British Journal of Developmental Psychology (2011), 29, 612–634

The British Psychological Society

www.wileyonlinelibrary.com

The structure of effortful control in preschoolers and its relation to externalizing problems

Lisette M. A. Gusdorf, Annemiek Karreman*, Marcel A. G. van Aken, Maja Deković and Cathy van Tuijl

Utrecht University, The Netherlands

The first aim of the present study was to examine the structure of effortful control. The second aim was to determine whether components of effortful control relate to conduct problems and hyperactivity. Effortful control was measured in 3-year-old children ($N = 89$) with an observational measure, the effortful control battery (ECB), and a parent report, the Children's Behaviour Questionnaire (CBQ). Principal component analysis showed that the ECB measures five components, assessing two higher-order constructs, which can be labelled as Self-Control and Attention/Motor Control. The five scales of the CBQ appeared to measure one construct – a more general measure of effortful control. The components and constructs of the ECB as well as the scales of the CBQ were differently related to conduct problems and hyperactivity. Conduct problems were most strongly predicted by observed Delay of Gratification and parent-reported Inhibitory Control, whereas Hyperactivity was most strongly predicted by observed Delay of Gratification, and the higher-order construct Attention/Motor Control, as well as parent-reported Attentional Focusing and Inhibitory Control. It is important to keep in mind that effortful control is composed of heterogeneous components, all having their own unique values.

Effortful control, the ability to inhibit a dominant response and activate a subdominant response, is implicated in multiple developmental processes and is considered to be a key characteristic in socialization (Murray & Kochanska, 2002; Rothbart, Ellis, Rueda, & Posner, 2003). There is a body of research on effortful control, and studies have demonstrated its importance for concurrent and later externalizing problems (Kochanska & Knaack, 2003; Valiente *et al.*, 2003). Studies increasingly focused on the structure of the effortful control construct, i.e., whether it is a one-dimensional construct or that it consists of related components, such as delaying, effortful attention, and suppressing (Murray & Kochanska, 2002; Rothbart, Ahadi, Hershey, & Fisher, 2001). However, further evidence on this important topic is needed, connecting cognitive and temperament approaches to effortful control, and studying their contributions to

*Correspondence should be addressed to Dr Annemiek Karreman who is now at Tilburg University; Department of Developmental, Clinical and Crosscultural Psychology, Tilburg University, PO Box 90153, 5000 LE Tilburg, The Netherlands (e-mail: a.karreman@uvt.nl).

DOI:10.1348/026151010X526542

conduct and hyperactive components of externalizing problems (see also Barkley, 1997, for a related clinical theory).

The present study has two foci. The methodological focus concerns the investigation of the structure of effortful control in 3-year-old children; the theoretical focus concerns the study of how specific components of effortful control are related to conduct problems and hyperactivity in these children.

Effortful control

Effortful control is the self-regulatory aspect of temperament, playing a fundamental role in various aspects of life: expression of emotions, modulation (e.g., maintenance, activation, inhibition) of emotion-related activities, internalization of rules, and self-regulation (Eisenberg *et al.*, 2005; Kochanska, Murray, & Harlan, 2000). Effortful control has a genetic basis, but is also shaped by experience in the social world (Eisenberg *et al.*, 2005). Rapid development of the frontal cortex at the end of the first year appears to be important for coordinating and controlling attention, which can be considered as a precursor of effortful control (Kochanska *et al.*, 2000; Nigg, 2000). Between 12 and 18 months of age, children become aware of social demands and able to comply with parental requests (Kochanska, Coy, & Murray, 2001). By the age of 2 years, children have developed the ability to inhibit responses (Posner & Rothbart, 2000), and at the age of three children become capable of self-regulation or behaviour that is totally modulated by the child and that meets social demands. From this age, the rank ordering of children with respect to their level of effortful control is assumed to be relatively stable (Kochanska *et al.*, 2001; Kochanska & Knaack, 2003), but the average level of effortful control continues undergoing developmental change (Davies, Segalowitz, & Gavin, 2004). Effortful control is considered to be a precursor of later personality (Rothbart *et al.*, 2001).

Many constructs resembling effortful control circle in the literature, pertaining to cognitive or neuropsychological models (focusing on executive functions and specific brain circuits), and personality or temperament models (representing a more general level of analysis) (Nigg, 2000). Although these models are generally examined separately, Nigg (2000) provided an overarching taxonomy linking cognitive, neural, and temperament views. According to this taxonomy, Rothbart's temperamental concept of effortful control can be linked to executive functions and to neurological regions reflecting prefrontal cortical circuits (Nigg, 2000; Martel & Nigg, 2006). Barkley (1997) furthermore developed a theory in which executive functions depend on more temperament-based inhibition.

Effortful control battery

For the measurement of executive functions in young children different instruments have been used pertaining to the cognitive, neuropsychological view on effortful control: cognitive tempo tasks, slow-down tasks, delay tasks, and go–no go tasks. Ideally, researchers would replicate basic findings on effortful control regardless of the specific task set. However, the problem with these tasks is that the procedure differs among studies. Therefore, Kochanska *et al.* (2000) constructed a standardized observational measure: the effortful control battery (ECB). According to Kochanska and colleagues it is possible to break effortful control down into five components (see Table 1, first column). The ECB of Kochanska *et al.* (2000) assesses these functions, appealing to similar and

Table 1. Components, tasks, and scales of effortful control according to ECB (Kochanska *et al.*, 2000) and CBQ (Rothbart *et al.*, 2000, 2001)

Observation battery ECB		Parent report measure CBQ	
Theoretical components	Tasks of ECB	Theoretical components	Scales of CBQ
Delaying	Snack Delay Tongue Task Dinky Toys Wrapped Gift Gift-in-Bag	Inhibitory Control	Inhibitory Control
Effortful attention	Shapes Task	Attentional Control/Focusing	Attentional Focusing
Suppressing or initiating activity to signal	Tower Task		
Slowing down motor activity	Turtle-and-Rabbit		
	Walk-a-Line-Slowly Drawing Task		
Lowering voice	Whisper Task		
		Activation Control	Low Intensity Pleasure Perceptual Sensitivity Smiling/Laughter

Note. Components, tasks, and scales in the same row are expected to correspond based on their theoretical resemblance.

overlapping attention-based components of executive functions, with 11 different tasks (see Table 1, second column).

The ECB tasks appear to reflect a highly coherent underlying broad competence (Kochanska *et al.*, 2000). Effortful control as measured by ECB tasks is internally consistent and correlates with mother reports of effortful control in their children (Karreman, Van Tuijl, Van Aken, & Dekovic, 2008; Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996). In most studies, an aggregate score of effortful control is computed, but studies have used the ECB in different ways, some using all 11 tasks (Kochanska *et al.*, 2000), others using some of the tasks (Olson, Sameroff, Kerr, Lopez, & Wellman, 2005), or measuring the delay component of effortful control only (Aksan & Kochanska, 2004).

Studies that used tasks to measure cognitive flexibility and executive function found moderate correlations among subcomponents, but factor analysis provided evidence against a unitary nature, suggesting that it is important to recognize both the unity and diversity of these constructs (Deák, 2003; Miyake *et al.*, 2000). After age 5, components of executive functioning are generally moderately correlated but separable, and there appears to be neural support for unity and diversity in executive functions (Best, Miller, & Jones, 2009). A core attention system is considered to serve as a foundation of components of executive functions, which are generally labelled as working memory, inhibition, and shifting (Garon, Bryson, & Smith, 2008). Murray and Kochanska (2002) performed a factor analysis of the ECB in which an underlying four-factor structure had been found: delay, gross-motor control, fine motor control, and suppress/initiate. However, they used a battery, lacking the task that comprised the fifth factor of

Kochanska *et al.* (2000) – effortful attention. In the current study, we provide further evidence of the structure of effortful control. We expect that the behavioural tasks of the ECB measure diverse constructs of effortful control – the five components that formed the basis for the ECB (Table 1, first and second column). The five components together are expected to form the unitary construct effortful control.

Children's Behaviour Questionnaire

In line with broader temperament models, Children's Behaviour Questionnaire (CBQ), developed by Rothbart *et al.* (2001), has generally been used as caregiver report on children's effortful control. According to Rothbart, Ahadi, and Evans (2000), effortful control includes three different components: inhibitory control, attentional focusing/attentional control, and activation control (see Table 1, third column). Inhibitory control is the capacity to voluntarily inhibit behaviour and the capacity to resist inappropriate approach tendencies. Attentional focusing or attentional control is the capacity to intentionally shift and focus attention (Valiente *et al.*, 2003). Activation control is the capacity to voluntarily activate behaviour and the capacity to resist inappropriate avoidance tendencies (Rothbart, 1989).

The CBQ consists of 15 scales, clustering reliably into three factors: Effortful Control, Negative Affectivity, and Extraversion/Surgency (e.g., Rothbart *et al.*, 2001). The factor Effortful Control consists of five different scales (see Table 1, fourth column), which we theoretically connected to the different components of the ECB in Table 1. Both Inhibitory Control of the CBQ and Delaying of the ECB consist of the capacity to plan and to suppress dominant responses. The tendency to maintain attentional focus (Attentional Focusing of the CBQ) is linked with the other four components of the ECB, all requiring the capacity to maintain attention (Kochanska & Knaack, 2003; Rothbart *et al.*, 2001). The last three scales of the CBQ (Low Intensity Pleasure, Perceptual Sensitivity, and Smiling/Laughter) cannot be clearly linked to the components of the ECB. These three scales can be considered as reflecting a more general temperament way of thinking about effortful control, whereas the other scales represent executive functions (Nigg, 2000). However, Rothbart *et al.* (2001) speculated that alerting systems supporting the scale Smiling/Laughter may also support underlying executive attention processes.

Different scales of the CBQ have been used to measure effortful control. In some studies, two scales have been used – Inhibitory Control and Attentional Focusing – because these scales have been suggested to be the most theoretically and empirically salient components of the construct (Eisenberg *et al.*, 2003; Olson *et al.*, 2005). Furthermore, as with the ECB, most studies that used the CBQ computed a composite, aggregate score of the five scales of effortful control (e.g., Eisenberg *et al.*, 2003; Olson *et al.*, 2005). Therefore, we investigate the factor structure of the CBQ in this study. We hypothesize that the five scales of the CBQ assess one higher-order construct. Furthermore, we examine how the five scales separately relate to components of the ECB. We hypothesize that the scales of the CBQ correlate highly with theoretically corresponding components of the ECB (Table 1).

Relations between effortful control and externalizing problems

Effortful control is a key developmental construct to examine in studies on young children who are at risk for externalizing problems (Olson *et al.*, 2005). Moderate levels of effortful control reflect more adaptive functioning or fewer problem behaviours;

lower levels of effortful control (observation and mothers' rating) have been related to more externalizing problems such as aggression, inattention, and hyperactivity (Krueger, Caspi, Moffitt, White, & Stouthamer-Loeber, 1996; Murray & Kochanska, 2002; Olson *et al.*, 2005). Some researchers have argued that deficits in effortful control are the central impairment in attention-deficit hyperactivity disorder (ADHD; Murray & Kochanska, 2002). In most of these studies, composite scores have been used for effortful control and externalizing problems (Murray & Kochanska, 2002; Olson *et al.*, 2005), an approach which can result in loss of information (Tabachnick & Fidell, 2007). Miyake *et al.* (2000) found that components of the related construct executive functioning contribute differently to performance on complex frontal lobe tasks, and components of effortful control may differently affect categories of externalizing problems as well. In the current study, we examine two categories of externalizing problems – conduct problems and hyperactivity – separately. Conduct problems reflect behaviours that disobey social and legal norms, such as stealing and lying; hyperactivity reflects a set of symptoms or behaviours related to motor restlessness and overactivity (Hinshaw, 1987).

According to Kochanska, Murray, and Coy (1997) there is an association between aspects of effortful control, i.e., behavioural control, inhibitory control and attention, and rule following behaviour, which is likely to have implications for conduct problems. Children who can effectively use attention to regulate behaviour will be better able to inhibit prepotent responses, for example stealing and striking-out responses that are associated with conduct problems. In addition, executive function skills such as planning and inhibitory control have been found to be related to antisocial behaviours in preschoolers (Hughes, White, Sharpen, & Dunn, 2000). Barkley's theoretical model (Barkley, 1997), linking inhibition to executive neuropsychological functions, predicts that ADHD should be associated with secondary impairments in these executive functions and the motor control they afford. Children with ADHD have been found to perform worse on tasks assessing executive functions, such as task shifting and response inhibition, than aged-matched control children (Fugetta, 2006; Schachar, Tannock, Marriott, & Logan, 1995). Other studies have found low levels of a more general measure of parent-reported effortful control to be related to inattentive ADHD symptoms, but not or to a lesser extent to hyperactive–impulsive ADHD symptoms (Martel & Nigg, 2006; Martel, Nigg, & Lucas, 2008). Research seems to suggest that inhibitory, neuropsychological, and motor deficits are more likely to be characteristic of children with ADHD than of children with aggression and conduct problems, but more studies need to focus on ADHD and conduct problems (Barkley, 1997). In the current study, we explore which specific components of the ECB and which specific scales of the CBQ can predict conduct problems and hyperactivity in a community sample of young children.

In summary, the methodological focus of this study concerns the structure of effortful control in 3-year-old children. The research questions and hypotheses are: (1) do the eleven tasks of the ECB represent the five components of effortful control (Delaying, Effortful Attention, Suppressing or Initiating Activity to Signal, Slowing down Motor Activity, and Lowering Voice), and do these five components of the ECB together form the construct (observed) effortful control? We expect that the ECB tasks measure the five components of effortful control and that the five components form the construct effortful control. (2) Do the five scales of the CBQ (Inhibitory Control, Attentional Focusing, Low Intensity Pleasure, Perceptual Sensitivity, and Smiling/Laughter) together form the construct (parent reported) effortful control? We expect that the five scales of the CBQ measure one construct. (3) What is the relation between different components

of the ECB and the corresponding scales of the effortful control factor of the CBQ? We hypothesize that the components of the ECB that correspond theoretically with the scales of the CBQ are most strongly related: ECB Delaying with CBQ Inhibitory Control, and ECB Effortful Attention with CBQ Attentional Focusing.

The theoretical focus of this study relates to the issue of different predictive values of the components of effortful control, yielding the research question, (4) do the ECB and the CBQ predict conduct problems and hyperactivity in young children at 3 years and longitudinally from 3 to 4.5 years? Although in general effortful control is expected to be related to externalizing problems, due to the lack of theory and prior research on components of effortful control we did not formulate specific hypotheses for the components of the ECB and scales of the CBQ.

Method

Participants

At Time 1 (T1), participants were 89 two-parent families raising first-born children and 81 preschool playground teachers. The children (45 boys, 44 girls) were 36 months (range 35–37). Mother's mean age was 34.5 years ($SD = 4.2$, range 21–46) and father's mean age was 36.5 years ($SD = 4.7$, range 22–50). All mothers and fathers were the biological parents of the children. Ninety-eight percent of the fathers and 99% of the mothers had the Dutch nationality. The majority of the parents were highly educated (30.7% of the fathers and 23.9% of the mothers had a university education and 36.0% of the fathers and 32.6% of the mothers had college education).

At Time 2 (T2), when the children were 4.5 years 76 families and 68 kindergarten teachers participated. No differences were found between drop-out group and the group for which all data were available either on demographic variables (i.e., educational level, nationality, one vs. more children, age of parents, number of years together with partner) or on the independent and dependent variables.

Procedure

This study was part of a research project on family dynamics and child adjustment. Families were recruited through day-care centres and preschool playgrounds in different parts of The Netherlands. After agreeing to participate, day-care centres and playgroups distributed letters among parents of preschool-aged children asking them to participate in the study. Parents who indicated willingness to participate were selected if the parents lived together and if the first-born child was nearly 3 years old.

At T1, effortful control was observed at day-care centres and preschool playgroups while children performed 11 tasks. During this session, there were no other children present. All tasks were presented as games and after each task the child was rewarded, regardless of his/her performance. The tasks were independently coded by a team of trained coders. The broader research project included a home visit. After this visit, the parents were asked to fill out a questionnaire about their child. The preschool teacher was also asked to fill out a questionnaire assessing problem behaviour and to send it back to the university. One and a half years later, at T2, parents were contacted again and asked to fill out a questionnaire on children's problem behaviour. With the permission of parents, the same questionnaire was also sent to the kindergarten teacher.

Measures

Observed effortful control

At T1, each child performed the 11 tasks (see Table 1, second column) of the ECB (Kochanska *et al.*, 2000). Each task was adapted and translated into Dutch and videotaped. The tasks were afterwards independently coded by five coders. Reliability, based on approximately 15% of all cases, was computed for each task for all pairs of coders. Cohen's kappa was calculated for all aspects of each task using categorical scores and percentage agreement was calculated for aspects of the tasks using latency scores.

Delaying. In *Snack Delay*, the child had to wait with his or her hands on a mat on the table, until a bell was rung to retrieve a piece of candy that was laying under a glass cup (four times). Coding involved one score, reflecting the ability to wait for the candy (1 = child eats the candy before the bell is lifted, 2 = child eats the candy before the bell is rung, 3 = child touches the candy before the bell is lifted, 4 = child touches the candy before the bell is rung, 5 = child touches the glass cup or bell before the bell is lifted, 6 = child touches the glass cup or bell before the bell is rung, 7 = child waits until the bell is rung). Points were added, with a maximum of two points, for the child's ability to keep his or her hands on the mat. The average score on the four trials was the final score. Kappa was .82. In the *Tongue Task*, the child had to wait with a piece of candy on his or her tongue (3 trials: 20, 40, and 30 s). The final score was the average length of time before the child ate the candy. Percentage agreement was 99% (latencies coded within 1 s). In *Dinky Toys*, the child was asked to tell the experimenter which toy he or she finds most attractive from a box filled with toys while keeping his or her hands on his or her knees. Coding involved one score (0 = grabs a toy, 1 = touches a toy, 2 = point at a toy, 3 = removes hands of the knees, 4 = removes hands, but they stay on the knees, 5 = hands remain on the knees the entire time). Kappa was .78. In *Wrapped Gift*, the experimenter noisily wrapped a gift sitting directly in front of the child for exactly 60 s. After the gift had been wrapped, the child was left alone in the room with the gift for 3 min trying 'not to touch' the gift so it would remain 'a surprise'. Coding involved latency scores and behaviour scores. Latency scores reflect the times before peeking and turning while the experimenter wrapped the gift (ranging from 0 to 60 s) and the times before touching, lifting, and opening the gift after the child was left alone (ranging from 0 to 180 s). Behaviour scores consist of the peeking score (1 = turns and obviously peeks, 2 = turns to peek, but turns back, 3 = turns to see the wrapping, 4 = turns, but less than 90°, 5 = does not peek) and touching score (1 = opens gift before experimenter returns, 2 = lifts the gift, 3 = touches the gift, 4 = waits to open gift). There were two final scores, one Wrapping score (average of standardized peeking and time before peeking and turning scores) and one Waiting for bow score (average of standardized touching and time before touching, lifting, and opening scores). Kappa was .85; 88% of the latencies were coded within 1 s. In *Gift-in-Bag*, the child had to wait while the researcher leaves the room for 3 min to get a bow for the gift. Dependent variables were the ability to not touch the bag and the ability to sit down. Scores reflect behaviour involving the bag (1 = pulls gift from bag, 2 = puts a hand in bag, 3 = opens the bag to look into it, 4 = touches the bag, does not look into it, 5 = does not touch) and time in seat (1 = less than 30 s, 2 = less than 60 s, 3 = less than 120 s, 4 = more than 120 s), as well as latencies to touch and open the bag, put hand in the bag, pull the gift,

and leave the seat. The final score was the average of the two standardized behaviour scores and the standardized latencies. Kappa was .63; 89% of the latencies were coded within 1 s.

Effortful attention. The *Shapes Task* is a modified version of the Stroop paradigm and measures the ability to focus on a subdominant rather than a dominant picture. The child was asked to point to the image of a small fruit that was embedded in a dominant picture of a large fruit (three times). Coding involved the ability to identify the little picture (1 = incorrect response, 2 = self-corrected response, and 3 = correct response). The final score was the average of the responses on the three trials. Kappa was .85.

Suppressing or initiating activity to signal. In the *Tower Task*, the child and the experimenter took turns in building a tall, vertical tower with 20 blocks (two times). The experimenter did not automatically take her 'turn', purposely waiting with a block in her hand until the child indicated to her that he or she was indeed giving the experimenter a turn. The ability of the child to give turns is the scores, ranging from 10 (no turns taken) to 20 (alternated every turn) points. The average of the two trials was the final score. Percentage agreement was 83% (scores coded within 1 s).

Slowing down motor activity. In *Turtle-and-Rabbit*, the child moved small figures along a curved path drawn through meadows and ponds to a wooden barn. The instruction was to move the turtle figure as slowly as the child could for two trials. The average of these two trials was considered the 'slow' time. The same procedure was followed for a very 'fast' rabbit (two trials). Coding involved the accuracy in following the path (0 = off path, 1 = occasional departure from the path, and 2 = essentially within the path) and the time in seconds. The final score was the average of the time for the rabbit trials subtracted from the turtle trials and the accuracy scores. With respect to reliability, 72% of the accuracy scores were coded within one point and 98% of the latencies were coded within 1 s. In *Walk-a-Line Slowly*, the child walked along a 180 cm strip (15 cm wide) taped to the floor, once at regular speed and twice slowly. The ability to walk slowly was the dependent variable in this task. Coding involved the time for each trial in seconds. The average of the two slow trials was the final score. Reliability was 100% (latencies coded within 1 s). The *Drawing Task* consisted of the Elmo and Circle task. In the Elmo task, the child drew a line between two Elmos. A fast and a slow trial were completed. In the Circle task, the child drew a circle in a circle, with again a fast and slow trial. The final score was the average difference between the duration of the slow and fast trials. With respect to reliability, 98% of the latencies were coded within 1 s.

Lowering voice. In the *Whisper Task*, the child whispered the names of 12 consecutively presented cartoon characters after practice trials in which the child whispered his or her own name. The child was instructed to tell the experimenter if he or she did not know the name of the cartoon character. Coding involved the ability to whisper (0 = shouts/speaks out loud, 1 = speaks normal, 2 = says nothing, 3 = whispers the name).

The final score was the sum of the scores on the 12 trials. Percentage agreement was 81% (scores coded within 1 s).

Reported effortful control

The CBQ is a widely used questionnaire for the measurement of temperament in 3 to 7-year-old children (Rothbart *et al.*, 2001). We used an adapted and translated Dutch version (Majdandžić & Van den Boom, 2007). This questionnaire was filled out by mother and father of the child at T1. Items were scored on a seven-point Likert scale, ranging from 1 (extremely untrue of your child) to 7 (extremely true of your child) on the basis of the child's characteristics over the last 6 months.

We used the five scales of the CBQ that according to Rothbart *et al.* (2001) reliably cluster in the factor effortful control (see Table 1, fourth column). The scales, consisting of 60 items in total (e.g., 'My child is good at following instructions'), were: Attentional Focusing (i.e., the capacity to maintain attentional focus on task-related channels; nine items), Inhibitory Control (i.e., the capacity to plan and to suppress inappropriate responses under instruction or in novel or uncertain situation; 13 items), Low Intensity Pleasure (i.e., pleasure or enjoyment related to situations involving low stimulus intensity, rate, complexity, novelty, and incongruity; 13 items), Perceptual Sensitivity (i.e., the detection of slight, low-intensity stimuli from the external environment; 12 items), and Smiling/Laughter (i.e., positive affect in response to changes in stimulus intensity, rate, complexity, and incongruity; 13 items). Cronbach's alphas for Attentional Focusing, Inhibitory Control, Low Intensity Pleasure, Perceptual Sensitivity, and Smiling/Laughter were .63, .65, .67, .70, and .80, respectively, for mothers and .75, .77, .75, .60, and .74, respectively, for fathers.

Conduct problems and hyperactivity

To measure externalizing problems at 3 and 4.5 years, two scales – conduct problems and hyperactivity – of the Strengths and Difficulties Questionnaire (SDQ, Dutch version; Goodman, 1997) were used. The SDQ is a widely used brief behavioural screening questionnaire, with psychometrical properties that are comparable to the Child Behaviour Checklist (Goodman & Scott, 1999; Muris, Meesters, & Van den Berg, 2003; Van Widenfelt, Goedhart, Treffers, & Goodman, 2003). Furthermore, the SDQ has been shown to be good at detecting externalizing problems in a community sample of children (Goodman & Scott, 1999). The questionnaire was filled out by mother, father, and preschool teacher at T1 and mother, father, and kindergarten teacher at T2. Each scale consisted of five items and was scored on a three-point scale (not true, somewhat true, certainly true). Items of the two scales are enclosed in the Appendix. Cronbach's alphas for conduct problems were .71, .66, .69 (T1) and .66, .72, .77 (T2) for mothers, fathers, and teachers, respectively. Alphas for hyperactivity were .83, .78, 81 (T1) and .77, .78, .89 (T2) for mothers, fathers, and teachers, respectively.

Analyses

To examine the research questions on the structure of effortful control (questions 1 and 2), three different factor analyses using principal components analysis with oblique rotation were conducted. This method was used because the factors describing the structure of effortful control were expected to be intercorrelated (Tabachnick & Fidell,

2007). Determination of the number of factors was based initially on eigenvalues. All factors with eigenvalue higher than 1 were extracted. The scree plot was also examined. To examine question 3 on associations between the five components of the ECB and corresponding scales of the CBQ, correlations were computed. Question 4 was studied by performing multiple regression analyses. To predict conduct problems and hyperactivity at 3 years, the components of the ECB and the scales of the CBQ were entered in separate regression analyses. To predict conduct problems and hyperactivity at 4.5 years, hierarchical regression analyses were conducted, with externalizing problems at 3 years entered at step 1, and the components or scales of effortful control entered at step 2.

Results

Descriptive analyses

Correlations among informants were calculated. Mothers' reports of the CBQ were significantly correlated with fathers' reports of the CBQ for all scales ($r = .47$, .63, .41, .37, and .39, respectively), with an average correlation of .45. Therefore, the scores of father and mother were averaged to create one score for each scale of the CBQ. Regarding the SDQ, correlations between mother and father reports were strong at T1 ($r = .65$ for conduct problems, $r = .68$ for hyperactivity) and at T2 ($r = .78$ for conduct problems, $r = .71$ for hyperactivity). Therefore, the scores of the father and mother were averaged to create one score for conduct problems and one for hyperactivity for both measurement points. Correlations between teachers and mothers were .40 for conduct problems and .56 for hyperactivity at T1, and .32 for conduct problems and .60 for hyperactivity at T2. Correlations between teachers and fathers were .40 for conduct problems and .49 for hyperactivity at T1, and .26 for conduct problems and .43 for hyperactivity at T2. These findings correspond with previous studies that found moderate correlations between parents and teachers and large correlations between mothers and fathers, indicating that different informants are needed to measure behaviour problems in different situations (Achenbach, Conaughy, & Howell, 1987; Achenbach, Dumenci, & Rescorla, 2002). Therefore, we will examine the score of the teacher separately. The correlation between conduct problems and hyperactivity was moderately high for both parent report (T1: $r = .54$, $p < .01$ and T2: $r = .67$, $p < .01$) and teacher report (T1: $r = .41$, $p < .01$ and T2: $r = .48$, $p < .01$).

The sample size of the observations ($N = 83$) differed from the sample size of parent/teacher reports (T1 SDQ: 70 parents and 81 teachers, T2 SDQ: 76 parents and 69 teachers). The CBQ was completed by 73 parents. In total, for 58 children, all questionnaire and observational data were available. The incomplete cases were compared with the complete cases with t tests. There were no differences on demographical variables or the independent variables between the complete and incomplete cases. Because of incomplete cases, data differed across the different analyses. We checked the assumption of normality in the distribution of variables of effortful control and externalizing problems. The ECB Snack Delay and Waiting for Bow scores were deviated from normal distributions, showing negative skewness (< -2) and kurtosis (>7; Curran, West, & Finch, 1996). After reflecting the data, taking the square roots, and reflecting the data back, these task scores were normally distributed. Transformed scores were used in the analyses. Means and standard deviations of all available data for each variable are shown in Table 2.

Table 2. Means and standard deviations of the ECB, the CBQ, and the SDQ

	M	*SD*
ECB		
Snack Delay	9.33	0.28
Tongue Task	23.13	9.78
Dinky Toys	1.10	1.59
Wrapping	0.00	0.93
Waiting for Bow	0.60	0.25
Gift-in-Bag	0.00	0.71
Shapes Task	2.60	0.55
Tower Task	18.12	2.76
Turtle-and-Rabbit	−0.01	0.77
Walk-a-Line-Slowly	5.15	2.15
Drawing Task	1.16	2.17
Whisper Task	27.52	9.38
CBQ		
Attentional Focusing	4.63	0.66
Inhibitory Control	4.81	0.71
Low Intensity Pleasure	5.53	0.52
Perceptual Sensitivity	5.11	0.69
Smiling/Laughter	5.63	0.51
SDQ		
Conduct Problems parents T1	0.41	0.35
Conduct Problems teacher T1	0.33	0.35
Hyperactivity parents T1	0.68	0.47
Hyperactivity teacher T1	0.66	0.56
Conduct Problems parents T2	0.40	0.35
Conduct Problems teacher T2	0.26	0.38
Hyperactivity parents T2	0.62	0.46
Hyperactivity teacher T2	0.62	0.59

Note. *N* ranges from 69 to 89.

Factor structure of ECB

A principal components analysis with oblique rotation was conducted to examine the factor structure of the ECB. Five factors were extracted with an eigenvalue higher than 1 (Table 3). The five-factor solution accounted for 65.5% of the variance in children's effortful control scores. The first factor was composed of tasks requiring delay of gratification. The second factor appeared to measure fine motor abilities. The third factor consisted of tasks reflecting the capacity to control impulses and the fourth factor consisted of tasks requiring effortful attention. The last factor was composed of a task measuring gross motor abilities.

To address the question whether these five components measure the same higher-order construct, a second-order principal components factor analysis[1] was conducted. The five components (Delay of Gratification, Impulse Control, Fine Motor Abilities, Gross Motor Abilities, and Effortful Attention) loaded on two factors. The total explained

[1] *We used factor analysis instead of structural equation modelling because of the ratio between variables and sample size (Kline, 2004).*

Table 3. Principal components analysis of the ECB

	Factor				
Tasks	Delay of gratification	Fine motor abilities	Impulse control	Effortful attention	Gross motor abilities
Snack Delay	.58				
Gift-in-Bag	.86				
Wrapping	.56				
Waiting for Bow	.85				
Drawing Task		.83			
Whisper Task		.68			
Dinky Toys			.45		
Tongue Task			.65		
Walk-a-Line-Slowly			.80		
Tower Task				.79	
Shapes Task				.62	
Turtle-and-Rabbit					.89

Note. Only factor loadings $>$ .40 are shown.

variance was 52.2%. Thus, we found two second-order factors that measured effortful control. The first factor was marked by loadings of .64 for Delay of Gratification, .67 for Fine Motor Abilities, and .66 for Impulse Control. This factor was labelled Self-Control, reflecting the capacity to control impulses. The second factor was marked by loadings of .57 for Gross Motor Abilities and .79 for Effortful Attention. This factor was labelled Attention/Motor Control, reflecting the capacity to focus and shift attention.

Factor structure of CBQ

To examine the factor structure of the CBQ, a second-order principal components analysis was conducted. Similar to Rothbart *et al.* (2001), we found that the five scales loaded on one factor. The one-factor solution accounted for 49.9% of the variance. The factor loadings were .52 for Smiling/Laughter, .66 for Perceptual Sensitivity, .70 for Attentional Focusing, .77 for Inhibitory Control, and .84 for Low Intensity Pleasure.

Correlations between components of ECB and scales of CBQ

Table 4 shows correlations between the observational measure and the parent report. A negative relation was found between observed Impulse Control and parent-reported Attentional Focusing. A positive relation was found between observed Delay of Gratification and parent-reported Inhibitory Control. The factor Attention/Motor Control of the ECB was positively related to parent-reported Attentional Focusing and Low Intensity Pleasure, and the CBQ total score. The correlations were also examined for boys and girls separately. No significant differences between boys and girls were found.

Table 4. Correlations between components of the ECB and the scales of the CBQ

	ECB components					ECB higher-order factors	
	Delay of gratification	Effortful attention	Fine motor abilities	Gross motor abilities	Impulse control	Self-control	Attention/motor control
Attentional Focusing	.06	.14	−.10	.22	−.32**	−.17	.26*
Inhibitory Control	.34**	.20	.07	.13	−.03	.19	.23
Low Intensity Pleasure	.19	.19	−.06	.12	.00	.07	.24*
Perceptual Sensitivity	−.05	.13	−.01	.21	−.21	−.13	.19
Smiling/Laughter	−.20	.03	−.05	−.05	−.20	−.21	−.02
CBQ total	.11	.20	−.04	.19	−.22	−.06	.27*

*$p < .05$; **$p < .01$.

Predicting conduct problems from components of ECB and scales of CBQ

To examine to what extent it is possible to predict concurrent conduct problems from the components of the ECB and the scales of the CBQ, four multiple regression analyses were performed. Separate analyses were conducted for parent and teacher report of conduct problems, and for effortful control measures (CBQ vs. ECB). Table 5 shows the results of these analyses. The less parent-reported Inhibitory Control and observed Delay of Gratification, the more conduct problems were reported by the parents. In total, the scales of the CBQ explained 39% and the components of the ECB explained 16% of the variance in conduct problems. Furthermore, the less observed Delay of Gratification, the more conduct problems were reported by the teacher. The scales of the CBQ explained 15% and the components of the ECB explained 12% of the variance in conduct problems reported by the teacher. To predict conduct problems from the higher-order factors of the ECB (Self-Control and Attention/Motor Control), two additional regression analyses were conducted. The two higher-order factors did not predict conduct problems reported by parents or teacher.

Table 5. Multiple regression analyses for variables of the CBQ and the ECB predicting conduct problems at Time 1

	Parents			Teacher		
Independent variable	*B*	*SE B*	β	*B*	*SE B*	β
Parent report						
Attentional Focusing	−0.08	0.06	−0.16	−0.01	0.08	−0.01
Inhibitory Control	−0.26	0.06	−0.53***	−0.14	0.07	−0.29
Low Intensity Pleasure	0.00	0.10	0.00	−0.07	0.12	−0.11
Perceptual Sensitivity	−0.01	0.06	−0.02	−0.03	0.07	−0.07
Smiling/Laughter	−0.00	0.08	−0.01	0.04	0.10	0.06
Observation						
Delay of Gratification	−0.19	0.06	−0.40**	−0.12	0.06	−0.25*
Effortful Attention	−0.02	0.06	−0.05	−0.07	0.05	−0.16
Fine Motor Abilities	0.06	0.05	0.14	0.04	0.05	0.09
Gross Motor Abilities	0.01	0.04	0.04	−0.02	0.04	−0.07
Impulse Control	0.08	0.07	0.15	0.01	0.06	0.01

Note. Parents: R^2 CBQ = .39, $p < .001$; R^2 ECB = .16, $p = .07$. Teacher: R^2 CBQ = .15, $p = .07$; R^2 ECB = .12, $p = .12$; *$p < .05$; **$p < .01$; ***$p < .001$.

To predict conduct problems over time four hierarchical regression analyses were performed. The dependent variable was conduct problems at T2 reported by parents versus teachers, predicted over time from scales of the CBQ versus components of the ECB. In these analyses, parent- or teacher-reported conduct problems at T1 were entered as independent variable at step 1, and scales of the CBQ or components of the ECB were entered at step 2. Conduct problems showed high stability, both according to parents ($\beta = 0.56, p < .001$) and teacher ($\beta = 0.54, p < .01$). Entering effortful control measures did not significantly add to the prediction, neither for parent nor for teacher report of conduct problems.

Additionally, we conducted stepwise regression analyses to test what are the most important aspects of effortful control to predict conduct problems cross-sectionally and

longitudinally. Therefore, we entered all observed and reported effortful control variables in each analysis. Four analyses were conducted. Dependent variables were conduct problems reported by parents and teachers, at T1 and T2. In the prediction of conduct problems at T2, again conduct problems at T1 was included as independent variable. Parent-reported Inhibitory Control uniquely predicted concurrent conduct problems reported by parents, explaining 36% of the variance ($\beta = -0.60$, $p < .001$). It was also parent-reported Inhibitory Control that was the most important aspect of effortful control predicting conduct problems, reported by teachers ($\beta = -0.36$, $p < .01$, $R^2 = .13$). No aspects of effortful control predicted conduct problems over time.

Predicting hyperactivity from components of ECB and scales of CBQ

To address the final question whether it is possible to predict hyperactivity from the components of the ECB and the scales of the CBQ, again four multiple regression analyses were conducted. Separate analyses were conducted for parent and teacher report of hyperactivity, and for effortful control measures (CBQ vs. ECB). Table 6 shows the results of these analyses. The less Attentional Focusing and Inhibitory Control of the CBQ and the less Delay of Gratification, the more hyperactivity was reported by parents. In total, the scales of the CBQ explained 62% and the components of the ECB explained 22% of the variance in hyperactivity reported by parents. The less Inhibitory Control and Low Intensity Pleasure of the CBQ and the less Delay of Gratification of the ECB, the more hyperactivity was reported by the teacher. The scales of the CBQ explained 28% and the components of the ECB explained 14% of the variance in hyperactivity reported by the teacher.

Table 6. Multiple regression analyses for variables of the CBQ and the ECB predicting hyperactivity at Time 1

	Parents			Teacher		
Independent variable	*B*	*SE B*	β	*B*	*SE B*	β
Parent report						
Attentional Focusing	−0.33	0.07	−0.48***	−0.01	0.11	−0.01
Inhibitory Control	−0.28	0.06	−0.44***	−0.24	0.11	−0.30*
Low Intensity Pleasure	−0.10	0.10	−0.10	−0.40	0.18	−0.37*
Perceptual Sensitivity	0.11	0.06	0.15	0.07	0.10	0.08
Smiling/Laughter	0.06	0.08	0.06	0.28	0.15	0.24
Observation						
Delay of Gratification	−0.26	0.08	−0.41**	−0.28	0.10	−0.36**
Effortful Attention	−0.10	0.07	−0.17	−0.05	0.09	−0.07
Fine Motor Abilities	0.05	0.07	0.09	0.01	0.08	0.01
Gross Motor Abilities	−0.02	0.06	−0.04	−0.01	0.07	−0.02
Impulse Control	0.18	0.09	0.20	0.04	0.10	0.05

Note. Parents: R^2 CBQ = .62, $p < .001$; R^2 ECB = .22, $p < .05$. Teacher: R^2 CBQ = .28, $p < .01$; R^2 ECB = .14, $p = .07$; *$p < .05$; **$p < .01$; ***$p < .001$.

To examine the prediction of hyperactivity from the higher-order factors of the ECB (Self-Control and Attention/Motor Control), two additional multiple regression analyses were conducted. A significant proportion of variance in hyperactivity reported by the

teacher (8%) was explained from Self-Control and Attention/Motor Control, entered simultaneously as independent variables. The factors separately did not significantly predict teacher-reported hyperactivity. In total, the two factors also explained 8% of the variance in hyperactivity reported by the parents. Attention/Motor Control was a significant predictor ($\beta = -0.27, p < .05$).

To predict hyperactivity over time again four hierarchical regression analyses were performed. The dependent variable was hyperactivity at T2 reported by parents versus teachers, predicted over time from scales of the CBQ versus components of the ECB. In these analyses, parent- or teacher-reported hyperactivity at T1 was entered at step 1, scales of the CBQ or components of the ECB were entered at step 2. Hyperactivity showed high stability according to parents ($\beta = 0.73, p < .001$) and moderate stability according to teachers ($\beta = 0.38, p < .01$). Entering effortful control measures did not significantly add to the prediction, neither for parent nor for teacher report of hyperactivity.

Similarly as in the prediction of conduct problems, we tested what are the most important aspects of effortful control to predict hyperactivity by performing stepwise regression analyses. Parent-reported Attentional Focusing most strongly predicted hyperactivity reported by parents ($\beta = -0.53, p < .001$ in the final step, $\Delta R^2 = .48$), followed by parent-reported Inhibitory Control ($\beta = -0.36, p < .001$ in the final step, $\Delta R^2 = .15$), and observed Delay of Gratification ($\beta = -0.18, p < .05$, $\Delta R^2 = .03$). Parent-reported Inhibitory Control was the strongest predictor of hyperactivity reported by teachers, explaining 19% of the variance ($\beta = -0.35$ in the final step, $p < .01$), followed by observed Delay of Gratification ($\beta = -0.29, p < .05$, $\Delta R^2 = .08$). No aspects of effortful control predicted hyperactivity over time.

Discussion

The aim of this study was twofold. First, the structure of effortful control in 3-year-old children was examined – the methodological focus of this study. Second, we studied if components of effortful control were related to conduct problems and hyperactivity – the theoretical focus of this study.

In general, the findings regarding the methodological question point towards a multidimensional structure of effortful control, as it appeared to be composed of a number of different, but related competencies. We studied effortful control assessed by two methods: observation, using the ECB (Kochanska *et al.*, 2001), and parent report, using the CBQ (Rothbart *et al.*, 2001). By using both methods, we have connected distinct approaches to examine effortful control, such as cognitive, neuropsychological models and broader temperament models (Barkley, 1997; Nigg, 2000). Although both the ECB and CBQ aim to measure Rothbart's temperament concept of effortful control, the tasks of the ECB require some abilities, such as attention shifting and response inhibition, that overlap with executive function tasks (described by cognitive, neuropsychological models), whereas the CBQ is more likely to assess broader temperament. We found that the 11 tasks of the ECB could be structured under five factors (Delay of Gratification, Impulse Control, Fine Motor Abilities, Gross Motor Abilities, and Effortful Attention) and two higher-order factors (Self-Control and Attention/Motor Control). The five scales of the CBQ (Attentional Focusing, Inhibitory Control, Low Intensity Pleasure, Perceptual Sensitivity, and Smiling/Laughter) measured one underlying factor.

Our hypotheses that the ECB and CBQ measured both unity and diversity in effortful control, was thus confirmed for the CBQ, but not the ECB. As expected and

corresponding with previous research (Murray & Kochanska, 2002), the ECB measured several components, but unexpectedly we did not find an underlying construct of effortful control. However, these findings can be explained by the above-mentioned view that the CBQ is a broader measure of temperament, and the ECB is a measure that relies to a greater extent on executive functions. The CBQ may give a more general picture of effortful control of the child. As the ECB is an observational instrument, it is more specific and measures effortful control in more specific situations (Kochanska *et al.*, 2001). Furthermore, the halo effect (i.e., tendency for a rater to give consistency ratings to an individual on a variety of different rating elements) could also cause the difference between the observational measure and the questionnaire. Parents' overall impression of the child, based on a large sample of behaviours (Mangelsdorf, Schoppe, & Buur, 2000), is thought to affect ratings of specific attributes (see Murphy, Jako, & Anhalt, 1993). Observational instruments have been shown to be less affected by halo effects (Kent, O'Leary, Diament, & Dietz, 1974).

Although Kochanska *et al.* (2000) proposed that the ECB measures five factors, their classification (Delaying, Effortful Attention, Suppressing or Initiating Activity to Signal, Slowing down Motor Activity, and Lowering Voice) is somewhat different from the classification found in this study. However, both studies have found a delay component, effortful attention component, and an inhibitory/suppressing component. The higher-order structure of the ECB found in this study shows that key components of observed effortful control are Self-Control, reflecting the capacity to control impulses and behaviour, and Attention/Motor Control, reflecting abilities that are strongly dependent on attention focus and shifting, and involving holding a rule in mind while suppressing a dominant response and initiating a subdominant response. The scales of the CBQ appear to share the child's voluntary and wilful regulation of attention and behaviour (Rothbart *et al.*, 2000).

We furthermore investigated the relation between components of the ECB and corresponding scales of the CBQ as suggested in Table 1. Significant correlations were found, although some unexpected results showed up. As hypothesized, Inhibitory Control of the CBQ was positively related to the factor Delay of Gratification of the ECB. Both constructs appeared to measure the capacity to plan and to suppress dominant responses. We did not find a relation between Inhibitory Control of the CBQ and the Impulse Control factor of the ECB. A tentative explanation for this finding could be that Impulse Control covers mainly the suppression of a response, whereas Inhibitory Control covers planning besides suppressing. Unexpectedly, we found no significant correlations between Attentional Focusing of the CBQ and Effortful Attention of the ECB. The observed capacity to focus on a subdominant aspect of a picture may not cover all aspects of concentration and distraction of a child in different situations that are measured by parent report. The significant relation between parent-reported Attentional Focusing and the broader higher-order construct observed Attention/Motor Control is in line with this explanation.

Besides hypothesized relations between corresponding components and scales, we found additional significant relations between the ECB and CBQ. We found that children scoring higher on observed Attention/Motor Control were more able to enjoy situations involving low stimulus intensity, reported by parents. A surprising finding was the negative relation between the component Impulse Control of the ECB and the scale Attentional Focusing of the CBQ. We cannot explain this finding, although this also shows that observed impulse control is different from the attention aspect of effortful control, as Impulse Control loaded on the Self-Control factor of the ECB and not on the

Attention/Motor factor. Furthermore, we found that the CBQ total score related to the Attention/Motor Control factor of the ECB, but not to the Self-Control factor, indicating that a key aspect of parent-reported effortful control reflects the regulation of attention. Because of some unexpected findings we need to be cautious of drawing conclusions. Future research should investigate in particular the distinction between the attention and impulse control aspects of effortful control in more detail.

Prediction of externalizing problems

Regarding the theoretical focus of this study to investigate the relation of effortful control to conduct problems and hyperactivity, we found that – despite the few significant correlations between components of the ECB and scales of the CBQ – both instruments predicted conduct problems and hyperactivity at the age of 3 years. These study findings denote that effortful control deficits are important characteristics of both conduct problems and hyperactivity, problems that have seldom been studied separately (see Barkley, 1997).

Conduct problems reported by parents and the teacher were most strongly predicted by Delay of Gratification, a component pertaining to Self-Control of the ECB. Parent-reported Inhibitory Control also predicted conduct problems reported by the parents. Of all (observed and reported) effortful control aspects, it was parent-reported Inhibitory Control that was the most important aspect, explaining 36% of the variance in parent-reported conduct problems, and 13% of the variance in teacher-reported conduct problems. Both Delay of Gratification and Inhibitory Control reflect the capacity to plan and to suppress dominant responses. Children who have conduct problems have problems with suppressing responses and they show behaviour that disobeys social and legal norms (Hinshaw, 1987). Other research also showed that children who can effectively use attention to regulate behaviour will be better able to inhibit prepotent responses (Kochanska *et al.*, 1997), which is in line with our finding that inhibitory difficulties are associated with conduct problems.

Hyperactivity reported by parents and by the teacher was most strongly predicted by the ECB component Delay of Gratification. Concerning the higher-order constructs of the ECB, Attention/Motor Control significantly predicted hyperactivity reported by parents. The parent-reported scales Attentional Focusing and Inhibitory Control predicted hyperactivity reported by the parents. The parent-reported scales Inhibitory Control and Low Intensity Pleasure predicted hyperactivity reported by the teacher. Overall, Attentional Focusing was the most important aspect of effortful control with respect to parent-reported hyperactivity, explaining as much as 48% of the variance. Parent-reported Inhibitory Control was the most important aspect of effortful control with respect to teacher-reported hyperactivity, explaining 19% of the variance. Attentional Focusing represents the capacity to maintain attentional focus. Children who are hyperactive have problems with sustaining and modulating their attention (Hinshaw, 1987). Other research showed that low levels of effortful control were related to inattention and not, or to a lesser extent, to hyperactivity (Martel & Nigg, 2006; Martel *et al.*, 2008). Future research should investigate the relation of attention and inhibitory difficulties to hyperactivity in more detail.

We also examined if the CBQ and the ECB predicted conduct problems and hyperactivity longitudinally. The results showed that both conduct problems and hyperactivity appeared to be stable between 3 and 4.5 years of age. Other studies also found that stability of behaviour problems is high after the age of 3 or 4 years (e.g.,

Mathiesen & Sanson, 2000; Murray & Kochanska, 2002). The two measures separately did not contribute significantly to predicting conduct problems and hyperactivity at age 4.5 after controlling for conduct problems and hyperactivity of age 3.

Some differences in the prediction of parent- versus teacher-reported externalizing problems were found. We firstly found smaller effect sizes for the teacher than for parents. Relations between effortful control and parent-reported externalizing problems may be inflated because both constructs are rated by the same individuals (Olson *et al.*, 2005). Smaller effect sizes for teacher report could also be due to the fact that teachers reported fewer conduct problems than the parents did, a finding that has been reported by other studies too (e.g., Achenbach *et al.*, 1987, 2002). Parents and teachers maintain different relationships with the child and observe him or her under different conditions, influencing their ratings. Different ratings are also reflected by our second finding that some other components of the ECB and scales of the CBQ predicted parent- versus teacher-reported externalizing problems. For example, Attentional focusing was a predictor of parent-reported hyperactivity, whereas Low Intensity Pleasure was a predictor of teacher-reported hyperactivity. In general, it has been suggested that disagreement between informants' reports about a child are as informative as agreements since they may highlight variations in judgments concerning the child's functions across situations (Achenbach *et al.*, 1987). Therefore, problem behaviour through the eyes of the parents as well as the teacher should be examined.

Another issue in research on associations between temperament and externalizing problems is whether the concepts that are measured are truly distinct. Measures of effortful control and externalizing problems could be confounded, because they are defined by similar items and/or constructs. This especially plays a role when questionnaires are used both for temperament and problem behaviour. However, studies found that conceptual overlap in the measurement of temperament and problem behaviour did not inflate associations (Lemery, Essex, & Smider, 2002; Lengua, West, & Sandler, 1998). Furthermore, according to Olson *et al.* (2005) effortful control and child externalizing problems are interrelated, but theoretically distinct constructs. By using an observational measure for temperament and a questionnaire for problem behaviour in the current study the problem of confounding was reduced.

Limitations and implications

The study had some limitations. First, most children in this study were from White, two-parent, middle- to upper-class, dual-income families. Therefore, the findings cannot be generalized to other populations. Second, the sample with families and teachers who filled out all the questionnaires was relatively small. Criteria for a minimum sample size for stable factor solutions vary widely, from a recommended ratio of sample size to number of variables ranging from between 3:1 and 6:1 through 10:1, to a desirable minimum sample size of 250 observations (see MacCallum, Widaman, Zhang, & Hong, 1999). However, MacCallum *et al.* (1999) found that stable factor solutions can be achieved with small sample sizes, if communalities are high and if factors are well determined. As our factor solutions satisfied these conditions, we did not expect to find other solutions with a larger sample size. Notwithstanding, to advance generalizability future research should investigate a larger and a more heterogeneous sample during a longer period of time.

The findings of this study have implications for the assessment of effortful control. In the future, it is important to keep in mind that effortful control is composed of

heterogeneous components that all have their own unique value. Furthermore, when we select measurement instruments we need to be aware of the difference between a more general picture (CBQ) and a more specific picture (ECB) of effortful control. The merits of this study were the multiple informants (mothers, fathers, and teachers), in multiple assessments settings (home and day-care centres) and with multiple measures (observations and parent/teacher report) of effortful control. With the observational measure, we found five components and two higher-order constructs of effortful control: Self-Control and Attention/Motor Control. The components are differently related to child externalizing problems. Conduct problems were most strongly predicted by observed Delay of Gratification and parent-reported Inhibitory Control. Hyperactivity was most strongly predicted by observed Delay of Gratification and parent-reported Attentional Focusing and Inhibitory Control.

References

Achenbach, T. M., Conaughy, S. H., & Howell, C. T. (1987). Child/adolescent behavioural and emotional problems: Implications of cross-informant correlations for situational specificity. *Psychological Bulletin*, *101*, 213–232. doi:10.1037/0033-2909.101.2.213

Achenbach, T. M., Dumenci, L., & Rescorla, L. A. (2002). Ten-year comparisons of problems and competencies for national samples of youth: Self, parent, and teacher reports. *Journal of Emotional and Behavioral Disorders*, *10*, 194–203. doi:10.1177/10634266020100040101

Aksan, N., & Kochanska, G. (2004). Links between systems of inhibition from infancy to preschool years. *Child Development*, *75*, 1477–1490. doi:10.1111/j.1467-8624.2004.00752.x

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin*, *121*, 65–94. doi:10.1037/0033-2909.121.1.65

Best, J. R., Miller, P. H., & Jones, L. L. (2009). Executive functions after age 5: Changes and correlates. *Developmental Review*, *29*, 180–200. doi:10.1016/j.dr.2009.05.002

Curran, P. J., West, S. G., & Finch, J. F. (1996). The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods*, *1*, 16–29. doi:10.1037/1082-989X.1.1.16

Davies, P. L., Segalowitz, S. J., & Gavin, W. J. (2004). Development of response-monitoring ERPs in 7- to 25-year-olds. *Developmental Neuropsychology*, *25*, 355–376. doi:10.1207/s15326942dn2503_6

Deák, G. O. (2003). The development of cognitive flexibility and language abilities. In R. V., Kail (Ed.), *Advances in child development and behavior* (pp. 271–327). San Diego, CA: Academic Press.

Eisenberg, N., Zhou, Q., Losoya, S. H., Fabes, R. A., Shepard, S. A., Murphy, B. C., … Cumberland, A. (2003).The relations of parenting, effortful control, and ego control to children's emotional expressivity. *Child Development*, *74*, 875–895. doi:10.1111/1467-8624.00573

Eisenberg, N., Zhou, Q., Spinrad, T. L., Valiente, C., Fabes, R. A., & Liew, J. (2005). Relations among positive parenting, children's effortful control, and externalizing problems: A three-wave longitudinal study. *Child Development*, *76*, 1055–1071. doi:10.1111/j.1467-8624.2005.00897.x

Fugetta, G. P. (2006). Impairment of executive functions in boys with attention deficit/hyperactivity disorder. *Child Neuropsychology*, *12*, 1–21. doi:10.1080/09297040500203418

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*, *134*, 31–60. doi:10.1037/0033-2909.134.1.31

Goodman, R. (1997). The Strengths and Difficulties Questionnaire: A research note. *Journal of Child Psychology and Psychiatry*, *38*, 581–586. doi:10.1111/j.1469-7610.1997.tb01545.x

Goodman, R., & Scott, S. (1999). Comparing the Strengths and Difficulties Questionnaire and the Child Behavior Checklist: Is small beautiful? *Journal of Abnormal Child Psychology*, *27*, 17–24. doi:10.1023/A:1022658222914

Hinshaw, S. (1987). On the distinction between attention deficit/hyperactivity and conduct problems/aggression in child psychopathology. *Psychological Bulletin*, *101*, 443–463. doi:10.1037/0033-2909.101.3.443

Hughes, C., White, A., Sharpen, J., & Dunn, J. (2000). Antisocial, angry, and unsympathetic: 'Hard-to-manage' preschoolers' peer problems and possible cognitive influences. *Journal of Child Psychology and Psychiatry*, *41*, 169–179. doi:10.1017/S0021963099005193

Karreman, A., Van Tuijl, C., Van Aken, M. A. G., & Dekovic, M. (2008). Parenting, coparenting, and effortful control in preschoolers. *Journal of Family Psychology*, *22*, 30–40. doi:10.1037/0893-3200.22.1.30

Kent, R. N., O'Leary, D. K., Diament, C., & Dietz, A. (1974). Expectation biases in observational evaluation of therapeutic change. *Journal of Consulting and Clinical Psychology*, *42*, 774–780. doi:10.1037/h0037516

Kline, R. B. (2004). *Principles and practice of structural equation modeling*. New York: Guilford Press.

Kochanska, G., Coy, K. C., & Murray, K. T. (2001). The development of self-regulation in the first four years of life. *Child Development*, *72*, 1091–1111. doi:10.1111/1467-8624.00336

Kochanska, G., & Knaack, A. (2003). Effortful control as a personality characteristic of young children: Antecedents, correlates, and consequences. *Journal of Personality*, *71*, 1087–1112. doi:10.1111/1467-6494.7106008

Kochanska, G., Murray, K. T., & Coy, K. C. (1997). Inhibitory control as a contributor to conscience in childhood: From toddler to early school age. *Child Development*, *68*, 263–277. doi:10.2307/1131849

Kochanska, G., Murray, K. T., & Harlan, E. T. (2000). Effortful control in early childhood: Continuity and change, antecedents, and implications for social development. *Developmental Psychology*, *36*, 220–232. doi:10.1037/0012-1649.36.2.220

Kochanska, G., Murray, K., Jacques, T. Y., Koenig, A. M., & Vandegeest, K. A. (1996). Inhibitory control in young children and its role in emerging internalization. *Child Development*, *67*, 490–507. doi:10.2307/1131828

Krueger, R. F., Caspi, A., Moffitt, T. E., White, J. L., & Stouthamer-Loeber, M. (1996). Delay of gratification, psychopathology, and personality: Is low self-control specific to externalizing problems?. *Journal of Personality*, *64*, 107–129. doi:10.1111/j.1467-6494.1996.tb00816.x

Lemery, K. S., Essex, M. J., & Smider, N. A. (2002). Revealing the relation between temperament and behavior problem symptoms by eliminating measurement confounding: Expert ratings and factor analyses. *Child Development*, *73*, 867–882. doi:10.1111/1467-8624.00444

Lengua, L. J., West, S. G., & Sandler, I. N. (1998). Temperament as a predictor of symtomatology in children: Addressing contamination of measures. *Child Development*, *69*, 164–181.

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, *4*, 84–99. doi:10.1037/1082-989X.4.1.84

Majdandžić, M., & Van den Boom, D. C. (2007). Multi-method longitudinal assessment of temperament in early childhood. *Journal of Personality*, *75*, 121–167. doi:10.1111/j.1467-6494.2006.00435.x

Mangelsdorf, S. C., Schoppe, S. J., & Buur, H. (2000). The meaning of parental reports: A contextual approach to the study of temperament and behavior problems in childhood. In V. J., Molfese D. L Molfese (Eds.), *Temperament and personality development across the life span* (pp. 121–140). Mahwah, NJ: Erlbaum.

Martel, M. M., & Nigg, J. T. (2006). Child ADHD and personality/temperament traits of reactive and effortful control, resiliency, and emotionality. *Journal of Child Psychology and Psychiatry*, *47*, 1175–1183. doi:10.1111/j.1469-7610.2006.01629.x

Martel, M. M., Nigg, J. T., & Lucas, R. E. (2008). Trait mechanisms in youth with and without attention-deficit/hyperactivity disorder. *Journal of Research in Personality*, *42*, 895–913. doi:10.1016/j.jrp.2007.12.004

Mathiesen, K. S., & Sanson, A. (2000). Dimensions of early childhood behavior problems: Stability and predictors of change from 18 to 30 months. *Journal of Abnormal Child Psychology*, *28*, 15–31. doi:10.1023/A:1005165916906

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Hawerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex 'frontal lobe' tasks: A latent variable analysis. *Cognitive Psychology*, *41*, 49–100. doi:10.1006/cogp.1999.0734

Muris, P., Meesters, C., & Van den Berg, F. (2003). The Strengths and Difficulties Questionnaire (SDQ): Further evidence for its reliability and validity in a community sample of Dutch children and adolescents. *European Child and Adolescent Psychiatry*, *12*, 1–8. doi:10.1007/s00787-003-0298-2

Murphy, K. R., Jako, R. A., & Anhalt, R. L. (1993). Nature and consequences of halo error: A critical analysis. *Journal of Applied Psychology*, *78*, 218–225. doi:10.1037/0021-9010.78.2.218

Murray, K. T., & Kochanska, G. (2002). Effortful control: Factor structure and relation to externalizing and internalizing behaviors. *Journal of Abnormal Child Psychology*, *30*, 503–514. doi:10.1023/A:1019821031523

Nigg, J. T. (2000). On inhibition/disinhibition in developmental psychopathology: Views from cognitive and personality psychology and a working inhibition taxonomy. *Psychological Bulletin*, *126*, 220–246. doi:10.1037/0033-2909.126.2.220

Olson, S. L., Sameroff, A. J., Kerr, D. C. R., Lopez, N. L., & Wellman, H. M. (2005). Developmental foundations of externalizing problems in young children; the role of effortful control. *Development and Psychopathology*, *17*, 25–45. doi:10.1017/S0954579405050029

Posner, M. I., & Rothbart, M. K. (2000). Developing mechanisms of self-regulation. *Developmental Psychology*, *12*, 427–441. doi:10.1017/S0954579400003096

Rothbart, M. K. (1989). Temperament and development. In G. A., Kohnstamm J. A Bates & M. K. Rothbart (Eds.), *Temperament in childhood* (pp. 187–247). New York: Wiley.

Rothbart, M. K., Ahadi, S. A., & Evans, D. E. (2000). Temperament and personality: Origins and outcomes. *Journal of Personality and Social Psychology*, *78*, 122–135. doi:10.1037/0022-3514.78.1.122

Rothbart, M. K., Ahadi, S. A., Hershey, K. L., & Fisher, P. (2001). Investigations of temperament at three to seven years: The Children's Behaviour Questionnaire. *Child Development*, *72*, 1394–1408. doi:10.1111/1467-8624.00355

Rothbart, M. K., Ellis, L. K., Rueda, M. R., & Posner, M. I. (2003). Developing mechanisms of temperamental effortful control. *Journal of Personality*, *71*, 1113–1140. doi:10.1111/1467-6494.7106009

Schachar, R., Tannock, R., Marriott, M., & Logan, G. (1995). Deficient inhibitory control in attention deficit hyperactivity disorder. *Journal of Abnormal Child Psychology*, *23*, 411–437. doi:10.1007/BF01447206

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics*. Boston: Pearson.

Valiente, C., Eisenberg, N., Smith, C. L., Reiser, M., Fabes, R. A., Losoya, S., ... Murphy, B. C. (2003). The relations of effortful control and reactive control to children's externalizing problems: A longitudinal assessment. *Journal of Personality*, *71*, 1172–1196. doi:10.1111/1467-6494.7106011

Van Widenfelt, B. M., Goedhart, A. W., Treffers, P. D. A., & Goodman, R. (2003). Dutch version of the Strengths and Difficulties Questionnaire. *European Child and Adolescent Psychiatry*, *12*, 281–289. doi:10.1007/s00787-003-0341-3

Received 11 July 2008; revised version received 3 May 2010

Appendix

Items to measure externalizing problems (SDQ; Goodman, 1997).

Conduct problems scale

Often has temper tantrums or hot tempers.
Generally obedient, usually does what adults request (R).
Often lies or cheats.
Steals from home, school or elsewhere.

Hyperactivity scale

Restless, overactive, cannot stay still for long.
Constantly fidgeting or squirming.
Easily distracted, concentration wanders.
Thinks things out before acting (R).
Sees tasks through to the end, good attention span (R).

Note. R indicates that item scores should be reversed.