

Predictors and Trajectories of Response to the Homework, Organization, and Planning Skills (HOPS) Intervention for Adolescents With ADHD

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The goal of the present study was to evaluate the relative importance of adolescent and parent skills acquired during participation in the Homework, Organization, and Planning Skills (HOPS) intervention in predicting intervention response. A sample of 111 middle school students with attention-deficit/hyperactivity disorder (66% male; $M_{\text{age}} = 11.99$, $SD = 1.05$) received the HOPS intervention, which includes 16 brief sessions with the adolescent and two parent meetings. Each session, school mental health providers completed checklists measuring students' acquisition of homework recording, materials organization, and time management skills. Parents provided information on whether they monitored and used contingencies to reinforce skills use at home. Outcome measures included parent and teacher ratings of homework problems and organizational/time management

skills postintervention. Grade point average and assignment completion were also evaluated as objective outcomes. Regressions found accurate homework recording and time management to be unique predictors of parent-reported homework and organizational skills outcomes. Growth mixture models examining organizational skills trajectories throughout the intervention significantly predicted parent- and teacher-reported outcomes, GPA, and assignment completion; homework recording trajectories predicted parent-reported outcomes and GPA. Sixty-eight percent of participants displayed high acquisition of organization and homework recording skills. Parent-reported use of monitoring and contingencies to support adolescent skills implementation was not associated with outcomes. Results highlight the importance of examining individual differences in school-based intervention studies targeting organization, time management, and planning. Importantly, for a school-based adolescent-focused intervention, improvement in outcomes does not appear to be dependent upon parent skills implementation.

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ADOLESCENTS WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER (ADHD) frequently experience significant academic impairment, including missing and incomplete homework assignments and low and

failing class grades (DuPaul & Langberg, 2014). Difficulties with organization of materials, homework recording, time management, and planning significantly contribute to this academic impairment (e.g., Boyer, Geurts, & Van der Oord, 2018; Sibley et al., 2011). For example, problems with organization result in misplaced homework assignments and disorganized bookbag and binder systems, difficulties with homework recording result in students not knowing what assignments they need to complete, and problems with planning and time management result in students with ADHD completing tasks last-minute or not having adequate time to complete all tasks (e.g., Booster et al., 2012; Langberg et al., 2008). Importantly, difficulties with parent-rated homework materials organization in elementary school predict grade point average (GPA) in high school, above the influence of ADHD symptoms, intellectual abilities, and treatment utilization (Langberg, Molina, et al., 2011). Accordingly, multiple interventions have been developed that focus on improving the organization, time management, and planning (OTMP) skills of elementary and secondary school age students with ADHD (Abikoff et al., 2013; Evans et al., 2016; Langberg et al., 2018; Pfiffner, Villodas, Kaiser, Rooney, & McBurnett, 2013; Sibley et al., 2016).

OTMP interventions have been developed for use in both clinic and school settings and have been implemented using both individual and small group delivery models. Overall, these interventions are very effective at improving parent and teacher ratings of organization and planning skills ($d = .54$ and $.83$, respectively; see Bikic, Reichow, McCauley, Ibrahim, & Sukhodolsky, 2017), with gains often sustained across time (e.g., Abikoff et al., 2013; Evans et al., 2016). OTMP interventions also have an impact on more objective outcomes, such as academic performance, assignment completion, and GPA, but the effects on these metrics are less robust ($d = .29-.33$) in comparison to improvement on ratings (Evans, Schultz, DeMars, & Davis, 2011; Langberg et al., 2018). OTMP interventions are usually multicomponent and train multiple skills, such as materials organization (e.g., binder, bookbag), accurate and consistent homework recording, and planning and time management skills. Further, most OTMP interventions actively engage parents and teach them how to monitor and reinforce skill implementation. Despite this, there has been almost no research examining which OTMP skills (or combination of skills) are most important to train to lead to improvements in academic outcomes, such as problems with homework materials management and planning,

assignment completion rates, and GPA. It is possible that the most important skill (e.g., organization versus homework recording) varies as a function of informant (parent or teacher) and/or as a function of the outcome of interest (e.g., ratings versus objective indicators). Identifying which OTMP skills are unique predictors of treatment outcomes may allow OTMP interventions to be streamlined, permitting stakeholders to emphasize the most effective skills for their main outcomes of interest. This is critical given the many challenges associated with dissemination and implementation of evidence-based interventions into school and community settings (Weisz, Ugueto, Cheron, & Herren, 2013). In particular, multicomponent interventions typically require significant time and resources to implement, which limits sustainability (Forman, Olin, Hoagwood, Crowe, & Saka, 2009). As such, the goal of the present study was to evaluate which adolescent (organization, time management, homework recording) and parent (monitoring behaviors, using rewards/consequences for behaviors) skills were the strongest predictors of intervention outcomes in a school-based OTMP intervention.

DIFFERENTIAL IMPORTANCE OF SKILL ACQUISITION

To date, there has only been one small open trial ($N = 23$) evaluating which OTMP skills are most important for predicting outcomes (Langberg, Becker, Epstein, Vaughn, & Girio-Herrera, 2013). In an evaluation of the Homework, Organization, and Planning Skills (HOPS) intervention, Langberg et al. (2013) found materials organization skills and accurate homework recording, but not time management skills, to be unique predictors of parent- and teacher-rated homework problems. In addition to being limited by the small sample size, this study did not evaluate the relative importance of parent skills implementation. Specifically, the HOPS intervention includes two parent meetings where parents are taught how to consistently monitor and reward OTMP skills to promote generalization to the home setting. Similar to the skills taught to youth, it is possible that certain parenting skills may be more important than others for intervention outcomes. In addition, Langberg et al. (2013) only evaluated OTMP skills implementation as an overall percentage, averaged across sessions. It is likely that adolescents with ADHD exhibit different trajectories of skills acquisition that may also be important for outcomes. Finally, the study did not examine objective treatment outcomes such as assignment completion and GPA—outcomes that tend to be most important to school stakeholders (e.g., Evans et al., 2016; Sibley et al., 2013).

DIFFERENTIAL RESPONSE TO OTMP INTERVENTIONS

Although understudied with OTMP interventions for youth with ADHD, evaluating trajectories of response has proven useful for multiple other mental health conditions (e.g., Cuijpers, van Lier, van Straten, & Donker, 2005; Moscovitch et al., 2012; Wilson, Fairburn, Agras, Walsh, & Kraemer, 2002). For example, Moscovitch et al. (2012) found that early skills acquisition (i.e., by mid-intervention) of cognitive reappraisal skills uniquely predicted treatment outcomes associated with cognitive-behavioral therapy for social anxiety disorder and differentiated the trajectories for responders from nonresponders. These studies suggest that trajectories of skills acquisition are important to consider in addition to overall or averaged skill acquisition.

There is some evidence that youth with ADHD respond at different rates to OTMP interventions. For example, Evans et al. (2009) evaluated rate of response among 26 responders to an OTMP intervention. Multiple trajectories were identified, including youth who were: fast and consistent adopters, slow but consistent adopters, and “honeymoon” responders who implemented the skills initially but gradually declined across time. However, given the small sample size, the authors were only able to look at patterns of response and could not evaluate if these differential response patterns predicted treatment outcomes.

PRESENT STUDY

Understanding which adolescent and parent OTMP intervention skills have the strongest influence on outcomes and identifying trajectories of skills acquisition has important clinical implications. Specifically, examining unique predictors allows for possible refinement of existing OTMP interventions, and evaluation of trajectories allows for identification of intervention responders and nonresponders. As such, the present study sought to examine the role of OTMP skills as measured by behavior checklists completed by school mental health (SMH) providers, as well as parent-reported implementation of monitoring and use of rewards and consequences for OTMP skills in predicting intervention outcomes associated with the HOPS intervention. Additionally, this study evaluated trajectories of adolescent skills acquisition over the course of the HOPS intervention and how differential trajectories predicted intervention outcomes. The present study uses data from a larger randomized controlled trial investigating the efficacy of HOPS relative to a waitlist control and another homework intervention (Langberg et al., 2018). In the present study, we focus on postintervention outcomes as effects were stable from postin-

tervention to 6-month follow-up with not enough variability to predict changes between these time points. Across multiple studies evaluating associations between OTMP skills and academic outcomes (e.g., GPA), homework materials management skills (including accurate recording of homework and transferring work to and from school) are the most robust predictors of outcomes (e.g., Langberg, Vaughn, et al., 2011; Langberg et al., 2016). This makes sense from a temporal perspective, given that an adolescent who does not know what homework was assigned and/or does not bring home the necessary materials to complete work would likely exhibit significant academic impairment regardless of use of time management and planning skills. Accordingly, although we hypothesized that all OTMP skills would be associated with outcomes, we predicted that the most robust associations would be for homework recording and organization of materials. Hypotheses for specific outcomes/raters were not made given that all of the ratings included in the study contain items related to homework recording, materials organization and time management skills. Finally, we expected to find three groups of responders similar to that found by Evans et al. (2009) in their OTMP intervention: fast-adopters (i.e., students who immediately began to utilize intervention skills), slow-adopters (i.e., students who gradually increased utilization of skills throughout the intervention), and honeymooners (i.e., students who initially show gains but then who decrease over the course of the intervention), and a fourth group of nonresponders, with fast-adopters and slow-adopters showing better adult-rated and objective outcomes than honeymooners and any non-responders. For the trajectory analyses, time management trajectories were not examined as this checklist was dependent on the number of long-term assignments (e.g., tests/projects) teachers assigned and as such, skills use would not be expected to increase linearly across time.

Method

PARTICIPANTS

Participants were 111 middle school students (66% male; $M_{\text{age}} = 11.99$ years, $SD = 1.05$) with ADHD who received the HOPS intervention. Participants were recruited from seven public middle schools, which were selected to represent a range of settings and family backgrounds (e.g., urban, suburban, and rural; varying percentage of free/reduced lunch). For example, one of the urban schools consisted largely of racial and ethnic minority students (9% White) and had 67% of students receiving free or reduced lunch, whereas one of the suburban schools included 45% African American, 38% White, and 9% Latinx

students, with 39% of students receiving free or reduced lunch. Fifty-three percent of participants met criteria for ADHD–inattentive presentation and 47% for ADHD–combined presentation. About a third of participants displayed comorbid oppositional-defiant disorder (37.8%) or an anxiety disorder (30.6%), with 5.4% of participants displaying a comorbid depressive disorder. The sample displayed intellectual abilities consistent with a normative sample ($M = 99.48$, $SD = 13.17$). Participants were ethnically diverse, with 56% identifying as White, 28% identifying as Black, 12% identifying as multiracial, and 4% identifying as another race or choosing not to disclose their race; 9% identified as Hispanic/Latinx. Adolescents came from families with a range of socioeconomic backgrounds: family income of <\$25,000 (14%), \$25,000–\$75,000 (39%), and >\$75,000 (47%), and parent education level ranging from high school degrees or less (31% for mothers, 35% for fathers) to advanced degrees (15% for mothers, 13% for fathers). The Virginia Commonwealth University institutional review board approved the study and all participants provided informed consent/assent.

PROCEDURES

The principal investigator went to each school and explained that the interventions focused on homework problems for students with attention and behavior problems; school staff were given recruitment flyers describing the study (e.g., offering “homework interventions for students with attention and behavioral difficulties and/or with ADD/ADHD”) to distribute. For interested parents/caregivers, a phone screen was administered. In order to be scheduled for a full inclusion/exclusion evaluation, parents had to endorse their child as displaying at least four of nine *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR) ADHD inattention symptoms on the phone screen. This threshold was chosen to reduce the number of families who participated in the full inclusion/exclusion evaluation who would ultimately not meet eligibility criteria.

Criteria for inclusion in the study required that children (a) attended one of the participating schools; (b) met full DSM-IV-TR diagnostic criteria for ADHD based on the Parent Children’s Interview for Psychiatric Syndromes (Weller, Weller, Fristad, Rooney, & Schecter, 2000) or parent interview combined with teacher ratings on the NICHQ Vanderbilt ADHD Rating Scale (Wolraich et al., 2003); (c) IQ of 80 or above as estimated using the Wechsler Intelligence Scale for Children – Fourth Edition (Wechsler, 2003); and (d) did not meet diagnostic criteria for a pervasive developmental disorder, bipolar disorder, or psychosis. Informed

consent was obtained by all participating parents; assent was obtained by all adolescents. Of the 355 screened families, 285 met criteria for the study with 280 being randomized (113 to HOPS); for additional information about study procedures, see Langberg et al. (2018). Of the 111 families who started the HOPS intervention, 108 completed measures postintervention.

The HOPS intervention implemented in this study followed the protocol described in the published manual (Langberg, Vaughn, et al., 2011). The study design, recruitment, and evaluation procedures from the randomized controlled trial from which this data come from are described in detail in Langberg et al. (2018) along with a consort diagram. Briefly, the HOPS intervention was implemented as an individual, 16-session intervention delivered by SMH providers in 20-minute sessions during the school day. Six SMH providers who had recently graduated with a master’s degree in school counseling (white, females ages 25–27 years) delivered the treatments. SMH providers were hired and paid through the research grant. SMH providers received the HOPS manual and met with the principal investigator twice (1 hour each time) to review the manuals prior to implementing the intervention; providers did not receive any ongoing consultation or supervision during the trial. Overall, adherence to the HOPS treatment across sessions and providers during the youth (85.4%) and parent (92.5%) meetings was high (see Langberg et al., 2018 for details). Attendance was also high, with 92% of participants attending all 16 sessions, with an average meeting length of 17.42 ($SD = 3.50$) minutes. The first 10 sessions occurred twice weekly and the final six sessions occurred once per week, resulting in the intervention being completed over an 11-week period. The intervention targeted three main skills: school materials organization and management, homework recording, and time management.

For materials organization, the SMH provider taught students an organization system for their bookbag and school binder and a system for transferring homework materials to and from school. For homework recording, students were taught how to accurately and consistently record homework assignments, projects, and tests in their planner. In the time management portion of the program, students were taught how to break up projects and study for tests in smaller, more manageable pieces, and how to plan for the timely completion of each piece. Specifically, when tests or projects were assigned, students were asked to record a plan for homework completion and studying in their planner (e.g., “study 20 minutes, make flash cards”). Skills instruction was completed by Session 10, after which

the SMH providers met with students weekly and focused on problem-solving difficulties, self-monitoring, and maintaining skills.

The HOPS intervention also included two parent meetings (M session length = 42.15 min, $SD = 14.26$), which were held at school and included the SMH provider, the student, and parent(s). Attendance was also high for parent meetings, with 87% of parents attending both parent sessions. The first meeting took place early in the intervention and parents established a plan for monitoring and rewarding OTMP skills use at home. Specifically, parents learned about the HOPS point system and worked with the SMH provider to establish a plan for providing home-based monitoring and rewards. The second meeting took place near the end of the intervention and focused on troubleshooting any difficulties parents had with the monitoring and rewarding home-based plan in the prior weeks.

MEASURES

OTMP Skills

SMH providers completed skills tracking checklists at each session that included operationalized definitions of materials organization, homework recording, and time management. At the beginning of each HOPS session, students' materials (e.g., binder, bookbag) were visually inspected by the SMH provider. Students received points on the *organizational skills checklist* for each criterion they met (e.g., no loose papers in bookbag = 1 point); this checklist consisted of seven criteria related to binder organization and four criteria related to bookbag organization. For regression models, an average of the total points earned across sessions for bookbag and binder was used as a measure of organizational skills acquisition. Each session, SMH providers also examined the student's planner to see if they had recorded homework assignments for their four core classes; the average percentage of homework assignments accurately recorded (SMH providers checked with teachers to see what homework had been assigned) served as the measure of *homework recording*. Finally, the *time management checklist* contained six criteria related to planning and studying for upcoming tests (max of 10 points), four criteria related to planning for the completion of long-term projects (max of 7 points), and three criteria related to planning out activities after school (max of 5 points). Higher points were earned for more detailed planning skills (e.g., students could earn 2 points for recording an upcoming test in *general terms* such as "test today" and 3 points for recording an upcoming test in *specific terms*, such as including what chapters or pages were covered on the test). Students earned points for the highest criterion met in each section of the checklist;

students could earn points for the same criterion for multiple class subjects (e.g., records an upcoming test in specific terms for both Science & Math = 6 points earned, 3 points for each class). For the present study, checklist data from all sessions except the final session were used, as this was a celebratory session. Skills checklists were introduced in the intervention sequentially: organization skills were introduced in Session 2, and were problem-solved, monitored, and reinforced through Session 11; homework recording skills were introduced in Session 3, and were problem-solved, monitored, and reinforced through Session 11; and time management skills were introduced in Sessions 7–9, and were problem-solved, monitored, and reinforced through Session 11; all skills were monitored and reinforced in Sessions 12–15, which focused on self-management skills. A new component of the time management checklist was introduced each week to accompany the skill taught (i.e., test and quiz recording and planning in Session 7; long-term project recording and planning in Session 8; evening schedule planning in Session 9). The session each skill was introduced served as a baseline of students' use of that skill.

Parent Implementation Ratings

Parents completed a measure postintervention asking if they were currently monitoring and/or rewarding at home the three behaviors the SMH providers were tracking: (a) recording homework assignments accurately and consistently, (b) binder and bookbag organization, and (c) use of planning and time management skills. If they answered yes to monitoring the behavior, they were asked if they were using rewards and/or consequences for the behavior. Two count variables consisting of the number of key behaviors (out of three) a parent was monitoring and the number of key behaviors (out of three) a parent was providing rewards and/or consequences for were used in the present study.

Homework Performance Questionnaire (HPQ)

The HPQ (Power et al., 2007, 2015) was completed by parents and teachers. The 13 HPQ items administered in this study used a five-point scale ranging from 0 (0% to 39% of the time) to 4 (90% to 100% of the time), with corresponding percentages to indicate the amount of time a behavior occurs. Items were worded in the positive so that 90–100% of the time indicates that the child does that behavior consistently well (e.g., student writes down homework assignments independently or manages homework time well). The HPQ has demonstrated convergent validity with other measures of homework (Power et al., 2007, 2015). Internal consistency was high pre- and post-intervention for parents $\alpha = .91$ and $.94$ and teachers $\alpha = .96$ and $.97$.

Children's Organizational Skills Scale (COSS; Abikoff & Gallagher, 2008)

The COSS is a measure of organization, planning, and time management skills—consisting of three subscales, Task Planning, Organized Actions, and Memory and Materials Management—and a total score that comprises all of the items. Test-retest reliability with the three COSS subscales is high for the parent (.94 - .99) and teacher (.88 - .93) versions (Abikoff & Gallagher, 2008). The COSS has been validated for use within an ADHD sample (Molitor et al., 2017). In the present study, the COSS total score was used and had adequate internal consistency at both time points (parent $\alpha = .80$ at baseline and postintervention; teacher $\alpha = .84$ and $.82$, respectively).

Grade Point Average (GPA)

Grades for each participant were collected from the school at the end of each academic year. All grades were converted into 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). School grades for the quarter closest to the respective assessment period (pre and postintervention) were included in the analyses.

Assignments Completion

Teachers reported the percentage of assignments (0–100%) students turned in on time. This is the same item included on the Classroom Performance Survey (Brady et al., 2012), which has been used to track assignment completion in multiple studies (e.g., Meyer & Kelley, 2007). This item has demonstrated good clinical utility in distinguishing teacher identified academically impaired students from nonimpaired students and good convergent validity with other measures of academic impairment such as grades (Brady et al., 2012; Langberg et al., 2016).

COVARIATES

Vanderbilt ADHD Diagnostic Parent Rating Scale (VADPRS; Wolraich et al., 2003)

The VADPRS is a DSM-IV-based scale that includes all 18 ADHD symptoms. Parents rated how frequently each symptom occurs on a 4-point Likert scale ranging from 0 (*never*) to 3 (*very often*). The total ADHD score was used in the present study, which consists of the Inattention score (sum of the nine inattention items) and the Hyperactivity/Impulsivity score (sum of the nine hyperactive/impulsive items). The VADPRS has acceptable internal consistency and factor structure (Wolraich et al., 2003) and internal consistencies were high in the present study ($\alpha = .90$).

ADHD Medication Status

Parents reported on whether adolescents were taking medication for ADHD through a structured service utilization interview which was completed as baseline and postintervention. In the present study the covariate was a dichotomous variable indicating whether the adolescent was on medication at any point during the intervention (i.e., either at baseline or postintervention).

Full Scale Intelligence Quotient (FSIQ)

FSIQ was estimated by the Block Design and Vocabulary subtests of the Wechsler Intelligence Scale for Children—Fourth Edition (Wechsler, 2003). This two subtest short form has been found to be a reliable and valid estimate of FSIQ (see Sattler, 2008).

ANALYTIC PLAN

A series of regression analyses were conducted in Mplus version 7 (Muthén & Muthén, 1998-2012) to examine which OTMP skills predicted intervention outcome measures, controlling for ADHD symptom severity, ADHD medication status during the intervention, FSIQ, and baseline scores for the relevant outcome measure. An average of each OTMP skill across the beginning of the intervention (i.e., Sessions 1–11), when skills were introduced and problem-solved, and the two parent meeting variables were first entered in separate models for each outcome variable; significant predictors from these analyses were then used in a combined model to examine which skill was the strongest predictor of each outcome. This two-step approach was utilized to prevent the inclusion of irrelevant variables which can bias coefficients. Full information maximum likelihood was used to address missing data, which uses all observed information to estimate parameters. Multicollinearity was tested using collinearity diagnostics (variance inflation factors and tolerance). To control for nesting effects, we used the sandwich variance estimator (Diggle, Heagerty, Liang, & Zeger, 2002), which produces corrected standard errors in the presence of nonindependent data due to nested data structures, in this case, students nested within SMH providers and schools. Standardized regression weights are presented as a measure of effect size.

Next, two growth mixture models (GMM) were run to examine the differential trajectories of organizational skills and homework recording across the intervention (time management trajectories were not examined as this was heavily dependent on the number of long-term assignments). Instead of assuming that there is one underlying population with a single change pattern, GMM allows for examining multiple unobserved (latent) subpopulations that can

differ in model parameters (intercepts and slopes) as well as class-specific variations around these parameters (Jung & Wickrama, 2008; Lubke & Muthén, 2007; Ram & Grimm, 2009). It is important to note that GMMs do not assume that “growth” occurs over time; that is, subpopulations may exhibit positive slopes, negative slopes, or even no change over time. To aid in reducing complexity for GMMs, we created weekly averages for the first 6 weeks (12 sessions) with scores averaged across each of the two session checklists; this reduction pattern was chosen given that 16 points is too many to fit on a trajectory and given that the first 12 sessions happened bi-weekly, whereas Sessions 13 through 16 happened weekly. A visual inspection of individual trajectories indicated a high level of variability between individuals, as well as a high number of nonlinear trajectories. Specifically, for both the organizational skills and homework recording models, trajectories exhibited periods of rapid acceleration (i.e., skills acquisition) followed by rapid deceleration (i.e., maximal skill use). Therefore, we used a freed loading growth mixture model with first and last time points fixed (Cudeck & Haring, 2007). In our model, the first time point was fixed to a value of 0 and last time point was fixed to a value of 1, with all intermediate time points freely estimated. Conceptually, the estimated factor loadings for the intermediate time points are representative of the amount of total change observed between the first and last time point (e.g., Cudeck & Haring, 2007; McArdle, 2009). This approach accounts for the rapid improvement (i.e., acceleration) that occurred across the first few sessions after skills were initially taught. Model solutions with an increasing number of classes were explored to determine the best fit for the data for each variable. In line with recommendation (e.g., Muthén & Muthén, 2000; Tein, Coxe, & Cham, 2013), model fit was determined using Akaike Information Criteria (AIC), Bayesian Information Criterion (BIC), Lo-Mendell-Rubin adjusted likelihood ratio test (LMR), bootstrapped parametric likelihood ratio test (BLRT), classification probabilities (greater than .70), and signs of model instability (e.g., few repetitions for seeds for log likelihoods, class membership of less than 10%). Specifically, the AIC and BIC decreasing, the LMR and BLRT remaining significant, and class sizes greater than 10% of the total sample were used as indication of better model fit; the model that had the majority of model fit indicators in its favor was determined to have the better fit. Classification probabilities can be used as an indication of how distinct each class is from the other group(s). Once the optimal number of classes was determined, Vermunt’s 3-step approach (Bakk, Tekle, & Vermunt, 2013),

which has been found to generate better estimates when evaluating distal outcomes, was used to examine mean differences in outcome variables based on class membership. Models controlled for ADHD symptoms, ADHD medication status, FSIQ, and baseline scores for the relevant outcome measure. Finally, to explore overlap in group membership across the two skill trajectories, estimates of best classification were used to determine group membership. A chi-square test was then run to examine differences in group memberships across the various trajectories for organizational skills and homework recording.

Results

PRELIMINARY ANALYSES

Intercorrelations and descriptive statistics for study variables are presented in Table 1. The organizational skills checklist was significantly correlated with GPA, parent- and teacher-reported homework problems, parent-rated organizational problems, and assignments completed postintervention. Homework recording was significantly correlated with GPA, parent-reported homework and organizational problems, and assignment completion postintervention. The time management checklist was significantly correlated with all outcome variables. Parent key behavior implementation and use of rewards and consequences were only significantly correlated with GPA and teacher-reported homework problems postintervention. Multicollinearity was not an issue as indicated by variance inflation factors much less than 10 (between 1 and 3) and tolerance above 0.2 (between .36 and .94; Bowerman & O’Connell, 1990; Menard, 1995).

ADHD symptoms, ADHD medication status, and FSIQ were explored as important covariates via bivariate correlations as well. ADHD symptoms were significantly correlated with parent-reported homework ($r = -.528, p < .001$) and organizational ($r = .496, p < .001$) problems, and teacher-reported organization problems ($r = .216, p = .022$) at baseline, but weakly correlated with other baseline scores and postintervention outcomes ($r_s = .003$ to $.192, p_s > .068$). ADHD medication status was largely unrelated to intervention outcomes ($r_s < .20, p > .053$), with one exception: ADHD medication status had a weak positive correlation with percent assignments turned in baseline ($r = .19, p = .041$). FSIQ was significantly correlated with parent- and teacher-rated homework problems postintervention, parent-rated organizational problems, assignment completion postintervention, and GPA both at baseline and postintervention ($r_s > .231, p_s < .023$); FSIQ was unrelated to parent- and teacher-reported organizational problems postintervention ($r_s = -.018$ and $-.111, p_s > .272$).

Table 1
Intercorrelations Between Study Variables

	<i>M(SD)</i>	n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. GPA Base	2.15(0.85)	104	–															
2. GPA Post	2.15(0.88)	105	.65***	–														
3. Parent HPQ Base	21.03(10.38)	110	.22*	.20*	–													
4. Parent HPQ Post	33.74(11.97)	99	.26*	.40***	.29**	–												
5. Teacher HPQ Base	24.82(11.72)	109	.52***	.37***	.21*	.20	–											
6. Teacher HPQ Post	28.93(12.68)	97	.40***	.58***	.12	.32**	.38***	–										
7. Assignment Completion Base	64.96(24.49)	111	.55***	.35***	.19*	.20*	.72***	.34**	–									
8. Assignment Completion Post	67.56(24.29)	101	.40***	.60***	.21*	.35***	.36***	.67***	.41***	–								
9. Parent COSS Base	67.14(9.76)	110	.00	-.11	-.50***	-.13	.19*	.02	.09	-.14	–							
10. Parent COSS Post	57.90(11.27)	91	-.11	-.21	-.17	-.60***	-.03	-.07	-.03	-.28**	.48***	–						
11. Teacher COSS Base	60.77(9.17)	110	-.10	-.07	-.22*	-.11	-.56***	-.04	-.42***	-.16	.22*	.21*	–					
12. Teacher COSS Post	58.29(9.14)	99	-.17	-.31**	-.15	-.35**	-.26*	-.67***	-.21*	-.49***	.22*	.36**	.39***	–				
13. Key Behavior Implementation	2.49(0.80)	84	-.08	-.28**	-.10	-.02	.04	-.27*	.03	-.15	.03	-.12	-.03	.00	–			
14. Rewards and Consequences	2.12(1.05)	81	-.22	-.39***	-.07	-.05	-.12	-.32**	-.09	-.22	-.03	-.11	.08	.07	.72***	–		
15. Organization Checklist	82.78(9.29)	86	.24*	.35**	-.01	.31**	.11	.31**	.21*	.33**	-.03	-.27*	-.03	-.07	-.29*	-.44***	–	
16. Homework Recording	60.70(23.17)	86	.16	.37**	-.07	.35**	.14	.17	.17	.33**	.02	-.36**	-.05	-.13	.00	-.19	.35***	–
17. Time Management Checklist	7.43(5.41)	86	.08	.26*	-.08	.33**	.29**	.33**	.23*	.35**	.06	-.37**	-.29**	-.40***	-.05	-.15	.22*	.40***

Note. Base = baseline; Post = postintervention; GPA = grade point average; HPQ = homework problem questionnaire; COSS = children's organizational skills scale. High scores on HPQ = less homework problems; high scores on COSS = more organizational problems.

* $p < .05$, ** $p < .01$, *** $p < .001$

REGRESSION MODELS

Adult-Reported Measures

All three adolescent OTMP skills significantly predicted parent-reported HPQ postintervention (β s = .27 - .38, p s = <.001 - .01), controlling for relevant baseline variables in separate models; parent skills of key behavior implementation and use of rewards and consequences were unrelated to parent-reported homework problems. When the three adolescent variables were entered into a combined model (Table 2), homework recording and time management were unique predictors of parent HPQ postintervention. Two adolescent OTMP skills, organizational skills and time management, and both parent skills of key behavior implementation and use of rewards and consequences were related to teacher-reported homework problems (β s = -.31 - .24, p s = .01 - .03). When these four variables were entered into a combined model (Table 2), no predictor was a unique predictor of teacher HPQ postintervention.

All three adolescent OTMP skills significantly predicted parent COSS total score postintervention, controlling for relevant baseline variables (β s = -.25 - .39, p s = <.001 - .02); parent skills were unrelated to parent-reported organizational skills. When the three OTMP skills were entered into a combined model (Table 2), homework recording and time management remained unique predictors of parent COSS total score postintervention. Time management was the only adolescent OTMP or

parent skill to significantly predict teacher-reported organizational skills (Table 2), controlling for relevant baseline variables.

Objective Measures

All three OTMP skills significantly predicted assignment completion postintervention, controlling for relevant covariates in separate models (β s = .21 - .27, p s = .01 - .04); parent skills were unrelated to percent assignments turned in postintervention. When each of the three OTMP skills were entered into a combined model none proved to be unique predictors of assignment completion postintervention (Table 2).

All three adolescent OTMP skills and one parent skill, use of rewards and consequences for key behaviors, significantly predicted GPA postintervention, controlling for relevant covariates in separate models (β s = -.20 - .33, p s = <.001 - .03). When each of these variables was included in a single combined model, none proved to be unique predictors of GPA (Table 2).

SKILLS TRAJECTORIES PREDICTING INTERVENTION OUTCOMES

The three-class model exhibited the best fit for organizational skills (Table 3). This model was able to adequately discriminate between classes with classification probabilities ranging from .76 - .98. All three classes made rapid improvements across the first two weeks of the intervention (see Fig. 1), with the three classes only being differentiated by their level of skill acquisition: “high acquisition”

Table 2
Combined Models with Adolescent and Parent Skills Predicting Outcomes

Variable	Parent HPQ			Teacher HPQ			Parent COSS			Teacher COSS			Assignment Completion			GPA		
	<i>b</i>	SE	β	<i>b</i>	SE	β	<i>b</i>	SE	β	<i>b</i>	SE	β	<i>b</i>	SE	β	<i>b</i>	SE	β
Organization Checklist	.17	.13	.14	.09	.17	.07	-.10	.12	-.09	–	–	–	.29	.26	.12	.01	.01	.07
Homework Recording	.13*	.06	.25	–	–	–	-.12*	.06	-.24	–	–	–	.20	.12	.17	.01 [†]	.00	.20
Time Management Checklist	.46*	.23	.21	.31	.32	.14	-.53*	.23	-.25	-.50**	.18	-.29	.78	.47	.17	.02	.02	.15
Key Behavior Implementation	–	–	–	-7.10	3.77	-.37	–	–	–	–	–	–	–	–	–	–	–	–
Rewards and Consequences	–	–	–	-.122	2.41	-.01	–	–	–	–	–	–	–	–	–	-.06	.09	-.07
ADHD Symptoms	.17	.13	.15	-.20	.16	-.16	-.07	.12	-.07	.16	.09	.18	-.24	.23	-.10	-.01	.01	-.12
Medication Status	-1.40	2.53	-.06	7.17*	3.49	.26	2.07	2.42	.08	-1.92	2.09	-.09	4.99	5.28	.09	.19	.17	.10
FSIQ	.19*	.09	.21	.05	.13	.05	.03	.09	-.09	.08	-.12	.03	.40*	.18	.21	.02**	.01	.27
Baseline Measure	.45**	.14	.38	.01	.16	.01	.60***	.13	.53	.33**	.12	.32	.36**	.10	.35	.56***	.11	.49

Note. GPA = grade point average; HPQ = homework problem questionnaire; COSS = children’s organizational skills scale; ADHD = attention-deficit/hyperactivity disorder; FSIQ = full scale intellectual quotient. Baseline measure represents the respective baseline score for each outcome. High scores on HPQ = less homework problems; high scores on COSS = more organizational problems. Standardized regression weights are presented as a measure of effect size. [†] $p < .10$ * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 3
Model Fit Statistics for Growth Mixture Models

Model	Organizational Skills							Homework Recording						
	AIC	BIC	LMR	<i>p</i>	BLRT	<i>p</i>	Class Sizes	AIC	BIC	LMR	<i>p</i>	BLRT	<i>p</i>	Class Sizes
1 Factor	8251.02	8340.43	–	–	–	–	111	8763.06	8847.05	–	–	–	–	111
2 Factor	8216.54	8332.21	44.89	.25	-4092.51	<.001	22, 89	8739.58	8839.83	34.27	.27	-4350.53	<.001	91, 20
3 Factor	8210.15	8332.07	17.76	.44	-4069.27	.11	14, 83, 14	8736.90	8853.41	14.18	.37	-4332.79	.36	3, 17, 91
4 Factor	8208.31	8346.50	13.36	.55	-4060.07	.67	29, 31, 22, 29	–	–	–	–	–	–	–

Note. Bolded row represents the best fitting model. AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; LMR = Lo-Mendell-Rubin adjusted likelihood ratio test; BLRT = bootstrapped parametric likelihood ratio anaytest. For the LMR, this test is comparing the fit of one model to the previous (k-1 factor) model.

group (76.4%), “moderate acquisition” group (16.5%), and “low acquisition” group (18.1%). Class membership for organizational skills significantly predicted parent-reported HPQ postintervention, such that individuals in the high acquisition group had significantly less parent-reported homework problems ($M = 39.72, SD = 11.46$) than individuals in the low ($M = 22.51, SD = 16.69; \chi^2 = 13.30, p < .001, d = 1.20$) and moderate ($M = 28.38, SD = 15.04; \chi^2 = 6.72, p = .01, d = 0.85$) acquisition groups, controlling for baseline parent HPQ and relevant covariates. Class membership for organizational skills also significantly predicted teacher-reported homework problems, with the high acquisition group displaying significantly less teacher-rated homework problems ($M = 34.06, SD = 19.98$) than individuals in the low ($M = 19.55, SD = 14.02; \chi^2 = 10.05, p = .002, d = 0.84$) and moderate ($M = 21.22, SD = 18.33; \chi^2 = 5.16, p = .02, d = 0.67$) acquisition groups, controlling for baseline teacher HPQ and relevant covariates. Class membership

for organizational skills did not significantly predict parent-reported organizational problems (overall $\chi^2 = 3.39, p = .184$), controlling for baseline parent COSS and relevant baseline variables ($Ms = 57.16 - 63.58$). Class membership for organizational skills significantly predicted teacher-reported organizational problems, with the high acquisition group displaying significantly less teacher-rated organizational problems ($M = 54.24, SD = 13.93$) than individuals in the moderate acquisition group ($M = 60.96, SD = 9.02; \chi^2 = 4.81, p = .03, d = 0.57$), controlling for baseline teacher COSS and relevant covariates; neither the high nor moderate acquisition group significantly differed from the low acquisition group ($M = 59.82, SD = 8.49$). Assignments completion was significantly predicted by class membership, such that high acquisition students ($M = 87.48, SD = 22.50$) completed significantly more assignments than low ($M = 49.17, SD = 31.62; \chi^2 = 18.70, p < .001, d = 1.40$) and moderate ($M = 67.84, SD = 24.58; \chi^2 = 7.90, p = .01, d = 0.83$) acquisition

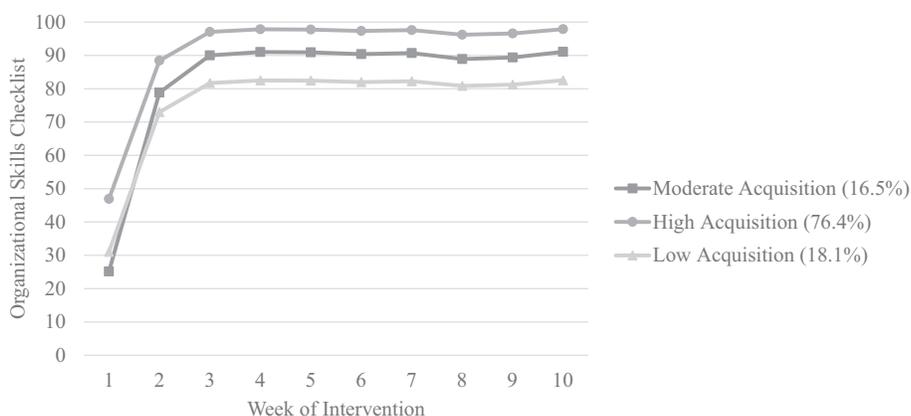


FIGURE 1 Trajectories for the three class growth mixture model of the organizational skills checklist over the first nine weeks of the intervention. Trajectories control for ADHD symptoms, ADHD medication status, and FSIQ.

students, controlling for baseline assignment completion and relevant covariates. Finally, class membership for organizational skills significantly predicted GPA postintervention, such that students in the high acquisition group had significantly higher GPAs postintervention ($M = 3.48, SD = 0.85$) than students in the low ($M = 1.83, SD = 0.21; \chi^2 = 4.06, p = .04; d = 2.67$) and moderate ($M = 1.91, SD = 0.22; \chi^2 = 4.53, p = .03, d = 2.53$) acquisition groups, controlling for baseline GPA and other relevant covariates.

A two-class model proved to have the best fit for assignments recorded (Table 3); this model was also able to adequately discriminate between classes with classification probabilities ranging from .70 - .99. The first class (25%; “non-responders” group) decreased in homework recording throughout the course of the intervention, whereas the second class (75%; “adopters” group) steadily improved on their homework recording throughout the course of the intervention (see Figure 2). Class membership for homework recording significantly predicted parent-reported HPQ, such that adopters had significantly less homework problems ($M = 40.42, SD = 10.57$) than nonresponders ($M = 18.52, SE = 8.53; \chi^2 = 3.87, p = .049, d = 2.28$). Class membership also significantly predicted parent-reported organizational problems, such that adopters had significantly less organizational problems than nonresponders ($\chi^2 = 6.99, p = .008$). Finally, class membership significantly predicted GPA postintervention, such that adopters had significantly higher GPA postintervention ($M = 3.26, SD = 0.76$) than nonresponders ($M = 1.58, SD = 0.36; \chi^2 = 9.97, p = .002, d = 2.83$). Class membership for homework recording did not significantly predict teacher-reported HPQ (overall $\chi^2 = 3.37, p = .067$), teacher-reported

organizational problems (overall $\chi^2 = 1.47, p = .255$), assignment completion ($\chi^2 = 3.35, p = .067$).

Using best classification probabilities for both of the skills trajectories (i.e., 14 members in the low and moderate acquisition groups and 83 in the high acquisition group for organization skills, and 91 in the adopters and 20 in the nonresponders), a chi-square test determined that group membership significantly differed from what would be expected based on probability estimates, $\chi^2(2) = 15.64, p < .001$). Specifically, a significantly higher proportion (standardized residual = 2.2 for both) of the low and moderate acquisition groups were nonresponders for homework recording (compared to those classified as responders; standardized residual = -1.0). Notably, 67.6% of the sample was classified as high acquisition for organizational skills *and* responders for homework recording, with only 8 of the 83 high acquisition organization skills students being classified as nonresponders for homework recording.

Discussion

The present study examined the relative importance of adolescent and parent skills, acquired during participation in a brief school-based intervention targeting homework, organization, and planning skills for adolescents with ADHD, in predicting adult-rated and objective measures of intervention response. Further, this study evaluated whether trajectories of adolescent skill acquisition differentially predicted outcomes. Accurate homework recording and time management skills were unique predictors of improvement in parent-reported homework and organization problems. Trajectories of organizational skills over the course of the intervention significantly predicted parent- and

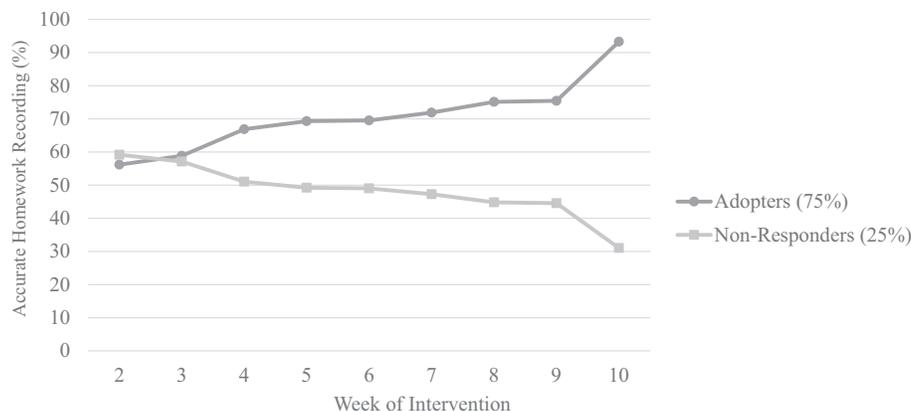


FIGURE 2 Trajectories for the two class growth mixture model of the homework recording checklist over the first nine weeks of the intervention. Trajectories control for ADHD symptoms, ADHD medication status, and FSIQ.

teacher-reported outcomes, GPA, and assignment completion, whereas homework recording trajectories only predicted parent-reported outcomes and GPA. Interestingly, although there was some variability, the trajectory analyses revealed that almost all participants demonstrated substantial improvement on bookbag and binder organizational skills. In contrast, for accurate homework recording, a portion of students proved to be nonresponders (25%). Students who were in the high acquisition organization skills group were more likely to also be adopters of homework recording; specifically, two-thirds of the sample was classified as high acquisition for organizational skills and responders for homework recording. Results highlight the importance of examining individual differences in response and group-level change in OTMP intervention studies. Clinical implications for OTMP interventions are discussed below.

Results of the present study suggest that all three skills taught in HOPS (organization skills, time management, and accurate homework recording) are independent predictors of objective measures of academic performance, which are historically harder to improve in school-based interventions (e.g., Evans et al., 2016; Sibley et al., 2013). In contrast, only accurate homework recording and time management were predictive of parent-reported organization and homework problems above and beyond the influence of ADHD symptoms, ADHD medication status, FSIQ, and the other OTMP skills. Thus, although the organization checklist was significantly correlated with parent-reported homework and organizational problems, when all three skills were entered in a single model, homework recording and time management proved to be the strongest predictors of parent-reported problems. This finding is in contrast to our hypothesis and prior work (Langberg et al., 2013) suggesting that organizational skills and homework recording are the strongest predictors of outcomes. However, the findings are consistent with a recent meta-analysis suggesting that OTMP interventions have a much stronger impact on parent- and teacher-report measures than on objective outcomes such as GPA (Bikic et al., 2017). These results highlight the importance of considering multiple outcomes and the stakeholder's perspective when evaluating and refining school-based interventions. Parents, and not teachers, are tasked with the often stressful responsibility of helping adolescents figure out what homework was assigned and when projects and exams take place. Many parents want to support their children in completing homework and preparing for projects/exams, but cannot do so if assignments, exams, and projects are not accurately recorded. Therefore, it makes sense that these skills

would have the strongest influence on parent ratings (i.e., organization is only relevant to parents once it is clear what materials need to be organized). However, improving parent perceptions of homework and organization problems may or may not be of importance to school stakeholders for whom academic outcomes such as assignment completion and GPA are likely of primary concern.

In addition to extending previous work (Langberg et al., 2013) by evaluating both predictors of ratings and objective measures, this was the first study to examine the importance of parent skills implementation in an OTMP intervention. Results revealed that parent self-report of skills implementation was not important for adolescent outcomes, at least when ADHD symptoms, ADHD medication status, FSIQ, and adolescent skills acquisition were taken into account (i.e., parent use of rewards and consequences with OTMP behaviors was bivariate associated with GPA and teacher-reported homework problems postintervention; see Table 1). These findings do not suggest that OTMP interventions should drop their parent components. HOPS is a school-based adolescent-focused intervention that includes only two meetings with parents. As such, it is to be expected that adolescent skills acquisition would drive outcomes. It may be that with clinic-based OTMP interventions with larger parent components (e.g., Abikoff et al., 2013), parent implementation of skills would be equally important. With HOPS, students are taught to self-monitor skills and, if possible, skills monitoring is incorporated into school-based systems, such as 504 plans or individualized education programs. This is done purposefully to decrease the reliance on parent monitoring as the primary mechanism for promoting generalization. In addition, it is possible that our lack of findings is a result of how we measured parent skills implementation. Specifically, parents reporting that they are monitoring a desired behavior does not necessarily mean that they are monitoring effectively (e.g., parents can monitor by saying "did you write down when your homework is due/tests are" versus actually looking through the planner and engaging the adolescent in a constructive discussion about homework recording and planning). Having a more detailed behavioral measure similar to the OTMP checklists could improve the sensitivity of measurement. For example, parents could record each night if and how they monitored the three key behaviors (e.g., asking, visually checking, and working with adolescent) and how they responded (e.g., praise, incentive, etc.).

The trajectory analyses found that all three trajectories were fast-adopters of bookbag and binder materials organizational skills with distinctions only

being made in level of acquisition; whereas, trajectories represented either slow-adopters or non-responders for homework recording. This suggests that response to the HOPS intervention varies depending on the skill. Specifically, all students in the present study improved on organizational skills as a result of the intervention, with even the low acquisition group reaching over 80% utilization by the third week of the intervention. Interestingly, despite significant increases in organization skills (improvement from about 30% to 81% and 24% to 90%), the low and moderate acquisition groups still performed significantly worse on parent- and teacher-reported and objective (assignment completion and GPA) outcomes, suggesting that this is an important set of skills to fully master. For homework recording, a more divergent pattern of skill acquisition was observed. Notably, approximately 25% of participants decreased their use of this skill during the intervention period (with a total decrease from about 60% to 31%). Nonresponders and adopters of homework recording significantly differed on parent-reported homework and organizational problems and GPA.

This lack of differential relations for teacher-reported outcomes for homework recording trajectories and lack of independent predictors of teacher-reported homework problems contribute to the growing literature suggesting that middle school teachers may not have enough exposure to students to comprehensively rate OTMP behaviors or to observe modest changes in these behaviors (see Sibley et al., 2012). That is, if use of the HOPS skills are significantly correlated with more distal outcomes such as the assignment completion and GPA, it would be expected that teachers would also notice and rate improvement. Future research is needed to more specifically evaluate which OTMP behaviors teachers can regularly observe and/or whether other assessment methodologies are needed.

Finally, it is important to highlight that for both organization and homework recording, the eventual trajectories started to separate and could be differentiated early in the intervention period, by Week 3 for organizational skills and Week 4 for homework planning. This is important as it means that if monitored closely, SMH providers implementing HOPS could potentially identify responders (68% of the current sample) from minimal/nonresponder, and troubleshoot with the latter to maximize gains. Additional predictor analyses are needed to determine if there are certain student characteristics associated with these trajectories. Possible student characteristics to explore include comorbid oppositional-defiant disorder, learning difficulties, and socioeconomic variables

(e.g., single parent status, parental education, family income).

LIMITATIONS

The results of the present study should be interpreted in the context of several limitations. First, as noted earlier, our limited findings for parent skill implementation may be partially attributed to measurement. The measure was based on a count variable created from single items of whether or not parents were doing different behaviors (i.e., yes or no), which does not assess the quality of skills implementation. Additionally, as the parent skill implementation rating was only collected at postintervention, we were unable to assess variability in skills use during the intervention (e.g., monitoring and rewarding some weeks but not others). It will be important for future research to look at parent implementation of skills in a more in-depth manner, including use of interview and observation, to more fully discern the importance of these skills. Second, our sample size may have limited the number of differential trajectories we were able to examine given small class membership; it is possible that there are additional trajectories that were not captured in the present study that could result in differential outcomes. Additionally, we were missing data for one SMH provider for one semester, which resulted in the smaller sample size for checklist data. Third, as homework recording was only recorded as the percentage of assignments correctly recorded, we could not account for differences based on the amount of homework assigned to students. Fourth, it is possible that the difference in trajectories observed across organizational skills and homework recording could have been a function of how the checklists were utilized by SMH providers. Theoretically, it would have been possible for students to organize their bookbag and binder right before a session with the SMH provider if they remembered when they were going to be pulled from class. In contrast, if students failed to record homework assignments accurately or at all for a couple of days, they would have a difficult time figuring out what to record last minute. Finally, the nature of our time-management checklist precluded us from examining trajectories of this skill. While this skill is more dependent on workload, it is still possible that increased use of time management and planning skills also has important differential outcomes.

FUTURE DIRECTIONS AND CONCLUSIONS

Given the findings from this study that the OTMP skills that are most important depend upon the perspective of the rater and the outcome of interest, a modular approach could be applied to implementing

the HOPS intervention. For example, whether or not a particular skill is introduced, and in what order, could be based upon which aspects of the homework completion cycle (Langberg et al., 2018) parents and teachers report to be most problematic. For example, in our clinic, there are adolescents with ADHD who are functioning fairly well, recording assignments accurately, and bringing home the necessary materials. However, they procrastinate and make careless mistakes, and often only complete work because parents monitor closely and establish work completion plans. In these cases, it would be reasonable to jump straight to teaching time management and planning skills; helping the adolescent begin to plan ahead and manage time more effectively and autonomously. In contrast, for many adolescents with ADHD, deficits exist in all skills areas, and the sequenced approach to intervention described in this study would be most appropriate given that earlier skills (e.g., homework recording) often serve as the foundation for other skills (e.g., time management and planning).

Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

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