Longitudinal evaluation of the importance of homework assignment completion for the academic performance of middle school students with ADHD

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ABSTRACT

The primary goal of this study was to longitudinally evaluate the homework assignment completion patterns of middle school age adolescents with ADHD, their associations with academic performance, and malleable predictors of homework assignment completion. Analyses were conducted on a sample of 104 middle school students comprehensively diagnosed with ADHD and followed for 18 months. Multiple teachers for each student provided information about the percentage of homework assignments turned in at five separate time points and school grades were collected quarterly. Results showed that agreement between teachers with respect to students assignment completion was high, with an intraclass correlation of .879 at baseline. Students with ADHD were turning in an average of 12% fewer assignments each academic quarter in comparison to teacher-reported classroom averages. Regression analyses revealed a robust association between the percentage of assignments turned in at baseline and school grades 18 months later, even after controlling for baseline grades, achievement (reading and math), intelligence, family income, and race. Cross-lag analyses demonstrated that the association between assignment completion and grades was reciprocal, with assignment completion negatively impacting grades and low grades in turn being associated with decreased future homework completion. Parent ratings of homework materials management abilities at baseline significantly predicted the percentage of assignments turned in as reported by teachers 18 months later. These findings demonstrate that homework assignment completion problems are persistent across time and an important intervention target for adolescents with ADHD.

1. Introduction

Children and adolescents with attention-deficit/hyperactivity disorder (ADHD) frequently experience clinically significant academic impairment (DuPaul & Langberg, 2014; Frazier, Youngstrom, Glutting, & Watkins, 2007; Kuriyan et al., 2013), and difficulties at school is one of the most prominent reasons youth with ADHD are referred for treatment (Loe & Feldman, 2007; Wolraich et al., 2005). Prevalence rates reported for comorbid learning and/or achievement problems in ADHD samples range from 50% to 80%, depending on the definition (DuPaul & Stoner, 2014). Children and adolescents with ADHD have lower school

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grades and are significantly more likely to be retained a grade and to drop out of school in comparison to their peers (Barbaresi, Katusic, Colligan, Weaver, & Jacobsen, 2007; Barkley, Fischer, Smallish, & Fletcher, 2006; Molina et al., 2009). Although a majority of youth with ADHD experience academic impairment, there is significant variability in the presentation, severity, and causes of this impairment (Martin, 2014). A clear understanding of the factors that contribute to the academic performance of youth with ADHD is needed to develop and refine interventions.

1.1. The role of homework in academic outcomes

Homework is a teacher-assigned task designed to be completed during non-school hours (Cooper, 1989) and is a core component of the educational curricula in the United States and abroad (Cooper, Robinson, & Patall, 2006). On average, secondary school students in the United States report spending approximately 1 h of after school time on homework each day (Kalenkoski & Pabilonia, 2012; U.S. Department of Education, 2008), and time spent on homework is even higher in other industrialized countries (e.g., 2.9 to 3.9 h per day in India; Loyd, Grant, & Ritchie, 2008). Given the broad utilization and emphasis on homework in education, multiple aspects of the homework process have been studied in relation to academic performance, including amount of work assigned, time spent on completing homework, difficulty level of work, and frequency of homework assignments (Cooper, Lindsay, Nye, & Greathouse, 1998; Cooper et al., 2006; Grodner & Rupp, 2013; Trautwein, 2007; Trautwein & Köller, 2003; Trautwein, Köller, Schmitz, & Baumert, 2002). Overall, extant research suggests that time spent on homework is positively correlated with academic performance (Cooper, 1989; Cooper et al., 1998), with the relation being moderated by grade in school and stronger in the secondary school grades (Cooper et al., 2006).

1.2. The homework completion cycle

The "homework completion cycle" (see Fig. 1) is complex, and consists of several temporally ordered behaviors. In order to be successful with homework, students must accurately record assignments in sufficient detail, bring home the necessary materials, plan ahead for the completion of work (i.e., not procrastinate), complete work efficiently and effectively (i.e., stay focused and complete work accurately), and bring the completed work back to school for submission. Although parents and teachers often provide some support for aspects of the homework completion process (e.g., parents may check completed homework for accuracy; Cooper, Lindsay, & Nye, 2000; Rogers, Wiener, Marton, & Tannock, 2009), the primary responsibility resides with the student. As such, self-regulation of behavior is necessary for successful homework completion (Xu & Wu, 2013), and may in part explain why many youth with ADHD experience significant homework problems. Specifically, individuals with ADHD often exhibit deficits in executive function (Barkley, 1997; Biederman et al., 2007), resulting in struggles in managing, monitoring, and self-correcting their own homework management and completion behaviors (Langberg, Dvorsky, & Evans, 2013). The literature indicates that youth with ADHD experience homework problems defined broadly (e.g., Langberg et al., 2011a; Mautone, Marshall, Costigan, Clarke, & Power, 2012; Power, Werba, Watkins, Angelucci, & Eiraldi, 2006; Rogers et al., 2009), with approximately 75% of youth with ADHD exhibiting clinically significant homework problems in comparison to 30% of typically developing youth (Coghill et al., 2008). These difficulties become particularly apparent and salient with
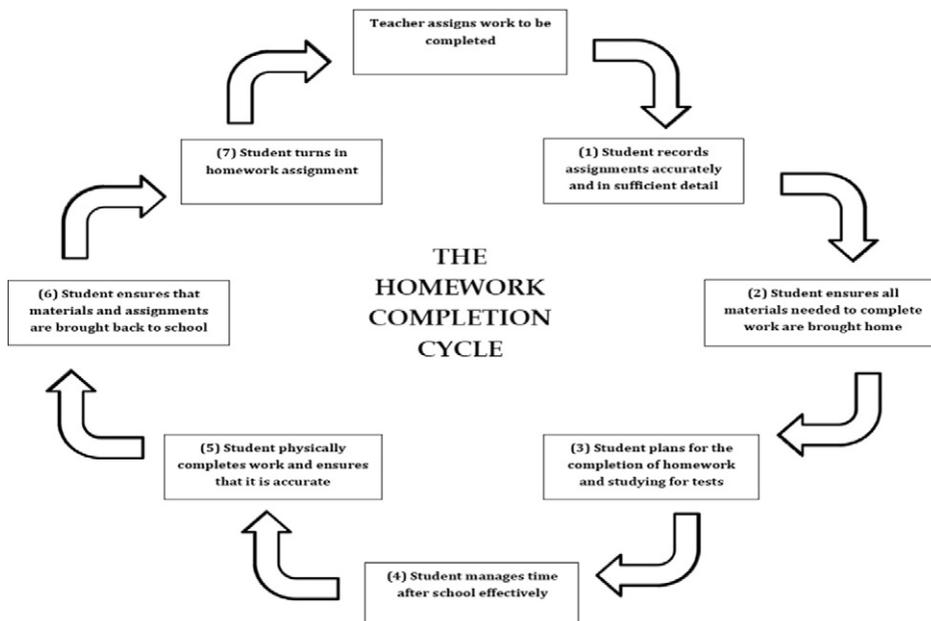

Fig. 1. Visual representation of the independent steps students must follow to successfully turn in assignments.

the transition from elementary to middle school because as academic demands increase, students are expected to become autonomous in more aspects of the homework completion cycle (Ramdass & Zimmerman, 2011).

1.3. Assignment completion and students with ADHD

Given the wealth of research on the homework problems of students with ADHD, surprisingly little is known about the last step of the homework completion cycle, physically turning assignments to teachers. Specifically, it is unclear what percentage of assignments adolescents with ADHD turn in on average, how this compares to their classroom peers, and whether rates of assignment completion vary over time. It is also unclear how homework assignment completion and school grades interact over time, and whether the association is unidirectional from assignments to grades or reciprocal, with poor grades in turn leading to lower rates of assignment completion. This represents an under-studied area in the context of homework research in general (e.g., community and school-based samples), as most of the research to date has been cross-sectional and the "long-term and cumulative effects of homework remain a largely unmapped terrain" (Cooper et al., 2006, p. 54). Importantly, there has also been little research on the complex and interacting factors that may predict how likely students with ADHD are to turn in assignments.

These are all critically important questions for ADHD interventions focused on improving academic performance, and these issues are also clinically relevant to teachers and parents. For example, in order to set realistic and developmentally informed treatment goals, it would be useful to know the average percentage of assignments adolescents with ADHD turn in and how that compares to the class average (i.e., what is reasonable to expect?). Likewise, when providing psychoeducation to parents, it is unclear if the message should be that variability across semesters is to be expected (i.e., "don't worry, your child's performance will bounce back") or if the message should be that problems are likely to persist across semesters and years in school. Further, if the percentage of assignments turned in is important for overall academic performance, but other factors account for a greater portion of the variance in turning in assignments (e.g., ADHD symptoms or reading ability), then intervention targets should be prioritized accordingly.

The limited prior work in the area suggests that youth with ADHD may turn in fewer assignments in comparison to their peers. In a small ADHD intervention sample (total $N = 42$), Meyer and Kelley (2007) reported that middle school students assigned to the waitlist group turned in approximately 60% of their assignments prior to intervention, but no "class average" was reported for comparison. Teacher report on the Classroom Performance Survey (CPS; Brady, Evans, Berlin, Bunford, & Kern, 2012) was used in the Meyer and Kelly study to obtain information about the percent of assignments turned in. In a large cross-sectional validation study of the CPS (general school sample; $N = 875$), the average teacher-reported percentage of homework assignments turned in was 73% (Brady et al., 2012). Interestingly, the students in the sample who were rated as academically impaired by the teachers on a separate measure of impairment (Impairment Rating Scale; Fabiano et al., 2006) were turning in only 45% of their assignments as compared to the students rated in the non-impaired range (83.7%). However, ADHD diagnostic information was not reported and patterns of assignment completion were not evaluated longitudinally or in relation to students' overall academic performance.

The only study to our knowledge to longitudinally evaluate the percentage of assignments turned in for students with ADHD as compared to their peers also used teacher report on the CPS (Kent et al., 2011). The participants were from the Pittsburgh ADHD Longitudinal Study (PALS), and were in grades 9 through 12. The CPS data were available for 83 adolescents with ADHD and 65 adolescents without ADHD. Kent et al. (2011) reported that the percentage of assignments turned in was significantly lower for the ADHD group (64%) in comparison to the non-ADHD control group (83%). The authors reported that there was not a significant effect of year in school for the assignment completion variable, which suggests that the proportion of assignments turned in was relatively stable over time. However, the study did not evaluate patterns or potential reciprocal associations between assignment completion and academic performance or predictors of assignment completion.

In sum, homework assignment completion is a major component of students' education. Children and adolescents with ADHD often exhibit homework problems and this negatively impacts their academic performance (Langberg et al., 2011b). However, little is known about the homework assignment completion patterns of youth with ADHD over time, or about the inter-play between school grades and assignment completion. Further, the process of completing homework is complex, and it is unclear which steps of the homework completion cycle are most salient in determining whether or not homework gets turned in to the teacher.

1.4. Study aims and hypotheses

Accordingly, the primary purpose of the present study was to evaluate the homework completion patterns of middle school age adolescents with ADHD across two school years and longitudinal predictors of assignment completion. Given that the CPS was used in this study and prior work (e.g., Kent et al., 2011) to determine how many assignments students completed each semester, we first wanted to evaluate consistency across teachers in reporting these data. Past research with middle school ADHD samples has called into question the reliability of teacher ratings of more covert behaviors such as symptom of inattention, as agreement across teachers is often low (Evans, Allen, Moore, & Strauss, 2005). However, given that teachers in this study were being asked to rate a more overt behavior, and one that they would naturally monitor over time, we predicted that the agreement measured through ICCs would be moderate to high.

The second aim of the study was to determine if consistent with past research, students with ADHD in this sample were completing significantly fewer homework assignments in comparison to the teacher-reported classroom average. Based upon Kent et al.'s (2011) study, we predicted that students with ADHD would be turning in significantly fewer assignments each semester across the entire study period.

The third aim of the study was to evaluate the longitudinal importance of homework assignment completion in predicting the grades of students with ADHD relative to other factors known to be important for predicting grades, such as reading and math ability and intelligence. Based upon prior longitudinal research on parent-rated homework problems (Langberg et al., 2011b), it was hypothesized that the percentage of assignments completed as reported by teachers at baseline would predict the GPA of the following school year above and beyond baseline GPA and covariates.

The fourth aim of the study was to evaluate potential reciprocal associations between assignment completion and GPA over time using cross-lag modeling. The cognitive behavioral model of ADHD (Safren, Sprich, Chulvick, & Otto, 2004) states that because individuals with ADHD often experience "repeated failures," over time they develop negative thought patterns and low self-concept about their abilities, which in turn leads to additional impairment. Although we could not test the proposed mechanisms, we were interested in evaluating whether the association between homework and grades was solely unidirectional, with assignment completion predicting GPA, or if "failure" (low GPA), in turn, led to fewer assignments being completed in the future. As this is the first study to our knowledge to explore these reciprocal associations, no specific hypotheses were made.

The final aim of the study was to explore malleable factors that might longitudinally predict assignment completion and school grades. A multitude of factors can influence homework completion (see Cooper, 1989, for a discussion of this issue). The current study focuses on three specific aspects of homework completion cycle (see Fig. 1). Specifically, predictors evaluated in this study included homework materials management (i.e., organization), homework behaviors (e.g., on- or off-task while completing homework), and time-management/planning skills. In the homework completion cycle figure, materials management is represented in boxes 1, 2, 6, and 7, homework completion behaviors in box 5, and time-management/planning behaviors in boxes 3 and 4. The impact of these predictors as rated by parents at baseline on homework completion as rated by teachers 18 months later and on GPA was examined as part of the cross-lagged modeling.

2. Method

2.1. Participants

Participants were 104 young adolescents (77 males, 27 females) with ADHD between the ages of 10 and 14 at baseline ($M = 12.33$, $SD = 0.99$). Per criteria described below, 55 participants were diagnosed with ADHD predominantly inattentive type (ADHD-I) and 49 participants were diagnosed with ADHD combined type (ADHD-C). 76% of the participants were taking medication for ADHD ($n = 71$). 79% of the participants were Caucasian ($n = 83$), with the remaining participants being African American ($n = 15$), multiracial ($n = 5$), or Hispanic/Latino ($n = 1$). The participants' annual family income ranged from less than $10,000 to over $225,000 ($M = $54,248$; $Median = $37,500$).

2.2. Procedures

Data were collected as part of a randomized clinical trial (total $N = 326$) examining school-based psychosocial interventions for adolescents with ADHD. The participants were randomly assigned to receive intervention through an after school program or mentoring during the school day, or to a community care (i.e., control) condition. The 104 community control participants were included in the current set of analyses. The participants were in the sixth ($n = 43$), seventh ($n = 31$), and eighth ($n = 30$) grades and were recruited from nine urban, suburban, and rural public middle schools in three cohorts over three successive academic years. The schools included in the study were diverse both in terms of size, location, and student demographic characteristics. Specifically, the schools ranged in size from approximately 600 to 1400 students and the percentage of students receiving free/reduced lunch ranged from 6% to 75%. Similarly, the diversity of the students at each school varied greatly with the lowest being 8% minority and the highest being 75% minority. The study was reviewed and approved by the Institutional Review Board (IRB) and parents signed an informed consent and youth provided assent.

Recruitment was conducted through three primary methods: study announcement letters were mailed to the parents of all students attending the middle school, school staff directly informed parents of some students about the opportunity to participate, and fliers were posted in each school. Parents/guardians who called the research staff to express interest in the study were administered to a phone screening. On the phone screening, parents had to indicate that their child had a diagnosis of ADHD or had to endorse their child as currently exhibiting at least 4 of 9 *Diagnosis and Statistical Manual of Mental Disorder, Fourth Edition* (DSM-IV; American Psychiatric Association, 1994) symptoms of inattention on a rating scale in order to be scheduled for an eligibility evaluation which was completed in a mental health outpatient clinic. After providing consent/assent, parents and adolescents completed the evaluation procedures in separate rooms. The inclusionary criteria were: (a) meeting full diagnostic criteria for ADHD-I or ADHD-C; (b) an IQ ≥ 80 as estimated using the *Wechsler Intelligence Scale for Children, Fourth Edition* (WISC-IV; Wechsler, 2003); and (c) not meeting the criteria for a primary diagnosis of a pervasive developmental disorder or meeting diagnostic criteria for any of the following: bipolar disorder, psychosis, substance dependence other than tobacco, or obsessive–compulsive disorder. Participants with these disorders were excluded because this was an intervention trial focused on providing ADHD specific interventions and it is likely that adolescents with these diagnoses would be better served by a different intervention approach. Similarly, adolescents with an IQ below 80 were excluded given the cognitive nature of some of interventions (e.g., long-term planning) would like to necessitate a different intervention approach or at least that intervention delivery procedures be altered.

ADHD diagnosis was established using the *Children's Interview for Psychiatric Syndromes—Parent Version* (P-ChIPS; Fristad, Teare, Weller, Weller, & Salmon, 1998; Weller, Weller, Fristad, Rooney, & Schecter, 2000), a well-validated structured diagnostic interview

that was administered to parents by advanced doctoral students and doctoral-level psychologists. A recent review of child and adolescent diagnostic interviews (Leffler, Riebel, & Hughes, 2014) found five separate studies documenting that the ChIPS has good concurrent validity with other validated diagnostic interviews, including the Diagnostic Interview for Children and Adolescents-Revised-Child Version (DICA-R-C) and the Schedule for Affective Disorders and Schizophrenia for School Aged Children (K-SADS). Further, the ChIPS has good construct validity, with the percent of agreement between a consensus panel of child psychopathology experts and the results from ChIPS interviews ranging from 97.5% to 100%. Sensitivity averaged 87% across diagnostic categories and specificity averaged 76% (Fristad et al., 1998). For attention deficit disorder, sensitivity was 100% and specificity was 44%.

ADHD diagnoses were determined using procedures similar to those used in the Multimodal Treatment Study of ADHD (MTA Cooperative Group, 1999). Specifically, to be included in the study, parents needed to endorse the presence of at least six symptoms of ADHD within a domain as occurring often or very often on the P-ChIPS and these symptoms had to be associated with impairment in multiple settings. As part of the initial evaluation, the *Disruptive Behavior Disorder Rating Scale* (DBD; Pelham, Evans, Gnagy, & Greenslade, 1992) was mailed to each participant's four core class teachers. The DBD is a well-validated teacher-report measure of *DSM-IV* ADHD symptoms with items rated on a four-point scale ($0 = $ *not at all present*, $3 = $ *very much present*). The ADHD subscale of the DBD has demonstrated good internal consistency in young adolescent samples ($\alpha = $ .88–.91; Hartung, McCarthy, Milich, & Martin, 2005). In cases where the parent endorsed four or five symptoms within a domain on the P-ChIPS, supplementation with non-overlapping symptoms from the teacher DBD was allowed (i.e., to reach the threshold of six symptoms within a domain). However, supplementation could only occur if the teacher endorsed at least four symptoms in a domain on the DBD. The same supplementation rules were used to make ADHD subtype determinations. Finally, other criteria for *DSM-IV* ADHD (i.e., age of onset, pervasiveness, impairment, and ruling out the possibility of other causal disorders) also had to be met. The P-ChIPS was also used to assess for the presence of comorbid psychiatric disorders. Using the *DSM-IV* criteria, 46.2% of the participants ($n = 48$) met the criteria for comorbid oppositional defiant disorder (ODD), 9.6% ($n = 10$) met for comorbid conduct disorder (CD), and 35.6% of the participants ($n = 37$) met criteria for a comorbid internalizing disorder.

2.3. Measures

All the participants were assessed at five time points across the study: four equally spaced occasions during the school year and a fifth time point halfway through the subsequent school year. Accordingly, CPS data are available at five time points (see Table 2), with the first four time points corresponding with quarter grades during the school year (i.e., T1 = Q1 grades, T2 = Q2 grades, T3 = Q3 grades, & T4 = Q4 grades). Completion of ratings at follow-up (T5) corresponded with the end of the first semester of the subsequent school year.

2.4. Demographics and covariates

The participants' parents/guardians completed a demographics questionnaire at the study baseline that included information on sex, race/ethnicity, grade in school, parent education and income, and ADHD medication status. Means and standard deviations for these variables are reported in Table 1 along with their association with assignment completion and grades.

All the participants were administered the *Wechsler Individual Achievement Test, Third Edition* (WIAT-III; Wechsler, 2009) at baseline. The WIAT is a widely used individually administered, norm-referenced, test with exemplary psychometric properties. The reading and math standard scores were included as covariates in the regression model predicting GPA.

2.5. Homework completion

2.5.1. Classroom Performance Survey (CPS; Brady et al., 2012)

The CPS is a teacher-completed rating scale that includes two items that ask teachers to report the percentage of assignments completed on time by the student being assessed and the percentage of assignments completed on time by the average student in the class. As noted in the introduction, the CPS has been used to assess homework completion in multiple studies and the full scale has undergone psychometric validation in a large sample of adolescents (Brady et al., 2012). Brady et al. found that the CPS contains two separate factors which are highly reliable ($\alpha = $ .98 and .91). Importantly for the present study, the items assessing the percentage of assignments turned in were found to have good clinical utility in distinguishing teacher identified academically impaired students from non-impaired students and good convergent validity with other measures of academic impairment. Multiple teachers completed the CPS for each participant in the study since this is a middle school sample (Median = 3 per participant). The percentage of teachers from each core academic subject that completed the CPS is reported in the results section along with data on agreement.

2.6. Outcome

2.6.1. Grade point average (GPA)

The grades for each participant in the study were collected from the school offices at the end of each academic year. All the grades were converted into grade point averages (GPA) for core subject areas (English/Language Arts, Social Studies, Math, Science) with a range from 0.0 to 4.0 (4.0 = A; 0 = F). The grades from each of the four core classes were averaged to create one overall GPA variable.

2.7. Predictors

2.7.1. Homework management, completion and planning behaviors

The Homework Problems Checklist (HPC; Anesko, Schoiock, Ramirez, & Levine, 1987) is a 20-item parent completed rating scale assessing performance on homework. For each item, parents rate the frequency of a specific homework problem on a 4-point Likert scale (0 = *never*, 1 = *at times*, 2 = *often*, 3 = *very often*). Higher scores on the measure indicate more severe problems. The measure has excellent internal consistency, with α coefficients ranging from .90 to .92 and corrected item-total correlations ranging from .31 to .72 (Anesko et al., 1987). Factor analyses indicate that the HPC has two distinct factors (Langberg et al., 2010; Power et al., 2006) measuring homework behaviors (HPC Factor I) and homework materials management (HPC Factor II). These factors are consistent across general education and clinical samples. Example items from Factor I (homework behaviors) include: a) must be reminded to sit down and start homework; b) daydreams during homework; c) doesn't complete work unless someone does it with him/her; and d) takes an unusually long time to complete homework. Example items from Factor II (homework materials management) include: a) fails to bring home assignments and materials; b) forgets to bring assignments back to class; and c) doesn't know exactly what has been assigned. In the present study, internal consistencies were high (Factor I α = .87, Factor II α = .88).

The Children's Organizational Skills Scale (COSS; Abikoff & Gallagher, 2009) is also a parent-completed rating scale and is composed of 58 items each with a 4-point rating scale (1 = *hardly ever or never*; 2 = *sometimes*; 3 = *much of the time*; 4 = *just about all of the time*). The COSS has good discriminative validity and is sensitive to treatment effects (Pfiffner et al., 2007). The COSS Task Planning subscale which is comprised of 6 items [α = .81] was included in the regression analyses predicting missing assignments as a measure of time-management and planning skills.

2.8. Analytic plan

To accomplish aim 1, intra-class correlations were calculated at baseline to assess how similarly teachers rated the homework assignment completion of the same student. For aim 2, the average assignment completion rates of ADHD participants and their classmates were compared at all five time points using paired-samples t-tests.

To evaluate the longitudinal association between homework completion and academic performance (i.e., aim 3), a multiple regression model was tested. In the first step of the model, all covariates that were significantly correlated with T5 GPA were entered, followed by T1 GPA in the second step to control for prior levels of academic performance. T1 teacher-reported assignment completion was entered into the third step of the model.

For aim 4, cross-lag path analysis was used to evaluate the potential reciprocal association between assignment completion and grades over time. Assignment completion and GPA at all five time points were included in the model. The effect of prior GPA and assignment completion, as well as the correlation between assignment completion and GPA, were accounted for at each time point. Specific paths of interest were the predictive ability of assignment completion to GPA one time point later (e.g., T1 assignment completion predicting T2 GPA), and the reciprocal relationship (e.g., T1 GPA predicting T2 assignment completion). For aim 5, three theoretical predictors related to different aspects of the homework cycle – homework behaviors, homework materials management, and time-management/planning behaviors – measured at T1 were included in the path analysis to assess whether any of these factors predicted assignment completion and GPA at T5.

Model fit was evaluated using a combination of comparative and absolute fit indices based upon Hu and Bentler's (1999) recommended threshold criteria for acceptable fit. Given the modest sample size, the Comparative Fit Index (CFI) and standardized root-mean-square residual (SRMR) were chosen given the evidence that these are the most robust indicators when sample size is small (Hu & Bentler, 1998). According to Hu and Bentler's (1999) recommendations, the threshold for CFI values should approach

Table 1
Correlations of participant characteristics with assignment completion and GPA.

Variable	% or M ± SD	T1 assignment completion (74.22 ± 22.40)	T5 semester grade point average (2.10 ± .98)	T5 Assignment Completion (68.68 ± 23.60)
Sex	74% Male	−.16	−.10	−.17
Race	79% Caucasian	.27**	.33**	.29**
Grade	6.86 ± .86	−.27**	−.19	−.19
Family income	54,393.20 ± 49,950.30	.31**	.36**	.38***
Medication status	.46 ± .43	−.02	−.02	.06
Math achievement	93.05 ± 15.72	.34**	.51***	.45***
Reading achievement	96.51 ± 14.47	.21*	.27**	.23*
Intelligence	95.30 ± 13.62	.24**	.43***	.42***

Note. N = 104. For medication status, 0 = not taking medication and 1 = taking medication.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

or exceed 0.95, and SRMR values should approach or fall below 0.09 to indicate acceptable model fit. The Tucker–Lewis Index (TLI) and root mean square error of approximation (RMSEA) were also examined, but these indicators should not be the primary tools to evaluate model fit due to evidence suggesting they over-reject true models that have small sample sizes and low degrees of freedom (Hu & Bentler, 1998; Kenny, Kaniskan, & McCoach, 2014).

3. Results

3.1. ICCs and between group differences

The first study aims were to examine whether students with ADHD in this sample were completing significantly fewer home-work assignments in comparison to the teacher-reported classroom average, and to evaluate consistency across teachers in reporting these data. The mean number of teacher ratings per participant across time points on the CPS was 3.07 and the median was 3.00. At baseline, 87 out of the 104 participants had ratings from English teachers (83.7%), 81% from Math teachers, 62.5% from Social Studies teachers, and 65.4% from Science teachers. As shown in Table 2, the percentage of assignments completed by the participants with ADHD at each time point ranged from 68.68% to 74.22%. In comparison, the percentage of teacher-reported assignments completed by their classmates ranged from 82.76% to 84.81%. Paired-samples dependent t-tests revealed that the percentage of assignments completed by the participants with ADHD was significantly less than their classmates at each of the five assessment points; $p < .001$. Agreement between teachers at baseline adjusting for the varying numbers of raters for each participant (Bartko & Carpenter, 1976) was high; intraclass correlation (ICC) = .879. Accordingly, teacher ratings of as-signment completion for each student were averaged, and the mean score was used in the regression and cross-lag analyses.

Table 2
Means, standard deviations, and intercorrelations of assignment completion and grade point average.

	Time 1	Time 2	Time 3	Time 4	Time 5
Percent assignments completed ADHD	74.22 ± 22.24	72.01 ± 23.11	73.06 ± 20.97	71.87 ± 24.31	68.68 ± 23.60
Percent assignments completed class	84.81 ± 7.66	84.10 ± 7.53	83.41 ± 7.80	82.76 ± 7.92	82.97 ± 7.61
Grade point average	Q1	Q2	Q3	Q4	S1
	2.32 ± .94	2.15 ± 1.04	2.12 ± 1.00	2.21 ± 1.05	2.10 ± .98
Cross-sectional correlations between assignments and grades within time points	T1 Assignments to T1 GPA .737***	T2 Assignments to T2 GPA .755***	T3 Assignments to T3 GPA .758***	T4 assignments to T4 GPA .695***	T5 assignments to T5 GPA .798***
Longitudinal correlations between T1 assignments and grades Over time	T1 GPA .737***	T2 GPA .730***	T3 GPA .689***	T4 GPA .631***	T5 GPA .652***

Note. ADHD = attention-deficit/hyperactivity disorder; Q = quarter; S = semester.
*** $p < .001$.

Table 3
Hierarchical regression model of T1 assignment completion predicting T5 semester grade point average above and beyond T1 quarter grade point average, achievement, cognitive ability, and family income.

	Step 1 model summary				Step 2 model summary				Step 3 Model Summary			
	B	SE	β	t	B	SE	β	t	B	SE	β	t
DV: T5 grade point average	$F(6,74) = 6.98^{***}, R^2 = .36$				$F(7,73) = 11.46^{***}, R^2 = .52$				$F(6, 79) = 19.01^{***}, R^2 = .61$			
					$\Delta F(1) = 24.88^{***}, \Delta R^2 = .16$				$\Delta F(1) = 16.04^{***}, \Delta R^2 = .09$			
Grade	−.07	.11	−.06	−.62	.01	.10	.01	.11	.07	.09	.06	.75
Race	.35	.23	.15	1.50	.20	.20	.08	.95	.09	.19	.01	.50
Math achievement	.02	.01	.34	2.47*	.01	.01	.21	1.74	.01	.01	.17	1.54
Reading achievement	.00	.01	−.06	−.51	.00	.01	−.04	−.42	.00	.01	−.05	−.51
Intelligence	.01	.01	.19	1.33	.01	.01	.19	1.53	.01	.01	.18	1.62
Family income	2.39	.00	.13	1.21	−3.99	.00	−.02	−.22	−2.85	.00	−.02	−.17
T1 grade point average	–	–	–	–	.50	.10	.49	5.00***	.31	.10	.31	3.04**
T1 assignment completion	–	–	–	–	–	–	–	–	.02	.00	.00	4.01***

Note.
* $p < .05$.
** $p < .01$.
*** $p < .01$.

3.2. Regression predicting grade point average (GPA)

The next study aim was to evaluate the longitudinal importance of homework assignment completion in predicting the grades of students with ADHD. The correlation analyses between demographic variables and grades (see Table 1) showed that race, income, reading and math achievement, and intelligence were each significantly associated with T5 semester GPA. Accordingly, these variables were all included in the first step of the multivariate regression with T1 assignment completion predicting T5 GPA. The multivariate regression (see Table 3) revealed that T1 assignment completion significantly predicted T5 GPA above and beyond all other variables. Both T1 GPA and T1 assignment completion were significant in the final model predicting T5 GPA. The ΔR^2 was significant moving from step 2 to step 3 (the addition of homework completion) of the regression model with 61% of the variance in grades explained at step 3.

3.3. Cross-lag and predictor analyses

The final study aims were focused on examining potential reciprocal associations between assignment completion and GPA over time and to explore malleable factors that might longitudinally predict these outcomes. A longitudinal structural equation model was conducted to examine (a) the reciprocal relationships between assignment completion and GPA over time, and (b) baseline (T1) parent-rated predictors of assignment completion and GPA at T5.

To assess the degree to which one construct at one point in time predicted the other at a subsequent point in time, we adopted the cross-lag model described by Jöreskog and Sörbom (1993). Fig. 2 shows the results for model fit for the longitudinal cross-lag analysis, including the standardized path coefficients. The combinational rule indices indicated that the model had acceptable fit (CFI = .947, SRMR = .085). As expected given the small sample size, the TLI (.925) and RMSEA (.091) values indicated worse fit than the CFI and SRMR values. Omitted from the figure are the within-time correlations/covariances among constructs; however these are presented in Table 2. All paths from homework completion (HW) to GPA were positive and significant, with the exception of the path between HW3 and GPA4, which was marginally significant ($p = .07$), and the path between HW4 and GPA5, which was not significant. The cyclical and reciprocal nature of the model was partially supported in that assignment completion has a positive direct relation to GPA (significant between HW1 and GPA2), which had a positive direct relation to subsequent assignment completion (significant between GPA2 and HW3), followed by a positive direct relation back to GPA (approached significant at $p = .07$ between HW3 and GPA), and finally followed by a positive direct relation predicting final assignment completion (significant between GPA4 and HW5).

The SEM model also examined T1 parent-ratings of homework materials management, homework behaviors, and time-management/planning as predictors of T5 GPA and assignment completion. Higher scores on each of these parent-rated predictor variables are indicative of more problems in that domain. Homework materials management was negative and significant in the model for predicting both GPA and assignment completion at T5.

4. Discussion

The primary goals of this manuscript were to explore the longitudinal associations between homework assignment completion and grades to determine if they were unidirectional or reciprocal and to evaluate longitudinal predictors of assignment completion. In this sample, ratings of students' assignment completion across teachers were highly consistent, with ICCs at baseline approaching .9. According to these teacher ratings, students with ADHD in this sample turned in approximately 12% fewer assignments each semester in comparison to the classroom average. As hypothesized, homework assignment completion as
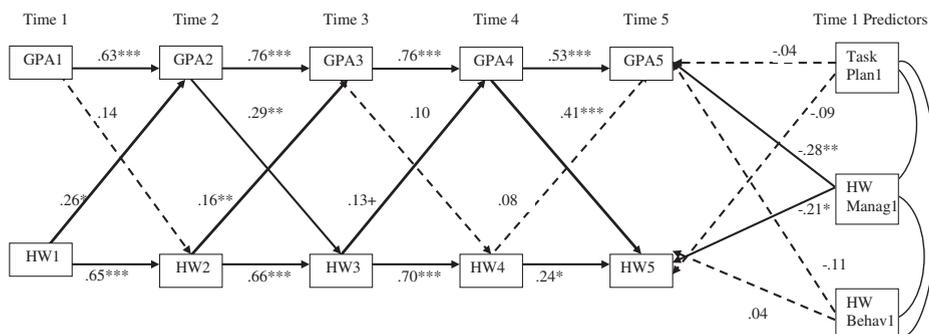
Fig. 2. Visual presentation of the reciprocal cross-lagged model. Standardized path coefficients for significant and marginally significant paths of the model are presented as solid arrows. Numbers denote time point of data collection. Although not included in the figure, within-time correlations across domains were also estimated. Dashed arrows indicate nonsignificant paths between Time 1 predictors and Time 5 GPA and homework completion. GPA = grade point average. HW = percentage of homework assignments turned in as rated by teacher. Task Plan = Task planning subscale from COSS. HW Behav = Homework behavior scale from HPC. HW Manag = Homework management scale from HPC. Model fit indices: $\chi^2 = (68, N = 104) = 846.14$, $p < .001$; CFI = .947, TLI = .925, SRMR = .085, RMSEA = .091. $+p < .08$. $*p < .05$. $**p < .01$. $***p < .001$.

rated by teachers at baseline was a strong predictor of GPA, above and beyond baseline levels of GPA, intelligence, achievement, race, and family income. Interestingly, the association between GPA and assignment completion appears to be reciprocal. Specifically, across school years (see Fig. 1; T4–T5), there was a robust association with GPA predicting future assignment completion. In terms of predictors, homework materials management abilities as rated by parents at baseline predicted assignment completion and GPA 18 months later. Together, these findings suggest that homework assignment completion is an important intervention target for middle school students with ADHD with low and failing grades.

In Cooper et al.'s (2006) meta-analysis of the association between homework and academics, the weighted average correlation was .24 (across all definitions of homework and measures of academic achievement). In the community and school samples reviewed by Cooper et al., correlations were higher in the secondary school grades than elementary grades and when the specific focus was on assignment completion (e.g., as opposed to time spent on homework). For example, in a secondary school age sample, Cooper et al. (1998) reported correlations between assignment completion and grades in the .31–.36 range. It is important to note that Cooper et al.'s (1998) study and most of the studies in the meta-analysis focused on parent and student report of assignment completion. It is possible that parents and students cannot accurately report these data, especially since most of the studies reviewed in the meta-analysis were completed prior to when homework completion information was readily available online. Indeed, one of the interesting findings from the present study was the very high ICCs for teacher ratings of assignment completion. This was not in line with or not consistent with hypotheses as middle school teacher agreement has been found to be quite low for ratings of more subjective behavior, such as ADHD symptoms (Evans et al., 2005). This high level of consistency across teachers may reflect their greater ability to report concrete information that they routinely monitor as compared to more vague constructs such as symptoms and estimates of degrees of impairment. In addition, these data may indicate that students' rates of homework completion may be consistent and pervasive across classrooms. Further research is needed to confirm these hypotheses.

The discrepancies between the present study and the meta-analysis might also relate to the fact that this study focused on adolescents with ADHD. It may be that once students reach a certain threshold of assignment completion (e.g., 85%) that variation in homework completion above that threshold is not particularly relevant for grades and other factors become more important at that point, such as achievement ability, test grades, or behavior in the classroom. Below a certain threshold, missing homework assignments may overwhelm all other factors that constitute grades. For example, a child missing 30% of their assignments may only have the opportunity to get a C or D at best, even with perfect classroom behavior and high achievement/ability.

In this sample, middle school age adolescents with ADHD were turning in 10%–15% fewer assignments per quarter in comparison to teacher reported class averages. The only other study to evaluate this issue in an ADHD sample found a lower rate of homework completion (64%) average for the ADHD group and an 83% average for the comparison group (Kent et al., 2011). One significant difference between these two ADHD samples is that the sample for the present study is a middle school sample whereas the Kent et al. (2011) sample was high school age (grades 9–12). Accordingly, one possible explanation for the slightly lower rates of assignment completion in the Kent et al. (2011) ADHD sample is that adolescents with ADHD experience increased difficulties with homework following the transition to high school and rates of assignment completion decline. Indeed in the present study, the lowest percentage of assignments turned in ($M = 68.7$) was the final semester when the mean sample age was almost 14.

The cross-lag model suggests that the association between assignment completion and GPA is reciprocal and demonstrates that homework materials management abilities are important longitudinal predictors of assignment completion and school grades. With respect to the reciprocal associations, as hypothesized, the percent of homework turned in each semester was a significant predictor of subsequent semester GPA and of subsequent semester assignment completion within the school year. However, when looking across school years, the association between assignment completion at the end of the spring semester (T4) and homework completion at the 6-month follow-up (T5) was significant but small (.24). In contrast, the association between spring semester GPA and assignment completion during the subsequent school year (i.e., 6-month follow-up) was significant and moderate (.41). Although not measured in this study, it seems likely that cognitive and motivation factors are at least partly responsible for this cross-year association. As described in the cognitive–behavioral model of ADHD (Safren et al., 2004), individuals with ADHD who experience repeated failures (e.g., low and failing grades) are unlikely to be motivated to try in the future (e.g., completing and turning in assignments). Specifically, after repeated failure experiences individuals with ADHD may start exhibiting negative maladaptive cognitions such as, "I can't do it so why try." It is noteworthy that the present study includes a young adolescent sample, a developmental period for which to date, there is minimal evidence to suggest that cognitive treatment approaches are effective (Antshel & Olszewski, 2014). As noted by Antshel and Olszewski (2014), future intervention research for adolescents with ADHD should not only continue to emphasize a behavioral approach and skills building components (e.g., organizational skills training) but may also need to include cognitive components to address negative cognitions and motivation for academic tasks.

With respect to predictors of assignment completion and GPA, in this study we explored three potentially malleable predictors: homework materials management, homework behaviors, and time-management/planning skills. Homework materials management as measured by HPC Factor 2 at baseline was a significant longitudinal predictor of assignment completion and GPA at follow-up. This finding is consistent with prior work (Langberg et al., 2011b) and contributes to a growing body of research supporting the importance of homework materials management skills in adolescents with ADHD. This finding is logical when viewed in the context of the homework completion cycle (see Fig. 1). Specifically, even when students are focused during work completion and manage time effectively, if they fail to bring home assignments or lose them after completion (i.e., material management), they will not be able to consistently turn their work in to the teachers. Accordingly, focus during homework completion and planning behaviors are likely necessary and important but not sufficient. This assertion is also consistent with the finding that ADHD medication use was not significantly associated with assignment completion. Specifically, ADHD medication can have a large and significant impact

on homework completion behaviors (e.g., focus; Evans, Pelham, Smith, & Bukstein, 2001), but does not normalize materials management behaviors (Abikoff, Nissley-Tsiopinis, Gallagher, & Zambenedetti, 2009).

4.1. Measuring homework completion

This study has some interesting implications for the measurement of homework problems. Middle school students with ADHD turn in significantly fewer homework assignments in comparison to their peers and this pattern seems to be pervasive across classes. Accordingly, weekly teacher report of missing assignments would seem to have strong potential as an idiographic measure of functioning to track progress associated with response to interventions. However, the homework completion cycle is complex and improvements in one aspect of the cycle with intervention may not result in changes in the percentage of assignments turned in. Consider an intervention that focuses on ensuring that adolescents record homework accurately. An adolescent who moves from recording homework accurately 20% of the time to doing so 75% of the time may still struggle with materials organization, focus and inattention during work completion, and procrastination/time-management, and fail to improve the rate of assignments completed. As such, measures need to be developed that comprehensively evaluate each step of the homework completion cycle in order to provide proximal indices of change for interventions targeting homework completion. One measure recently developed that has parent and teacher versions and that assesses multiple aspects of the homework completion cycle is the Homework Performance Questionnaire (Power et al., 2014). Another measure that broadly assesses the academic behaviors that adolescents with ADHD struggle with including homework behaviors is the Adolescent Academic Problems Checklist (AAPC; Sibley, Altszuler, Morrow, & Merrill, 2014). Both of these measures would appear to be good tools for broadly assessing treatment outcomes with homework focused interventions as they have parent and teacher versions. However, they also do not assess all steps in the homework completion cycle and additional measure development is warranted to create a comprehensive measure that can be used to prioritize treatment targets.

4.2. Limitations

This study has a few limitations that should be noted. First, the sample size was modest, which may have limited our ability to detect smaller associations. Second, the study did not include a non-ADHD control group. The CPS asks teachers to report on the percent of assignments completed for the target adolescent and for the class as a whole. These data were used in the present study to compare the rates of assignment completion in the ADHD group to classmates. However, no information was available about the demographics or mental health characteristics of the classmates in this study. It is likely that there is considerable variability in assignment completion within a classroom and a more nuanced evaluation of this issue is needed. For example, it is possible that some of the "classmates" in this study met criteria for a learning disorder or an internalizing disorder, factors that might limit their homework completion and pull down teacher report of the class average. Third, teachers reported on the percentage of assignments completed and also assigned the grades from which GPA was generated. Accordingly, shared source variance could be considered a bias, inflating the association between homework and GPA. Further, it is important to acknowledge that one reason correlations between homework assignment completion and GPA are high is because assignment completion often accounts for a percentage of students' grades (i.e., in addition to test performance and behavior). Future studies should seek to use more objective assignment completion data, such as gradebook records. Fourth, as noted above, there are many factors that might predict assignment completion and only a few were chosen for inclusion in this study. Other important factors that were not measured in this study that have been shown to be important in general education samples include attitudes about academics and homework, academic motivation, and self-regulation or executive functions (Cooper et al., 1998; Xu & Wu, 2013).

4.3. Future directions and conclusions

Given the complexity of the homework completion cycle, adaptive interventions are needed that can provide needs-based intervention based upon assessment. There are multiple interventions that are effective for targeting homework and organization problems (e.g., Abikoff et al., 2013; Pfiffner, Villodas, Kaiser, Rooney, & McBurnett, 2013; Power et al., 2012) and some that are specific to adolescents with ADHD (Evans, Schultz, DeMars, & Davis, 2011; Langberg, Epstein, Becker, Girio-Herrera, & Vaughn, 2012). However, these interventions are all one size fits all and are likely implementing unnecessary intervention components (e.g., targeting family involvement when that is not the issue or targeting accuracy of homework recording when materials organization is the primary problem). One way to streamline these interventions and to make it more likely that they will be widely disseminated and adopted would be to use an adaptive approach driven by assessment. Adaptive interventions have been developed for other conditions (e.g., Weisz et al., 2011, 2012) and have been shown to lead to greater improvements in comparisons to standard, one-size-fits-all, evidence-based treatments. Given that multiple evidence-based homework interventions exist for youth with ADHD, an important next step could be the development of a modular, adaptive treatment. Such an intervention would need to take into consideration that the aspects of the homework completion cycle that are most relevant likely vary as a function of development.

The findings from this study suggest that homework completion is a critical component of the academic performance of young adolescents with ADHD and likely needs to be the focus of intervention when the referral question surrounds low and failing grades. Data from the present study show that homework completion problems are persistent across time and are unlikely to be ameliorated without intervention.

Acknowledgments

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