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The Developmental Trajectories of Attention Focusing, Attentional and Behavioral Persistence, and Externalizing Problems during School Age Years

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Abstract

The developmental trajectories of attention focusing (parents' and teachers' reports) and attentional and behavioral persistence (observed during a laboratory task) -- two indexes of effortful control -- and externalizing problems from age 5 to 10 years were examined for 356 children combined from two three-wave (two years apart) longitudinal studies. We identified clusters of children with distinct trajectories for these variables and examined the links between the effortful control trajectories and the externalizing problem trajectories. Although attention focusing remained relatively stable, attentional and behavioral persistence continued to show mean-level changes (especially among the children with less optimal persistence). Children with high and stable trajectories of effortful control tended to exhibit low and stable trajectories of externalizing problems, whereas those with lower and/or less stable trajectories of effortful control showed more elevated and/or fluctuating trajectories of externalizing problems.

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Effortful control is a multidimensional temperament construct reflecting the efficiency of executive attention, including the ability to inhibit a dominant response and/or to activate a subdominant response, as well as to plan and detect errors (Rothbart & Bates, 2006). Components of effortful control have been associated with a wide range of positive adjustment outcomes in children and adolescents (see Eisenberg, Smith, Sadovsky, & Spinrad, 2004). However, little is known about individual differences in the developmental trajectories of effortful control, especially beyond preschool age, and their relations to developmental outcomes such as externalizing problems. Thus, the primary goals of the present study were twofold: (a) to identify the developmental trajectories of two indexes of effortful control --- attention focusing, and attentional and behavioral persistence (which involves effortful

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executive attention and inhibitory control) -- from age 5 to 10 years by aggregating and analyzing data from two three-wave longitudinal studies, and (b) to study the relations of the effortful control trajectories to the externalizing problem trajectories.

The Development of Effortful Control

Effortful control is believed to play a major role in self-regulation, including the regulation of emotions and behaviors that are associated with emotions. In fact, the regulation of emotion and related behaviors is often achieved through effortful deployment of attention (e.g., one can regulate negative emotions by shifting attention away from the emotion-provoking stimuli and/or focusing attention on relaxing stimuli), inhibition of dominant behavior impulses (e.g., aggression), and/or activation of less dominant behaviors (e.g., planning and problem solving; see Rothbart & Bates, 2006). Effortful control likely involves executive functioning, a broad construct encompassing a number of cognitive processes that are integral to self-regulation and goal-directed activities (e.g., working memory, inhibition of prepotent responding, planning, and shifting and sustaining attention) (Blair, Zelazo, & Greenberg, 2005). Because the functions of the executive attention network (e.g., conscious detection, inhibition, and conflict resolution) --- the core of effortful control --- overlap with the more general domain of executive functioning, effortful control and executive function are viewed as interrelated or overlapping constructs (Rueda, Posner, & Rothbart, 2005). Indeed, children's performance on neuropsychological tests of executive function (e.g., working memory, flexible rule use) was associated with caregivers' reports of temperamental effortful control (Hongwanishkul, Happaney, Lee, & Zelazo, 2005).

Because effortful control consists of multiple capacities including the voluntary focusing and shifting of attention, inhibitory control (i.e., the capacity to suppress inappropriate responses), activation control (i.e., the capacity to perform an action when there is a strong tendency to avoid it), planning, detecting errors, and sustaining working memory (Derryberry & Rothbart, 1997; Rothbart & Bates, 2006), it is possible that different components of effortful control follow different trajectories. For example, executive attention is believed to show significant development around the second half of the first year of life (Diamond, 1991; Ruff & Rothbart, 1996; Posner & Rothbart, 1998), but continues to develop in childhood (Gerardi-Caulton, 2000; Posner & Rothbart, 1998; Posner & Rothbart, 2005). In contrast, the ability to effortfully inhibit behavior upon command (inhibitory control) may not be very evident for most children until 24 to 36 months of age but is fairly developed by age 4 (Kochanska, Murray, & Harlan, 2000; Rothbart & Bates, 2006). Nonetheless, in longitudinal work (Murphy et al., 1999), parents' rating of children's attention shifting and inhibitory control increased from ages 4-5 to 10-12 years, and in cross-sectional research (Williams et al., 1999), inhibitory control (assessed by a stop-signal task) showed age-related improvement throughout childhood. Similarly, research on the normative development of executive functions --- a construct with functional and structural overlap with effortful control --- generally suggests that the development of executive functions is a multistage process in which different components develop at different times, spanning from infancy until at least adolescence, and that the development of basic functions precedes the development of more complex functions (Klenberg et al., 2001; Welsh & Pennington, 1988). Therefore, we expected to find different patterns of trajectories (both in terms of overall shapes and individual differences) for different indexes of effortful control.

Age-related changes in effortful control may be related to several developmental processes. First, because effortful control is hypothesized to reflect the functions of the executive attention network located in midfrontal lobe, including the anterior cingulate gyrus (Posner & DiGirolamo, 2000), the overall trends in effortful control development may be associated with structural changes in normative brain maturation. Results of neuroimaging and physiological studies indicate that the prefrontal cortex is one of the last brain regions to mature in normative

development, and significant development in this region (e.g., myelination, pruning, blood flow changes) continues throughout childhood and adolescence (Casey, Giedd, & Thomas, 2000). In addition, because common academic tasks for school-age children often involve the abilities to focus and sustain attention, to shift attention from task to task, and to inhibit dominant emotional and behavioral tendencies (e.g., sitting still), it is likely that school education partly contributes to the overall age-related development in effortful control. Indeed, McCrea, Mueller, and Parrila (1999) found that formal schooling was associated with the development of executive function (e.g., verbal fluency and planning) in grades 1 to 4.

Because the socialization processes within school and other social contexts (e.g., peer relationships) are unlikely to be the same for different individuals, they may be associated not only with overall trends, but also with individual differences in effortful control development. Aspects of family socialization, including parental warmth and positive expressivity (Eisenberg, Zhou, et al., 2005), parental discipline (Kochanska & Knaack, 2003), parent-child attachment (Olson, Bates, & Bayles, 1990), and specific features of parent-child dyadic interaction such as joint attention, reciprocity and turn taking (Raver, 1996), have also been linked to individual differences in children's effortful control or its related abilities.

Thus, it is important to examine both overall trends and individual differences in the developmental trajectories of various components of effortful control. Recent methodological advances in mixture modeling statistical methods allow researchers to detect population heterogeneity in the developmental trajectories of psychological characteristics (Muthen & Curran, 1997). For example, Nagin and colleagues (Jones, Nagin, & Roeder, 2001; Nagin, 1999) developed a semi-parametric¹, group-based method using multinomial modeling, which can identify clusters of individuals with distinctive developmental trajectories for a given characteristic and describe the average patterns of change over time (e.g., the intercept and slope) among the clusters. Using this method, Côté et al. (2002) identified four clusters of children (within both boys and girls) with distinct trajectories of behavioral impulsivity from age 6 to 12: the *low-*, the *moderate-* (for girls) or *moderate-rising* (for boys), the *moderate-declining*, and the *high-declining impulsivity* clusters; in contrast, they found three clusters of children who followed distinct (*low*, *moderate*, and *high*) and mostly stable developmental trajectories of fearfulness. These results support the hypothesis that different temperament characteristics may follow different developmental trajectories.

The first goal of the present study was to use the group-based trajectory approach (Nagin, 1999) to identify developmental trajectories for children's attention focusing (parents' and teachers' reports) and attentional and behavioral persistence (observed during a challenging task) from age 5 to 10 years. The abilities to focus and sustain attention and the ability to regulate emotional and behavioral impulses to persist on challenging tasks have long been studied as indexes of effortful control or related constructs (e.g., executive functioning, Anderson, 2002; emotion- or self- regulation, Dennis, 2006; effortful control, Eisenberg, Spinrad et al., 2004; Eisenberg, Zhou et al., 2005). In our previous research (based on the same samples as the present one), attention focusing and persistence were positively loaded on the same effortful control factor and both related similarly to other indexes of effortful control (e.g., physiological indexes of regulation, Liew, et al., 2003) and children's adjustment at multiple time points from early to middle childhood (Eisenberg, Spinrad, et al., 2004; Eisenberg, Zhou, et al., 2005; Valiente, et al., 2004). Because the persistence in completing a challenging task is a more complex ability than attention focusing, and may be affected by multiple components of effortful control (e.g., sustained attention, and inhibitory control) as well as reactive/involuntary control (e.g., impulsivity), it is expected to develop later than

¹The term "semi-parametric" refers to the fact that no distributional assumptions are made about the growth curve parameters (Nagin & Jones, 1999).

attention focusing and thus may show less stability and more variability in its developmental trajectories.

Associations between the Trajectories of Effortful Control and Externalizing Problems

Because children with deficits in effortful control have difficulty regulating attention, emotion (e.g., anger/frustration), and behavioral impulses (e.g., aggression), they are expected to be at higher risk for externalizing problems (Eisenberg & Morris, 2002; Olson et al., 2005). Consistent with the hypothesis, children's lack of control (a combination of low effortful and reactive control and high negative emotionality) at ages 3 and 5 positively predicted self-reported delinquency and the number of criminal convictions at age 21 (Henry, et al., 1999). Moreover, children's lack of effortful control measured at 22, 33, and 45 months was related to higher externalizing problems at 73 months (Kochanska & Knaack, 2003). In addition, low effortful control (assessed as adults' reports of attention focusing and shifting, inhibitory control, and observed behavioral persistence) and high impulsivity (adults' reports) uniquely predicted higher externalizing problems over two years in elementary school, even after controlling for prior levels of externalizing problems (Eisenberg, Spinrad et al., 2004).

Previous work on the development of externalizing problems (e.g., conduct problems, aggressive/disruptive behaviors, or antisocial behaviors) is consistent with the existence of different developmental pathways to externalizing problems from childhood to adulthood. For example, Patterson, Capaldi, and Bank (1991) and Moffitt (1993) argued for the distinction between two types of trajectories for antisocial behaviors: (1) the life-course-persistent trajectory, representing those children who exhibit high levels of aggression starting in early childhood and maintaining a high level throughout development; and (2) adolescent-limited trajectory, representing those who display high levels of aggressive behaviors only during middle childhood and adolescence. Partly consistent with this theory, four developmental trajectories were identified for boys' externalizing problems from ages 2 to 8, as well as from ages 6 to 15 in two study samples (Nagin & Tremblay, 1999; Shaw, Gilliom, Ingoldsby, & Nagin, 2003): a *persistent problem* trajectory, a *high-level desister* trajectory, a *moderate-level desister* trajectory, and a *persistent low* trajectory. Schaeffer, Petras, Ialongo, Poduska, and Kellam (2003) identified four somewhat different pathways of antisocial behavior from 1st to 7th grade within an epidemiological sample of primary African American boys: the *chronic high*, *moderate* (and stable), and *increasing aggression* trajectories, as well as the *non-aggressive* trajectories. In a study of 2- to 11- year olds, Côté, Vaillancourt, LeBlanc, Nagin, and Tremblay (2006) found three groups: *low desisters*, *moderate desisters*, and a *high stable* group. In addition, the NICHD Early Child Care Research Network (2004) identified five aggression trajectories from 24 months to third grade based on mothers' report of physical aggression: the *very low* (and stable), the *low* (and stable), the *moderate and declining*, the *moderate* (and stable), and the *high* (and stable) aggression trajectories.

The majority of research on the associations between effortful control and externalizing problems used the variable-centered analysis approaches, which focus on the covariance patterns among variables aggregated across individuals. Because of the existence of subgroups of individuals with distinct developmental pathways to externalizing problems within the population (e.g., Nagin & Tremblay, 1999; Shaw et al., 2003; Scheaffer et al., 2003), the relations among variables aggregated over the full sample may not accurately capture the relations within subgroups of individuals. A negative correlation between effortful control at age 5 and externalizing problems at age 8 may occur for a variety of reasons, even if one assumes some causal rather than merely correlated effects, including: (a) because children with high and stable levels of effortful control from early- to middle-childhood also exhibit low and stable levels of externalizing problems in the same developmental period. This pattern would suggest that the developmental processes underlying the links between effortful control and

externalizing problems (e.g., brain development and physiological processes) are established in early development and do not change with age; (b) because young children with low effortful control at age 5 develop *increasing* externalizing problems from age 5 to age 10. This pattern would indicate that effortful control in early development is especially important for later externalizing problems, probably because children with deficits in effortful control elicit or intensify the environmental precipitators/perpetuators of externalizing problems such as punitive/coercive reactions from adults, affiliation with deviant peers, and school failure (Coie & Dodge, 1998); or (c) because the *pattern* of developmental change in effortful control from age 5 to 10 years cooccurs or corresponds with the development of externalizing problems. For example, children who are low (moderate to high) on effortful control at age 5 but increase (decrease) in effortful control from age 5 to age 10 may develop decreasing (increasing) externalizing problems accordingly. This pattern would indicate that effortful control exerts more direct and proximal influences on externalizing problems, or that there is a continually emerging pattern of association (and perhaps causal relations) between effortful control and externalizing problems. Therefore, examining the patterns of co-development of effortful control and externalizing problems within subgroups of individuals with relatively homogeneous trajectories can provide a richer picture of the relations between the two constructs.

Thus, another goal of the present study was to examine associations between the developmental trajectories of effortful control and those of externalizing problems. After identifying the clusters of individuals with distinct trajectories of externalizing problems, we examined the relations between the trajectories of effortful control (attention focusing and persistence) and externalizing problems using the dual-trajectory method, an extension of the group-based approach (Nagin & Tremblay, 2001). Based on the theoretical and empirical relations between effortful control and children's externalizing problems (e.g., Eisenberg, Smith, et al., 2004; Kochanska & Knaack, 2003), we expected to find systematic associations between the developmental trajectories of effortful control and externalizing problems. Specifically, we predicted that children with high (low) and stable effortful control would be likely to display low (high) and stable externalizing problems throughout childhood. In contrast, for children with changing levels of effortful control, their developmental trajectories for externalizing problem were expected to fluctuate (inversely) correspondingly. Another pattern also seemed quite possible although less likely—one in which a stable deficit in effortful control is related to an increase in externalizing problems over time because of the increasingly important role of, and higher expectation for, effortful control in children's psychological adjustment, academic and social competence from early- to middle- childhood.

In addition, we examined the relations of demographic variables such as child sex and family SES with effortful control and externalizing trajectories. Based on the existing findings that girls generally displayed higher levels of effortful control than boys (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006), and that children from higher-SES families had higher effortful control than those from lower-SES families (e.g., Zhou, Eisenberg, Wang, & Reiser, 2004), female status and/or growing up in higher-SES families were expected to be associated with higher trajectories of effortful control. Most studies on externalizing behavior trajectories either studied one sex (e.g., Shaw et al., 2003; Schaeffer et al., 2003) or examined the trajectories separately by sex. In general, higher proportions of girls than boys have exhibited low trajectories of impulsivity and opposition /disruptive behaviors, although the number of trajectory groups identified and their shapes were similar across sex (Nagin & Tremblay, 1999; Côté et al., 2001, 2002). Based on prior research (NICHD ECCRN, 2004), higher family SES was also expected to predict lower trajectories externalizing problems.

Method

Participants

The sample included data from two 3-wave (2 years apart) longitudinal studies investigating children's socio-emotional functioning from late preschool to elementary school in the same city. They were conducted during overlapping periods, although one study started approximately three years before the other (all data were collected between 1992 and 1999).

Study 1—The first sample came from a longitudinal study of emotional and social development that included 199 children (49% girls, age range = 5.3 – 10.4 years, mean age = 7.5, $SD = 1.2$) first assessed in kindergarten through third grades (Wave 1; Eisenberg, Fabes, Guthrie, et al., 1996; Eisenberg, Valiente et al., 2003). At T1, the percentages of children in kindergarten and in the first, second, and third grades were 20%, 31%, 24% and 25%, respectively. Seventy-nine percent of the participants were Caucasian, 4% were African American, 10% were Hispanic, .5% were Asian, 2% were Native American, and 4.5% were classified as other. The participants were mostly from working and middle-class families (the mean family income at T1 = \$46,000, $SD = \$24,000$, the mean years of education = 14.60 and 14.99 for mothers and fathers, respectively, $SDs = 2.0$ and 2.6). Of those who participated in Wave 1, 169 were assessed 2 years later (W2), and 169 participated 4 years later (W3).

Study 2—The second sample initially included 214 children (96 girls, M age = 6.2 years, $SD = 0.9$; 118 boys, M age = 6.1 years, $SD = 0.8$) first assessed between 55 and 97 months of age (Wave 1) (Eisenberg, et al., 2001; Eisenberg, Spinrad, et al., 2004). About two-thirds of these children came from the same school district and similar schools as the children in Study 1. A selective screening procedure was used to oversample children at risk for behavioral problems, and as a result, approximately 65% of the participants were at risk (T scores ≥ 60 on parent report of the Child Behavior Checklist, Achenbach, 1991) for internalizing, externalizing or both at W1 (for detailed descriptions of recruitment and selection procedures, see Eisenberg, et al., 2001; Eisenberg, Spinrad et al., 2004). Seventy-four percent of the W1 sample were Caucasian, 13% were Hispanic, 5% were Native American, 3% were African American, less than 1% were Asian, and 4% were of other origin. At W1, annual family income ranged from \$6,000 to \$160,000 ($median = \$35,000$). Mean years of maternal and paternal education were 14.1 ($SD = 2.5$) and 14.1 ($SD = 3.1$), respectively. Of those children assessed at W1, 193 (age range = 6 to 10 years) were assessed 2 years later (W2), and 184 (age range = 8 to 12 years) were assessed 4 years later (W3). Compared to the children in Study 1, those in Study 2 were younger at the first wave of assessment ($M_s = 6.1$ vs. 7.2 years), $t(354) = -11.0$, $p < .001$, and lower on family SES ($M_s = -.15$ vs. $.16$), $t(351) = -3.3$, $p < .002$. The two samples did not differ on other demographic variables.

The combined data set—The data set used for the present analyses was created by combining the above two samples and including the assessments from age 5 to 10.99 years. The two studies have wide age-ranges of participants at each wave and overlap in participants' age ranges between waves (e.g., there were 7-year-olds at both the W1 and W2 assessments), and included different ages of participants at the initial assessment (i.e., age 5-9 at W1 for Study 1, age 4.5 to turning 8 years at W1 for Study 2). Therefore, when combining the two datasets, we grouped the children by age rather than by wave of assessment. Moreover, only the children with at least two waves of data were included, resulting in a combined sample of 356 children (47% female, 56% from Study 2²). According to the participants' age at the first

²Of the 199 children selected from the Study 2 sample, 28 (14%) exhibited clinically significant externalizing problems at Wave 1 (T score ≥ 70 on parents' reports of CBCL externalizing), 19 (10%) exhibited clinically significant internalizing problems, 11 (6%) displayed clinically significant comorbid externalizing and internalizing problems.

assessment ($M = 6.6$ years, $SD = 1.0$), we classified them into four age cohorts. Cohort 1 (45% female) included 93 children first assessed between 60 and 71 months old (5-year-olds); among them 90 were assessed again two-years later (at Wave 2) and 86 were assessed four-years later (at Wave 3). Cohort 2 (46% female) included 152 children first assessed between 72 and 83 months of age (6-year-olds); among them 144 were assessed at Wave 2 and 133 at Wave 3. Cohort 3 (55% females) included 64 children first assessed between 84 and 95 months of age (7-year-olds); they were all assessed again at Wave 2. Cohort 4 (43% female) included 46 children first assessed between 96 and 107 months of age (8-year-olds); they were all assessed again at Wave 2. Because we only included assessments conducted between 60 months (age 5) and 131 months (age 10), the 7-year-olds and 8-year-olds had only two waves of data. As shown in Table 1, the combined data resembles a cohort-sequential design consisting of four age cohorts assessed up to three waves (two years apart). In a cohort-sequential design, or the accelerated longitudinal design (see Duncan, Duncan, & Hops, 1996), participants of varying ages are sampled at a single time point and then followed for several years. The age of the participants defines a cohort. By combining the data involving repeated measurements of several overlapping age cohorts, researchers can use information from shorter-term studies to determine longer term developmental growth trajectories (Bell, 1964). Application of the semi-parametric, group-based method in examining growth trajectories with an accelerated longitudinal design has been demonstrated by other researchers (e.g., Chassin, Pitts, Post, 2002; Vitaro et al., 2004).

Within each of the two study samples, we compared the participants who were included in the trajectory analyses with those who were not on Wave 1 demographic variables and measures of attention focusing, persistence, and externalizing problems. Within the Study 1 sample, the children who were included in the trajectory analyses ($N = 157$) compared with those who were excluded ($N = 45$) were younger in age and higher on maternal education, $t(158 \text{ and } 195) = 8.7$ and -2.26 , $ps < .002$ and $.026$, had a lower proportion of ethnic minorities, Pearson's $\chi^2(5) = 16.33$, $p < .007$, and were higher on parents' reports of externalizing problems, $t(189) = -1.99$, $p < .049$. Within the Study 2 sample, the children who were included in the trajectory analyses ($N = 199$) compared with those who were excluded ($N = 15$) had higher family incomes, $t(192) = 2.13$, $p < .036$, lower parents' and teachers' ratings of attention focusing, $t(207 \text{ and } 193) = -2.22$ and -3.72 , $ps < .023$ and $.001$, and a lower proportion of ethnic minorities, Pearson's $\chi^2(5) = 18.3$, $p < .004$.

There were two sources of missing data in the present sample: a) missingness due to accelerated longitudinal design (i.e., the 5- and 6- years-olds had missing data at three age points, the 7- and 8-years-olds had missing data at four age points); and b) missingness due to attrition (thirty-eight participants, or 10.7% of the whole sample, attrited after the first or second assessment). Data missing by design (such as the accelerated longitudinal design) are considered missing at random (or MAR, Schafer & Graham, 2002). Although the data missing due to participant dropouts may be not at random (MNAR), the percentage of dropouts was relatively small in the sample ($< 11\%$). Moreover, we compared the individuals who dropped out after the first or second assessment ($n = 38$) with those who did not drop out ($n = 318$) on demographic and study variables, and found no difference on child sex, race, and family SES and very few differences on the study variables (only 5 out of 30 significance tests conducted were significant). Therefore, dropout did not seem to lead to any major biases into the sample. In addition, we estimated the mixture models using the sample that included only the participants with three waves of data ($N = 209$) versus the larger sample that included participants with at least two waves of data ($N = 356$), and compared the trajectories. For all five sets of variables (i.e., parents' and teachers' reports of attention focusing, behavioral persistence, and parents' and teachers' reports of externalizing problems), the same number of trajectory clusters and similar patterns of mean trajectories were identified. Therefore, the results based on the larger sample (including those with at least two waves of data) are reported below.

Procedure

At each wave and for both studies, the child came with a parent (usually the mother) to a university laboratory. After all necessary consent forms were signed, parents completed questionnaires on children's regulation and externalizing problems while children engaged in multiple laboratory tasks in a different room, including a behavioral task (puzzle box) that was designed to measure primarily regulation. With parental consent, questionnaires on regulation and externalizing problems were sent to teachers who sent them back to the university (the return rates for teachers' questionnaires were above 88% in both studies and for all waves). After being debriefed, children picked a gift and families were paid for their participation.

Measures

Because slightly different measures (or different sets of items) on some constructs (e.g., attention focusing and externalizing problems) were used with the two samples, before combining the data sets, a careful matching procedure was applied to identify the common items of the measures used in both studies.

Attention focusing—At each wave and in both studies, children's attention focusing was assessed with a 7-item subscale adapted from the CBQ (Rothbart, Ahadi, & Hershey, 1994, see also Rothbart et al., 2001; e.g., “When picking up toys or other jobs, usually keeps at the task until done”, “When drawing or coloring a book, shows strong concentration”). Parents and teachers rated the items on a 7-point scale (from 1 = *extremely untrue* to 7 = *extremely true*). Two items were worded slightly differently in the two studies but were kept in the analyses because the difference was small (i.e., “When practicing an activity, has a hard time keeping her/his mind on it” vs. “When working on a school activity, has a hard time keeping his/her mind on it”, “When building or putting something together, becomes very involved in what she/he is doing, and works for long periods” vs. “When working on a task, becomes very involved in what she/he is doing and works for long periods”). The alphas for the attention focusing subscale were .69, .70, and .74 for parents' reports at T1, T2, and T3, respectively, and .83, .82, and .81 for teachers' reports at T1, T2, and T3, respectively. The within-time correlations between parents' and teachers' reports ranged from .24 to .47 ($Ns = 82$ to 183), $ps < .05$. The across-time correlations of attention focusing ranged from .36 to .70 ($ns = 77$ – 160), $ps < .01$, for parents' reports, and from .35 to .56 ($ns = 68$ – 142), $ps < .01$, for teachers' reports.

Observed behavioral persistence—At each wave and in both studies, children's behavioral persistence was assessed with a puzzle box task (see also Eisenberg, et al., 2001). Children were instructed to try to assemble a wooden puzzle in a large box without looking at it. A cloth covered the front; children slipped their arms through sleeves to get into the box. The cloth could be lifted up so that a child could cheat by looking. Children were told that if they finished the puzzle within 5 minutes, they would receive an attractive prize; they were also told that they could call the experimenter back by ringing a bell if they finished in less than 5 minutes. An unseen observer timed children's persistence on the puzzle box (without cheating). A second observer timed approximately 50% of the sample for reliability (reliabilities were above .95 for all assessments). Because some children called for the experimenter before 5 minutes had elapsed, an index reflecting the degree of children's persistence on task was calculated as the proportion of time persisting on the puzzle (i.e., the number of seconds persisting divided by the total time spent with the task). Because low scores on the behavioral persistence index may be due to both cheating and off-task behaviors, the measure taps both effortful attention control and the ability to inhibit the urge to cheat (an aspect of effortful control). However, because the task involves a reward (albeit not visible), it may also tap reactive control (e.g., impulsivity or approach tendencies) for some children

and children's motivation on task. The across-time correlations of behavioral persistence ranged from .29 to .58 ($ns = 77 - 147$), $ps < .01$.

Externalizing problems—In Study 1, children's externalizing problems were assessed with the 24-item Child Behavior Checklist (CBC, Lochman et al., 1995), a measure including items from the Child Behavioral Checklist (e.g., “argues”, “lies”, “aggressive to adults”). Parents and teachers rated each item on a 4-point scale (1 = *never* to 4 = *often*). One item (“set fires”) was dropped because it was expected to be offensive to parents and also low frequency. In Sample 2, children's behavioral problems were assessed with parents' reports on the CBCL (Achenbach, 1991) and teachers' reports on the Teacher Report Form (Achenbach, 1991). The CBCL and the TRF consisted of similar items (although the wordings were slightly different for some items). Parents and teachers rated the items on a 3-point scale (from 1 = *not true* to 3 = *very or often true*). After carefully matching the items from the CBC measure used in Sample 1 with the CBCL and TRF measures used in Sample 2, we identified 14 common items of externalizing problems for parents' reports and 13 common items for teachers' reports in the two studies.³ Before combining, item scores on the CBC were recoded to adjust for metric differences between the CBC and CBCL/TRF (the middle two responses -- “2” and “3” -- were combined and then all responses were recoded so that the final set of items are on a 3-point scale ranging from 0 to 2). For the combined data, a composite score of children's externalizing problems were created at each wave by averaging across the 14 items for parents' reports and the 13 items for teachers' reports. The alphas were .84, .81, and .84 for parents' reports at T1, T2, and T3, respectively, and .93, .92, and .89 for teachers' reports at T1, T2, and T3, respectively. The within-time correlations between parents' and teachers' reports ranged from .27 to .46 (Ns ranged from 80 to 183), $ps < .01$. The across-time correlations of externalizing ranged from .48 to .77 ($Ns = 78 - 163$), $ps < .001$, for parents' reports, and from .28 to .61 ($ns = 67 - 146$), $ps < .05$, for teachers' reports.

Data Analysis

The analyses were conducted in two steps. First, we identified the best fitting single-variable trajectory models for children's attention focusing, behavioral persistence, or externalizing problems. We used the SAS-based procedure, PROC TRAJ (Jones et al., 2001), which is a semi-parametric method for identifying between-group differences in trajectory shapes (Nagin, 1999). For each construct of interest, to determine the optimal number of trajectory clusters and the shape of each trajectory, we first specified a single cluster with a stable/flat shape and then tested a series of models by increasing the number of clusters and the number of polynomial terms (e.g., linear or quadratic) for each trajectory cluster. Following the suggestions of Jones et al. (2001) and Nagin (1999), we selected the model with the maximum Bayesian Information Criterion (BIC) as the optimal model for this construct. The PROC TRAJ procedure generated the probability of each participant being classified in each of the trajectory clusters and assigned trajectory cluster membership for each participant based on his or her highest probability of classification across clusters (Côté et al., 2002). Within each identified cluster, the average probability of participants being classified in this cluster provides another index of model fit (i.e., probabilities around or greater than .7 to .8 imply a good model fit; see Côté et al., 2002). The above analyses were conducted for children's attention focusing, behavioral persistence, and externalizing problems from age 5 to 10 years. Because researchers have suggested that parents and teachers observe different aspects of children's behaviors (Achenbach et al., 1987), we conducted the analyses separately for parents' and teachers' reports of attention focusing and externalizing problems. Once the trajectories for the individual variables were identified, multinomial logistic regressions were conducted to examine the

³The zero-order correlations between the shortened and the original measures of externalizing problems were between .93 and .98 for Study 1 ($ns = 62$ to 157), and between .94 and .97 for Study 2 ($ns = 126$ to 183).

effects of demographic variables (child age at first assessment, sex, family SES, and ethnicity) and study sample (Study 1 vs. Study 2) on children's membership in the trajectory clusters.

Next, we examined the associations between the trajectories of attention focusing or behavioral persistence and externalizing problems by using the PROC TRAJ joint trajectory modeling (Nagin & Tremblay, 2001). This method is a generalization of the group-based method for identifying trajectory clusters of a single construct (Nagin, 1999) and provides joint estimation of trajectory models for two distinct but theoretically related measurement series (Nagin & Tremblay, 2001). This statistical approach generates three sets of probability estimates: (a) the probability of belonging to the trajectory clusters of construct A given membership in the trajectory clusters of construct B (henceforth called the probability of A cluster conditional on B cluster); (b) the probability of belonging to the trajectory clusters of construct B given membership in the trajectory clusters of construct A (henceforth called the probability of B cluster conditional on A cluster); and (c) the joint probability of belonging to both the trajectory cluster of construct A and the trajectory cluster of construct B (henceforth called the joint probability of A and B clusters).

Results

The Trajectories of Children's Attention Focusing, Persistence, and Externalizing Problems from Age 5 to 10: Single-Variable Trajectory Analysis

The means and standard deviations of the major variables at each age are presented in Table 2. For both parents' and teachers' reports of children's attention focusing (AF), a three-cluster model with no polynomial term was found to be the most parsimonious fit to the data based on the BIC (BICs = -1088.2 and -1270.9 for parents' and teachers' reports, respectively; changes in BIC = -1.99 and -5.87 from the three-cluster to four-cluster solution; a negative change in BIC suggests a poorer model fit). The average probabilities of cluster membership ranged from .85 to .86 for parents' reports and from .74 to .89 for teachers' reports, indicating reasonably good fits of the overall models (Cole et al., 2002). As shown in Figure 1A and 1B, for both parents' and teachers' reports, the three clusters exhibited stable attention focusing from age 5 to 10, and included the following: a *low-and-stable AF* cluster (n s = 75 and 31 for parents' and teachers' reports, respectively, 21.4% and 10.3% of the sample), a *moderate-and-stable AF* cluster (n s = 190 and 105 for parents' and teachers' reports, respectively, 51.9% and 30.5% of the sample), and a *high-and-stable AF* cluster (n s = 91 and 220 for parents' and teachers' reports, respectively, 26.8% and 59.3% of the sample).

For children's persistence (assessed as the percentage of persistence on laboratory task), a three-cluster solution was the most parsimonious fit to the data based on the BIC (BIC = -90.4, the change in BIC = -5.87 from the 3-cluster to 4-cluster solution). Nonsignificant higher order polynomial terms were trimmed for model parsimony. The average probability of cluster membership ranged from .76 to .85, indicating a reasonably good fit of the overall model. As shown in Figure 2, the three clusters were as follows: the *high-and-stable persistence* cluster (n = 170, 44.1% of the sample), the *moderate-and-slightly-declining persistence* cluster (n = 115, 31.0%), and the *low-and-rising persistence* cluster (n = 71, 25.0%) that included children who started with low persistence at age 5 but displayed a quadratic increase (i.e., a steep rise in persistence then followed by a slower rise) in persistence through age 10.

A three-cluster model was again identified as the best-fitting model for both parents' and teachers' reports of externalizing problems (BICs = -117.6 and -601.5 for parents' and teachers' reports, respectively; the changes in BIC = -1.19 and -3.70 from the three-cluster to four-cluster solution). The average probability of cluster membership ranged from .88 to .89 for parents' reports and from .81 to .91 for teachers' reports, indicating satisfactory model fit. As presented in Figure 3A, the three parent-reported clusters were the *low-and-stable EXT* cluster

($n = 96$, 27.9% of the sample), the *moderate-and-slightly-declining EXT* cluster ($n = 200$, 54.2%), and the *high-and-slightly-declining EXT* cluster ($n = 60$, 17.9%). A different pattern was found with teachers' reports of externalizing problems (see Figure 3B), which included: a) the *low-and-stable EXT* cluster ($n = 219$, 60.2% of the sample), b) the *low-and-rising EXT* cluster ($n = 27$, 8.3% of the sample) which included children who displayed relatively low externalizing problems at age 5 and a quadratic increase followed by a modest decrease (although remaining the highest compared to all groups) through age 10, and c) the *moderate-and-stable EXT* cluster ($n = 110$, 31.6% of the sample).

The Effects of Demographic Variables and Study Sample on Trajectory Cluster Membership

Five multinomial logistic regressions were conducted to examine the effects of children's age (at their first assessment), child sex, family SES, ethnicity (white Euro-American vs. nonwhite/Hispanic), and study sample (Study 1 vs. Study 2) on the membership of the trajectory clusters for parents' and teachers' reports of attention focusing, persistence, and parents' and teachers' reports of externalizing problems. The family SES variable was created by first averaging maternal and paternal education levels at the first assessment, and then averaging the standardized scores for parental education and family income. Ethnicity (white versus nonwhite) and age at the first assessment were unrelated to any trajectories. Child sex and family SES uniquely predicted the cluster membership for parents' reports of attention focusing: girls had lower odds (than boys) of being in the *low-stable AF* cluster versus the *high--stable AF* cluster or the *moderate-stable AF* cluster, $Bs = -1.00$ and $-.66$, $ps < .004$ and $.03$; higher family SES increased the odds of being in the *high-and-stable AF* cluster or the *moderate-and-stable AF* cluster versus the *low-and-stable AF* cluster, $Bs = .90$ and $.49$, $ps < .001$ and $.10$; higher family SES also decreased the odds of being in the *moderate-and-stable AF* cluster versus the *high-and-stable AF* cluster, $B = -.42$, $p < .02$. Child sex, family SES, and study sample uniquely predicted the cluster membership for teachers' reports of attention focusing: girls had lower odds (than boys) of being in the *low-and-stable AF* cluster or the *moderate-and-stable AF* cluster versus the *high-and-stable AF* cluster, $Bs = -1.18$ and -1.28 , $ps < .008$ and $.001$; higher family SES decreased the odds of being in the *low-and-stable AF* cluster or the *moderate-and-stable AF* cluster versus the *high-and-stable AF* cluster, $Bs = -.89$ and $-.44$, $ps < .002$ and $.008$; children in Study 2 had lower odds (than those in Study 1) of being in the *low-and-stable AF* cluster or the *moderate-and-stable AF* cluster versus the *high-and-stable AF* cluster, $Bs = -1.24$ and $-.74$, $ps < .013$ and $.016$. None of the demographic or study sample variables predicted the persistence clusters. Child sex and study sample predicted parents' reports of externalizing clusters: girls had higher odds (than boys) of being in the *low-stable EXT* cluster or the *moderate-and-slightly-declining EXT* cluster versus the *high-and-slightly-declining EXT* cluster, $Bs = 1.36$ and 1.14 , $ps < .001$ and $.002$; and children in Study 2 (compared to those in Study 1) had higher odds of being in the *low-stable EXT* cluster versus the *high-and-slightly-declining EXT* cluster or the *moderate-and-slightly-declining EXT* cluster, $Bs = 2.67$ and 2.17 , $ps < .001$. Similarly, child sex and study sample predicted teachers' reports of externalizing clusters: girls had higher odds of being in the *low-stable EXT* cluster versus the *low-rising EXT* or the *moderate-stable EXT* cluster, $Bs = 2.29$ and 1.46 , $ps < .001$; children in Study 2 (compared to those in Study 1) had higher odds of being in the *low-stable EXT* cluster versus the *low-rising EXT* cluster or the *moderate-stable EXT* cluster, $Bs = 1.90$ and 1.46 , $ps < .002$ and $.001$. Recall that approximately one-third of the youth in Study 2 were selected for being low in problem behaviors at the initial assessment and another one-third were selected for being high in internalizing problems (but not necessarily externalizing problems); this selection likely accounts for the study sample effects.

Links between Trajectories of Effortful Control and Externalizing Problems: Joint Trajectory Analyses

Attention focusing and externalizing problems—Because both parents and teachers reported on children's attention focusing and externalizing problems, to reduce the reporter effect, we conducted two sets of joint trajectory analyses: one for parents' reports of attention focusing and teachers' reports of externalizing (Table 3), and one for teachers' reports of attention focusing and parents' reports of externalizing (Table 4). The first part of Table 3 reports the probability of membership in each of the externalizing (teachers' reports) trajectory clusters conditional on membership in a given attention focusing (parents' reports) trajectory cluster. For example, among the children in the *low-and-stable AF* (parents' reports) cluster, 25.6% were in the *low-and-stable EXT* (teachers' reports) cluster, 55.7% were in the *moderate-and-stable EXT* cluster, and 18.7% were in the *low-and-rising EXT* cluster. Note that these percentages are affected by the percentages of children in each of the externalizing clusters for the overall sample; if there were fewer children in a given externalizing cluster, they were less likely to account for a large percent of children in any AF cluster. For example, only 8.3% of children in the overall sample were in the *moderate-and-stable EXT* cluster, thus the fact that 55.7% of children in the *low-and-stable AF* cluster were in the *moderate-and-stable EXT* cluster is especially notable. Pearson Chi-square tests were conducted to compare the probability distributions of externalizing clusters for each of the three contrasts among the attention focusing clusters. The results suggested that children in the *high-and-stable AF* cluster had a higher probability of being in the *low-and-stable EXT* cluster than those in the other two AF clusters, $\chi^2(2) \geq 9.4, ps < .01$. Compared to children in the *moderate-and-stable AF* cluster (parents' reports), those in the *low-and-stable AF* cluster had higher probabilities of being the *moderate-and-stable EXT* or the *low-and-rising EXT* cluster, $\chi^2(2) = 20.7, p < .001$. The second part of Table 3 reports the converse set of probabilities for each attention focusing (parents' reports) cluster conditional on a given externalizing (teachers' reports) cluster. Pearson Chi-square tests indicated that the children in the *low-and-stable EXT* cluster had higher probabilities of being in the *high-and-stable AF* or the *moderate-and-stable AF* clusters than those in the other two EXT clusters, $\chi^2(2) \geq 28.4, ps < .001$. No significant differences were found in the attention focusing cluster distributions between the *low-and-rising EXT* and the *moderate-and-stable EXT* clusters. The third part of Table 3 reports the joint probabilities of attention focusing and externalizing trajectory clusters. The modal cluster, which accounted for 30.1% of the population, was composed of children belonging to both the *moderate-and-stable AF* and the *low-and-stable EXT* clusters.

Similarly, the joint trajectory analyses of teachers' reports of attention focusing and parents' reports of externalizing problems (Table 4) suggested that children from the *high-and-stable AF* cluster were more likely to be in the *low-and-stable EXT* cluster than those in the other two AF clusters, $\chi^2(2) \geq 33.7, ps < .001$. (The probabilities of being in the *moderate-and-declining EXT* cluster were relatively high because parents reported that over half of the sample was in this cluster.) No significant differences were found in externalizing cluster distributions between the *low-and-stable AF* and the *moderate-and-stable AF* clusters. Conversely, the children in the *low-and-stable EXT* cluster had a higher probability of being in the *high-and-stable AF* cluster than those in the other two EXT clusters, $\chi^2(2) \geq 23.3, ps < .001$. Moreover, compared to those in the *moderate-and-slightly-declining EXT* cluster, children in the *high-and-slightly-declining EXT* cluster had higher probabilities of being in the *low-and-stable AF* cluster or the *moderate-and-stable AF* cluster, $\chi^2(2) = 18.3, p < .001$.

In summary, the joint trajectory analyses based on teachers' and parents' reports of attention focusing and externalizing suggested that children with high and stable attention focusing from age 5 to 10 were more likely to display low and stable externalizing problems at the same time than were other children. In contrast, children with low and stable attention focusing were more

likely to display moderate to high and relatively stable levels of externalizing problems, and were also more likely to start with low levels of externalizing problems in early childhood and increase in externalizing through elementary school age (especially for teachers' reports) than were other children. Conversely, children with low and stable externalizing problems (for both reporters) were more likely than other children to have high and stable attention focusing at the same time; the children rated by teachers as displaying moderate and stable externalizing problems and those displaying initially low but rising externalizing problems did not differ on trajectories of attention focusing. In addition, the children rated by parents as displaying high (and slightly declining) externalizing problems were more likely to have low to moderate (and stable) attention focusing trajectories than others.

Persistence and externalizing problems—Because different patterns of trajectory clusters were found with parents' and teachers' reports of externalizing problems in single-variable trajectory analyses, separate joint trajectory analyses were conducted for persistence and teachers' or parents' reports of externalizing problems, and both results were presented. Table 5 includes the estimates from the joint trajectory model for persistence and teachers' reports of externalizing problems. The children in the *high-and-stable persistence* cluster had a higher probability of being in the *low-and-stable EXT* (teachers' reports) cluster than those in the other two persistence clusters, $\chi^2(2) \geq 6.7$, $ps < .05$. Compared to those in the *low-and-rising persistence* cluster, the children in the *moderate-and-slightly-declining persistence* cluster had higher probabilities of being in the *moderate-and-stable EXT* or the *low-and-rising EXT* clusters, $\chi^2(2) = 10.5$, $p < .01$. Conversely, the children in the *low-and-stable EXT* cluster had a higher probability of being in the *high-and-stable persistence* cluster than those in the other two EXT clusters, $\chi^2(2) \geq 30.9$, $p < .001$. No significant differences were found in the persistence cluster distributions in the contrast of *low-and-rising EXT* vs. the *moderate-and-stable EXT* clusters.

Similarly, the joint trajectory model for persistence and parents' reports of externalizing problems (Table 6) suggested that the children in the *high-and-stable persistence* cluster tended to have higher probabilities of being in the *low-and-stable EXT* cluster and the *moderate-and-declining EXT* cluster than those in the two other persistence clusters, $\chi^2(2) \geq 8.6$, $p < .02$. No significant differences were found in the externalizing cluster distributions between the *moderate-and-slightly-declining persistence* and the *low-and-rising persistence* clusters. Conversely, compared to the children in the *high-and-slightly-declining EXT* cluster, those in the *low-and-stable EXT* cluster had higher probabilities of being in the *moderate-and-declining persistence* and the *low-and-rising persistence* clusters, $\chi^2(2) = 11.7$, $p < .003$. No significant differences were found in the persistence cluster probabilities between the *low-and-stable EXT* and the *moderate-and-declining EXT* clusters, or between the *moderate-and-declining EXT* and the *high-and-slightly-declining EXT* clusters.

In summary, the joint trajectory analyses of persistence and parents' or teachers' reports of externalizing problems both indicated that children with high and stable persistence trajectories were more likely to display low and stable externalizing problems during the same period than other children. Compared to children who displayed moderate and generally stable persistence trajectories, those who displayed low persistence at age 5 but became more persistent by age 10 were more likely to exhibit low and stable teacher-reported externalizing problems, although the two groups were not different on parent-reported externalizing problem trajectories. Conversely, children (according to both reporters) displaying low and stable externalizing trajectories were more likely to have high and stable persistence trajectories at the same time than were other children; children reported by teachers as exhibiting moderate and stable externalizing trajectories did not differ on the persistence trajectories from those with initially low but rising externalizing trajectories.^{4,5}

Discussion

This is one of the first longitudinal studies to examine the overall trends and individual differences in developmental trajectories of effortful control from early- to middle- childhood. The results provide important insight on the stability and change (and the potential susceptibility to intrapersonal and environmental influences) in the development of attention focusing and persistence (attentional and behavioral) – two indexes of effortful control. Moreover, the results on the links between the trajectories of effortful control and those of externalizing problems suggested that the associations between effortful control and externalizing problems may differ among subgroups of children with distinct effortful control or externalizing problem trajectories.

Developmental Trajectories of Attention Focusing and Persistence (Attentional and Behavioral)

The single-variable trajectory analyses based on parents' and teachers' reports of attention focusing consistently yielded three clusters of attention focusing trajectories from age 5 through 10 years: *the low, moderate, and high* trajectory clusters with stable levels of attention focusing. These results suggest that the ability to sustain attention seems to reach maturity and become stabilized by early to middle childhood. Because the children were rated by different teachers at different waves (although they were rated by the same parent across waves), it is unlikely that these results were purely due to reporter effects. The results are generally consistent with the research on the development of attention and executive functions using neuropsychological measures (e.g., tests of visual and auditory attention, computerized tasks measuring the efficiency of attention networks), which indicate that orienting and focusing attention reach maturity earlier in development (usually between age 6 and 10) than the more complex executive functions such as conflict resolution, strategy use and planning, monitoring and evaluation of performance (some of which may continue to develop during adolescence) (e.g., Anderson et al., 2001; Klenberg, Korkman, Lahti-Nuuttila, 2001; Rueda et al., 2005). However, because attention focusing trajectories before age 5 were not examined, the speculation on the peak in attention focusing in early childhood could not be confirmed. Further research is needed to examine this hypothesis with a wider age span of assessments.

In contrast to attention focusing, we found that children's attentional and behavioral persistence while working on challenging tasks was less stable for some children. Three trajectory clusters were identified for persistence: the cluster with a high and stable level of persistence from age 5 to 10 (about 44% of the sample), the cluster with moderate and generally stable (although with slight declining) persistence from age 5 to 10 (about 31% of the sample), and the cluster with initially low persistence age 5 but a quadratic increase in persistence that reached a level of persistence similar to that in the *high-and-stable* cluster by age 10 (about 25% of the sample). Thus, at least for a subgroup of children, the capacity to persist on a challenging task (without cheating) changed more with age compared with the global adult-reported attention focusing from early- to middle-childhood.

⁴Using the same method, we also examined the associations between the attention focusing (parents' or teachers' reports) and the behavior persistence trajectories. In summary, children with high and stable attention focusing from age 5 to 10 were more likely to display high and stable persistence on the frustration task during the same period compared to other children. In contrast, the behavioral persistence trajectories for children with low or moderate and stable attention focusing were mixed: they might display moderate and generally stable (albeit slight declining) persistence trajectories; they might also display low persistence at age 5 but increase in persistence from age 5 to 10. Conversely, children with high and stable persistence were more likely to display high and stable attention focusing than their peers. However, children with less optimal and/or less stable persistence trajectories did not differ on the attention focusing trajectories.

⁵To examine the links between the effortful control and externalizing trajectories controlling for the effects of child sex, study sample, and family SES, we re-ran the joint trajectory analyses by including the three covariates in the models. The estimates of the conditional and joint probabilities were similar to the original models without the covariates. Therefore, the covariates did not substantially affect the relations between the effortful control trajectories and the externalizing trajectories.

Note that children's persistence on the challenging task could have been jointly affected by multiple components of effortful control (e.g., the ability to focus and sustain attention on task, and the ability to inhibit the urge to cheat – an aspect of inhibitory control), as well as reactive control (e.g., impulsivity, approach/reward orientation). Because some components of effortful control (e.g., inhibitory control) may continue to develop in middle childhood and adolescence (Murphy et al, 1999; Williams et al., 1999), they may be more susceptible to environmental (e.g., family socialization, school education, peer relationship) influences than those effortful control components that have reached maturity by this developmental period (e.g., attention focusing), leading to both age-related changes in population means and within-population heterogeneity in their developmental trajectories. Therefore, it is possible that the children in *high-and-stable persistence* cluster reached maturity in various components of effortful control relatively early in development and thus displayed relatively stable level of effortful control from early to middle childhood. In contrast, the children in the *low-and-rising persistence* cluster may have been late-developing in effortful control (especially in inhibitory control) as a result of favorable socialization environment (e.g., parental warmth and effective discipline, secure attachment, meaningful peer relationship).

The last cluster, accounting for 31% of the sample, exhibited moderate and generally stable levels of persistence (although with slight declining). Because temperamental tendencies such as high negative emotionality and/or high impulsivity may interfere with the development of higher-order cognitive abilities such as strategic thinking, attention, memory, and problem solving (many of them are involved in effortful control) (Blair, 2002), it is possible the children in the *moderate-and-slightly-declining persistence* cluster also displayed high or increasing levels of impulsivity (e.g., as evidenced by the *moderate-rising impulsivity* cluster in Côté et al., 2002) and/or high levels of negative emotionality (anger/frustration and anxiety), which interfere with the acquisition of effortful control abilities. Environmental factors such as low parental warmth and support, family conflict, and other stressors may also be associated with the less optimal development in effortful control (although SES was not related to this trajectory). In addition, because this was a behavioral task, factors such as the child's desire for the reward for success, or perhaps age-related changes in children's willingness to cheat (which would reduce persistence scores), may have played a role. However, these interpretations are speculative, and future studies are needed to replicate these trajectory clusters and to examine the intrapersonal and external processes associated with the trajectories of different effortful control components.

Developmental Trajectories of Externalizing Problems

We also identified clusters of children with different trajectories of externalizing problems. Analyses based on parents' and teachers' reports yielded a cluster of children with consistently low externalizing problems, and a cluster with moderate and somewhat stable externalizing problems (although parents' reports showed a slight declining in this cluster). The children with consistently low or moderate externalizing problems accounted for about 82% (parents' reports) or 92% (teachers' reports) of the sample. More children were classified as high on externalizing problems by parents than teachers, likely because parents and teachers observe children's behaviors in different settings (at home vs. school) and children may be more regulated and display fewer externalizing problems at school (where there are usually more rules and restrictions on children's behaviors) than at home. These results are generally consistent with the conclusions from large national longitudinal studies (e.g., NICHD ECCRN, 2004; Côté et al., 2006) that the majority of children exhibited low to moderate levels of physical aggression, oppositional, and disruptive behaviors and followed relatively stable and declining trajectories between toddlerhood and middle childhood.

A slightly different trajectory pattern was found with parents' versus teachers' reports for children with high externalizing problems. Parents identified a cluster of children (*high-and-slightly-declining EXT*, 18%) with chronically high (even at age 10) but slightly desisting trajectories of externalizing problems, whereas teachers' reports included a small cluster (*low-and-rising EXT*, 8%), which started low but increased substantially in externalizing throughout elementary school. Although the *high-and-slightly-declining* externalizing trajectory cluster was consistently found in other studies (e.g., Nagin & Tremblay, 1999; Côté et al., 2001, 2006), fewer studies had documented the *low-and-rising* externalizing cluster (Schaeffer et al., 2003). Because the major increase in externalizing among children the *low-and-rising EXT* cluster (teacher reported) in this study occurred between age 5 and 7 (kindergarten to 2nd grade), it is possible that environmental (e.g., school/classroom environment, peer relationships) and intra-individual (e.g., cognitive, emotional) changes involved in the transition to elementary school were associated with the increased manifestations of externalizing problems especially at school settings among these children (who tend to be boys). In addition, most investigators have examined aggression rather than the broader category of externalizing problems, and some externalizing problems (such as problems with authority, oppositional or disruptive behaviors) may increase modestly for a small percent of children in the early school years (see Côté et al., 2002).

Links between Trajectories of Effortful Control and Externalizing Problems

Another unique feature of the present study is that we examined the patterns of co-development between effortful control and externalizing problems. The cross-reporter analyses for teachers' and parents' reports of attention focusing or observed behavioral persistence with externalizing problems yielded consistent results: children with high and stable attention focusing or behavioral persistence throughout childhood tended to display stably low externalizing problems across the same time span (proportionally, taking into account the number of children with *low-and-stable* externalizing). The co-occurrence across age of high and stable attention focusing or behavioral persistence with low and stable externalizing problems across the elementary school years -- even across reporters or types of measures -- supports the theoretical perspectives on the roles of attentional, emotional, and behavioral regulation in the manifestation of aggression and other externalizing behaviors (e.g., Eisenberg & Morris, 2002; Olson et al., 2005), and is consistent with findings from research using variable-centered analyses (e.g., correlations) (e.g., Eisenberg et al., 2004; Henry et al., 1999; Kochanska & Knaack, 2003). This finding further suggests that the negative correlation between effortful control and externalizing problems may be largely contributed by the group of children with steadily high effortful control and steadily low externalizing problems. For these children, the causal connections between effortful control and externalizing problem may be established early and remain stable from early- to middle- childhood, although research examining the co-occurrence of these trajectories in the first five years of life is needed to better assess if early changes in effortful control affect individual differences in trajectories of externalizing problems.

In contrast, a more diverse pattern of externalizing trajectories was found for children with lower and/or less stable trajectories of attention focusing or persistence. Specifically, although some of them tended to disproportionately display moderate to high and relatively stable levels of concurrent externalizing problems, others exhibited low externalizing in early childhood but increased in externalizing through elementary school years. The children reported by teachers as displaying *low-and-stable AF* did not differ from those with *moderate-and-stable AF* on the externalizing cluster distributions (although the two groups identified based on parents' reports differed significantly on teachers' reports of externalizing clusters). This result suggests that children with deficits in effortful control may disproportionately manifest an

increase in externalizing problems at more than one developmental period (e.g., early childhood, or during the transition to elementary school).

The finding that some children low in attention focusing (about 8%) displayed low externalizing problem at age 5 but started to increase in externalizing around age 6 or 7 was only detected with teachers' reports of externalizing problems (parents' reports did not identify a *low-and-rising EXT* cluster). Teachers observe children in academic contexts; and as the structure increases with age in the classroom, a small percent of children may increasingly exhibit defiant, oppositional, or disruptive behaviors. Further study is needed to replicate this finding with a different sample and to investigate the specific environmental and intra-individual factors that are associated with the onset of externalizing problems.

In addition, when comparing the *moderate-and-slightly-declining persistence* cluster with the *low-and-rising persistence* cluster, we found that the children in the former cluster were more likely to exhibit either *moderate-and-stable* teacher-reported externalizing across age 5 to 10 or low externalizing at age 5 with an increase in externalizing by age 10, and were less likely to be stably low in externalizing. This finding is again consistent with our speculation that compared with the children in the *low-and-rising persistence* cluster (who may be late-developing in effortful control), the children in the *moderate-and-slightly-declining persistence* cluster may have difficulties in developing effortful control abilities with age due to high or increasing impulsivity and/or unfavorable environments, and thus may be at high risk for manifesting externalizing problems. Together, the findings suggest that the associations between effortful control and externalizing problems (and likely the underlying mechanisms) are more heterogeneous among children with lower and/or less stable effortful control than among those with high and stable effortful control from early- to middle- childhood.

The above findings have several important implications for theory on effortful control and prevention research aimed at reducing children's behavioral problems by promoting effortful control. First, although attention focusing (which reflects mostly effortful control of sustained attention) remains relatively stable beginning from early childhood, behavioral persistence, which probably reflect multiple components of effortful control such as inhibitory control, planning, and strategy use, may continue to change in either direction into elementary school years for subgroups of children. This suggests that elementary school years may be another critical period during which intervention efforts aimed at promoting effortful control-related abilities (e.g., behavioral parent training, child coping skill training) can be effective. Second, the greater heterogeneity found in the association between effortful control and externalizing problems among children with lower and/or less stable trajectories of attention focusing or behavior persistence (compared to those with stable and high effortful control trajectories) highlight the potential to change the development of externalizing problems among these children. Specifically, the finding that the children with *low-and-rising persistence* trajectories were at lower risk for externalizing problems than those with *moderate-and-slightly-declining persistence* suggests it may be possible to change the developmental trajectories of externalizing problems through preventions promoting children's effortful control.

Gender, SES, and Sample Differences in Trajectories

Consistent with the literature on effortful control (Else-Quest, et al., 2006) and externalizing (Côté et al., 2001), girls were more likely than boys to exhibit optimal trajectories of attention focusing and externalizing problems (according to both reports), suggesting that gender differences can be seen not only in mean differences between boys and girls, but also in patterns of change and stability of these constructs across development. Moreover, higher SES was associated with more optimal developmental trajectories of attention focusing, suggesting that environmental factors related to family income and parental education may affect the development of effortful control. Children from higher SES families are more likely to receive

optimal parenting and are exposed to fewer risk factors, both of which would be expected to predict better regulation (Eisenberg et al., 2005; Zhou et al., 2004). However, genetic factors could also contribute to this pattern of findings (e.g., parents high in temperamentally based effortful control may do better academically and in their jobs, and also have children genetically prone to effortful control).

A few sample differences in the trajectories were found. Children in Study 2 were more likely than those in Study 1 to be in the high, stable AF clusters, and the low and stable externalizing clusters. Although the Study 2 sample was selected to include children with externalizing problems, it also included control children (approximately 1/3 of the sample) and those with only internalizing problems. In contrast, although the Study 1 sample was an unselected school sample, it was found to have a relatively high rate of externalizing problems (see Eisenberg, Losoya, et al., 2001). In addition, age at the first assessment was not related to trajectories, so differences between the two samples in that regard apparently do not explain the aforementioned differences in trajectory groups.

Limitations

As one of the first studies on developmental trajectories of effortful control and their associations to externalizing trajectories in school age years, this study has several strengths, including the multi-informant (parent and teacher report) and multi-modality (rating scale and behavioral observation) measurements, the longitudinal design, and the application of group-based semi-parametric statistical approach to identify distinct developmental trajectories. However, the study has several limitations. First, because only two indexes of effortful control – attention focusing and behavioral persistence --- were used in this study, the results may not generalize to other indexes of effortful control (e.g., activation control, physiological indicators such as vagal suppression). Further research is needed to study the developmental trajectories of other components of effortful control (e.g., attention shifting, activation control). Second, because children's attention focusing and externalizing were rated by the same parent repeatedly over time (although by they were rated by different teachers), reporter effect might have affected the nature of the data (although they should be somewhat diluted by the 2-year time interval in-between assessments). Third, we examined the development of effortful control and externalizing problems from age 5 to 10 only. Thus, an important question to address in future research is the nature of these developmental trajectories as youth move into and through adolescence. Fourth, because the study samples included mainly working- or middle-class Caucasian participants living in a metropolitan area, the findings may not generalize to ethnic minority, rural, or low-SES population. Finally, because one of the subsamples (the Study 2 sample) selected some children at risk for behavioral problems (including externalizing and/or internalizing problems) and included a no-problem comparison group, the combined sample may not be fully representative of the community child population. Nonetheless, the results provided important insights on the development of effortful control and externalizing among school-age children.

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Figure 1.

The trajectories of parents' and teachers' reports of attention focusing. *Note.* Solid lines represent observed means of attention focusing at each age for each cluster; dashed lines represent model-predicted means of attention focusing at each age for each cluster.

Figure 2. The trajectories of behavioral persistence. *Note.* Solid lines represent observed means of persistence at each age for each cluster; dashed lines represent model-predicted means of persistence at each age for each cluster.

Figure 3.

The trajectories of parents' and teachers' reports of externalizing problems. *Note.* Solid lines represent observed means of externalizing problems at each age for each cluster; dashed lines represent model-predicted means of externalizing problems at each age for each cluster.

Table 1.
The Ns for the Combined Sample by Age Cohort and Wave of Data Collection

Table 2
The Means and SDs for Major Variables at Each Age.

		Age 5	Age 6	Age 7	Age 8	Age 9	Age 10
Attention Focusing (P ^a)	M (<i>N</i>)	4.88 (92)	4.85 (150)	4.84 (150)	4.86 (187)	4.97 (140)	4.81 (170)
	SD	.90	.90	.88	.97	.89	.99
	Range	2.00–6.57	3.00–6.71	1.71–6.86	1.71–7.00	2.57–4.97	2.29–7.00
Attention Focusing (T ^b)	M (<i>N</i>)	5.23 (83)	4.77 (148)	4.99 (145)	4.84 (185)	4.96 (136)	4.77 (152)
	SD	1.16	1.14	1.15	1.15	1.18	1.19
	Range	2.14–7.00	2.00–7.00	1.80–6.86	1.71–6.86	1.14–7.00	1.33–6.86
Behavioral Persistence	M (<i>N</i>)	.52 (92)	.63 (151)	.63 (141)	.73 (178)	.65 (134)	.70 (155)
	SD	.29	.28	.29	.27	.31	.31
	Range	.00–1.00	.09–1.00	.03–1.00	.03–1.00	.00–1.00	.05–1.00
Externalizing (P)	M (<i>N</i>)	.62 (90)	.67 (150)	.58 (150)	.58 (188)	.52 (138)	.60 (172)
	SD	.31	.33	.31	.31	.30	.31
	Range	.00–1.50	.00–1.64	.00–1.57	.00–1.50	.00–1.50	.07–1.43
Externalizing (T)	M (<i>N</i>)	.25 (83)	.34 (148)	.35 (144)	.38 (186)	.29 (135)	.36 (155)
	SD	.38	.37	.41	.43	.37	.39
	Range	.00–1.85	.00–1.43	.00–2.00	.00–1.86	.00–1.46	.00–1.92

Note.

^aP = parent reports,

^bT = teacher reports.

Table 3

Conditioned and Joint Probabilities of Attention Focusing (Parents' Reports) and Externalizing Problems (Teachers' Reports)

	<i>Low-and-stable EXT (T)</i>	<i>Moderate-and-stable EXT (T)</i>	<i>Low-and-rising EXT (T)</i>
<i>For the overall sample^a</i>	.602	.083	.316
Probabilities of externalizing cluster conditional on attention focusing cluster			
<i>Low-and-stable AF (P^b)₁</i>	.256	.557	.187
<i>Moderate-and-stable AF (P)₂</i>	.588	.334	.078
<i>High-and-stable AF (P)₃</i>	.791	.172	.036
	<i>Low-and-stable AF (P)</i>	<i>Moderate-and-stable AF (P)</i>	<i>High-and-stable AF (P)</i>
<i>For the overall sample^c</i>	.214	.519	.268
Probabilities of attention focusing cluster conditional on externalizing cluster			
<i>Low-and-stable EXT (T^d)₁</i>	.093	.523	.384
<i>Moderate-and-stable EXT (T)₂</i>	.346	.511	.143
<i>Low-and-rising EXT (T)₂</i>	.436	.450	.114
Joint probabilities of attention focusing cluster co-occurring with externalizing cluster			
	<i>Low-and-stable EXT (T)</i>	<i>Moderate-and-stable EXT (T)</i>	<i>Low-and-rising EXT (T)</i>
<i>Low-and-stable AF (P)</i>	.053	.116	.039
<i>Moderate-and-stable AF (P)</i>	.301	.171	.040
<i>High-and-stable AF (P)</i>	.221	.048	.010

Note.

^aThe probabilities of externalizing clusters for the overall sample based on the single-trajectory analyses.

^bP = parents' reports.

^cThe probabilities of attention focusing clusters for the overall sample based on the single trajectory analyses. For the probabilities of externalizing (attention focusing) clusters conditioned on attention focusing (externalizing) clusters, the attention focusing (externalizing) clusters sharing the same numeric subscript do not show significant differences in the probabilities of externalizing (attention focusing) clusters according to the Pearson's chi-square tests of independence.

^d_T = teachers' reports.

Table 4

Conditioned and Joint Probabilities of Attention Focusing (Teachers' Reports) and Externalizing Problems (Parents' Reports)

	<i>Low-and-stable EXT (P)</i>	<i>Moderate-and-slightly-declining EXT (P)</i>	<i>High-and-slightly-declining EXT (P)</i>
<i>For the overall sample^a</i>	.279	.542	.179
Probabilities of externalizing cluster conditional on attention focusing cluster			
<i>Low-and-stable AF (T)₁</i>	.000	.600	.400
<i>Moderate-and-stable AF (T)₁</i>	.142	.558	.300
<i>High-and-stable AF (T)₂</i>	.389	.532	.080
	<i>Low-and-stable AF (T)</i>	<i>Moderate-and-stable AF (T)</i>	<i>High-and-stable AF (T)</i>
<i>For the overall sample^b</i>	.103	.305	.593
Probabilities of attention focusing cluster conditional on externalizing cluster			
<i>Low-and-stable EXT (P)₁</i>	.000	.175	.825
<i>Moderate-and-slightly-declining EXT (P)₂</i>	.105	.339	.555
<i>High-and-slightly-declining EXT (P)₃</i>	.209	.543	.248
Joint probabilities of attention focusing cluster co-occurring with externalizing cluster			
	<i>Low-and-stable AF (T)</i>	<i>Moderate-and-stable AF (T)</i>	<i>High-stable AF (T)</i>
<i>Low-and-stable EXT (P)</i>	.000	.047	.222
<i>Moderate-and-slightly-declining EXT (P)</i>	.058	.186	.304
<i>High-and-slightly-declining EXT (P)</i>	.038	.100	.045

Note.

^a The probabilities of externalizing clusters for the overall sample based on the single-trajectory analyses.

^b The probabilities of attention focusing clusters for the overall sample based on the single trajectory analyses. For the probabilities of externalizing (attention focusing) clusters conditioned on attention focusing (externalizing) clusters, the attention focusing (externalizing) clusters sharing the same numeric subscript do not show significant differences in the probabilities of externalizing (attention focusing) clusters according to the Pearson's chi-square tests of independence. T = teachers' reports. P = parents' reports.

Table 5
Conditioned and Joint Probabilities of Externalizing (Teachers' Reports) and Persistence

	<i>Low-and-stable EXT (T)</i>	<i>Moderate-and-stable EXT (T)</i>	<i>Low-and-rising EXT (T)</i>
<i>For the overall sample^a</i>	.602	.316	.083
Probabilities of externalizing cluster (teachers' reports) conditional on persistence cluster			
<i>Moderate-and-slightly-declining persistence₁</i>	.373	.473	.154
<i>Low-and-rising persistence₂</i>	.611	.316	.072
<i>High-and-stable persistence₃</i>	.768	.211	.021
	<i>Moderate-and-slightly-declining persistence</i>	<i>Low-and-rising persistence</i>	<i>High-and-stable persistence</i>
<i>For the overall sample^b</i>	.310	.250	.441
Probabilities of persistence cluster conditional on externalizing cluster (teachers' reports)			
<i>Low-stable EXT (T)₁</i>	.197	.227	.576
<i>Moderate-stable EXT (T)₂</i>	.475	.223	.302
<i>Low-rising EXT (T)₂</i>	.657	.217	.126
Joint probabilities of behavioral persistence cluster co-occurring with externalizing cluster			
	<i>Moderate-and-slightly-declining persistence</i>	<i>Low-and-rising persistence</i>	<i>High-and-stable persistence</i>
<i>Low-stable EXT (T)</i>	.120	.137	.350
<i>Moderate-stable EXT (T)</i>	.151	.071	.096
<i>Low-rising EXT (T)</i>	.049	.016	.009

Note.

^aThe probabilities of externalizing clusters for the overall sample based on the single-trajectory analyses.

^bThe probabilities of persistence clusters for the overall sample based on the single trajectory analyses. For the probabilities of externalizing (persistence) clusters conditioned on persistence (externalizing) clusters, the persistence (externalizing) clusters sharing the same numeric subscript do not show significant differences in the probabilities of externalizing (persistence) clusters according to the Pearson's chi-square tests of independence. T = teachers' reports.

Table 6
 Conditioned and Joint Probabilities of Persistence and Externalizing (Parents' Reports)

	<i>Low-stable EXT (P)</i>	<i>Moderate-and-slightly declining EXT (P)</i>	<i>High-and-slightly declining EXT (P)</i>
<i>For the overall sample^a</i>	.279	.542	.179
Probabilities of externalizing problem cluster conditional on persistence cluster			
<i>Moderate-and-slightly-declining persistence₁</i>	.247	.511	.242
<i>Low-rising persistence₁</i>	.183	.612	.206
<i>High-stable persistence₂</i>	.358	.527	.115
	<i>Moderate-and-slightly-declining persistence</i>	<i>Low-rising persistence</i>	<i>High-stable persistence</i>
<i>For the overall sample^b</i>	.310	.250	.441
Probabilities of persistence cluster conditional on externalizing cluster			
<i>Low-stable EXT (P)^c₁</i>	.274	.153	.572
<i>Moderate-and-slightly-declining EXT (P)₁₂</i>	.295	.267	.438
<i>High-and-slightly-declining EXT (P)₂</i>	.429	.276	.294
Joint probabilities of behavioral persistence cluster co-occurring with externalizing cluster			
	<i>Moderate-and-slightly-declining persistence</i>	<i>Low-rising persistence</i>	<i>High-stable persistence</i>
<i>Low-stable EXT (P)</i>	.077	.043	.161
<i>Moderate-and-slightly-declining EXT (P)</i>	.160	.145	.238
<i>High-and-slightly-declining EXT (P)</i>	.076	.049	.052

Note.

^aThe probabilities of externalizing clusters for the overall sample based on the single-trajectory analyses.

^bThe probabilities of persistence clusters for the overall sample based on the single trajectory analyses.

^cP = parents' reports. For the probabilities of externalizing (persistence) clusters conditioned on persistence (externalizing) clusters, the persistence (externalizing) clusters sharing the same numeric subscript do not show significant differences in the probabilities of externalizing (persistence) clusters according to the Pearson's chi-square tests of independence.