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The Impact of Idle Time in the Classroom: Differential Effects on Children With ADHD

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Abstract

Objective: Studies have identified an exacerbation of ADHD deficits under specific laboratory conditions. Less is known about the significance of such contextual factors in relation to everyday functioning in naturalistic settings. **Method:** This study investigated the differential impact of classroom "idle time"—periods when students are not actively engaged or waiting for a task—on the behavior of 31 children with ADHD (25 boys and 6 girls; aged 6-12 years) and 31 sex- and age-matched typically developing classmates, who were simultaneously observed in their normal classroom during two school days. **Results:** Both groups experienced the same amount of idle time (12% of the time). During idle time, however, levels of hyperactivity and noisiness increased significantly more in children with ADHD than in their classmates (p < .05). **Conclusion:** Findings highlight the differential susceptibility of ADHD children to classroom idle time. Classroom interventions might consider targeting specifically these periods to reduce disruptive behavior in these children. *(J. of Att. Dis. 2013; XX(X) 1-XX)*

Keywords

ADHD, disruptive behavior, classroom, context, variability

Introduction

ADHD (age-inappropriate and impairing levels of inattention and hyperactivity-impulsivity; American Psychiatric Association [APA], 1994) is a high prevalence (Spencer, Biederman, & Mick, 2007), high impact disorder (Barkley, Fischer, Smallish, & Fletcher, 2006). Laboratory studies have yielded significant advances in our understanding of the psychopathophysiology of the condition implicating a wide range of cognitive and motivational processes in ADHD (i.e., behavioral inhibition and executive functioning; Barkley, 1997), cognitive-energetic resources (Sergeant, 2000), motivational pathways, and temporal processes (Sonuga-Barke, Bitsakou, & Thompson, 2010). However, there are still few examples of therapeutic and clinical innovation that build directly on these advances (Sonuga-Barke, 2009). This is in part due to limitations in our understanding of the significance of these deficits for everyday behavior and functioning. Some have questioned the ecological validity of laboratory measures of these basic deficits (Barkley & Fischer, 2011): Can they really capture the complexity of real-world situations?

One finding from the laboratory that may have more practical resonance than other relates to evidence that performance by children with ADHD varies considerably from setting to setting. In particular, behavior of individuals with ADHD seems worse in situations with low stimulation (Antrop, Roeyers, Van Oost, & Buysse, 2000), high delay (Antrop et al., 2006), and a lack of structure (Zentall & Leib, 1985) and reward (Luman, Oosterlaan, & Sergeant, 2005). Such effects of context are consistent with a number of theories of ADHD. For instance, the delay aversion hypothesis (Sonuga-Barke, 1994) relates symptoms of ADHD to a motivational style characterized by a negative emotional reaction to the imposition of delay (Bitsakou, Psychogiou, Thompson, & Sonuga-Barke, 2009; Sonuga-Barke, 1994, 2005). The theory predicts that children with

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ADHD learn to behave in ways that reduce the negative experience of delay, in particular by acting on the environment to alter the perception of time during the passage of delay, which results in inattentive and hyperactive behavior (Sonuga-Barke, 1994; Sonuga-Barke, Wiersema, van der Meere, & Roeyers, 2010). Therefore, it is expected that ADHD behavior exacerbates during periods of low stimulation and delay (Antrop, Buysse, Roeyers, & Van Oost, 2002). A second relevant model is the cognitive-energetic model of ADHD (Sergeant & Van der Meere, 1988, 1990). This explains ADHD as a deficit in state regulation associated with failures to appropriately allocate effort during information processing which can arise due to over arousal/activation and/or under arousal/activation (Sonuga-Barke, Wiersema, et al., 2010). The latter has previously been postulated by the optimal stimulation theory (Zentall, 1975) describing ADHD in terms of a nonoptimal state of under arousal. Exposed to low levels of stimulation, these theories predict that children with ADHD will show sensation-seeking behavior in an attempt to increase arousal to optimal levels.

As ADHD behavior at school represents one of the most potent factors predicting school-related and broader patterns of achievement and functioning (Barkley, et al., 2006; Fergusson & Horwood, 1995), the classroom represents an environment of choice to observe behavioral symptoms in children with ADHD (Abikoff et al., 2002; Junod, DuPaul, Jitendra, Volpe, & Cleary, 2006). However, only a few classroom studies have identified environmental conditions that trigger and maintain problematic behavior in ADHD (Lauth, Heubeck, & Mackowiak, 2006). Although these environmental triggers are not assumed to be causal by themselves, they may interact with specific (causal) deficits in children with ADHD (Barkley, 2007).

In this study, we build on the laboratory findings about the context specificity of ADHD behaviors to explore the impact of a highly relevant classroom equivalent. One such condition—often referred to as problematic by teachers—may relate to "idle time" in the classroom, for instance, when children are waiting between tasks or for the teacher to help them. These periods could be considered as waiting conditions (periods of "delay") with typically low degrees of environmental stimulation (no task or instruction) and external structure (no directions from the teacher). To our knowledge, only one study has attempted to link laboratory-based measures of sensitivity to delay or low arousal settings to behavior in the naturalistic classroom environment. Solanto et al. (2001) correlated impulsive choice patterns (preference for small immediate rewards over large delayed rewards) on a laboratory task with a range of classroom behaviors such as gross motor activity and physical aggression, highlighting the potential everyday significance of laboratory measures of delay sensitivity. A later experimental study in the naturalistic setting confirmed the view that low-stimulation, delay-rich situations in the classroom are associated with more ADHD behaviors (Antrop, Buysse, Roeyers, & Van Oost, 2005). Naturalistic classroom studies have not considered idle time as such, but they do support the view that disruptive behavior in ADHD is affected by amount of stimulation and levels of structure in the class context (Jacob, Oleary, & Rosenblad, 1978; Lauth et al., 2006; Whalen, Henker, Collins, Finck, & Dotemoto, 1979; Zentall & Leib, 1985). Whereas some studies described an exacerbation of hyperactive and socially disruptive behavior in low structure settings (Lauth et al., 2006; Whalen et al., 1979; Zentall & Leib, 1985), others reported highly structured environments to increase disruptive behavior (Handen, McAuliffe, Janosky, Feldman, & Breaux, 1998; Whalen et al., 1979). Also low-stimulation classroom settings (e.g., seatwork) have been reported to increase noise-vocalization, disruptive, and off-task behavior (Zentall, 1980).

The aims of this study therefore were to (a) characterize the patterns of exposure to "idle time" for ADHD children and controls during an average school day, in terms of duration, and transition periods as a contributor to idle time; and (b) examine the impact of idle time on ADHD behaviors and more general disruptive behavior in the classroom. We predicted that children with ADHD will show more ADHD and disruptive classroom behaviors in general and that these effects will be exacerbated in the idle time condition. In statistical terms, we predict a significant interaction between group (ADHD vs. control) and context (idle time vs. nonidle time) with the difference between idle and nonidle time being greater for ADHD than control children. As comorbid oppositional defiant disorders (ODD) problems and academic underperformance in children with ADHD may have an impact on classroom disruptive behavior, these confounding effects were additionally taken into account.

Method

Participants

A total of 31 children diagnosed with ADHD (25 boys and 6 girls), aged 6 to 12 years (M = 8.94, SD 1.52), were recruited from a local child psychiatric outpatient unit. Each had a formal diagnosis of ADHD combined type (*Diagnostic and Statistical Manual of Mental Disorders* [4th ed.; *DSM-IV*]; APA, 1994) obtained by a clinical child psychiatric assessment (parents' history, child observation, and school information). Prior to participation, diagnosis of ADHD combined type was confirmed using the Diagnostic Interview Schedule for Children–Parent Version (PDISC-IV; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). Participants were excluded if they had an IQ less than 80 (Wechsler Intelligence Scale for Children–Third Edition, Revised Version [WISC-III-R]; Wechsler, 1991), a diagnosis of pervasive developmental disorders, neurological disorders such as epilepsy, or another chronic medical condition or if they were on medication for mental health problems except for methylphenidate. Twenty-six children with ADHD took methylphenidate (17 short- and 9 long-acting formulation), but all children were free from treatment at least 24 hr prior to participation in the study. Eleven of the children with ADHD received (extrascholarly) special education services. Controls were 31 age- and sex-matched healthy, normally developing children from the same class as the child with ADHD. These children had no medical condition and were free of medication/psychotherapy or special education classes. All children attended a regular elementary school. Socioeconomic status did not differ significantly between groups in terms of highest achieved educational level of mothers, $\chi^2(2) = 1.07$, $p = .30$.

To screen for current behavioral problems in both groups, the Disruptive Behavior Disorder Rating Scale (DBDRS; Oosterlaan et al., 2008; Pelham, Gnagy, Greenslade, & Milich, 1992) was filled out by teachers. Validity and reliability of the Dutch translation of the DBDRS have been proved adequate in Dutch and Flemish children aged 6 to 12 years (Cronbach's α range = .88-.94; Oosterlaan et al., 2008). This 42-item questionnaire contains four child behavior scales according to the *DSM* criteria: inattention (9 items), hyperactivity and impulsivity (9 items), ODD (8 items), and conduct disorder (CD; 16 items). Teachers rated each item on a 4-point Likert-type scale from 0 (*not at all*) to 3 (*very much*). Children with ADHD were rated significantly higher than their normally developing classmates on all subscales: Inattention: M (SD) = 12.48 (5.95) vs. 2.26 (3.08); Hyperactivity/Impulsivity: 11.00 (6.48) vs. 1.65 (2.20); ODD: 4.71 (4.35) vs. 0.55 (1.39); and CD: 1.55 (2.22) vs. 0.10 (0.30); $p < .01$ for all scales. In addition, child's performance on different lesson contents was evaluated on a scale from 1 (*insufficient*) to 5 (*well* to *very well*) by the teacher (as included in the Teacher Report Form [TRF]; Achenbach, 2001; Verhulst, van der Ende, & Koot, 1997). Children with ADHD performed less on mathematics, M (SD) = 3.43 (1.23) versus 4.30 (0.79), $p < .01$; language arts, 3.33 (1.04) versus 4.20 (0.85), $p < .001$; sciences, 3.46 (1.17) versus 4.44 (0.70), $p < .001$; but not on music and arts, 3.55 (1.13) versus 3.85 (0.80), *ns*. The observation of ADHD-related classroom behaviors may be related to comorbid ODD problems and academic underperformance rather than to ADHD as such, the ODD score of the teacher DBDRS and an "overall" performance score (calculated as the average score on mathematics, language, and science) were additionally included as a covariate in the analyses.

Procedure

This study was approved by the Ethical Committee of Ghent University Hospital, Ghent, Belgium. Parents of children with ADHD provided written consent and the teacher of the child with ADHD agreed to collaborate in the study. Teachers selected three sex- and age-matched normally developing classmates for each ADHD participant; they were asked to not pick their most talented or best-behaved children, but those performing and behaving on average. If all parents provided written consent, one child in the control group was selected randomly to participate in the study. Prior to the observation days, teachers checked that the child with ADHD and the control child did not sit next to each other to minimize the chance of influencing each other's behavior. Classroom observations took place over two consecutive school days, between 2008 and 2010, in 30 different schools. Seventeen paired (ADHD and control classmate) observations were randomly selected to be carried out on Monday and Tuesday, and 14 on Thursday and Friday. During the observation, no specific changes (e.g., with respect to schedules) were required as it was designed to interfere minimally with the normal class procedures. The observers were introduced to the children as a trainee teacher, and were seated in the back of the classroom to serve the cameras during each observation. A camera was positioned in each corner at the front of the classroom. The children were told that these cameras helped the trainee teacher to remember class activities. At the end of the second day, the real aims of the study were revealed to the children.

Measures

Observational coding scheme. This article is part of a broader study investigating the influence of contextual factors on ADHD behavior. Although several standardized observation coding schemes are currently available (for a review, see Volpe, DiPerna, Hintze, & Shapiro, 2005), none contains information regarding the various factors that potentially influence classroom observations. Our coding scheme was developed specifically for this study, that is, the Ghent University Classroom Coding Inventory (GUCCI), which is partly adapted from previously published coding schemes (Abikoff, Gittelman, & Klein, 1980; Blatchford, Bassett, & Brown, 2005; Lauth et al., 2006; Milich & Landau, 1988; Porrino et al., 1983; Tsujii et al., 2007).

Coding procedure. Across 2 full school days, four observation blocks were coded for each child taking into account between- and within-day effects. On one day, the first part (start of the day to morning playtime) and the last part (afternoon playtime to end of the day) were coded, and on the other day the second part (morning playtime to lunch) and the third part (lunch to afternoon playtime) of the day. Thus, together, these four blocks (two morning and two afternoon blocks) covered a whole school day across the 2 days combined. The mean coded observation time in the classroom was 4:34 hr (SD = 36:29 min). Although observation times differed between schools, observation times for the members of each dyad were similar because the child with ADHD and his matched control were observed simultaneously under the same conditions.

The Observer software. Class context categories (idle time vs. nonidle time vs. alternative, individually assigned, activity) and child's disruptive behavior (hyperactivity vs. noisiness vs. disruptive social behavior) were continuously coded in The Observer (Noldus, Version 9; see description of variables below). Video material was imported in this professional software for the coding and analysis of observations. The Observer has the advantage that it can select each specific contextual condition to analyze the duration of child's disruptive behavior (% of time) during that period. For the purpose of this study, durations of all three target behavior scores (% of time showing problematic levels of hyperactivity, noisiness, and disruptive social behavior) were calculated during idle time and nonidle time. Supplementary tasks were not assigned sufficiently frequently to allow further analyses. During out-of-class activity, children were not visible on the film; therefore, this condition could also not be included in further analyses. The fine-grained nature of the coding (continuous coding without considering fixed intervals for coding) allowed us to additionally analyze characteristics of the idle time periods such as the length of each individual episode.

Context and behavioral codings. Three class conditions were coded (button was pressed when condition began and ended): (a) *idle time* (e.g., the child has finished his task and is waiting for the next task to start, child is waiting for help/instructions of the teacher), (b) *nonidle time* (i.e., the child is involved in a main task/activity for the whole class group), and (c) *alternative, individually assigned, activity (i.e., a supplementary task when the child has finished the main task, for example, silently reading a book or drawing; or out-of-class activity, for example, by going to the bathroom, delivering an out-door message for the teacher)*. Class conditions were mutually exclusive. The coding included separate measures for these codes for children with ADHD and controls.

During these conditions, three categories of classroom behaviors were continuously scored: (a) *activity* (no hyperactivity vs. problematic levels of hyperactivity), (b) *nonsocial vocalization* (no noisiness vs. problematic levels of noisiness), and (c) *social behavior* (no disruptive social behavior vs. disruptive social behavior). These categories were not mutually exclusive (i.e., three categories were coded simultaneously). A more detailed description of the GUCCI codings of disruptive behavior variables can be found in Table 1.

As we predicted that there would be a close relation between idle time and *transition periods* (i.e., class periods just before or after playtime and periods between two different lessons), these periods were additionally coded. Transitions reflect periods of preparation and "winding up" of lessons (e.g., taking/put away pen, book, etc.) and are mostly a combination of nonidle time (listening to teacher instruction and carrying out the task) and idle time (when finishing the task and waiting for the next instructing or start of the lesson). Thus, transition periods overlapped with nonidle time as the target child was carrying out the transitional instruction, and with idle time as soon as done with the instruction.

Interobserver agreement. For this study, six undergraduate psychology and medical students were intensively trained to work with The Observer and supervised by the main researcher to code situational condition (one student), activity/nonsocial vocalization (two students), social behavior (two students), or transition periods (one student). Observers were blind for the diagnostic status of the children. Interobserver variability between the students and the main researcher was calculated with Cohen's kappa for categorical variables. Based on Watkins and Pacheco (2000), agreement was excellent for idle time versus nonidle time ratings (κ = .99), transitions (κ = .98), hyperactivity (κ = .91-.97), noisiness (κ = .96-.99); and very good for disruptive social behavior (κ = .74-.79).

Statistical Analyses

To investigate whether exposure to idle time differed between children with ADHD and their normal developing classmates, we first calculated the proportion of time spent on each context condition (e.g., time spent on idle time/total duration of the observation). Groups (ADHD vs. controls) were compared using ANOVA. Specific characteristics of idle time periods were additionally investigated: (a) duration of each interval and (b) transition periods as a potential contributor to idle time.

A different approach was used to assess whether the level of disruptive classroom behavior (% of time showing hyperactivity, noisy behavior, social disruptive behavior) was exacerbated during idle time as compared with nonidle time conditions. The dependent variables associated with classroom behaviors were not normally distributed but rather showed a Tweedie distribution (summed poisson-gamma distribution with p = 1.5), which refers to (a) the "exact zeros" in our data when no disruptive behavior was present during the observation (count data) and (b) to the positively skewed proportions of time as soon as disruptive behavior was present (continuous data; Gilchrist & Drinkwater, 2000). For this reason, we used generalized estimation equation (GEE) models that have the additional advantage to take account of the within-subject correlations present in repeated measurement data, without the covariance structure being of central interest (Zeger & Liang, 1986). Because data were correlated across conditions, GEE analyses with an exchangeable correlation-working matrix were performed. Data across four observation blocks (across 2 days, morning vs. afternoon)

Table 1. General Description of Behavior Codings (XXCCI).

Behavior	Coding	Description
Activity	No problematic levels of hyperactivity	The child sits still. Little movements of fingers, hands, arms, feet or legs are tolerated as long as these are not observably annoying the teacher or disturbing their peers. The child has no difficulty sitting down and shows no gross motor movements (unless when allowed by the teacher, for example, going to the blackboard).
	Problematic levels of hyperactivity	The child shows (a) minor activity that is observably annoying/disturbing or (b) the child is not able to sit still and shows gross motor activity that is not allowed by the teacher: (i) squirms in chair, swings or overturns his chair, turns his entire trunk over each side of the chair, shows difficulty sitting down; (ii) gets out of his chair, stands up without permission; (iii) runs and climbs in the room and shows chaotic, uncontrollable behavior. The behavior is disruptive as it may interfere with normal class procedures, distract peers, or require instructions of the teacher to correct behavior.
Nonsocial vocalization	Not noisy	Child is quite. No noisy behavior.
	Noisy	The child shows noisy behavior that is not socially oriented. This behavior may be vocal/verbal or nonvocal/verbal and is not allowed by the teacher: (a) the child makes small noises such as humming, mumbling, sighing, whispering to self, ticking a pencil, ticking with fingers or feet; (b) the child is talking to self, laughing in itself, singing, or moving chair/table; (b) the child talks and sings loudly, and yells. The behavior is disruptive as it may interfere with normal class procedures, distract peers, or require instructions of the teacher to correct behavior. Unintentional behaviors such as coughing and sneezing are tolerated.
Social behavior	Not disruptive social behavior	The child is not interacting with peers. Alternatively, the child could interact with peers during specific tasks as expected by the teacher.
	Disruptive social behavior	The child shows forbidden or aggressive behavior toward peers. This could be (a) whispering or talking to peers when this behavior was not expected by the teacher in the context of the task, or (b) being verbally aggressive (abusing, blaming, threatening) or physically aggressive (pushing, hitting, fighting).

Note: GUCCI = Ghent University Classroom Coding Inventory. More detailed information can be obtained from the authors.

were averaged by the software program. In a first set of analyses, variations in disruptive behavior levels were assessed as a function of group (ADHD vs. control) and condition (idle time vs. nonidle time), and the Group × Condition interaction was studied. Where the latter was significant, we explored the nature of interaction by comparing the difference between idle and nonidle time for ADHD and control children. As this *change score* was normally distributed, we used ANOVA for this analysis. Cohen's *d* effect sizes were additionally calculated (Cohen's $d = M_{diff}/SD_{pooled}$), which are defined as small (0.20), moderate (0.50), and large (0.80). In a second set of analyses, we adjusted our results for possible confounding effects by controlling our first set of analyses for the presence of comorbid ODD problems (DBDRS teacher score) and overall performance score. Supplementary activities were too infrequently coded to allow analysis. All analyses were performed in SPSS (Version 19).

Results

Characteristics of Idle Time in the Class Context

Children spent, on average, 12% (SD = 5%) of their time on idle time during a normal school day, which is equivalent to 32 min/day. During 83.5% (SD = 8%) of their time, children were engaged in a main task or instruction (i.e., nonidle time for the sake of current analysis). During 4.5% of this time, they performed a supplementary task (2.1%; SD = 5%) and were excused from the class for 2.4% (SD = 3%) of their time. There was no difference between the amount of idle time experienced by ADHD and control participants, $F(1, 61) = 0.74$; $p = .39$. Idle time intervals had a mean duration of 54 s (SD = 66 s). Although a large number of intervals (i.e., 72%) were shorter than 1 min, the smaller number of longer intervals (i.e., 28%) was responsible for 65% of the total idle time duration. Half of the idle time occurred during transition moments. During transitions, idle time was present during 33% of the time as compared with 10% of idle time during nontransition periods. There was no difference between ADHD and control participants on any of these parameters.

Testing for Differential Effects of Idle Time on ADHD-Related Disruptive Classroom Behavior

Because of the nonnormal nature of the data, median values of hyperactivity, noisiness, and disruptive social behavior by group and condition are presented in Figure 1. For both groups, the average change in disruptive classroom behavior ratings from nonidle to idle time condition (normally distributed) is shown in Figure 2.

When problematic levels of hyperactivity were the dependent variable, there was a main effect of group (Wald $\chi^2 = 17.64$; $p < .001$) and condition (Wald $\chi^2 = 45.41$; $p < .001$), and a significant interaction effect (Wald $\chi^2 = 5.65$; $p < .05$). Children with ADHD showed higher levels of hyperactivity relative to their normal developing classmates. Levels of hyperactivity were higher during idle time as compared with nonidle time conditions for both groups. The interaction effect was confirmed by additional analyses of the *change score* (ANOVA): The average increase during idle time was significantly different ($F = 4.99$; $p < .05$; Cohen's $d = 0.57$) for the ADHD group, M (SD) = 9.2% (10.3%), and for the control group, M (SD) = 4.5% (5.3%). When noisiness was the dependent variable, there was a significant main effect of group (Wald $\chi^2 = 7.84$; $p < .01$) and a significant interaction effect (Wald $\chi^2 = 5.79$; $p < .05$), but no main effect of condition (Wald $\chi^2 = 1.47$; $p = .23$). Children with ADHD showed higher levels of noisiness relative to their normal developing classmates. Additional analyses based on the *change score* confirmed that the average increase during idle time was significantly different ($F = 4.82$; $p < .05$; Cohen's $d = 0.51$) for the ADHD group, M (SD) = 1.8% (4.0%), and for the control group, M (SD) = −0.02% (3.0%). When disruptive social behavior was the dependent variable, the pattern was somewhat different. There was a significant main effect of group (Wald $\chi^2 = 4.01$; $p < .05$) and condition (Wald $\chi^2 = 163.59$; $p < .001$), but no interaction effect (Wald $\chi^2 = 0.96$; $p = .33$). Children with ADHD were more socially disruptive than their peers, M_{diff} (SD_{pooled}) = 2.1% (4.0%). Both groups showed more of this behavior during idle time as compared with nonidle time conditions, M_{diff} (SD_{pooled}) = 11.6% (3.8).

Although higher ODD problems were associated with higher levels of hyperactivity (trend effect: Wald $\chi^2 = 2.99$; $p = .08$) and disruptive social interactions with peers (significant effect: Wald $\chi^2 = 3.82$; $p < .05$), controlling for ODD problems in the main analyses did not alter the pattern of any of the previously reported results. When included in the models above, academic performance score did not significantly contribute to variations in disruptive behavior levels and did not alter our main findings.

Discussion

Laboratory studies have shown that ADHD children's disruptive behavior and performance deteriorate in certain contexts (Antrop et al., 2000; Antrop et al., 2006; Zentall & Leib, 1985). These setting-specific effects are predicted by a number of theories of ADHD—especially those that emphasize the role of context-dependent dynamic processes in ADHD pathophysiology (Sonuga-Barke, Bitsakou, et al., 2010). However, little is understood about the practical implications of context effects on everyday behavior and functioning in naturalistic environments (Barkley & Fischer, 2011; Lauth et al., 2006). The current study tested the prediction that classroom idle time (e.g., when the child is between tasks or when waiting for help from the teacher) would have a greater impact on the behavior of children with ADHD than non-ADHD classmates.

There were a number of findings of interest. First, all children appeared to spend a surprising amount of their school day in the classroom confronted by idle time. As idle time is expected to be a risk factor in triggering and maintaining disruptive behaviors, it was worthwhile to explore its effects in the classroom. Second, unexpectedly, children with ADHD were not exposed to more idle time than were their non-ADHD classmates. We initially assumed that children with ADHD would finish their tasks sooner based on their impulsive style. One possibility is that inattention problems in these children may prevent them from finishing their tasks (high degree of off-task rather than idle time). On the other hand, despite their putative aversion for delay situations (Sonuga-Barke, Sergeant, Nigg, & Willcutt, 2008), it appeared that children with ADHD nor their teachers could reduce the amount of idle time exposed to as compared with their peers, for example, by shifting to alternative class activities. Third, not surprisingly, ADHD children displayed higher levels of each of the three measured target behaviors—hyperactivity, noisiness, and inappropriate social behavior—irrespective of setting. In general, the classroom is a setting requiring high levels of self-regulation (Barkley, 1997), motivation (Sonuga-Barke, 2005), and cognitive and information processing skills (Sergeant, 2000) and is likely to be especially demanding for ADHD children who often have deficits in these domains (Abikoff et al., 2002; Junod et al., 2006). Fourth, for two of the target behaviors, there was a general effect of idle time on behavior—hyperactivity and inappropriate social behavior. Even nonhyperactive children engaged in potentially disruptive behavior during these periods when there is no specific task to perform. Finally, in the case of hyperactivity and noisiness, as

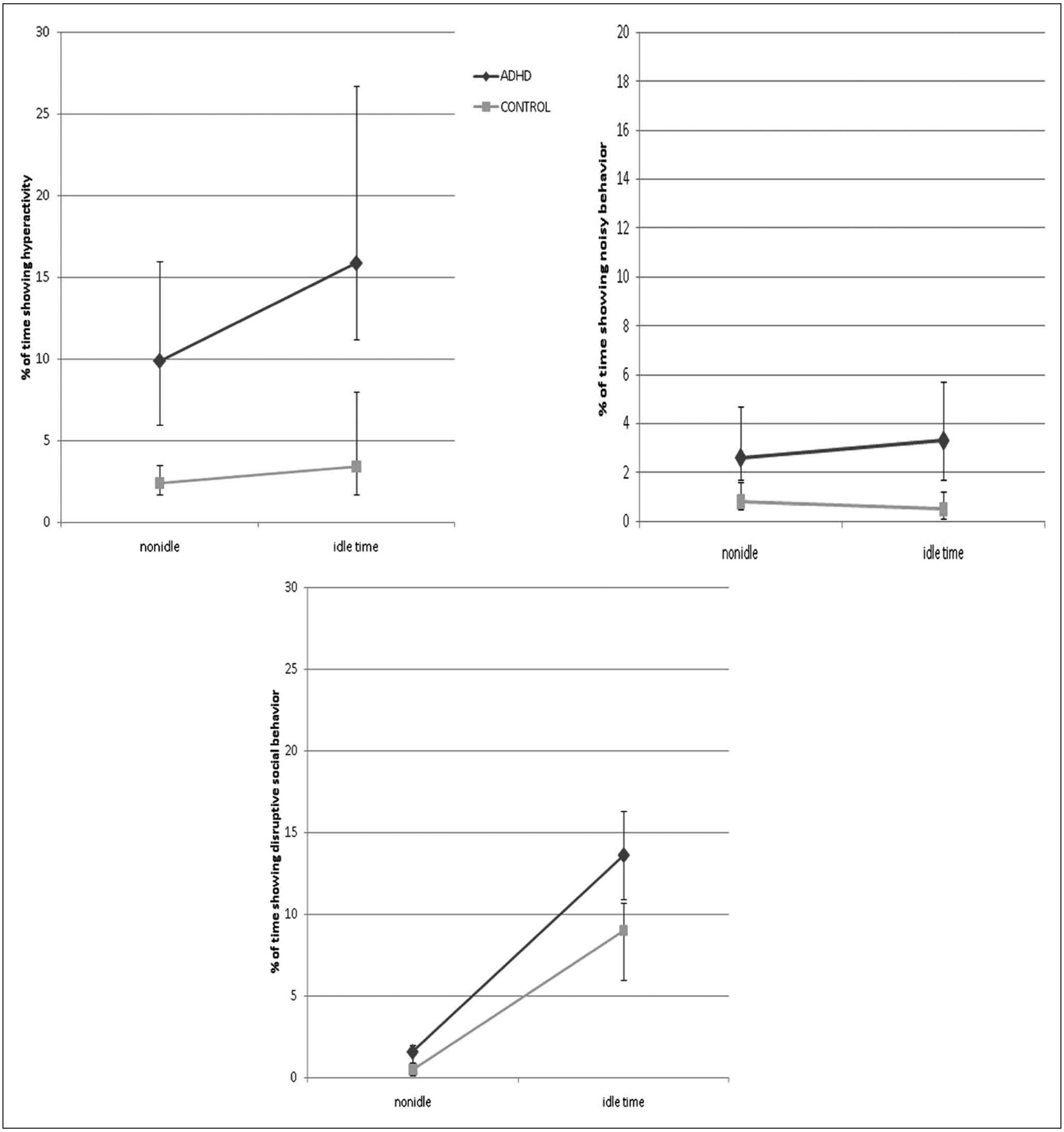

Figure 1. Median values of hyperactivity, noisiness, and disruptive social behavior by group and condition.
Note: Median values were presented as behavioral ratings were positively skewed. Error bars represent the semi-interquartile range.

predicted, it did appear that idle time had a differential impact on ADHD children and their classmates. These findings are consistent with laboratory nonchoice conditions (waiting situations from which children could not escape; Bitsakou et al., 2009; Sonuga-Barke, 1994, 2005). However, in their semiexperimental classroom observation, Antrop, Buysse, et al. (2005) reported a similar effect of waiting on both groups in terms of increased activity (only 14 children were observed in each group). These "additive" effects indicated that children with ADHD experience more difficulties

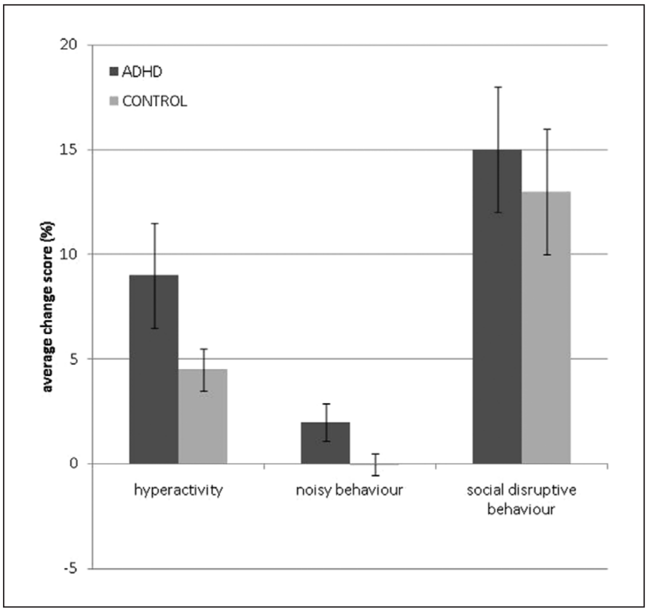

Figure 2. The average change in disruptive classroom behavior from nonidle to idle time condition by group.
Note: Error bars represent the 95% confidence interval.

within the idle time condition relative to control children or relative to nonidle time conditions.

From a *practical perspective*, differential effect of idle time may have a substantial impact on everyday functioning of ADHD children as we showed that children in general are exposed to idle time for substantial proportion of lesson time (i.e., 12%). The failure to engage effectively in, and operate efficiently in, a delay-rich environment may reduce the development of organizational skills and strategies (Sonuga-Barke, 2005), which over time contributes to academic failure in children with ADHD (Fergusson & Horwood, 1995). Although the majority of idle time periods was very short (<1 min), the longer periods (≥1 min) were still responsible for two thirds of total idle time. Furthermore, exposure to idle time seems to be associated especially with transition periods (i.e., class periods before or after playtime and between different tasks). During these vulnerable time periods, children spent one third of their time exposed to idle time. Previously, Antrop, Roeyers, and De Baecke (2005) reported an increase in hyperactive behavior after playtime in the afternoon. It is unclear whether this rise is due to the transition period as such or to delay periods associated with it. In either way, these transition-idle time moments are a primary focus of concern and represent a good candidate target for intervention. The special structuring of classroom transitions, for example, has been proven to be an effective way of reducing disruption (Lee, 2006).

Considering idle time to be a relevant classroom equivalent for laboratory conditions related to high delay, low structure, and low stimulation, from a *theoretical perspective*, findings may be consistent with a number of different models of ADHD that emphasize the role of environmental conditions on ADHD behavior. In terms of the delay aversion model (Sonuga-Barke, 2005), this effect of idle time can be explained in terms of the negative emotional reaction in children with ADHD to the imposition of delay (Bitsakou et al., 2009; Sonuga-Barke, 1994, 2005). When these children are exposed to waiting situations (with low stimulation), which they cannot "escape" from, ADHD behavior is exacerbated (Antrop et al., 2002) in an attempt to reduce the negative experience of delay (Sonuga-Barke, 1994; Sonuga-Barke, Wiersema, et al., 2010). In terms of the optimal stimulation model (Zentall, 1975), children with ADHD will show sensation-seeking behavior (e.g., hyperactivity) when confronted with low-stimulation conditions such as idle time, in an attempt to increase their nonoptimal arousal levels. In terms of state regulation deficit model (Sergeant, 2000), failures to properly regulate energetical state (arousal/activation) become obvious when challenged to do so in nonoptimal settings such as conditions with low stimulation and slow event rate (Sonuga-Barke, Wiersema, et al., 2010).

Previous naturalistic observational studies have reported differences in behavior as a function of structure and stimulation. Some of them found differential patterns in children with ADHD with respect to hyperactivity during in-seat versus out-of-seat lessons (Porrino et al., 1983; Tsujii et al., 2007) and social interactions during self-paced activities versus externally paced ones (Whalen et al., 1979). Other authors described comparable effects in both groups rather than differentiating between ADHD and control: For example, children with and without ADHD were reported to show more disruptive behavior in noninstructional or self-paced settings (Lauth et al., 2006; Zentall & Leib, 1985) and during low stimulation (Zentall, 1980). It must be noted that these studies included a smaller sample size, shorter observation periods, and different operationalization as compared with this study. Although we found a differential exacerbation during idle time for hyperactivity and noisiness, with respect to social disruptive behavior, the increase during idle time was similar for both groups. It is possible that during idle time situations, the "true" nature of a child's behavior tends to emerge, and for *all* children, this seems to include an increase in socially disruptive behavior, whereas only *some* children will show an increase in hyperactivity. Explanatory theories of ADHD may therefore relate to core ADHD behavior rather than less central facets of the condition. Either way, it seems reasonable to assume that children with ADHD will more easily exceed "normal levels" and that such extreme levels of disruptive behavior will never occur in control children in any situation.

This study had a number of strengths especially relating to its naturalistic observational study, its sampling over large periods of the day using a reliable coding scheme, and the relatively large sample of patients. There were some limitations. First, the naturalistic class environment represents a less-standardized, less-controlled setting as compared with the laboratory context. It was not possible to control for every aspect of stimulation or structure within the environment: for example, the effect of the camera, the presence of the examiner, additional noise, and unexpected interference. As the child with and without ADHD were observed simultaneously in the same classroom, it is reasonable to assume that these effects were similar for both children. Second, despite the ecological nature of our observations, findings may not generalize to all settings and all school days (Hintze & Matthews, 2004). Current findings relate to Flemish regular elementary classrooms and may therefore not be representative for other world parts or special education settings. Third, we considered idle time to be a relevant classroom equivalent of laboratory settings with high delay, low stimulation, and low structure, but this measure may not map exactly on these theoretical constructs. Moreover, nonidle time may include times when students were involved in unstructured or low-stimulation tasks. Despite these overlap in terms of these features, the current operationalization seemed highly relevant and practically useful in children's everyday classroom environment. Fourth, as children with ADHD may face motivational problems and aversive feelings toward academic tasks, classroom idle time may be a welcome break rather than an aversive challenge. However, we expect that these children do not choose to have an idle time period but prefer to shorten the period of delay as suggested by several laboratory tasks (Marco et al., 2009; Sonuga-Barke, Taylor, Sembi, & Smith, 1992).

In sum, this study found that idle time in the classroom had a significant effect on behavior in the classroom, eliciting more potentially disruptive behaviors. For hyperactivity and noisiness, these effects were exacerbated more for children with ADHD as compared with their peers. Classroom interventions might consider targeting specifically these periods to improve behavior and academic performances especially in children with ADHD (Antrop, Buysse, et al., 2005; Hoff & DuPaul, 1998).

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