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Measurement of Impulsivity: Construct Coherence, Longitudinal Stability, and Relationship with Externalizing Problems in Middle Childhood and Adolescence

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This study focused on the assessment of impulsivity in nonreferred school-aged children. Children had been participants since infancy in the Bloomington Longitudinal Study. Individual differences in impulsivity were assessed in the laboratory when children were 6 (44 boys, 36 girls) and 8 (50 boys, 39 girls) years of age. Impulsivity constructs derived from these assessments were related to parent and teacher ratings of externalizing problems across the school-age period (ages 7–10) and to parent and self-ratings of these outcomes across adolescence (ages 14–17). Consistent with prior research, individual measures of impulsivity factor-analyzed into subdimensions reflecting children's executive control capabilities, delay of gratification, and ability or willingness to sustain attention and compliance during work tasks. Children's performance on the main interactive task index, inhibitory control, showed a signficant level of stability between ages 6 and 8. During the school-age years, children who performed impulsively on the laboratory measures were perceived by mothers and by teachers as more impulsive, inattentive, and overactive than others, affirming the external validity of the impulsivity constructs. Finally, impulsive behavior in the laboratory at ages 6 and 8 predicted maternal and self-ratings of externalizing problem behavior across adolescence, supporting the long-term predictive value of the laboratory-derived impulsivity measures.

KEY WORDS: Impulsivity; children; externalizing problems; development.

The construct of impulsivity plays a central role in conceptualizations of child psychopathology (Quay, 1993). Impulsive behavior is a defining feature of attention-deficit hyperactivity disorder (ADHD; American Psychiatric Association, 1994), and an associated feature of many other types of childhood maladaptation, including conduct disorder, problems in learning (Barkley, 1990), and peer rejection (Whalen & Henker, 1985; Buhrmester, Whalen, Henker, Macdonald, & Hinshaw, 1992). Recently, there have been significant theoretical advances in our understanding of relationships between childhood impulsivity and psychopathology (Barkley, 1994; Newman & Wallace, 1993; Quay, 1993). For example, drawing on a model of neuropsychological functioning (Gray, 1987), investigators have tested predictions about specific, neurologically mediated patterns of disinhibition that may underlie disruptive behavior disorders (see reviews by McBurnett, 1992, and by Milich, Hartung, Martin, & Haigler, 1994). However, measurement of childhood impulsivity has lagged behind these theoretical advances.

Prior studies have not paid sufficient attention to the developmental contexts of impulsive behavior (Olson, 1996). As children mature, they undergo dramatic changes in the ability to organize attention and impulses in response to situational demands (Kopp, 1989). Understanding the normal development of impulsive behavior provides an essential baseline for defining "abnormality" at any given age point. However, most prior studies of childhood impulsivity have been cross-sectional. Consequently, psychologists know little about the continuity of individual

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differences in impulsive functioning across time. This is an important omission, because impulsivity has been viewed as a trait-like dimension of children's behavioral organization (e.g., Block & Block, 1980; Buss & Plomin, 1984; Rothbart, Ahadi, & Hershey, 1994). Moreover, the extent and nature of temporal continuity in children's impulsivity are important to issues of risk and prevention.

Noteworthy exceptions have focused on the development of self-regulation in very young children, toddlers (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Vaughn, Kopp, & Krakow, 1984), and preschoolers (Block & Block, 1980; Levy, 1980; Olson, 1989; Olson, Bates, & Bayles, 1990). Longitudinal studies have shown that individual differences in children's impulsive functioning develop rapidly in early childhood and are related to a broad range of important developmental competencies and processes including moral understanding (Kochanska et al., 1996), social competence (Block & Block, 1980; Olson, 1989), temperament (Kochanska, DeVet, Goldman, Murray, & Putnam, 1994), and patterns of parent–child interaction (Olson et al., 1990). These studies have underscored the developmental importance of the construct and have suggested possible antecedents of individual differences in children's self-regulatory competence. However, relatively little is known about the development of impulsivity in middle childhood, and thus longitudinal studies of the school-age period are needed.

Relatedly, investigators have achieved little consensus on two fundamental questions: How should impulsivity be defined? And, what is the most valid way of assessing individual differences in children's impulsive functioning? For example, salient operational definitions have included the inability to inhibit impulsive functioning to achieve a goal or to comply with a request (Kagan, Rosman, Day, Albert, & Phillips, 1964; Schachar, Tannock, & Logan, 1993), the inability to wait for a desired goal or object (Barkley, 1994; Mischel, Shoda, & Rodriguez, 1989), and the inability to behave in a "socially approved" manner in the absence of external controls (Sears, Rau, & Alpert, 1964; Kopp, 1989). Relatively few investigators have compared measures of impulsivity derived from different contexts and methods of observation. Available studies have revealed negligible to modest interrelationships between different measures, suggesting that impulsivity is a complex, multidimensional construct that cannot be "captured" by single measurement paradigms (Milich & Kramer, 1984; Olson, 1989). It is plausible, however, that there are independent subdimensions of impulsivity, with differing implications for understanding children's behavioral adjustment. For example, studies of toddler- and preschool-aged children have shown that one subdimension of childhood impulsivity, inhibitory control, can be reliably distinguished from other forms of impulsive behavior. *Inhibitory control* refers to the child's ability to respond to task situations in a planful manner and to inhibit inappropriate responses according to situational demands. In young children, inhibitory control has been shown to be qualitatively distinct from other forms of impulsivity such as speed of response initiation (Kochanska et al., 1996; Rothbart, Ahadi, & Hershey, 1994), resistance to temptation (Kochanska et al., 1996), and ability to delay immediate gratification (Olson, 1989). Studies of impulsivity in school-aged children are needed to evaluate the generalizability of the inhibitory control construct across different developmental periods.

Finally, it is essential to determine how measures of impulsivity derived from laboratory tasks relate to children's social-adaptive functioning outside the laboratory. Traditionally, inferences about children's impulsive functioning have been drawn from specific tests of impulsive behavior, administered in a laboratory setting in the context of one-to-one interaction with an adult examiner. Studies of nonreferred school-aged children have revealed only modest, and inconsistent, linkages between adult ratings of impulsive behavior and laboratory measures of impulsivity (Milich & Kramer, 1984). However, a growing body of literature on children with clinically significant behavior problems has indicated linkages between ADHD, the behavior disorder most highly reflective of impulse control deficits, and specific laboratory measures of impulsivity. For example, children with clinical diagnoses of ADHD tend to perform poorly on laboratory tasks measuring ability to inhibit impulsive responding (Quay, 1993; Schachar & Logan, 1990; Schachar, Tannock, & Logan, 1993). Children with conduct disorder (CD), or with mixed diagnoses of CD and ADHD, do not show problems in inhibitory control, but rather, in areas of functioning associated with avoidance of punishment (Daughtery & Quay, 1991; Schachar & Logan, 1990). As yet, studies have not been conducted to examine the generalizability of these associations to nonreferred school-aged children.

In light of these general issues, the current study was longitudinal in nature and focused on the assessment of individual differences in impulsivity in normal school-aged children. At each assessment point, we compared multiple measures of impulsive functioning that were derived from three different contexts: Specific laboratory tasks, observations of children's behavior in academic-like situations, and global ratings of adult informants. Major research questions were as follows:

(a) To what extent do different measures of impulsive functioning show meaningful interrelationships? On the basis of previous research, we did not expect to find a "unitary" dimension of impulsive functioning. However, consistent with prior research on impulsive behavior in preschool-aged children (Olson, 1989), we did expect to find qualitatively distinct subdimensions of impulsivity.

(b) How much consistency in impulsive functioning do children show over time? As noted above, there is a dearth of information concerning the development of impulse control during the middle childhood years. To examine continuity in children's impulse-control capabilities during the school-age period, individual differences in impulsivity were assessed when children were 6 years of age, and reassessed 2 years later.

(c) What are the links between laboratory measures of children's impulsive functioning and measures of their behavioral adjustment at home and in school settings? On the basis of previous research, we expected that laboratory measures of impulsivity would be most closely associated with parent and teacher ratings of hyperactivity, indexed by levels of impulsive, inattentive, and overactive behavior (Quay, 1993; Schachar, Tannock, & Logan, 1993). The extent to which measures of impulsivity predicted other, related dimensions of psychopathology (such as conduct problems) was also examined, as was the possibility that interrelations between behavior-problem ratings and impulsivity measures may be differentially patterned for boys and girls (as suggested by Milich et al., 1994, among others).

(d) Finally, the predictive value of the laboratory-derived impulsivity measures was examined in two different ways. First, we askesd whether laboratory measures of children's impulsive functioning would predict individual differences in externalizing problem behavior over a long time period—in this case, throughout adolescence. Recent research has indicated the importance of examining a broad range of externalizing problem outcomes during the adolescent period, as these outcomes vary with age and gender (Zoccolillo, 1993). Distinguishing between aggressive and nonaggressive forms of CD is especially important for understanding differential developmental trajectories in adolescent boys and girls (e.g., McGee, Feehan, Williams, & Anderson, 1992). Thus, children's impulsive functioning during the school-age period was related to parent and self-ratings of three different behavior problem outcomes, aggregated between ages 14–17: Hyperactivity, aggression, and acts of minor delinquency. Second, because laboratory measures of children's impulsive functioning are expensive and time-consuming to obtain, we asked whether laboratory-derived measures of impulsivity added significantly to the prediction of children's later externalizing behavior, beyond variance accounted for by prior ratings of maladjustment.

METHOD

Participants

Children (and their families) had been participants since infancy in an ongoing longitudinal study (see Bates, Olson, Pettit, & Bayles, 1982, for details concerning sample selection). Subsequent to the intensive 6–24-month phase of the study, follow-ups between ages 3 and 17 have included a core sample of 90 families, varying somewhat according to the particular year and procedure (for details see Bates, Bayles, Bennett, Ridge, & Brown, 1991). Analyses comparing participating versus nonparticipating families have revealed no systematic biases on such variables as sex of child, child temperament, family socioeconomic status (SES), or early childhood adjustment (Bates & Bayles, 1988). In the core sample, parental occupations were largely middle-class (64%), which included skilled trades, white-collar jobs, and student status. Working-class families (22%) and upper-middle-class families (15%) comprised the remaining sample. All children were White.

Laboratory assessments of impulsivity were conducted at ages 6 and 8: Eighty children (44 boys, 36 girls) participated in the age 6 assessment, and 89 (50 boys, 39 girls) in the 8-year follow-up. At ages 6, 7, 8, and 10, parents and teachers contributed ratings of children's behavioral adjustment. Finally, at ages 14 and 17, parental and self-ratings of behavioral adjustment were obtained. Families were paid for their participation.

Procedures at Age 6

At 6 years of age, children participated in two laboratory visits that were designed to assess individual differences in impulsive functioning. Visits were scheduled approximately 2 weeks apart. Assessments of impulsive behavior included a range of interactive tasks, as well as behavioral observations in simulated, academic-like situations. Finally, parents and teachers completed standardized behavior problem checklists.

Interactive Laboratory Tasks. Children participated in a series of laboratory tasks, each designed to measure a major operational definition of impulsivity. Descriptions of each task are as follows.

(a) Matching Familiar Figures Test. This is a widely used measure of cognitive impulsivity developed by Kagan et al. (1964). A single drawing of a familiar object, the standard stimulus, is paired with an array of six variants of the drawing. All but one of the variants differ slightly from the standard stimulus, and the child must choose the alternative that matches the standard. Two dependent variables were used to summarize children's performance on this test: Mean latency to first response and mean number of errors.

(b) Draw-a-Line-Slowly, Walk-a-Line-Slowly. This task measures the ability to inhibit fine and gross motor movements in response to situational demands (Maccoby, Dowley, Hagen, & Degerman, 1965). In the Draw-a-Line-Slowly (DALS) task, each child is given an $8\frac{1}{2}'' \times 11''$ piece of paper with two "telephone poles" drawn in black ink. The child is given practice using a ruler, then asked to connect the poles by drawing a straight line. After two trials at regular speed, the child is asked to draw the line as slowly as possible (two trials). In the Walk-a-Line-Slowly (WALS) task, the child is asked to walk a 5-ft "sidewalk" (marked with tape on the floor), first at regular speed (two trials) and then as slowly as possible (two trials). The main dependent variables are inhibition scores (one for each task situation), derived by subtracting the child's mean score on the slow trials from his or her mean score on the regular trials.

(c) Delay of Gratification. A measure of self-control developed by Block and Block (1980). In this task, the experimenter "discovers" a small wrapped gift and informs the child that he or she may have it "later." Next, a 2–3 min cover task is carried out, during which the experimenter records any attempts to open the gift prematurely. The main dependent variable is a delay score, indexing the amount of time (in seconds) that elapses between onset of the cover task and taking the reward. The number of times the child touched the gift or made verbal references to it were also recorded.

(d) Choice Delay. This is a test of the ability to delay immediate gratification for a later outcome (Mischel, 1968). The child is asked to choose between a single treat immediately available or a handful of treats later on. The dependent variable is a 2-point score indicating the child's willingness to wait for a larger reward.

Work and Play Tasks. In order to obtain behavioral observations relevant to children's self-control capabilities, children participated in a 30-min period of semistructured work and play tasks. Procedures were based on modifications (see Milich, Loney & Landau, 1982; Olson et al., 1990) of an original design by Routh and Schroder (1976). Three 10-min observation periods were carried out, with observers stationed behind a one-way glass. The room was equipped with a small work table and with a variety of age- and sex-appropriate toys. During the free play period, each child was ushered into the room and allowed to play as he or she wished for 10 min. During the restricted task period, the child was asked to sit down at a small table. Other tables held a number of attractive toys that were clearly visible to the child. A set of geometric shapes drawn in black ink on $8\frac{1}{2}'' \times 11''$ pieces of white paper was presented. Small representations of the shapes were depicted at the bottom of the page, each with a different color. The child's task was to color in each large shape, matching its hue to the key below. The child worked a sample worksheet with the examiner to ensure understanding of the task. Additional pages of shapes to be colored were made available. Next, the examiner announced that she had some work to do in the next room. The child was told that he or she must stay in the chair and color until the experimenter returned and that it was forbidden to touch or play with toys in the room. Finally, during the incentive restricted task period, the same procedure was repeated, except that this time the child was told that he or she would receive a prize for each worksheet completed (a choice of one small toy from the "prize bag" for each worksheet). Although an incentive restricted task was not used by Milich et al. (1982), it was added as a means of examining motivational variance in children's self-control behaviors.

Observers were trained in the use of all coding methods and participated in practice sessions with same-age children who were not actual participants. During the practice trials, two observers independently coded each variable until they reached levels of agreement that equaled or exceeded .90. During the actual study, two observers were present for each observation, each recording different behaviors. This was desirable because time measurements of different behaviors were required.

Because of their direct relevance to constructs of impulsivity, behaviors coded during the restricted task conditions were extracted for use in the current study. The following behaviors were recorded during the restricted and incentive restricted periods:

(a) Frequency of off-task behavior. The child was considered to be "off-task" anytime he or she was not engaged in the task of coloring symbols or in a related activity (placing a worksheet on a pile). The number of separate occurrences of off-task behavior were counted.

(b) Duration of off-task behavior. Each occurrence of off-task behavior described above was timed (from the time the child stopped attending to the time he or she returned to copying). Individual times were summed to yield a total score.

(c) Frequency of out-of-seat behavior. The child was considered to be out-of-seat any time more than 50% of his or her body weight was off the chair. Such occurrences included the child's leaning on his or her elbows on the table to look at his or her reflection in the mirror, falling off the chair while clowning, and getting up to play with forbidden toys. For this tally, only out-of-seat behaviors that were also off-task were counted.

(d) Duration of out-of-seat behavior. Each episode of behavior described above was timed from the time the child left his or her seat to the time of returning to the chair. Individual times were summed to yield a total score.

(e) Frequency of touching forbidden toys. A tally was kept of the number of times the child touched any toy in the room.

(f) Number of symbols colored correctly. After the session, the examiner checked the accuracy of symbols colored. The number of accurately colored symbols was tallied.

Peabody Picture Vocabulary Test. The Peabody Picture Vocabulary Test–Revised (PPVT–R; Dunn & Dunn, 1981), a short test of receptive vocabulary, was included in the battery as an estimate of intellectual ability. The main dependent measure is an age-based standard score.

Parent and Teacher Behavior Problem Questionnaires. Mothers completed the Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1983), a well-standardized measure of behavior problems. The CBCL consists of 118 behavior-problem items that are scored 0, 1, or 2, representing *not true*, *somewhat true*, or *very true* in relation to the child. The narrow-band subscales Hyperactivity and Aggression were used to examine the hypothesis that different subtypes of externalizing problem behavior may have different relationships with the impulsivity constructs. Teachers completed the Teacher Report Form (TRF), a school-appropriate version of the CBCL (Achenbach & Edelbrock, 1986). As with the parent scale, the narrow-band subscales Inattention, Overactivity, and Aggression were extracted for use in the current study.

Table I. Measures of Impulsivity: Descriptive Data

Interactive test variables and work tasks	Time 1		Time 2	
	M	*SD*	*M*	*SD*
Matching Familiar Figures Test				
Error score	1.19	0.59	0.62	0.41
Response time score	17.41	11.36	23.87	14.67
Motor Inhibition Test				
Drawing task score	29.84	22.77	—	—
Walking task score	17.48	15.49	—	—
Gift Delay Test				
Delay time score	83.12	22.66	—	—
Verbal references to gift	2.09	2.62	—	—
Frequency of gift touching	0.49	0.75	—	—
Choice Delay Task	1.44	0.50	1.87	0.34
Draw-a-Star-Slowly Test				
Error score	—	—	0.11	0.39
Response time score	—	—	142.03	104.79
Draw-a-Star-Fast Test				
Error score	—	—	1.64	2.15
Response time score	—	—	16.20	8.93
Nonincentive academic condition				
Number of times out-of-seat	1.39	3.40		
Amount of time out-of-seat	21.85	67.52	33.29	95.16
Touching forbidden toys (frequency)	0.27	0.61	0.85	1.92
Number of times off-task	3.01	2.96	2.81	2.43
Amount of time off-task	53.14	87.53	73.94	114.68
Number of symbols colored	12.31	5.60	85.32	28.22
Incentive academic condition				
Number of times out-of-seat	0.84	1.51	0.14	0.46
Amount of time out-of-seat	19.32	62.70	4.27	15.16
Touching forbidden toys (frequency)	0.16	0.59	0.13	0.48
Number of times off-task	2.00	2.76	1.18	1.90
Amount of time off-task	29.90	58.59	21.27	78.26
Number of symbols colored	20.07	9.34	134.11	38.38

Procedures at Age 8

During the 8-year follow-up, children again participated in two laboratory visits that were designed to assess individual differences in impulsivity, and parents and teachers contributed behavior-problem ratings. We attempted to keep the 6- and 8-year measures as similar as possible. However, some of the 6-year tasks were inappropriate for 8 year-olds, and thus we substituted other relevant measures as described below. Table I contains a summary of tasks and measures used at each age level. The means and standard deviations are included.

Interactive Laboratory Tasks. The Matching Familiar Figures Test (MFFT), PPVT–R, and choice delay tasks were readministered at age 8. The gift delay task was not. Finally, the Draw-a-Star-Slowly and Draw-A-Star-Fast tasks were administered instead of the WALS–DALS. These new procedures are described below.

(a) Draw-a-Star-Slowly (DASS). A modification of the original draw-a-line procedure (see Milich & Kramer, 1984) was used, in order examine both the speed and accuracy of the child's performance. This procedure required the child to draw a line within the $\frac{1}{4}''$ boundaries of a mimeographed star ($8 \times 6\frac{1}{2}''$, with six points). The child was given one chance to practice with no speed instructions. Next, the child was asked to repeat the task, drawing the line as slowly as possible. Two measures were recorded: speed (the amount of time to completion of the star) and errors (the number of times the child's line touched or went beyond the border of the star).

(b) Draw-a-Star-Fast (DASF). This variation of the DALS procedure was developed by Levy (1980). The child was given another mimeographed star and asked to draw a line within the borders, but this time to draw it as fast as possible. Speed and error scores were recorded.

Work and Play Tasks. The free play, restricted academic task, and incentive restricted academic task observational procedures (described previously) were repeated during the 8-year follow-up assessment. All procedures were identical to those of the 6-year assessment, with the exception that the work task involved copying symbols rather than coloring shapes.

Parent and Teacher Behavior Problem Questionnaires. As with the 6-year assessment, mothers ($n = 89$) completed the CBCL, and teachers ($n = 65$) completed the TRF.

Behavior Problem Questionnaires at Other Age Periods

In addition to assessments described above, mothers completed CBCLs when children were 7, 10, 14, and 17 years of age. At ages 7 and 10, teachers contributed ratings of children's behavioral adjustment on the TRF. Finally, at ages 14 and 17, adolescents contributed self-ratings of behavioral adjustment on the Achenbach Youth Self-Report and Profile (Achenbach, 1991).

RESULTS

Overview

The first step in data analysis was to examine potential developmental and gender differences in measures of impulsivity. Next, at each age level, factor analysis was used to examine the internal structure of individual differences in impulsivity, particularly whether distinct subdimensions could be identified. Third and fourth, we examined empirical interrelationships between different subdimensions of impulsivity, both within and across time. Fifth, we examined the validity of the laboratory-derived impulsivity measures by relating them to parent and teacher reports of children's externalizing problem behavior across the school-age period. Finally, we examined the long-term predictive value of the laboratory measures by relating them to parent and self-ratings of externalizing problem behavior across adolescence and by determining whether the impulsivity constructs made unique contributions to the variance in these later outcomes.

Developmental and Gender Effects

Developmental Effects. Using repeated measures analysis of variance, we examined potential developmental effects in relation to the subset of measures that were administered at both age points. Significant developmental effects were found for measures derived from interactive testing. In relation to their performance at age 6, at age 8 children were significantly more likely to choose a delayed as opposed to an immediate reward, $F(1, 66) = 45.23, p < .0001$; made fewer errors on the MFFT, $F(1, 66) = 93.56, p < .0001$; and manifested longer response times on the MFFT, $F(1, 66) = 14.96, p < .001$. Developmental effects also were found for children's performance on some behavioral indices of impulsivity. Children's off-task and out-of-seat behavior in the nonincentive academic condition did not vary significantly between ages 6 and 8. However, children were less likely to touch "forbidden" toys at age 8 than at age 6, $F(1, 67) = 19.98, p < .001$. Similarly, a highly significant developmental effect was found for the number of symbols copied, $F(1, 68) = 78.49, p < .0001$.

Within the incentive academic condition, children showed significantly less frequent off-task behavior, $F(1, 68) = 4.50, p < .05$; shorter durations of out-of-seat behavior, $F(1, 68) = 4.43, p < .05$; and less frequent out-of-seat behavior, $F(1, 68) = 10.49, p < .001$, at age 8 than at age 6. In addition, the number of shapes that were correctly completed increased significantly from ages 6 to 8, $F(1, 68) = 35.92, p < .0001$.

Gender Differences. At each age, two sets of multiple analyses of variance (MANOVAS) were conducted using child gender as the between-subjects factor: One with interactive lab task measures as dependent variables and the other with observationally derived measures. At age 6, no significant multivariate main effects were found for child gender, and thus univariate tests were not conducted. At age 8, however, there was a significant multivariate main effect for child gender on the interactive task measures of impulsivity, $F(7, 72) = 2.09, p < .05$. Univariate tests revealed that boys made more errors than girls on the DASF test, $F(1, 78) = 4.36, p < .05$. A significant multivariate main effect for child gender also was found for the observationally derived variables, $F(15, 53) = 1.92, p < .05$. Univariate tests revealed that boys behaved more impulsively than girls on the following observational measures: Occurrences of out-of-seat behavior (nonincentive), $F(1, 87) = 10.12, p < .001$; occurrences of out-of-seat behavior (incentive condition), $F(1, 87) = 4.28, p < .05$; occurrences of off-task behavior (nonincentive condition), $F(1, 87) = 5.09, p < .05$; duration of out-of-seat behavior (nonincentive), $F(1, 87) = 3.97, p < .05$; and duration of off-task behavior, $F(1, 87) = 6.97, p < .01$. In addition, girls copied more symbols than boys in both the nonincentive and incentive conditions, $F(1, 87) = 11.53, p < .001$, and $4.88, p < .05$, respectively. Thus, by age 8, gender differences in observed behavioral impulsivity were quite prominent and were in the expected direction of girls showing less impulsivity than boys.

Interrelations Between Different Measures of Impulsivity

First, factor analysis (principal components analysis with varimax rotation) was used to examine the structure of individual differences in children's impulse-control capabilities. As shown below, separate analyses were conducted for measures of impulsivity derived from interactive laboratory tests and from observations of children's behavior in the structured task situations. Composite variables were constructed from unweighted sums of standardized, individual items that discriminatively loaded .50 or above on each factor.

Factor Analyses of Interactive Tasks

Age 6. A two-factor solution accounted for 64.4% of the variance in children's test scores. As shown in Table II, the first factor summarized accurate, reflective performance on the MFFT and the child's ability to inhibit motor behavior on command in the walking and drawing tasks. This factor was labeled "Inhibitory Control." The second factor, Delay Ability, summarized children's ability to wait patiently during the gift delay task and was defined by the amount of time that elapsed before taking the gift minus the number of times the child talked about or touched the gift. Choice delay, the child's stated willingness to wait for a larger but delayed reward, did not load discriminatively on either factor, but was retained as a single variable. Thus, on both factor scales and on choice delay, high scores indicated high levels of impulse control.

Table II. Principal Components Analysis: 6-Year Interactive Laboratory Measures of Impulsivity[a]

Variable	Loadings I	Loadings II
I. Inhibitory control		
Response time, MFFT	.76	−.14
Errors, MFFT	−.71	.29
Inhibition score, WALS	.77	.23
Inhibition score, DALS	.70	−.07
II. Delay of gratification		
Gift touching, delay task	.30	.86
Verbal references, delay task	−.18	.74
Response time, delay task	.26	−.64

Note. $N = 79$. Eigen values = 2.57, 1.77. Two factors accounted for 64.4% of the variance. MFFT = Matching Familiar Figures Test; WALS = Walk-a-Line-Slowly task; DALS = Draw-a-Line-Slowly task.
[a] Varimax rotation, orthogonal transformation.

Table III. Principal Components Analysis: 8-Year Interactive Laboratory Measures of Impulsivity[a]

Variable	Loadings I	Loadings II
I. Inhibitory control		
Errors, MFFT	.76	−.28
Response time, MFFT	−.68	.31
Errors, DASS	.66	.17
Response time, DASS	−.56	.00
II. Fast motor control		
Errors, DASF	.14	−.78
Response time, DASF	−.12	.82

Note. $N = 89$. Eigen values = 2.26, 1.34. Two factors accounted for 51.4% of the variance in the analysis. MFFT = ; DASS = Draw-a-Star-Slowly task; DASF = Draw-a-Star-Fast task.
[a] Varimax rotation, orthogonal transformation.

Age 8. As shown in Table III, a two-factor solution, accounting for 51.4% of the variance in the analysis, was chosen. The first factor was very similar to Factor 1 in the 6-year analysis, in that it was defined by reflective and accurate performance on the MFFT and DASS tasks. The second factor was narrower, summarizing inaccurate and impulsive performance on the DASF task. Finally, again replicating results obtained at age 6, choice delay did not load discriminatively on either factor and was retained as an individual variable. Composite scales derived from these analyses were labeled Inhibitory Control and Fast Motor Control.

Factor Analyses of Behavioral Observations During Structured Task Situations

Age 6. As shown in Table IV, a three-factor solution accounted for 73.9% of the variance in children's behavior. The first factor was defined by the duration and frequency of out-of-seat behavior in both the nonincentive and incentive conditions. The second factor was defined by the frequency and duration of off-task behavior and by frequency of touching forbidden toys, with a negative loading for the number of symbols correctly colored. This factor was specific to the nonincentive condition. Finally, the third factor was defined by the frequency and duration of off-task behavior during the incentive condition. Composite scales representing the factors were labeled Out-of-Seat, Off-Task, and Off-Task–Incentive.

Age 8. Measures of impulsivity derived from observations during the 8-year structured task conditions were

Table IV. Principal Components Analysis: 6-Year Behavioral Observations, Structured Task Conditions[a]

Variable	Loadings I	II	III
I. Out-of-Seat			
Frequency, out-of-seat	.82	.04	.14
Duration, out-of-seat	.70	.22	−.12
Duration, out-of-seat–incentive	.62	−.02	−.13
Frequency, out-of-seat–incentive	.51	−.08	−.00
Number of symbols colored–incentive	.49	−.46	−.37
II. Off-task–nonincentive			
Duration, off-task	.21	.81	.05
Number of symbols colored	.36	−.74	.11
Forbidden toys	.47	.64	.19
Frequency, off-task	.06	.60	.40
Forbidden toys–incentive	.25	.46	.24
III. Off-task–incentive			
Frequency, off-task–incentive	−.10	.16	.89
Duration, off-task–incentive	.02	−.00	.86

[a]Eigen values: 2.79, 2.47, 1.42. Three factors accounted for 73.9% of the variance in the analysis.

factor-analyzed, resulting in a three-factor solution that accounted for 69.5% of the total variance in children's performance. As shown in Table V, the first dimension was defined by the frequency and duration of out-of-seat and off-task behavior and by the frequency with which the child touched forbidden toys, all in the incentive condition. A complementary second factor was defined by the durations of out-of-seat and off-task behavior and by frequency of toy-touching in the nonincentive condition. The final factor summarized children's lack of task productivity during both conditions, as well as frequency of off-task behavior during the nonincentive condition. Composite scales derived from the analyses were labeled Out-of-Seat and Off-Task: Incentive, Out-of-Seat and Off-Task: Nonincentive, and Nonproductivity.

Table V. Principal Components Analysis: 8-Year Behavioral Observations, Structured Task Conditions[a]

Variable	Loadings I	II	III
I. Out-of-seat and off-task–incentive			
Duration, out-of-seat–incentive	.91	.14	.13
Frequency, out-of-seat–incentive	.89	.21	.19
Toy touching–incentive	.84	.08	.14
Frequency, off-task–incentive	.69	.03	.36
Duration, off-task–incentive	.27	−.05	.36
II. Out-of-seat and off-task–nonincentive			
Duration, out-of-seat	.09	.91	.00
Toy touching	.16	.87	.00
Duration, off-task	.03	.83	.30
Frequency, out-of-seat	.50	.65	.11
III. Nonproductivity			
Off-task	.17	.12	.61
Number of symbols copied	.07	−.48	−.70
Number of symbols copied–incentive	−.25	−.05	−.76

[a]Eigen values = 4.92, 2.19, 1.23. Three factors accounted for 69.5% of the variance in the analysis.

Bivariate and Partial Correlations Between Composite Measures of Impulsivity

Next, we examined bivariate relationships between different measures of children's impulsive functioning. To eliminate the possibility that significant correlations between measures primarily reflected the common attribute of cognitive ability (e.g., see Milich & Kramer, 1984), first-order partial correlations also were computed, controlling for variations in children's PPVT–R standard scores. In addition, because a relatively large number of correlations was computed, Bonferroni's correction was used to control for possible family-wise errors (.95 level of confidence and beyond). Finally, at both age levels the correlational patterns were found to be very similar for boys and girls. Thus, bivariate and partial correlations based on the full sample are described below.

Age 6. A total of 15 correlations were computed, and only 3 reached statistical significance at the .05 level or higher.[4] To a modest degree, children who received high scores on Inhibitory Control behaved less impulsively than others on the gift delay and choice delay tasks ($rs = .22$ and .26, respectively, $ps < .05$). Children's off-task behavior during the nonincentive and incentive structured task conditions converged modestly, $r = .26$, $p < .05$. When variations in children's PPVT–R scores were controlled for, two of these interrelationships failed to reach significance (Inhibitory Control and Choice Delay, Off-Task–Nonincentive and Off-Task–Incentive).

Age 8. There were relatively few significant intercorrelations between the 8-year measures of impulsivity. Of the 15 correlations that were computed, 3 reached statistical significance at the .05 level or higher (see Footnote 4). Children's impulsive behavior in the incentive and nonincentive structured task conditions was modestly intercorrelated, $r = .23$, $p < .05$. In addition, impulsive behavior during the incentive and nonincentive conditions was significantly correlated with low productivity on the symbol-copying task, $rs = .34$ and .40, respectively, $ps < .01$.

[4]The full table of correlation coefficients is available from the authors.

When children's PPVT–R scores were partialed, the relationship between out-of-seat and off-task behavior in the incentive versus nonincentive conditions failed to reach significance.

Stability of Impulsive Behavior Between Ages 6 and 8

Composite measures of impulsivity at ages 6 and 8 were intercorrelated to examine levels of temporal stability in children's impulsive functioning. Bonferroni's correction was used to control for possible family-wise error rates in the correlational matrices. Because the pattern of correlations was similar for boys and girls, findings based on the full sample are described below (see Footnote 4).

Of the 36 correlations that were computed, only 6 reached statistical significance. First we will describe patterns of stability within the same construct. Individual differences in children's performance on the Inhibitory Control scale showed modest, significant levels of stability between ages 6 and 8, $r = .44$, $p < .001$. Similarly, individual differences in children's willingness to wait for a delayed reward were relatively stable across time, $r = .39$, $p < .01$.

The remaining significant correlations summarized patterns of temporal continuity between different impulsivity constructs. Children who scored highly on Inhibitory Control at age 6 achieved higher levels of task productivity than others at age 8, $r = .24$, $p < .05$. Conversely, frequent off-task behavior during the 6-year nonincentive structured task condition predicted low task productivity at age 8, $r = -.25$, $p < .05$. Off-task behavior during the incentive condition was related to children's unwillingness to wait for a delayed reward at age 8, $r = -.25$, $p < .05$. Similarly, children who were frequently out-of-seat during the nonincentive structured task condition at age 6 made relatively frequent errors on the DASF at age 8, $r = -.31$, $p < .05$.

Interrelations Between Laboratory Measures of Impulsivity and Ratings of Children's Externalizing Problems in Home and School Settings

To examine the external validity of the impulsivity constructs, measures of impulsivity derived from laboratory testing and observation were intercorrelated with parent and teacher ratings of externalizing problem behavior. For a variety of reasons, adult ratings of children's behavioral maladjustment may fluctuate significantly from year to year. In order to achieve robust and reliable indexes of children's behavioral maladjustment during the school-age years, parent and teacher ratings of hyperactivity and aggression on the Achenbach scales were averaged between ages 7, 8, and 10. T-scores on the aggregated scales ranged from 34 to 82.[5] Because a relatively large number of correlations were computed, Bonferroni's correction was used to control for possible family-wise errors. Finally, the correlational patterns varied significantly for boys and girls, and therefore we will describe them separately.

First, we examined correlations between age-6 measures of impulsivity and the school-age composite measures of externalizing problem behavior. As shown in Table VI, boys and girls who scored highly on the Inhibitory Control scale (indexing good control) received low maternal ratings of hyperactivity in middle childhood. In addition, for girls only, this relationship extended to teachers' ratings of inattention and overactivity. For both sexes, frequency of out-of-seat behavior (structured academic condition) was significantly correlated with teachers' ratings of overactivity and inattention. Similarly, for both boys and girls, off-task behavior during the nonincentive structured academic condition was related to teacher ratings of inattention. Finally, girls who manifested superior delay ability tended to receive low teacher ratings of aggression, whereas those who were frequently out of their seats received high ratings of aggression. However, for boys, there were no significant relationships between impulsivity in the laboratory and rated aggression.

Next, we examined intercorrelations between the 8-year impulsivity measures and the composite indexes of school-age externalizing problems. As shown in Table VII, boys who were considered extremely hyperactive by mothers behaved impulsively during the 8-year academic task condition and received relatively low scores on the Inhibitory Control scale. There were no significant relationships between boys' 8-year impulsivity scores and teachers' ratings of hyperactivity and aggression. However, girls who behaved impulsively during the 8-year incentive academic task condition received high teacher ratings of overactivity. Similarly, girls who behaved impulsively during the nonincentive academic task condition received relatively high maternal ratings of hyperactivity and aggression. Finally, girls who achieved low levels of symbol-task productivity received relatively high ratings of hyperactivity from mothers and low ratings of inattentive problem behavior from teachers.

In summary, laboratory measures of impulsivity were significantly associated with parent and teacher ratings of hyperactive symptoms, in the expected direction: Children who performed more impulsively in the laboratory tended

[5]Descriptive information concerning the aggregated measures is available from the authors.

Table VI. Intercorrelations Between Age 6 Laboratory Measures of Impulsivity and Parent and Teacher Ratings of Children's School-Age Externalizing Behavior

	Mother and teacher ratings of externalizing behavior (ages 7–10)				
Impulsivity measures: Age 6	M-HA	M-AGG	T-INATT	T-ACT	T-AGG
Inhibitory control					
Boys	−.35*	−.27	.01	.05	−.01
Girls	−.52**	−.22	−.60*	−.52*	−.44
Delay of gratification					
Boys	−.23	−.19	.14	.23	.19
Girls	−.13	−.08	.03	−.25	−.59*
Choice delay					
Boys	−.06	.30	.11	.02	.17
Girls	−.04	.00	.11	−.11	−.36
Out-of-seat					
Boys	.02	.14	.45*	.62**	.18
Girls	−.18	−.03	.57*	.76**	.69**
Off-task–nonincentive					
Boys	.11	−.09	.49*	.18	.03
Girls	−.10	−.10	.65*	.33	.11
Off-task–incentive					
Boys	.06	−.06	−.13	−.14	−.30
Girls	.16	.10	.44	.28	−.01

Note. M-HA = maternal rating, Hyperactivity; M-AGG = maternal rating, Aggression; T-INAT = teacher rating, Inattention; T-ACT = teacher rating, Overactivity; T-AGG = teacher rating, Aggression.
$^{*}p < .05$. $^{**}p < .01$.

Table VII. Intercorrelations Between Age 8 Laboratory Measures of Impulsivity and Parent and Teacher Ratings of Children's School-Age Externalizing Behavior

	Mother and teacher ratings of externalizing behavior (ages 7–10)				
Impulsivity measures: Age 8	M-HA	M-AGG	T-INATT	T-ACT	T-AGG
Inhibitory control					
Boys	−.34*	−.30	.04	.28	−.34
Girls	−.19	.07	−.25	−.06	.01
Fast motor control					
Boys	−.11	−.10	−.11	.06	.03
Girls	−.15	.04	.06	−.17	.13
Choice delay					
Boys	.02	.21	−.11	.06	.20
Girls	−.25	−.06	−.24	−.31	−.22
Out-of-seat and off-task–incentive					
Boys	.36*	.02	.13	.04	.00
Girls	.20	.32	.35	.59**	.25
Out-of-seat and off-task–nonincentive					
Boys	.11	−.09	.49*	.18	.03
Girls	.50***	.46**	.30	.16	.06
Nonproductivity					
Boys	−.06	−.15	−.31	.16	.11
Girls	−.37**	−.23	−.46*	.13	−.27

Note. M-HA = maternal rating, Hyperactivity; M-AGG = maternal rating, Aggression; T-INAT = teacher rating, Inattention; T-ACT = teacher rating, Overactivity; T-AGG = teacher rating, Aggression.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

to receive higher ratings of hyperactive problem behavior than others. However, significant relationships between impulsivity and aggression were found for girls only.

Interrelations Between Laboratory Measures of Impulsivity and Ratings of Externalizing Problems Across Adolescence

In the following sections, we examine relationships between laboratory constructs of impulsivity assessed during the school-age years and measures of children's behavioral and academic adjustment assessed across adolescence. As with school-age ratings of behavioral maladjustment, parent and adolescent ratings of hyperactivity, aggression, and delinquency were averaged across ages 14 and 17 to obtain reliable estimates of externalizing problem behavior during the adolescent years. T-scores on the aggregated scales ranged from 30 to 91 (see Footnote 5). Bonferroni's correction was used to control for familywise error rates in the correlational matrices.

Relationships with Parent and Self-Ratings of Adolescent Externalizing Behavior. First, we examined intercorrelations between school-age measures of impulsivity and maternal ratings of adolescent externalizing behavior, computed separately for boys and girls. Of the 36 correlations computed with age-6 measures of impulsivity, only 2 reached statistical significance (see Footnote 4). Girls who achieved high scores on Inhibitory Control at age 6 received relatively low maternal ratings of adolescent hyperactivity, $r = -.40$, $p < .05$. Similarly, boys who performed patiently on the 6-year gift delay task received low maternal ratings of hyperactivity across adolescence, $r = -.43$, $p < .05$. Likewise, of the 36 correlations computed with age-8 measures of impulsivity, only 3 reached statistical significance. Girls who behaved impulsively during the 8-year incentive structured task situation received high maternal ratings of later hyperactivity ($r = .48$, $p < .01$) and delinquency ($r = .64$, $p < .001$). Conversely, girls who chose delayed rewards during the 8-year choice delay task received relatively low ratings of hyperactivity across adolescence, $r = -.57$, $p < .01$.

Next, we examined intercorrelations between school-age measures of impulsivity and adolescent self-ratings of externalizing behavior. These correlations were similar for boys and girls, and thus whole sample relationships are described. Of the 18 correlations computed with age-6 measures of impulsivity, only 1 reached statistical significance (see Footnote 4). Children who performed patiently on the delay of gratification task at age 6 perceived themselves as relatively low in aggression across adolescence, $r = -.41$, $p < .05$. Finally, of the 18 correlations computed with age-8 measures of impulsivity, 3 reached statistical significance. Children who performed more impulsively than others on the 8-year inhibitory control and fast motor control tasks and who behaved impulsively during the 8-year incentive structured task situation reported committing relatively frequent acts of minor delinquency across adolescence, $rs = -.27, -.33$, and $.29$, respectively, $ps < .05$, but they did not differ from others in self-reported problems of hyperactivity and aggression.

Hierarchical Multiple Regression Analyses. Finally, we examined the extent to which laboratory measures of children's impulsive functioning during the school-age years predicted externalizing problems in adolescence, beyond variance accounted for by prior ratings of behavioral maladjustment. Hierarchical multiple regression analyses were conducted, using the composited (ages 14–17) parent and self-ratings of aggression, inattention, and delinquency as dependent variables. In each analysis, the school-age composite rating of externalizing problem behavior was entered first, to control for initial levels of maladjustment. Next, age-6 measures of impulsivity that showed significant zero-order correlations with the dependent variable were entered simultaneously, as a block. On the final step, age-8 measures of impulsivity that showed significant zero-order correlations with the dependent variable were entered as a block. These procedures allowed us to determine whether measures of impulsivity made unique contributions to the variance in adolescent externalizing problem ratings and whether these contributions were incremental between ages 6 and 8. As shown in Table VIII, laboratory indexes of impulsivity added significantly to the proportion of variance explained in later measures of hyperactivity and delinquency, beyond variance accounted for by school-age externalizing problem behavior. Finally, measures of impulsivity were not incrementally predictive of parents' later ratings of aggression in boys; however, they did incrementally predict boys' and girls' self-ratings of aggressive problem behavior in adolescence.

DISCUSSION

The construct of impulsivity has far-reaching importance for understanding children's normal and abnormal development. However, to date there have been few longitudinal studies of individual differences in children's impulsivity, particularly during the school-age years. We have argued for a developmental approach to the assessment of impulsivity, which incorporates multiple measures, situational contexts, informants, and age points. Hence, in the current study, individual differences in children's impulsive functioning were assessed at two different

Table VIII. Hierarchical Multiple Regression Analyses: Incremental Prediction of Adolescent Externalizing Problems From Laboratory Measures of Impulsivity at Ages 6 and 8

Variable	R^2	Fchng	*p*
Parent ratings, ages 14–17			
Hyperactivity (Boys)			
Externalizing problems, ages 7–10	.29	12.35	<.001
Impulsivity measures, age 6	.45	3.99	<.05
Impulsivity measures, age 8	.50	1.26	*ns*
Hyperactivity (Girls)			
Externalizing problems, ages 7–10	.20	4.59	<.05
Impulsivity measures, age 6	.32	1.40	*ns*
Impulsivity measures, age 8	.86	17.69	<.0001
Aggression (Boys)			
Externalizing problems, ages 7–10	.42	21.29	<.0001
Impulsivity measures, age 6	.43	0.71	*ns*
Impulsivity measures, age 8	.43	0.02	*ns*
Delinquency (Girls)			
Externalizing problems, ages 7–10	.25	5.96	<.05
Impulsivity, age 6	.30	1.11	*ns*
Impulsivity, age 8	.61	16.72	<.0001
Self-ratings, ages 14–17			
Aggression			
Externalizing problems, ages 7–10	.03	0.63	*ns*
Impulsivity, age 6	.22	4.77	<.01
Delinquency			
Externalizing problems, ages 7–10	.01	0.74	*ns*
Impulsivity, age 8	.28	3.82	<.01

Note. Dependent variables included adolescent outcomes that had significant zero-order correlates in antecedent measures of impulsivity.

age points using a broad range of laboratory measures, and these measures were related to ratings of externalizing problem behavior across the school-age and adolescent years. Findings are summarized below, in the context of each major research question.

Do Measures of Child Impulsivity Vary with Age and Gender?

Children's self-regulatory competence has been shown to increase markedly with age (Kopp, 1989). Thus we expected, and found, that controlled performance on interactive task measures increased significantly between ages 6 and 8. Similarly, levels of overt impulsivity in the academic-like task situations showed this developmental effect when children were offered incentives for task-oriented performance. However, levels of impulsivity during the nonincentive work task did not decrease over time, illustrating the potentially critical role that motivational factors may play in the assessment of children's impulse-control capabilities. To date, this issue has not been well-researched, and it deserves much further attention (see Sonuga-Barke, Williams, Hall, & Saxton, 1996, for a discussion of motivational factors and impulsivity in clinically referred groups).

Analyses of potential gender differences in impulsivity yielded an interesting pattern of findings. At the 6-year level, there were no significant gender differences on any measure of impulsivity. However, at age 8, girls were significantly less impulsive than boys during the play and work tasks. These findings converge with other research showing that school-aged boys are rated more highly than girls on behavioral measures of hyperactive symptoms (Heptinstall & Taylor, 1996). In addition, these data suggest that behavioral differences between boys and girls become more pronounced as children mature into the school-age years, perhaps reflecting different socialization pressures and experiences.

Do Different Measures of Impulsivity Show Meaningful Interrelations?

Investigators have achieved little agreement regarding the operational definition and assessment of childhood impulsivity. However, there is a growing consensus that impulsivity is a multidimensional construct and that qualitatively distinct subdimensions of impulsivity can be identified (Kochanska, et al., 1996; Olson, 1989; Schachar, Tannock, & Logan, 1993). These important issues require further empirical study and refinement, particularly with normal, school-aged populations. Thus, we compared multiple measures of children's impulsive functioning derived from two different laboratory-based assessment contexts—interactive testing and behavioral observation. Most measures were assessed at two separate age points, allowing us to evaluate the generalizability of interrelations among the measures across time. In addition, our laboratory measures tapped procedures that have been used to assess inattention (e.g., off-task behavior). For a variety of reasons that include lack of direct empirical comparisons, the exact relationship between laboratory measures of impulsivity and inattention is unclear (Van der Meere, 1996).

Factor analyses of children's performance on the interactive lab tasks showed remarkable consistency between the two assessment periods, lending strong support to the internal validity of the dimensions. At each age level, the most robust factor indexed the child's ability to engage in careful cognitive task analyses and to inhibit impulsive behavior according to the demands of the task situation. This broad dimension of executive competence, inhibitory control, has been identified in prior studies of toddler- and preschool-aged children (Kochanska et al., 1996; Olson, 1989) and in studies of clinically referred children with attention-deficit hyperactivity disorder (Tannock & Schachar, 1996). Thus, our findings are consistent with a growing body of research showing that inhibitory control is an important subdimension of impulsivity in young children. In addition, they suggest that the inhibitory control construct has broad generalizability across different developmental periods and across normal and atypical populations.

Also consistent with previous studies of younger age groups (Kochanska et al., 1996; Olson, 1989), children's performance on delay of gratification tasks comprised a separate dimension of impulse control. Moreover, at age 6 we had two different assessment paradigms: A gift delay task that required children to wait patiently for a few min, and a choice delay task reflecting the child's preference for a small reward given immediately versus a larger, delayed reward. Separate factor dimensions were obtained for each task. Thus, results lend support to earlier findings indicating that children's delay ability comprises distinct subdimension of impulsivity. Recalling Mischel's (1968) classic critique of impulsivity as a trait construct, these findings suggest the need to be especially careful about the measurement of children's delay capabilities, in that individual differences in children's willingness or ability to delay immediate gratification may be sensitive to specific situational factors (see also Sonuga-Barke et al., 1996).

Observations of children's impulsive behavior during structured academic-like tasks were conducted with and without incentives for task-oriented performance. The incentive condition was added because relatively little research attention has been given to the role of motivational factors in children's impulsive functioning. Factor analyses revealed that the motivational context of the task situation had substantial impact on individual differences in children's impulsivity, indicating the importance of further research into this issue.

Finally, we examined interrelations between different, laboratory-based composite measures of impulsivity. Consistent with previous studies, there were few, and quite modest, interrelations between different measures. These findings provide strong additional support for a conceptualization of impulsivity as a multidimensional construct. Even within the laboratory context, children who perform impulsively on the cognitive tasks may or may not manifest high levels of overt behavioral impulsivity. Schachar and Logan (1993) reached a similar conclusion based on research with clinically referred children.

Are Individual Differences in Impulsivity Stable Across Time?

Individual differences in children's impulsivity have been conceptualized as "trait-like" dimensions of cognitive and behavioral functioning. However, because of the dearth of prior longitudinal research on childhood impulsivity, there has been little direct substantiation of this idea. Thus it was important that children's performance on the main interactive task index, inhibitory control, showed a significant level of stability between ages 6 and 8. A narrower dimension, children's preference for an immediate versus delayed reward, also showed a significant level of stability. On the other hand, measures of impulsivity derived from behavioral observation during our work tasks were not stable between the two assessment points.

Once again, these findings call our attention to the multifaceted nature of the impulsivity construct. It is probably not meaningful to refer to "impulsivity" as an inclusive dimension of individual differences in children's behavior. At the very least, researchers must differentiate between impulsive responding on tasks requiring concentration, planning, and willingness to delay immediate gratification versus overt behavior in situations requiring compliance, as only the former showed meaningful levels of temporal continuity.

Are Laboratory Measures of Impulsivity Associated with Ratings of Behavioral Adjustment in Home and School Settings?

To be useful, laboratory indexes of children's impulsive functioning must relate to assessments of their adaptive behavior in broader social contexts such as home, school, and peer groups. In the current study, we related laboratory-derived constructs of impulsivity to aggregated ratings of children's externalizing problem behavior across the school-age years. On the basis of conceptual similarities and prior research (e.g., Schachar et al., 1993), we expected that laboratory indexes of impulsivity would be most closely associated with adult ratings of inattentive, overactive, and impulsive problem behavior. These hypotheses were largely confirmed. For both sexes, there were modest intercorrelations between laboratory measures of impulsivity and parent and teacher ratings of hyperactive problem behavior. However, laboratory measures of impulsivity were unrelated to ratings of aggressive problem behavior in boys, whereas in girls, there were significant links between impulsivity in the laboratory and aggressive problem behavior.

In conclusion, these findings provide consistent support for the external validity of the laboratory measures. In line with a growing body of research on child clinical populations, children who performed impulsively on the laboratory tasks tended to be perceived by mothers and teachers as more impulsive, inattentive, and overactive than others. The fact that impulsivity was linked to aggressive–disruptive problems in girls only was intriguing, and to our knowledge, empirically unprecedented. Most prior empirical work linking impulsiveness with externalizing problems has focused on boys alone, because of their greatly elevated risk of manifesting these disorders (Heptinstall & Taylor, 1996). However, recent investigators have hypothesized that the developmental underpinnings of externalizing problems may differ significantly for boys and girls (e.g., Keenan & Shaw, 1997; Olson & Hoza, 1993). Additional research is needed to evaluate this interesting hypothesis.

Do Laboratory Measures of Impulsivity Predict Externalizing Problems in Adolescence?

Finally, we examined the extent to which our laboratory indexes of impulsivity predicted parent and self-ratings of externalizing problem behavior across adolescence. Linkages between the school-age impulsivity measures and adolescent externalizing behavior were relatively few in number and modest in magnitude. However, as predicted, children who performed impulsively in the laboratory at ages 6 and 8 received higher maternal ratings of externalizing problem behavior than others in adolescence. This was especially true for girls in relation to later parent reports of minor delinquency. Moreover, for both boys and girls, several measures of impulsivity in the laboratory at age 8 predicted self-perceptions of later delinquent behavior across adolescence. Finally, hierarchical multiple regression analyses revealed that the laboratory indexes of impulsivity made unique and significant contributions to the variance in measures of later externalizing problem behaviors, beyond variance accounted for by prior ratings of behavioral maladjustment.

Limitations and Conclusion

There are noteworthy limitations to the generalization of our findings. First, we sampled a broad range of laboratory paradigms that have been used in the assessment of childhood impulsivity. However, our procedures did not encompass tasks based on information-processing theory, such as those used by Schachar and Logan (1990). Thus, the stability, coherence, and external validity of measures of impulsivity based on information-processing theory must be independently evaluated.

Similarly, our study focused on the assessment of impulsivity in nonreferred school-aged children. Much prior literature on childhood impulsivity has focused on clinically referred samples, particularly children with ADHD. Thus, we emphasize that our findings are not generalizable to clinical samples. It would be very desirable to have further longitudinal research on the development of impulsive functioning among children with disruptive behavior disorders.

In conclusion, these data affirmed the developmental significance of individual differences in childhood impulsivity, and they provided clear support for the external validity of the laboratory-derived impulsivity measures. In addition, they showed that childhood impulsivity in the school-age years is linked to a broad range of externalizing problems in adolescence, not just features of ADHD. As children mature, the network of adaptational problems associated with impulsivity may expand considerably. Understanding processes that may underlie these developmental pathways is a research problem of great importance.

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