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Brief Homework Intervention for Adolescents with ADHD: Trajectories and Predictors of Response

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In the present study, we sought to examine response trajectories to brief (11-week) school-based homework interventions and factors that may help schools predict responses. Participants included 222 middle-school students (72% boys; M_{age} = 12.00 years, SD = 1.02) who had been diagnosed with attention-deficit/hyperactivity disorder (ADHD) and had received either a contingency-management or skills-based intervention for homework problems. Both interventions included 16 20-min student meetings with a school counselor and two parent meetings. Trajectories of response for ratings of homework problems and assignment completion were examined from baseline to a 6-month follow-up using growth-mixture models. Baseline variables routinely measured in school settings, including grade-point average (GPA), math and reading achievement, and externalizing and internalizing symptoms, were examined as predictors of treatment-response trajectories. The majority of students (68–81%) showed positive treatment response across outcomes. However, trajectories of students who did not respond to intervention were identified for each outcome. Baseline GPA significantly predicted trajectories for all outcomes and achievement scores significantly predicted trajectories of teacher-reported homework performance and parent-reported homework problems, such that youth with relatively higher baseline GPAs and achievement were most likely to respond. In contrast, neither externalizing nor internalizing symptoms were significant predictors of response trajectories. Schools can use GPA and academic-achievement data to determine whether brief school-based interventions for homework problems are likely to succeed. Students with ADHD who display severe academic impairment (i.e., GPA lower than 2.0 at baseline) may benefit from a more long-term, intensive intervention.

Impact and Implications

The majority of students with ADHD displayed a significant and positive response to a brief homework intervention, according to both parent and teacher ratings and the percentage of assignments turned in (68–81% across outcomes). Students with ADHD and severe academic impairment, as indicated by a grade-point average (GPA) below 2.0 at baseline, are less likely to respond and may require more intensive interventions to address homework problems and academic impairment.

Keywords: school mental health, ADHD, adolescents, homework, school-based interventions

Homework problems are one of the most prevalent areas of impairment that adolescents with attention-deficit/hyperactivity disorder (ADHD) experience, and include difficulties accurately recording assignments, organizing materials, and turning in completed work (DuPaul & Langberg, 2014). Multiple interventions have been staged to teach homework completion, organization, and planning skills to students with ADHD (e.g., Evans et al., 2016; Sibley et al., 2016), and have been effective at reducing homework problems (e.g., Merrill et al., 2017) and improving school grades (e.g., Evans et al., 2016). Although improvement at the group level is important, studies evaluating trajectories of response to these interventions suggest that not all students with ADHD respond equally well or at all (e.g., Breaux, Langberg, Molitor et al., 2018; Langberg, Evans et al., 2016). Ideally, schools would be able to use resources efficiently by identifying which students are most likely to respond to intervention. Evaluating trajectories and predictors of response may be particularly important for brief, school-based interventions, which may not be sufficiently intensive for some students. Studies that have evaluated predictors of intervention response often focus on constructs that schools do not routinely have access to, such as symptoms of anxiety or oppositional defiant disorder (ODD), working alliance,

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parent stress, and parent–adolescent conflict. Taken together, there is a clear need to understand what percentage of students would respond well to brief homework interventions and to identify variables accessible to schools that predict responses.

Mechanisms of Change in Homework Interventions

The homework-completion process is complex and requires that students initiate and complete a series of distinct behaviors (Langberg, Dvorsky et al., 2016). Students with ADHD often experience difficulty with multiple aspects of the homework-completion process. Some students fail to accurately record information about upcoming assignments and tests; others lack adequate systems of binder and bookbag organization and misplace or lose materials. Students may also experience difficulties with time management and planning, and/or with focus and concentration during work completion. As such, ADHD interventions are used to try to improve homework completion from several angles and have different theorized mechanisms of change. For example, in skills-based interventions, the proposed mechanisms of change often include adherence to a specific binder-organization system or increased accurate homework recording. In contrast, in contingency-management-based interventions, the theorized mechanisms of change are improved focus and concentration during homework completion and accuracy of work completion.

Differential Responses to Homework Interventions

Evaluation of intervention–response trajectories often provides clinically relevant information that group-level analyses mask, such as revealing subgroups that do not respond to or get worse with treatment (e.g., Warren, Nelson, Mondragon, Baldwin, & Burlingame, 2010). For example, in a 3-year follow-up study with the Multimodal Treatment Study of ADHD (MTA Study; Swanson et al., 2007) sample, trajectory analyses revealed that 34% of participants made small initial improvements and gradually improved thereafter, 52% made large initial improvements that they maintained, and 14% made large initial improvements, but then deteriorated over time. There is also some evidence that youth with ADHD respond to homework and organizational-skill interventions at different rates. Evans, Langberg, Raggi, Allen, and Buvinger (2005) examined patterns of treatment response in 26 students with ADHD who received the Challenging Horizons Program, a year-long, biweekly afterschool psychosocial intervention teaching academic skills (i.e., materials organization, homework management, homework recording). Three trajectories were identified: (a) immediate responders (42%), (b) slow but steady adopters (27%), and (c) "honeymoon" responders who responded initially, but gradually declined across time (31%). Further, a study by Langberg, Evans et al. (2016) examined organization, homework, and academic-impairment response trajectories associated with the Challenging Horizons Program in a sample of 112 adolescents with ADHD. This study found that for homework problems, 23% of adolescents with ADHD displayed fast improvement that continued during treatment, 36% made smaller improvements gradually over the intervention (two trajectories), and 41% remained at relatively the same level of homework problems throughout the intervention (two trajectories). There is some evidence from a recent study conducted by Breaux, Langberg, Molitor et al. (2018) that similar trajectories may be associated with brief school-based interventions. Specifically, their study examined skill-acquisition trajectories during the Homework, Organization, and Planning Skills (HOPS) intervention and found that 100% of the sample displayed full acquisition of organizational skills, and 75% of the sample displayed full acquisition of homework-recording skills, but 25% of participants actually declined in homework-recording skill use during the intervention. However, the study did not evaluate trajectories of response for outcomes (e.g., homework problems, assignment completion).

Predictors of Treatment Response

Several predictors of group-level response have been identified in earlier treatment-outcome research. For example, ADHD severity and comorbid psychological conditions (e.g., anxiety, ODD) significantly predicted treatment response in the MTA study (e.g., Murray et al., 2008; Swanson et al., 2007). Specifically, children with ADHD and anxiety displayed better responses to behavioral treatment, whereas children with ADHD and ODD had poorer treatment outcomes than children with ADHD only (Murray et al., 2008). Parent/family level predictors (e.g., parental self-esteem, parenting practices) of treatment response have also been identified (e.g., Hoza et al., 2000).

Only one study to date has examined predictors of outcome trajectories for an intervention targeting homework problems in students with ADHD (Langberg, Evans et al., 2016). They found that adolescent sex, engagement in treatment, and parent/family variables, including conflict and stress, predicted parent-reported homework problems. They also explored ADHD, ODD, and anxiety symptoms as predictors, but failed to find significant unique relations. However, schools typically do not administer narrowband diagnostic questionnaires; rather, school psychologists often use broadband measures of emotional and behavioral functioning, such as the Behavior Assessment System for Children (BASC; Reynolds, & Kamphaus, 2004; or the Achenbach System of Empirically Based Assessment; Achenbach & Rescorla, 2001) on identified students. Overall, school personnel rarely have access to comprehensive diagnostic information such as ADHD presentation or the presence of comorbid conditions. The most readily available source of data schools have access to are in the academic domain, and include grades and achievement scores (e.g., standardized testing, achievement tests). Thus, schools could realistically use student-academic records to determine whether to proceed with an intervention.

Present Study

The present study focused on evaluating trajectories of response to brief school-based homework interventions for adolescents with ADHD. A secondary aim was to examine whether baseline factors could distinguish responders from nonresponders. First, we predicted that response trajectories would be similar to those found in more intensive, multimodal interventions for homework problems in youth with ADHD (Evans et al., 2009; Langberg, Evans et al., 2016). For the secondary aim, we used predictor variables that schools routinely have access to, including GPA, academic achievement, broadband symptom measurement (externalizing and internalizing symptoms), ADHD-medication status, and adolescent sex. Consistent with most past research (e.g., Langberg, Evans et al., 2016;

Murray et al., 2008), we predicted that ADHD-medication use would not have an association with treatment response, but internalizing symptoms would be associated with more positive treatment responses, and externalizing symptoms would be associated with poorer treatment responses. We also hypothesized that students with the most severe academic impairment (i.e., failing overall GPA and low math/reading achievement), would display poorer treatment responses, given that severe academic impairment leads to a host of issues that contribute to poor academic outcomes, with homework performance being one of multiple relevant factors (e.g., classroom behavior problems and learning disabilities). This study evaluated responses to two brief homework interventions. As students in both interventions significantly improved compared with a waitlist control on the outcomes of interest in this study (Langberg et al., 2018), response trajectories were not predicted to differ by treatment condition.

Method

Participants

Participants were 222 middle-school students (160 boys; M_{age} = 12.00, SD = 1.02) with ADHD (with 61% presenting as primarily inattentive and 39% presenting as combined, i.e., both inattentive and hyperactive/impulsive) who received school-based homework interventions as part of a randomized controlled trial (Langberg et al., 2018). Participants were recruited from seven public middle schools, representing a range of settings and family backgrounds. Comorbidity rates in the present sample were consistent with that of other ADHD populations: ODD (37.8%), anxiety disorder (30.6%), and depressive disorder (5.4%). Participants were racially diverse: 57% White, 30% Black, 9% multiracial, and 4% another race or did not disclose their race; 8% identified as Hispanic/Latino. Median family income was $62,500.

Procedure

The study and its procedures were approved by the Virginia Commonwealth University Institutional Review Board. Caregivers provided signed consent; adolescents provided assent. Joshua M. Langberg went to each school and explained that the interventions focused on homework problems for students with attention and behavior problems. School staff distributed recruitment flyers describing the study (e.g., offering "homework interventions for students with attention and behavioral difficulties and/or with ADD/ADHD") to parents of students they thought would benefit from the intervention. Interested families completed a phone screen. Parents who endorsed that their children displayed at least four of nine ADHD inattention symptoms were scheduled for a full inclusion/exclusion evaluation, to reduce the number of families who would ultimately not be eligible. Further information on recruitment is available in Langberg et al. (2018).

Inclusion criteria included (a) attended a participating school, (b) met full diagnostic criteria for ADHD based on the parent diagnostic interview or the parent interview combined with teacher ratings using the Vanderbilt ADHD Rating Scale (Wolraich et al., 2003), (c) an estimated IQ of at least 80, and (d) did not have a diagnosis of pervasive developmental disorder, bipolar disorder, or psychosis. A total of 381 students were referred, 355 families of whom were screened (24 did not meet screening criteria; two were not interested) and 285 met study criteria (target sample size was 264), and 280 were randomized to one of two intervention groups or to a waitlist control. Only the two intervention groups are included in this study with N = 111 in each group. Of the 222 students who received intervention, 214 completed measures postintervention, and 199 completed measures at the 6-month follow-up. The full consort diagram is available in Langberg et al. (2018). We used measures from baseline, postintervention, and 6-month follow-up in the present study.

Participants received one of two homework interventions: Completing Homework by Improving Efficiency and Focus (CHIEF), a contingency-management-based intervention that provides structure and rewards during homework-completion time to increase on-task behavior and the completion of homework goals, or HOPS (Breaux, Langberg, Molitor et al., 2018), a skills-based intervention that teaches organization and planning skills to help with homework completion. The CHIEF intervention was designed specifically to serve as an active control for the HOPS intervention in the larger RCT. Both interventions included 16 individual sessions delivered during students' elective periods and two parent sessions held in the evenings at the school. The individual sessions occurred twice weekly for the first 10 sessions and weekly for the final six sessions, resulting in interventions being completed in 11 weeks. The first parent meeting occurred around Session 3 or 4 and oriented parents to the program; parents left this meeting with an initial plan for monitoring and rewarding key homework behaviors. For the HOPS intervention, plans focused on monitoring and rewarding accurate homework recording and use of organization and planning skills. For the CHIEF intervention, plans focused on on-task behavior during homework completion and setting and meeting homework-completion and accuracy goals. The second meeting occurred around Session 14 and focused on working with parents to troubleshoot difficulties with plan implementation. Attendance at the parent sessions was high, with 83% of CHIEF and 87% of HOPS parents attending both meetings. Student attendance was also high, with 93% of CHIEF and 92% of HOPS participants attending all 16 sessions. The average student meeting length was 19.42 (SD = 1.88) min for CHIEF and 17.42 (SD = 3.50) min for HOPS. Treatment adherence across sessions and providers was high (HOPS = 85.4% and 77.9%, CHIEF = 89.2% and 92.5% for adolescent and parent meetings, respectively; see Langberg et al., 2018 for details).

Outcome Measures

Homework Performance Questionnaire (HPQ). Parents and teachers completed the HPQ (Power, Dombrowski, Watkins, Mautone, & Eagle, 2007; Power, Watkins et al., 2015). The HPQ consists of 13 items on a 5-point Likert scale ranging from 0 (*0% to 39% of the time*) to 4 (*90% to 100% of the time*). Percentages indicate how often a behavior occurs, with items worded in the positive such that 90–100% means the child does a task consistently well. Thus, higher scores indicate less impairment. The HPQ has good convergent validity with other measures of homework performance (Power et al., 2007, 2015). Internal consistency was high for parents (ω = .92, α = .91) and teachers (ω = .96, α = .96). The HPQ total score was used in the present study; HPQ scores ranged from 0 to 51 for parents and 0 to 52 for teachers at baseline.

Homework Problems Checklist (HPC). Parents completed the HPC (Anesko, Schoiock, Ramirez, & Levine, 1987), a 20-item measure assessing homework completion and homework materials-management problems. Items were rated on a 4-point Likert scale (0 = *never*, 1 = *at times*, 2 = *often*, 3 = *very often*). In contrast to the HPQ, higher scores on the HPC indicate more severe problems. The HPC has been found to be internally consistent and sensitive to intervention effects (Anesko et al., 1987). Internal consistency in the present study was high (ω = .92, α = .88); scores ranged from 26 to 80 at baseline.

Percentage of assignments turned in. Using an item identical to the one on the Classroom Performance Survey (Brady, Evans, Berlin, Bunford, & Kern, 2012), teachers reported what percentage of assigned work students completed. This item has good clinical utility in distinguishing academically impaired from nonimpaired students, and has good convergent validity with other measures of academic impairment (Brady et al., 2012; Langberg, Evans et al., 2016). Good variability in this measure was found in the present sample at baseline (M = 63.12, SD = 26.28).

Predictors

GPA. Each middle-school office provided participants' grades at the end of the academic year. GPA was calculated using a 4.0 system by converting grades for the four core subject areas (English/language arts, social studies, math, science; A = 4.0, B = 3.0, C = 2.0, D = 1.0, F = 0.0). The quarter that was closest to baseline for each participant was used in the present study.

Reading and math achievement. Reading and math achievement were assessed using the Wechsler Individual Achievement Test (3rd ed.; WIAT-III; Wechsler, 2009). Reading achievement consisted of the Word Reading and Pseudoword Decoding subtests; math achievement consisted of the Math Problem Solving and Numerical Operations subtests.

BASC (2nd ed.). The BASC-2 (Reynolds & Kamphaus, 2004) is a broadband rating scale for youth behavioral and emotional functioning. In the present study, parent-reported Externalizing and adolescent-reported Internalizing composite scales were used, given evidence that adolescents are better able to report Internalizing symptoms than parents or teachers (e.g., Sourander, Helstelä, & Helenius, 1999). The BASC-2 has good convergent validity (Reynolds & Kamphaus, 2004). Internal consistency in the present study was good for both parent-reported Externalizing and adolescent-reported Internalizing composite scales (ω = .81, α = .87 and ω = .87, α = .89, respectively).

ADHD-medication status. During a structured interview assessing service utilization, parents provided information on adolescents' use of medication for ADHD. A dichotomous variable indicating whether the adolescent was on medication either at baseline or postintervention (1 = on medication; 0 = not on medication) was used in the current study.

Analytic Plan

In the event that more than one teacher submitted rating scales, the most severe teacher ratings at baseline were used. This strategy was chosen to reduce the potential for a floor effect, given that middle-school teachers sometimes have difficulty recognizing problems in youth with ADHD and noticing small to moderate improvements (Sibley et al., 2012). There is also a substantial literature showing that agreement between middle-school teachers is fairly low with respect to ADHD behaviors and functioning (e.g., Evans, Allen, Moore, & Strauss, 2005) and averaging across teachers may mask within-teacher change on ratings. Descriptive statistics and bivariate correlations were first examined. Next, we ran growth-mixture models (GMMs) in Mplus, Version 7 (Muthén & Muthén, 1998–2012) to explore the differential trajectories of homework performance. GMMs examine multiple unobserved (latent) classes that can differ in intercepts and slopes, and allow for class-specific variations in these parameters (Jung & Wickrama, 2008; Lubke & Muthén, 2007; Ram & Grimm, 2009). An increasing number of classes were examined to determine the best fit for the data for each outcome variable. In line with recommendations (Muthén & Muthén, 2000; Ram & Grimm, 2009; Tein, Coxe, & Cham, 2013), model fit was determined using the Akaike information criterion (AIC), the Bayesian information criterion (BIC), Lo–Mendell–Rubin adjusted likelihood ratio test (LMRRT), the bootstrapped parametric likelihood ratio test (BLRT), classification probabilities (how distinct each class is from the other classes), and signs of model instability (e.g., class membership of less than 10%). Specifically, better model fit was indicated by having the majority of model-fit indicators in a model's favor, that is, with the (a) AIC and BIC decreasing, (b) the LMRRT and BLRT remaining significant, and (c) classification probabilities remaining greater than .80. Once the best fitting model was determined, models were examined to determine if trajectories had significant slopes (i.e., indicating either improvement or worsening in functioning; nonsignificant slope indicated stable functioning). Next, models were run in Mplus with the AUXILIARY function and Vermunt's three-step approach (Vermunt, 2010), with treatment condition included as a predictor. Important baseline characteristics (i.e., GPA, reading and math achievement, and externalizing and internalizing symptoms) were then entered as predictors using Vermunt's three-step approach. Missing data were addressed using maximum-likelihood estimation with robust standard errors in all models. To get an estimate of effect size for any significant predictors, estimates of best classification were used to determine group membership; Cohen's d was then calculated based on means and standard deviations for each group. Finally, to evaluate the overlap in trajectories across outcomes, best classification probabilities and chi-square tests were used.

Results

Preliminary Analyses

Descriptive statistics and correlations for baseline variables are presented in Table 1. Consistent with prior research, parent and teacher reports of homework performance (HPQ; Power et al., 2007, 2015) were moderately correlated. Parent reports of homework performance and problems (HPC; Anesko et al., 1987) were strongly negatively correlated with each other. GPA was weakly to moderately correlated with parent-reported homework performance and problems, but strongly correlated with teacher-reported homework performance and percentage of assignments turned in. Math achievement displayed weak correlations with all outcomes and reading achievement was weakly correlated with teacher-reported homework performance; both reading and math achieve-

Table 1
Descriptive Statistics and Correlations for Primary Study Variables at Baseline

Variable	*M* (*SD*) or %	*n*	1	2	3	4	5	6	7	8	9	10
1. HPQ parent	21.50 (11.21)	222	—									
2. HPQ teacher	24.10 (11.95)	218	.31***	—								
3. HPC	54.06 (11.88)	222	−.72***	−.22**	—							
4. Percentage of assignments turned in	63.65 (25.57)	219	.27***	.71***	−.13	—						
5. Grade-point average	2.18 (.88)	205	.33***	.59***	−.24**	.57***	—					
6. Externalizing symptoms	58.19 (11.29)	222	−.30***	−.01	.45***	.00	−.06	—				
7. Internalizing symptoms	50.61 (9.78)	222	.03	−.02	.02	−.07	−.03	.15*	—			
8. Medication status	55%	219	−.07	.11	.02	.09	.08	.26***	.04	—		
9. Math achievement	92.75 (14.06)	222	.19**	.30***	−.16*	.22**	.45***	−.08	−.14*	−.02	—	
10. Reading achievement	98.83 (12.59)	222	.05	.19**	−.03	.07	.27***	.03	−.01	−.04	.53***	—

Note. HPQ = Homework Performance Questionnaire; HPC = Homework Problems Checklist; all variables from baseline; medication codes: 1 = on stimulant medication, 0 = not on stimulant medication; percentage indicates the percentage of participants on medication; point-biserial correlations were used for medication status.
* $p < .05$. ** $p < .01$. *** $p < .001$.

ment were weakly to moderately correlated with GPA. Externalizing symptoms were moderately correlated with parent-reported homework problems and performance and unrelated to teacher-report or percentage of assignments turned in; Internalizing symptoms were unrelated to all outcomes. Medication status was unrelated to all outcomes. As predicted, intervention condition was not a significant predictor of response trajectories for any of the outcome trajectories (*p*s > .19); thus, all analyses were run with participants collapsed across the two interventions.

Parent-Reported HPQ

A two-class model was determined to be the best fit for parent-reported HPQ (Power et al., 2007, 2015; see Table 2). This model adequately discriminated between classes, with classification probabilities equaling .85 and .96. The trajectories (see Figure 1a) consisted of a group that started low ($M = 19.02$, $SE = 1.83$) and remained so on homework performance throughout the intervention (stable; 60 students; 27%; nonsignificant slope, $b = -0.74$, $SE = 0.99$, $p = .45$, $d = 0.12$) and a group that started moderate on homework performance ($M = 24.84$ $SE = 1.13$) and significantly improved during the intervention (improving; 161 students; 73%; significant slope, $b = 8.14$, $SE = 0.77$, $p < .001$, $d = 1.83$). At baseline, the improving group for parent-reported HPQ had significantly higher homework performance than the stable group, $t = -5.45$, $p < .001$.

GPA significantly predicted parent-reported HPQ groups such that the stable group ($M = 1.93$, $SD = 0.86$) had a significantly lower GPA at baseline than the improving group ($M = 2.35$, $SD = 0.86$; $b = -0.54$, $SE = .26$, $p = .04$), with the difference between trajectories representing a small effect size ($d = 0.35$). Parent-reported HPQ trajectories did not significantly differ on sex or baseline-reading achievement, math achievement, Internalizing symptoms, Externalizing symptoms, or medication status (*p*s ≥ .06).

Teacher-Reported HPQ

A three-class model was the best fitting model for teacher-reported HPQ (Power et al., 2007, 2015; see Table 2). The three-class model had classification probabilities of .87–.92, indicating adequate discrimination of classes. The first trajectory had moderate levels of homework performance at baseline ($M = 27.81$, $SE = 1.03$) and improved throughout the intervention (improving

Table 2
Model-Fit Statistics for Outcome Trajectories

Model	Parent-reported HPQ							Teacher-reported HPQ						
Factor	AIC	BIC	LMR	*p*	BLRT	*p*	Class size	AIC	BIC	LMR	*p*	BLRT	*p*	Class size
1.	4,261.56	4,288.75	—	—	—	—	221	4,244.07	4,271.26	—	—	—	—	221
2.	**4,232.91**	**4,270.29**	**32.64**	**<.001**	**−2,122.78**	**<.001**	**60,161**	4,236.11	4,273.49	13.15	.27	−2,114.04	.04	113,108
3.	4,232.79	4,280.37	5.76	.18	−2,105.46	.67	30,157,34	**4,223.91**	**4,271.48**	**17.15**	**.01**	**−2,107.06**	**<.001**	**87,40,94**
4.	—	—	—	—	—	—	—	4,225.16	4,282.93	4.47	.43	−2,097.95	.33	87,6,87,41
	Parent-reported HPC							Percentage of assignments turned in						
1.	4,353.71	4,380.89	—	—	—	—	221	5,062.00	5,089.11	—	—	—	—	219
2.	**4,337.12**	**4,374.50**	**21.27**	**.16**	**−2,168.85**	**<.001**	**150,71**	5,031.30	5,068.58	34.57	.06	−2,523.00	<.001	188,31
3.	4,288.61	4,366.77	13.53	.29	−2,128.28	.07	112,29,80	**5,012.83**	**5,060.27**	**23.05**	**<.001**	**−2,504.65**	**<.001**	**43,26,150**
4.	—	—	—	—	—	—	—	5,007.13	5,064.75	16.15	.56	−2,495.14	<.001	147,43,10,19

Note. HPQ = Homework Performance Questionnaire; HPC = Homework Problems Checklist; AIC = Akaike information criterion; BIC = Bayesian information criterion; LMR = Lo−Mendell−Rubin adjusted likelihood ratio test; BLRT = bootstrapped parametric likelihood ratio test. The LMR compares the fit of one model to the previous (k – 1 factor) model. Bolded values represent the best fitting growth-mixture model.

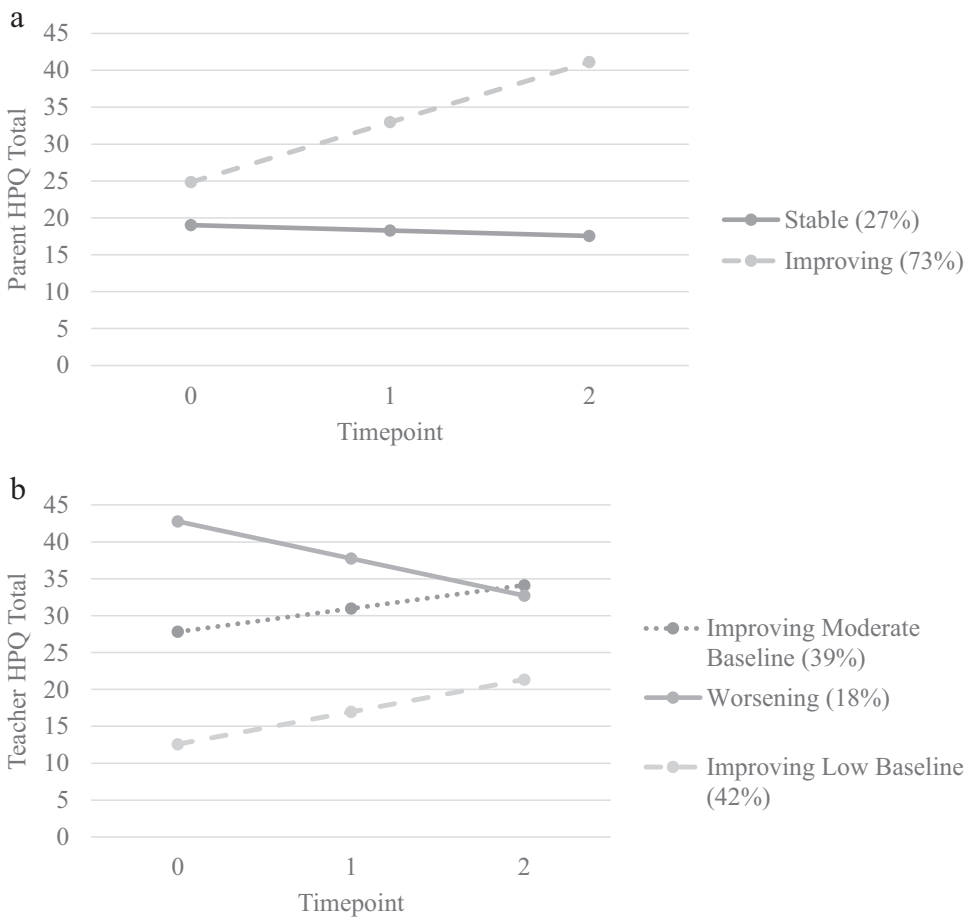

Figure 1. (a) Differential trajectories for parent-reported HPQ (Power et al., 2007, 2015); (b) differential trajectories for teacher-reported HPQ; lower scores indicate more homework problems.

moderate baseline; 87 students; 39%; significant slope, $b = 3.15$, $SE = 0.99$, $p = .001$, $d = 0.74$). The second trajectory had high homework performance at baseline ($M = 42.77$, $SE = 1.08$), which decreased throughout the intervention (worsening; 40 students; 18%; significant slope, $b = -5.03$, $SE = 1.07$, $p < .001$, $d = 1.17$). The third trajectory started low on homework performance ($M = 12.58$, $SE = 0.81$) and significantly improved throughout the intervention (improving low baseline; 94 students; 42%; significant slope, $b = 4.38$, $SE = 0.87$, $p < .001$, $d = 0.82$; see Figure 1b). The three teacher-reported HPQ trajectories significantly differed at baseline, $F = 608.14$, $p < .001$, such that the improving moderate-baseline and worsening groups had significantly higher homework performance at baseline than the improving low-baseline group; the worsening group at baseline had significantly higher homework performance than the improving moderate-baseline group ($ps < .001$ for all comparisons).

There were significantly fewer girls in the improving moderate-baseline (27.6% girl; $b = 1.33$, $SE = .49$, $p = .007$, $d = 0.57$) and the improving low-baseline (16.1%; $b = 2.03$, $SE = .48$, $p < .001$, $d = 0.89$) groups than in the worsening group (55%), suggesting that boys were more likely to respond than girls. Baseline GPA significantly predicted teacher-reported HPQ groups such that the improving moderate-baseline ($M = 2.52$, $SD = 0.69$; $b = 1.86$, $SE = .32$, $p < .001$) and worsening ($M = 2.78$, $SD = 0.58$; $b = 4.50$, $SE = .42$, $p < .001$) groups had significantly higher GPA than the improving low-baseline group ($M = 1.63$, $SD = 0.81$); the differences in GPA for these trajectories represent large effect sizes ($d = 1.18$ and 1.63, respectively). The improving low-baseline group had significantly lower math and reading achievement at baseline ($M = 87.45$ and 95.81, $SD = 12.35$ and 11.49, respectively) than the improving moderate-baseline group ($M = 97.39$ and 100.94, $SD = 14.28$ and 13.24, respectively; $b = -.08$ and $-.04$, $SE = .03$ and .02, $p = .001$ and .04), with a large effect size distinguishing between trajectories for math ($d = 0.74$) and a moderate effect size distinguishing between trajectories for reading ($d = 0.41$). The improving low-baseline group also had significantly lower math and reading achievement at baseline than the worsening group ($M = 95.25$ and 101.55, $SD = 13.54$ and 12.47; $b = -.06$ and $-.04$, $SE = .02$ and .02, $p = .004$ and .02, respectively), with a large effect size distinguishing between trajectories for math ($d = 0.60$) and a moderate effect size distinguishing between trajectories for reading ($d = 0.48$). Teacher-reported HPQ (Power et al., 2007, 2015) trajectories did not significantly differ on baseline Internalizing symptoms, Externalizing symptoms, or medication status ($ps > .08$).

HPC. A two-class model was identified as the best fitting model for parent-reported HPC (Anesko et al., 1987; see Table 2). The two-class model adequately discriminated between classes (classification probabilities = .84 and .92). The first trajectory started with a moderate level of homework problems ($M = 48.09$, $SE = 1.39$), which significantly improved throughout the intervention (improving; 150 students; 68%; significant slope, $b = -7.97$, $SE = 1.14$, $p < .001$, $d = 1.69$). The second trajectory started high (more severe) in homework problems ($M = 61.23$, $SE = 3.26$) and made nonsignificant but moderate improvements throughout the intervention (stable; 71 students; 32%; nonsignificant slope, $b = -3.75$, $SE = 2.30$, $p = .10$, $d = 0.60$; see Figure 2a). HPC groups significantly differed at baseline, such that the improving group had significantly lower parent-reported homework problems at baseline than the stable group, $t = -9.98$, $p < .001$.

Baseline GPA significantly predicted HPC trajectories, such that the improving group ($M = 2.28$, $SD = 0.86$) had significantly higher GPA at baseline than the stable group ($M = 1.99$, $SD = 0.90$; $b = .51$, $SE = .25$, $p = .04$); the differences in GPA between trajectories indicated a small effect size ($d = 0.33$). Math achievement significantly predicted HPC groups, such that the improving group ($M = 96.24$, $SD = 14.16$) had significantly higher math achievement than the stable group ($M = 89.86$, $SD = 13.39$; $b = .03$, $SE = .02$, $p = .03$), with differences in math achievement between trajectories indicating a small effect size ($d = 0.32$). HPC trajectories did not significantly differ on adolescent sex or baseline reading achievement, Internalizing symptoms, Externalizing symptoms, or medication status ($ps > .18$).

Percentage of assignments turned in. A three-class model proved to be the best fit for percentage of assignments turned in (see Table 2). The model adequately discriminated between classes (classification probabilities = .81–.87). The first trajectory started with a moderate percentage of assignments turned in ($M = 54.12\%$, $SE = 4.97$) and remained moderate throughout the intervention (stable; 43 students; 19%; nonsignificant slope, $b = 0.75$, $SE = 2.65$, $p = .78$, $d = 0.03$). A second trajectory started moderate on percentage of assignments turned in ($M = 55.61\%$, $SE = 6.80$) and decreased during the intervention (worsening; 26 students; 12%; significant slope, $b = -18.10$, $SE = 3.75$, $p < .001$, $d = 1.17$). A third trajectory started above average on percentage of assignments turned in ($M = 69.38\%$, $SE = 2.61$) and increased during the intervention (improving; 150 students; 68%;

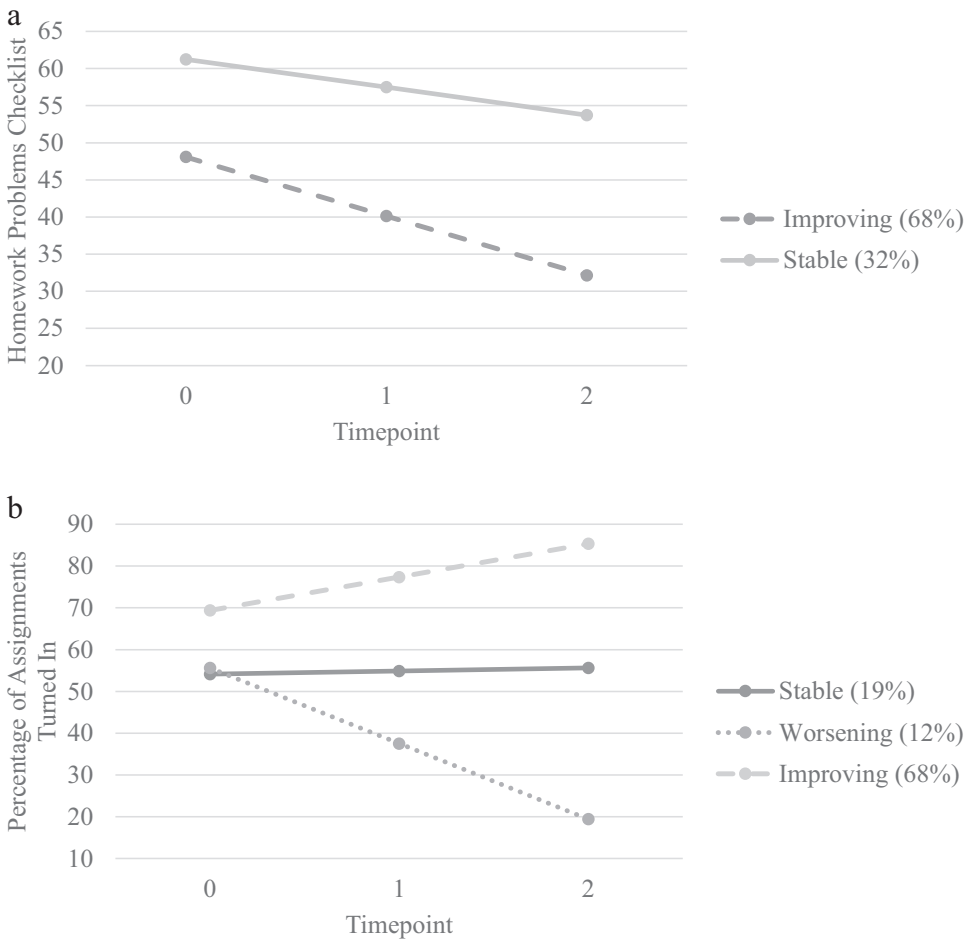

Figure 2. (a) Differential trajectories for parent HPC (Anesko et al., 1987); (b) differential trajectories for percentage of assignments turned in; percentage of assignments turned in was based on teacher report.

$b = 7.98$, $SE = 1.36$, $p < .001$, $d = 0.55$; see Figure 2b). Trajectories significantly differed with regard to the percentage of assignments turned in at baseline, $F = 15.89$, $p < .001$, such that the improving group turned in significantly more assignments at baseline than the stable ($p < .001$) and worsening ($p = .04$) groups.

The improving ($M = 2.80$, $SD = 0.88$) group had a significantly higher GPA at baseline than the stable group ($M = 1.76$, $SD = 0.58$; $b = 1.04$, $SE = .09$, $p < .001$), and the worsening group ($M = 1.14$, $SD = 0.65$; $b = 1.66$, $SE = .11$, $p < .001$). The stable group had a significantly higher GPA at baseline than the Worsening group ($b = 0.62$, $SE = .12$, $p < .001$). The differences in GPA between the trajectories represent large effect sizes ($d = 1.84$, 2.76, and 1.01, respectively). Trajectories of percentage of assignments turned in did not significantly differ on adolescent sex or baseline reading achievement, math achievement, Internalizing symptoms, Externalizing symptoms, or medication status ($ps > .05$).

Overlap Between Group Classifications for Homework Outcomes

Using best classification probabilities, we examined overlap in group membership for the four outcome trajectories (see Table 3). These were analyses of the percentage of participants in a trajectory (e.g., improving parent HPQ; Power et al., 2007, 2015) who were also present in a given trajectory for a different outcome (e.g., improving parent HPC; Anesko et al., 1987). Trajectories based on parent-reported HPQ and HPC displayed high overlap with each other, at a rate significantly more than chance ($\chi^2 = 86.56$, $p < .001$). Overlap between parent- and teacher-reported HPQ trajectories were also high, and significantly above chance ($\chi^2 = 9.37$, $p = .01$). Notably, 79% of participants identified as improving on parent-reported HPQ were also identified as improving (either with a moderate or low baseline) on teacher-reported HPQ. The percentage of overlap between parent-reported HPQ and percentage of assignments turned in was lower, though still significantly higher than chance ($\chi^2 = 13.70$, $p = .001$). Specifically, a majority of students who improved on parent-reported HPQ also improved on the percentage of assignments turned in, but those who were stable on parent-reported HPQ, were equally divided across the three assignments-turned-in trajectories. A similar pattern of overlap was found between parent-reported HPC and the percentage of assignments turned in ($\chi^2 = 9.57$, $p = .01$). The percentage of overlap between parent-reported HPC and teacher-reported HPQ was also high, with 79% of students rated as improving on the HPC also improving (from either moderate or low baseline) on teacher-reported HPQ ($\chi^2 = 14.48$, $p = .001$). Finally, for teacher-reported HPQ, 86% of students who improved (from either a moderate or high baseline) also improved on assignments turned in, and 60% of students who worsened on teacher-reported HPQ were also reported as worsening on percentage of assignments turned in ($\chi^2 = 89.51$, $p < .001$).

Discussion

In this study, we examined trajectories of response to brief (16 sessions over 11 weeks) school-based homework interventions in 222 middle-school students with ADHD. In addition, easily accessible factors such as GPA and achievement scores that may help schools predict the likely response to intervention were explored. The trajectory analyses revealed that the majority of students (68–81%) displayed significant positive treatment responses across outcomes, a rate similar to more intensive, multimodal treatments (Evans et al., 2009; Langberg, Evans et al., 2016; Swanson et al., 2007). Homework problems and performance trajectories did not significantly differ, depending on the mechanisms of change targeted in the intervention (i.e., for the HOPS; Breaux, Langberg, Molitor et al., 2018, the mechanisms were homework-recording accuracy and organization and planning skills; for the CHIEF, mechanisms were focus, concentration, and accuracy of work completion). This is consistent with group-level analyses comparing HOPS and CHIEF interventions, which found significant differences for organizational skill outcomes but not for homework problems and performance (Langberg et al., 2018). In the present study, the percentage of responders was similar across outcomes, including parent- and teacher-rated homework performance and problems and the percentage of assignments students turned in. However, for each outcome, group(s) of students were identified who did not respond (19–32%) or who responded poorly (12–18%). Baseline GPA and achievement scores proved the most useful predictors of response trajectories, with effects for distinguishing between trajectories being strongest for teacher-reported homework performance and percentage of assignments turned in. These findings and clinical implications are discussed in more detail below.

Results of the present study support and extend the limited prior research examining response trajectories for psychosocial ADHD

Table 3
Percentage of Overlap for the Four Outcome Trajectories

Trajectory	T-HPQ improving moderate baseline	T-HPQ worsening	T-HPQ improving low baseline	HPC improving	HPC stable	% Turned in stable	% Turned in worsening	% Turned in improving
P-HPQ stable	10%	32%	58%	20%	80%	33%	35%	34%
P-HPQ improving	43%	21%	36%	86%	14%	29%	13%	58%
T-HPQ improving moderate baseline	—	—	—	73%	23%	28%	4%	68%
T-HPQ worsening	—	—	—	80%	20%	7%	93%	0%
T-HPQ improving low baseline	—	—	—	54%	46%	39%	17%	44%
HPC improving	—	—	—	—	—	26%	16%	58%
HPC stable	—	—	—	—	—	36%	41%	23%

Note. Cell percentages based on rows. P = parent; T = teacher; HPQ = Homework Performance Questionnaire; HPC = Homework Problem Checklist; % Turned In = percentage of assignments turned in based on teacher report.

interventions. Specifically, across prior clinic- and school-based ADHD-intervention studies, three common trajectories have been identified: (a) gradual improvement throughout intervention (27–36% of youth), (b) large initial improvement that is maintained throughout intervention (23–52% of youth), and (c) initial improvement followed by deterioration over time (14–31% of youth) or nonresponse (e.g., 41% of youth remaining stable throughout intervention; see Evans et al., 2009; Langberg, Evans et al., 2016; Swanson et al., 2007). In the present study, similar trajectories were found, with a similar or higher percentage of positive responders across outcomes (68–81%). This finding suggests that, in many cases, a brief intervention would be sufficient for improving the homework problems of students with ADHD. Notably, the outcomes evaluated in the present study included parent and teacher ratings of homework performance, as well as a more objective outcome; the percentage of assignments turned in.

Boys and girls generally appeared to respond equally well to intervention. The one exception was for teacher-reported homework performance, such that boys had worse teacher-rated performances at baseline than girls, but were more likely to respond. These results suggest a possible ceiling effect. Specifically, if students do not have significant problems at baseline from the teacher perspective (i.e., are +1.5 *SD* above the mean, as was the case for the worsening-teacher-HPQ group), there is minimal room for improvement, and these students may even show negative performance as a result of regression to the mean (Healy & Goldstein, 1978).

Although it is promising that the majority of students responded to the interventions, stakeholders should be aware that one group of the student participants made small or negligible gains. Specifically, one or two groups of students who were identified for each outcome and who started with moderate homework problems remained impaired (on parent HPQ; Power et al., 2007, 2015; HPC; Anesko et al., 1987, and percentage of assignments turned in) or exhibited a decline in functioning (on teacher HPQ and percentage of assignments turned in). Fortunately, the percentage of students who responded negatively during the intervention period was small (12–18%). However, these findings do suggest that some students with ADHD do not respond well to brief homework intervention, which highlights the importance of being able to predict response.

The predictor findings from the present study extend prior work (Langberg, Evans et al., 2016; Murray et al., 2008; Swanson et al., 2007) by evaluating the effect of sex, ADHD-medication status, and broadband measures of psychological functioning on response trajectories. In addition, this was the first study to examine easily accessible academic data as predictors of treatment-response trajectories. Null results for broadband measures and ADHD-medication status suggest that additional testing or identification of students with mental health conditions is not necessary for these decisions to be made. Specifically, at the bivariate level, only externalizing symptoms were correlated with some of the homework-outcome variables, which is consistent with previous school-based research focused on academic outcomes (Langberg, Evans et al. 2016). We find it interesting that prior research with parent behavioral training and largely behavioral outcomes (e.g., Murray et al., 2008) has found comorbid externalizing and internalizing symptoms to be linked to treatment response. Overall, results suggest that comorbidity may play less of a role in academic-focused interventions for adolescents with ADHD. In contrast, academic variables proved to be the strongest predictors of positive treatment-response trajectories, with GPA proving to be the strongest predictor. Notably, effect sizes for trajectory differences in these predictors were largest for teacher-reported homework performance and percentage of assignments turned in. Thus, schools could realistically use data from students' academic records to determine whether to proceed with a brief, limited intervention or if a more intensive intervention would be warranted. Further, it is possible that use of more proximal indices of academic achievement, such as curriculum-based measures or other easily accessible academic measures such as class type (i.e., honors, regular education, special education) may be even more helpful in predicting response to brief homework interventions.

Specifically, results suggest that students who display low-average to below-average academic functioning (i.e., math- and reading-achievement standard scores <95 or lower than the 37th percentile; GPA < 2.0) are more likely to either not respond to the intervention, or to still display significant impairment postintervention, despite having a positive response trajectory (as was the case for teacher HPQ; Power et al., 2007, 2015). Students with below-average academic functioning may benefit from a more long-term, intensive intervention. For example, other homework interventions include biweekly sessions for a full school year (Evans et al., 2005) or involve a much larger parent component (Sibley et al., 2013). Identification of potential responders before beginning an intervention may help streamline use of limited time and resources of school mental health providers. Alternatively, a response-to-intervention approach could be used, with outcome measurements dictating which students need additional intervention after participating in brief homework interventions like the HOPS (Breaux, Langberg, Molitor et al., 2018) or the CHIEF.

Limitations

The findings from the present study should be interpreted with several limitations in mind. First, many variables could have been selected as predictors of intervention response. In this study, we prioritized examination of predictor variables that are easily accessible in schools (e.g., achievement scores, GPA). However, these are broad constructs and do not really provide insight into factors that could lead to intervention modifications to further enhance response. Future researchers should explore modification of homework interventions to address previously identified important and more malleable factors (e.g., working alliance, treatment engagement; Breaux, Langberg, McLeod et al., 2018; Langberg, Evans et al. 2016). Second, this study included only six school mental health providers who were newly graduated and hired by the study, possibly limiting generalizability of the findings. Specifically, school-based providers who are employed by a school district have many responsibilities and may have less time to provide an intervention (e.g., consistently meet with students). Third, our recruitment strategy had school counselors and psychologists identify students for the study, as opposed to broad mailings with passive recruitment, which can result in only the most motivated families' calling and participating or participants who are less severe (Weisz, Ugueto, Cheron, & Herren, 2013). However, this strategy may introduce bias because school mental health providers may have been identifying the most severe students

and/or those they thought would benefit most from intervention. Fourth, although the majority of students in our sample had positive trajectories, it is important to note that students in the present study had significant impairments at baseline. For example, even the group that started out above average and improved on percentage of assignments turned in was only turning in 69.38% of assignments at baseline. Similarly, students who showed positive improvement across outcomes had baseline GPAs between 1.63 and 2.52. Thus, results of the present study may not generalize to students with minimal academic impairment (i.e., A/B students). Further, the current study cannot make claims about why some students declined or did not make improvements. It may be that important contextual variables not measured or associated with the intervention led to declining performance. For example, negative student–teacher relationships, chaotic home environment, and/or significant life changes (e.g., parental divorce, move) might change intervention response and concurrent impairment. In addition, because most participants only had ratings from one teacher, and we used the most severe teacher rating if more than one rating was received, we cannot make claims about participants' improvements broadly across teachers. Finally, as outcome data were only collected at three time points, our GMMs could only model linear change. As such, the groups who displayed worsening trajectories throughout the intervention did not fully represent prior "honeymoon" trajectories (i.e., initial improvement followed by deterioration over time) and instead only appeared to deteriorate over time. For this reason, ADHD-intervention studies would ideally collect ratings at four or more time points, so that nonlinear trajectories can be modeled.

Conclusion

In conclusion, brief school-based interventions targeting the homework problems commonly exhibited by students with ADHD seem to produce similar positive response trajectories to more intensive, multimodal interventions. Differences in response trajectories did not depend on which intervention/mechanism of change was targeted (i.e., the HOPS (Breaux, Langberg, Molitor et al., 2018)) for homework-recording accuracy and organization and planning skills, and the CHIEF for focus, concentration, and accuracy of work completion). Findings from this study also suggest that schools can use GPA and achievement data to predict which students are unlikely to respond to a brief intervention. Specifically, in cases in which students experience below-average academic functioning (i.e., GPA $<$ 2.0, math- and reading-achievement standard scores $<$ 95 or below the 37th percentile), it would be reasonable to jump straight to a more intensive, long-term intervention. Such intensive interventions could include the Challenging Horizons Program (Evans, Langberg et al., 2005), an evidence-based biweekly afterschool program, or Supporting Teens' Academic Needs Daily (Sibley et al., 2013), a 5-month intervention with eight to eleven weekly family meetings, four parent-group sessions, and a teacher meeting with the student his or her and parent(s).

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