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Moderators of School Intervention Efficacy for Higher-Functioning Children with ASD

Background: Social impairments of higher-functioning children with ASD (HFASD; without intellectual disability) are the most handicapping symptom of the disorder (APA, 2013). Social interventions are often administered to target impairments in social cognition, social skills, and ASD symptoms (Scarpa et al., 2013). Meta-analyses of social intervention RCTs in clinic/university settings for youth with HFASD suggested low-to-moderate effects, highlighting the need for ongoing intervention development and RCTs (Gates et al., 2017; Reichow et al., 2012). Although reviews suggest some promise, the effects rarely transfer to schools leading to calls for studies of social interventions within schools (Kasari et al., 2016).

Lopata, Thomeer, and colleagues adapted an evidence-based cognitive-behavioral summer treatment for children HFASD (Lopata et al., 2010; Thomeer et al., 2012) into a comprehensive school intervention (schoolMAX) for these students and tested it in a large cluster RCT (Lopata, Thomeer, et al., 2018). That study ($n=103$ children) was the largest RCT of a school-staff delivered comprehensive intervention. Linear mixed effects model analyses found schoolMAX was superior to services-as-usual (SAU) on primary measures of social-cognition (emotion recognition testing [CAM-C] by blinded evaluators; $d=1.41$; $p<.001$) and ASD symptoms (parent-teacher ratings composite [SRS-2]; $d=-1.15$; $p<.001$) and secondary measure of social skills (parent-teacher ratings composite [ASC]; $d=1.29$; $p=.001$).

Although some evidence has supported social interventions, there has been limited testing of moderators of treatment efficacy for HFASD; this is problematic given variability in outcomes within and across studies. Testing moderators is essential to determine for whom an intervention is most effective (Lecavalier et al., 2017); this has significant educational practice implications. Available findings are inconsistent, yet there is widespread recognition of the need to test moderating effects of child characteristics including IQ and language ability on intervention effects (Gates et al., 2017; Kaat & Lecavalier, 2014; Reichow et al., 2012). Some studies suggested that IQ, language level, and/or age are predictive of intervention outcomes (Eldevik et al., 2006; Whalon et al., 2015), whereas others found no effects (Gates et al., 2017). A study comparing parent-delivered interventions for disruptive behaviors of young children with ASD found neither IQ nor ASD severity moderated treatment effects; however, baseline comorbid symptoms of ADHD, anxiety, and ODD moderated outcomes for irritable and noncompliant behaviors (lower comorbid levels associated with larger treatments effects; Lecavalier et al., 2017).

Purpose: This exploratory study examined the moderating effects of demographic, child, and school variables on outcomes from the schoolMAX cluster RCT for children with HFASD. Potential moderators were selected based on the available literature.

Participants and Setting: The original study included 103 children (6-12 years) with HFASD enrolled in 35 urban and suburban public elementary schools (17 schools [$n=52$ children] randomly allocated to schoolMAX and 18 schools [$n=51$ children] to SAU); 1 child withdrew from SAU leaving 102 completers (Table 1). Randomization was stratified by school economic level and there were no differences between conditions on any child variable, parent education, or baseline outcome measure (demonstrating baseline equivalence) or school SES (percentage of fee-or-reduced lunch).

Intervention: Children in schoolMAX received social skills groups, emotion recognition instruction, and therapeutic activities (weekly), a behavioral reinforcement system (daily), and parent training (monthly) administered by school staff during the school year and children in

SAU received their typical services (monitoring indicated that schoolMAX components were rarely provided in SAU schools; 0%-8%). Staff in schoolMAX were trained and different members of each student's educational team (e.g., counselor, SLP, teacher, classroom assistant/aide) were responsible for implementing an individual component (fidelity >92% for all components).

Research Design: The original study employed a cluster RCT design, with individual schools as the unit of randomization. Baseline testing was done 6-weeks into the school year (prior to intervention implementation) and follow-up at the beginning of June. Primary outcome measures: Cambridge Mindreading Face-Voice Battery for Children (CAM-C; Golan & Baron-Cohen, 2006; child test of social-cognitive skills [emotion recognition] administered by blinded evaluators) and Social Responsiveness Scale-2nd Edition (SRS-2; Constantino & Gruber, 2012; measures ASD-symptom severity via parent and teacher ratings). Secondary measure: Adapted Skillstreaming Checklist (ASC; Lopata et al., 2006; measures social/social-communication skills and behavioral flexibility via parent and teacher ratings). Moderator variables for this study: child age (years), sex, IQ (WISC-IV short-form; Wechsler, 2003), language (Comprehensive Assessment of Spoken Language short-form; CASL; Carrow-Woolfolk, 1999) and ASD symptoms (ADI-R; Rutter et al., 2003), parent education, school SES, and child baseline comorbid symptoms (Behavior Assessment System for Children-3; BASC-3; Reynolds & Kamphaus, 2015). All standardized outcome and moderator measures have strong reliability and validity and have been used in ASD/HFASD treatment trials.

Data Analyses: Given the school-level clustering, data were analyzed with linear mixed effects models with intervention group (schoolMAX vs. SAU) as a fixed effect, and school as a random effect. Outcomes were assessed by testing the mean change (baseline-to-follow-up) between-conditions. Moderation analyses were conducted by testing the addition of an interaction term including the potential moderator by condition. Statistical significance was set at .05.

Results: Table 1 provides descriptive statistics for sample demographics and outcome measures. Table 2 provides summary statistics for the moderator analysis, including p -values and the R^2 change associated with the interaction term. Moderation effects were not evident in demographics, IQ, language, or baseline ASD symptoms. There was evidence of moderation effects with two of the behavioral scales. Externalizing behaviors (measured by the BASC-3) appear to have impacted the treatment such that children in the treatment group who were lower in externalizing behaviors at baseline experienced a larger improvement in CAM-C scores ($p=.032$). Children who were initially lowest in BASC-3 Adaptive Skills demonstrated greater reduction in SRS-2 ASD-symptoms ($p=.010$). R^2 change values were uniformly small, including the two interactions with p -values $<.05$.

Conclusions: Moderation analysis addresses the issue of what works for whom. Within the limits of this exploratory examination, results suggest that the main effects of treatment were, with two exceptions, unlikely to have been affected by third variables. This provides tentative support for the generalizability of treatment outcomes across a broad set of variables including parent education, school SES, age, sex, IQ, language ability, and baseline ASD symptoms.

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Table 1

Descriptive Statistics for Demographic, Baseline, and Follow-Up Measures from Original schoolMAX Cluster RCT

| Characteristic | schoolMAX (<i>n</i> =52) | SAU Control (<i>n</i> =51) | <i>t</i> / Fisher's exact (<i>p</i>) | schoolMAX (<i>n</i> =52) | SAU Control (<i>n</i> =50) |
|--------------------------------------|------------------------------|--------------------------------|--|------------------------------|--------------------------------|
| <u>Demographic</u> | | | | | |
| Parent Education: Mean (<i>SD</i>) | 15.76 (2.08) | 15.41 (2.14) | .84 (.41) | | |
| Child: Mean (<i>SD</i>) | | | | | |
| Age | 8.65 (1.29) | 9.01 (1.45) | 1.32 (.19) | | |
| WISC-IV IQ | 103.82 (12.94) | 100.94 (14.84) | 1.05 (.30) | | |
| WISC-IV VCI | 103.04 (14.39) | 100.21 (14.07) | 1.01 (.32) | | |
| WISC-IV PRI | 103.82 (15.82) | 101.50 (16.59) | .73 (.47) | | |
| CASL Expressive Language | 98.04 (15.10) | 95.11 (14.52) | 1.02 (.32) | | |
| CASL Receptive Language | 103.84 (17.49) | 100.19 (16.22) | 1.10 (.27) | | |
| ADI-R Social Interactions | 18.31 (5.91) | 18.67 (5.72) | .31 (.76) | | |
| ADI-R Communication | 14.52 (3.91) | 15.20 (5.43) | .73 (.47) | | |
| ADI-R Repetitive Behavior | 6.10 (1.72) | 5.90 (2.24) | .50 (.62) | | |
| Sex (male): <i>n</i> (%) | 47 (90.4) | 47 (92.2) | .10 (1.0) | | |

| | | | | | |
|------------------------------------|-----------------|-----------------|------------|------------------|------------------|
| Ethnicity (Caucasian) <i>n</i> (%) | 50 (96.2) | 49 (96.1) | 1.34 (1.0) | | |
| <u>Outcome: Mean (SD)</u> | <u>Baseline</u> | <u>Baseline</u> | | <u>Follow-Up</u> | <u>Follow-Up</u> |
| CAM-C | 46.04 (12.92) | 46.09 (11.70) | .03 (.98) | 58.73 (14.60) | 48.76 (12.94) |
| SRS-2 Parent-Teacher | 71.93 (9.98) | 71.48 (7.04) | .27 (.79) | 64.84 (8.13) | 69.72 (9.23) |
| ASC Parent-Teacher | 104.73 (17.98) | 107.40 (13.33) | .86 (.39) | 112.20 (17.13) | 108.71 (14.03) |

Note. SAU=Services-As-Usual; WISC-IV=Wechsler Intelligence Scale for Children-4th Edition (short-form); VCI=Verbal Comprehension Index; PRI=Perceptual Reasoning Index; CASL=Comprehensive Assessment of Spoken Language (short-form); ADI-R=Autism Diagnostic Interview-Revised; CAM-C=Cambridge Mindreading Face-Voice Battery for Children; SRS-2=Social Responsiveness Scale, 2nd Edition; ASC=Adapted Skillstreaming Checklist.

Table 2

Summary of Exploratory Analysis of Moderators of Treatment Outcomes

| Moderator | Outcome | | | | | |
|----------------------------------|--------------------|-----------------------|--------------------|-----------------------|------------|-----------------------|
| | <u>CAM-C</u> | | <u>SRS-2</u> | | <u>ASC</u> | |
| | <i>p</i> | <i>R</i> ² | <i>p</i> | <i>R</i> ² | <i>p</i> | <i>R</i> ² |
| Parent Education | .204 | .006 | .248 | .005 | .764 | .000 |
| School SES | .920 | .000 | .538 | .001 | .855 | .000 |
| Age | .070 | .010 | .750 | .000 | .137 | .010 |
| Sex | .382 | .003 | .741 | .000 | .923 | .000 |
| WISC-IV IQ | .870 | .000 | .911 | .000 | .307 | .005 |
| WISC-IV VCI | .926 | .000 | .886 | .000 | .653 | .001 |
| WISC-IV PRI | .507 | .002 | .780 | .000 | .347 | .004 |
| CASL Expressive Language | .493 | .002 | .700 | .001 | .558 | .002 |
| CASL Receptive Language | .335 | .003 | .792 | .000 | .943 | .000 |
| ADI-R Social Interactions | .376 | .003 | .136 | .001 | .707 | .001 |
| ADI-R Communication | .434 | .002 | .077 | .011 | .459 | .003 |
| ADI-R Repetitive Behavior | .097 | .010 | .799 | .000 | .560 | .002 |
| BASC-3 Externalizing Composite | <u>.032</u> | <u>.015</u> | .450 | .002 | .566 | .001 |
| BASC-3 Internalizing Composite | .156 | .007 | .139 | .008 | .651 | .001 |
| BASC-3 Adaptive Skills Composite | .337 | .003 | <u>.010</u> | <u>.022</u> | .541 | .002 |

Note. WISC-IV=Wechsler Intelligence Scale for Children-4th Edition (short-form); VCI=Verbal Comprehension Index; PRI=Perceptual Reasoning Index; CASL=Comprehensive Assessment of Spoken Language (short-form); ADI-R=Autism Diagnostic Interview-Revised; BASC-3=Behavior Assessment System for Children-3rd Edition; CAM-C=Cambridge Mindreading Face-Voice Battery for Children; SRS-2=Social Responsiveness Scale, 2nd Edition; ASC=Adapted Skillstreaming Checklist.

Statistically significant values bolded and underlined.