no mediation effect was found. The partial mediation effect (depicted by the blue line in Figure 3) was demonstrated by indicating a significant predictive relation between executive functioning and social skills, between social skills (together indicating the indirect effect) and externalizing behaviour and between executive functioning and externalizing behaviour (indicating the direct effect).

Moderating and partial mediating role of social skills in the relationship between social cognition and psychopathology

In contrast with the hypotheses, social skills appeared to have no moderating role in the relation between social cognition and internalizing/externalizing behaviour problems. In the moderation models it was demonstrated that social cognition did predict internalizing problems, which is in concordance with previous studies (Zadeh, Im-Bolter & Cohen, 2007; Luebbe, et al., 2010; Scourfield, Martin, Eley & McGuffin, 2004). However, social cognition

did not predict externalizing behaviour which is in contrast with previous research (Oliver, Barker, Mandy, Skuse & Maughan, 2011). The interaction of social skills and social cognition appeared to be non-significant in the relation with psychopathology. The results for the mediating role of social skills in the relation of social cognition and psychopathology mimicked the results found in the moderation models: with regard to both internalizing and externalizing behaviour no mediation effects were found.

Social skills could not be identified as a mediator between social cognition and internalizing behaviour due to lack of associations among social skills and internalizing behaviour. The direct effect of social cognition could be demonstrated; however there was no evidence for an indirect effect of social cognition through social skills. With regard to externalizing behaviour, the direct effect of social cognition could not be demonstrated when controlling for EF and internalizing behaviour which is in contrast with previous studies (Oliver et al., 2011; Zadeh, Im-Bolter & Cohen, 2007). These results could possibly be explained by the fact that deficits in more specific social skills may be related to psychopathology. Galway and Metsala (2011) demonstrated in their study that in children diagnosed with NLD, specifically social problem solving skills predicted social-emotional maladjustment (including internalizing problems). Possibly, if social skills had been refined more into several kinds of social skills in the current study, the expected results might have been found.

In contrast with the hypothesis, social skills were not found to be a mediator in the relation between social cognition and externalizing behaviour either. Both the direct and indirect effect were non-significant. These results could possibly be explained by results from subsequent analyses in which the mediating role of executive functioning on the relationship between social cognition and externalizing behaviour was tested. Results from this mediation model showed that the influence of social cognition on externalizing behaviour was fully mediated by executive functioning. From this it can be hypothesized that the direct effect of social cognition on externalizing behaviour is only present due to shared variance of social cognition and executive functioning. Because social cognition apparently influences externalizing behaviour through executive functioning, controlling for executive functioning in the mediation model possibly resulted in the fact that a mediating role of social skills in the relation between social cognition and externalizing behaviour could not be demonstrated.

Moderating and mediating effect of social cognition and executive functioning

In the current study it was also examined whether social cognition and executive functioning influenced each other in their relationship with psychopathology.

Moderation analyses for executive functioning on the relationship between social cognition and psychopathology or for social cognition on the relationship between executive functioning and internalizing and externalizing behaviour problems, indicated no significant results.

Mediating analyses indicated no effect for a mediating role of social cognition in the relationship between executive functioning and psychopathology. However, the mediating role of executive functioning in the relation between social cognition and externalizing behaviour was demonstrated (Figure 4).

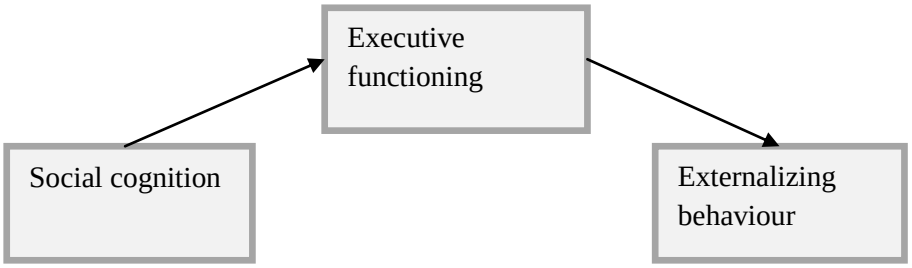

Figure 4: Full mediation effect of EF on the relation social cognition- externalizing behaviour

Specifically for externalizing behaviour problems, social cognition deficits appear to function as a precursor via executive dysfunctioning. The fact that the relation between social cognition and externalizing behaviour problems involves problems in the domain of executive functions, may have consequences for early interventions. Treatment for children showing externalizing problems and poorly developed social cognitive functions, should focus on improving or training executive functions such as planning ability, inhibitory control and word fluency.

Limitations

When interpreting the results from the current study, several limitations should be taken into account. A limitation of the study refers to the low correlations between the direct (empirical measures) and the daily life measures. Although it might have been possible to generate a total score for the social cognition measures, it didn't seem possible to generate one total EF score due to few and low correlations among the direct measures and of the direct measures

with the daily life measure DEX-C. Only the daily life measures showed significant results in the simple linear and the hierarchical multiple regression analyses (except for emotion recognition which was a significant predictor of both internalizing and externalizing behaviour). This could possibly indicate that the construct validity of the empirical measurements was limited; otherwise the same results would have been obtained for the empirical measurements as the daily life measurements. The results indicate that although measuring the same construct, indirect and direct measures may not be related. Another limitation of the study refers to the sample consisting of typically developing children. Due to low occurrence of internalizing and externalizing behaviour problems (low differentiation in these two variables), the strength of associations was quite small. Especially internalizing problems seemed to have a low incidence which might have led to low associations and predictive relations.

Conclusions and future recommendations

In conclusion, the current study has expanded on previous studies by examining the influence of social skills on relationships among neuropsychological functioning and psychopathology. The study has indicated the importance of social skills specifically for the relationship between neuropsychological precursors and externalizing behaviour problems. Furthermore, the results have expanded the view on the development and relation of social cognition and executive functioning by demonstrating the full mediation of associations between social cognition and externalizing behaviour by executive functioning.

More knowledge on neuropsychological and related (behavioural) constructs such as social skills improves screening for possible precursors of problem behaviour, identifying children at risk for developing psychopathology. To further examine the proposed relationships between social cognition, executive functioning, social skills and psychopathology, future studies should also take clinical samples into account. For example, studies examining children diagnosed with disruptive behaviour disorders such as ADHD, Oppositional Defiant Disorder or Conduct Disorder, but also children diagnosed with more internalizing psychiatric disorders such as depression and anxiety disorders. Furthermore, it would be informative to examine specific psychiatric disorders as outcome measures instead of the overall constructs of internalizing and externalizing behaviour problems. Further refinements in the outcome measures would lead to more knowledge on the developmental pathway towards maladaptive functioning. It would also be informative to examine the effects

of several kinds of executive functioning and social cognition measures. Unfortunately, the current study has not been able to demonstrate the effects of direct measures of executive functioning and social cognition. Also, the relationship of executive functioning and social cognition with internalizing behaviour could not have been demonstrated. The differences and effects of the use of direct and indirect measures should therefore be another focus of future studies. Finally, future studies can possibly determine whether the development of neuropsychological mechanisms related to psychopathology continues or in what way it changes throughout childhood and adolescence.

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