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An Ecobehavioral Analysis of Child Academic Engagement: Implications for Preschool Children Not Responding to Instructional Intervention

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Abstract

A gap exists in the information needed to make intervention decisions with preschool children who are unresponsive to instructional intervention. *Multi-Tiered System of Supports/Response to Intervention* (MTSS/RTI) progress monitoring is helpful in indicating when an intervention change is needed but provides little information on what to change. Ecobehavioral observation data may provide this support through information on a child's academic and other behaviors, given the opportunity to learn. We sought to investigate this hypothesis and develop benchmarks for decision making. Teachers (N = 39) and two representative age-cohorts of preschool children (N = 117, 51% boys) were observed using an ecobehavioral, momentary time sample observation system (the *Code for Interactive Recording of Children's Learning Environments* [CIRCLE]). Results provided insights into the content and amount of academic instruction children received, the responsiveness of children to instruction, and how context/teacher and child behaviors relationships were moderated by children's level of *Get Ready to Read* (GRTR) literacy and Individualized Education Plan (IEP) status risk. Implications are discussed.

Keywords

Multi-Tiered System of Supports (MTSS), language, literacy, child academic engagement, opportunity to learn

Early educators in their professional practice are expected to use data-based decision making when deciding which children may be at risk, and make changes in interventions based on data (Akers et al., 2015a, 2015b; Division for Early Childhood, 2014). While these concepts and practices are promoted in early intervention and early childhood special education (Division for Early Childhood, 2014), only recently have measures designed for use by practitioners engaged in universal screening and progress monitoring emerged in early childhood (Kaminski, Abbott, Bravo-Aguayo, Latimer, & Good, 2014; McConnell, Wackerle-Hollman, Roloff, & Rodriguez, 2014). These measures are very good at identifying children who are and are not making progress in the curriculum. However, because they are focused on learning outcomes, little information is available about what the instructional problem conditions are, the most likely treatment adaptations needed, and how such decisions should vary given a child with a weak literacy skill level (literacy risk) and/or an Individualized Education Plan (IEP). The implications of this information gap cross-cuts nationally and locally reported trends in (a) low levels of instructional supports provided to children by preschool teachers in early education (Justice, Hamre, & Pianta, 2008) and inclusive early childhood special education classrooms (Carta & Driscoll, 2013; Guo, Sawyer, Justice, & Kaderavek, 2013), and (b) the high rate of expulsion of children struggling to adhere to classroom routines (Gillam et al., 2008).

Children who are not responding to intervention are not learning from the experiences arranged for them by the teacher. Several approaches exist that seek to identify instructional problem conditions surrounding a child's lack of response, and suggest change in instructional intervention, including functional behavioral assessment (FBA) and ecobehavioral assessment (EBA; Watson, Gable, & Greenwood, 2010).

The goal of both approaches is to investigate response contingencies (environment–behavior interactions) that are

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maintaining the problem and suggest potential solutions. Both consider children's problems to be a function of proximal environmental factors, and assessment is used to understand which set or combination of immediate environmental factors is likely maintaining the problem (Schwartz, Boulware, McBride, & Sandall, 2001). Once determined, the data also suggest a course of action for treatment or treatment hypotheses. These are then tested for effectiveness. And, both play a role in *Multi-Tiered System of Supports/ Response to Intervention* (MTSS/RTI) decision making.

FBA (Hanley, Iwata, & McCord, 2003) is used primarily to inform children's behavior problems and their management including likely reasons explaining the problem behavior and selection of interventions to ameliorate the problem. Notably, FBA has been extended to analyzing academic performance problems in older students (Daly, Witt, Martens, & Dool, 1997). Standard reasons identified for lack of academic responding have included the following: *Not enough time spent doing it* (increase opportunity to learn/practice), *Not enough help* (provide more teacher prompting/feedback), *Don't want to* (strengthen motivation), *Done differently in the past* (need to program generalization), and *Too hard* (use explicit instruction to reduce difficulty). Each of these reasons suggest evidence-based procedures that are likely to overcome the problem and improve response in the context of instructional intervention, and they can be tested for function. FBA principles also have been extended from individuals to entire classrooms to prevent behavior problems from emerging in the first place. For example, Classwide Function-Related Intervention Teams (CW-FIT; Kamps et al., 2015) is such an approach in early elementary classrooms that addresses most of the common functions of problem behavior.

EBA (Morris & Midgley, 1990; Watson et al., 2010) also has a history of shedding light on children's poor response to academic instruction in a range of school settings, including preschool (Carta, Sainato, & Greenwood, 1988; Greenwood, Abbott, Beecher, Atwater, & Petersen, 2016). Common reports from classroom settings have indicated infrequent exposures to academic content, low levels of children's academic engagement, and increases in these outcomes given classwide instructional interventions such as Classwide Peer Tutoring (CWPT) and Literacy 3D (Greenwood et al., 2016; Greenwood, Delquadri, & Hall, 1989). However, less is known about the use of EBA with individual cases of response to intervention.

The standard reasons in understanding children's academic problems in EBA include (a) limited *opportunity to learn* defined by the low exposure to academic instruction and (b) limited *academically engaged behaviors* given instructional opportunities (Greenwood, Abbott, & Tapia, 2003). Interventions for children who are not receiving sufficient opportunity to learn need to focus on boosting daily exposure to academic content by intentionally embedding such content into daily preschool activities. Given the opportunity to learn is provided, interventions for children who are not engaging in academic behaviors need better response opportunities, those more likely to evoke, reinforce, and maintain academic behaviors rather than competing and/or other behaviors. Thus, all the FBA strategies previously mentioned also apply to EBA.

The particular advantages of EBA (and the *Code for Interactive Recording of Children's Learning Environments* [CIRCLE]) over FBA include direct assessment in authentic preschool contexts, measurement of instructional contexts aligned with the language and literacy goals of preschool instruction and evidence-based practice, and student behavior given the opportunity to learn language and literacy skills. Thus, EBA tools like CIRCLE seem well suited to providing helpful information to individual cases of instructional failure in the MTSS/RTI decision-making cycle that address the questions of "Why is the problem happening?" "What should be done about it?" and "Is it being implemented?" (Tilly, 2008).

Our long-term goal is to fill this information gap through a system involving (a) EBA information on instructional problem conditions, (b) strong validity evidence that children's behaviors are linked and sensitive to momentary variations in classroom instruction, (c) representative EBA benchmarks for comparative decision making, (d) a teacher coaching procedure for adapting instruction informed by an individual child's EBA data relative to benchmarks, followed by (e) assessing individual effectiveness, consistent with MTSS/RTI decision making (Tilly, 2008) and the IEP process.

The short-term goal of this report, however, was to investigate CIRCLE measurement and generate new evidence and benchmarks (Items a–c above). Thus, we examined the following research questions in a cross-validation design using two time-displaced samples:

Research Question 1: How was the opportunity to learn embedded in daily academic activity structures? This question sought to shed light on how teachers provided children with the opportunity to learn academic content and literacy focus given daily activity structures.

Research Question 2: Was children's academically engaged behavior significantly related to variations in children's behavior during instruction? This question sought to determine the extent to which desired children's behavior varied significantly with opportunities to learn provided during classroom instruction.

Research Question 3: Did children's personal characteristics moderate their instructional response dependencies? This question sought to shed light on whether or not personal characteristics (i.e., literacy risk and IEP status) moderated observed ecobehavioral relationships.

Method

We explored these questions using a representative, extant sample of CIRCLE data (Greenwood et al., 2016), containing a wealth of information on individual preschool children's experiences with core academic instruction. Because teachers organize daily preschool experience by Activity Structures (D. R. Powell, Burchinal, File, & Kontos, 2008), we assessed the Academic Content and Teacher Literacy Focus embedded in daily activities along with children's co-occurring behaviors (Academic Engagement, Other Engagement [OE], and Other Behaviors [OB]).

Participants

Programs. Preschool programs in two Midwestern school districts participated. The two programs were both half-day. District 1 offered parents a *reverse inclusion* program wherein children without IEPs were integrated with those with IEPs. Parents of children without IEPs paid tuition for them to attend the program, whereas Part B funds supported the services of children with IEPs. The average class size in the suburban district was 11, ranging from 8 to 14. The majority of children in these classrooms were White (81%). Forty percent of children had IEPs for speech and language services, developmental delay, behavior/emotional, occupational therapist/physical therapist, and autism. Only 10 children (3%) were dual language. District 1 participated in both Years 1 and 2. District 2 participated in Year 2. District 2 provided a combined state-funded Pre-K and Head Start program in an early childhood center. The rate of free or reduced-price lunch in the district was 60%. The average class size in this district was 13 children, ranging from eight to 15. The majority of children were African American (62%), 15% of children had IEPs, and four children (7%) were dual language.

Teachers. In Year 1, 20 preschool teachers in District 1 participated. In Year 2, 19 teachers (13 teachers in District 1 and six from District 2) participated. Eight District 1 teachers overlapped both years by participating again in Year 2 (see Table 1).

Children. Children (N = 117) from 39 Pre-K classrooms in the two school districts participated: 59 children in Cohort 1 in Year 1 (52% boys) and 58 children in Cohort 2 in Year 2 (48% boys) (see Table 1). All consented children's early literacy skills were universally screened using the *Get Ready to Read* (GRTR) measure (Whitehurst & Lonigan, 2001).

To identify a representative subsample of target children to receive observations, we stratified by children's literacy skill levels within each classroom. Three children in each classroom were randomly drawn, one each from the low, mid, and high GRTR standard score quartiles (M = 100, SD = 15, quartile cuts were at ±0.67 SD). Stratification was conducted in Cohort 1 in Year 2 and repeated again for Cohort 2 in Year 2. One of the three children in Class 6 had missing data in Year 1 (n = 2), and one additional child in Class 31 (n = 4) was advertently observed in Year 2 and included for a grand total of 117 children with complete data (see Table 2). All children in these samples were native English speakers. Twenty-seven percent of children had an IEP in Year 1, versus 28% in Year 2. There was a significantly greater concentration of children with an IEP in the lowest GRTR skills quartile group in Year 1—57%, 19%, and 10%; $\chi^2(2) = 11.022$, $p = .004$, in order by low, mid, and high quartile group—and in Year 2—43%, 29%, and 6%; $\chi^2(2) = 6.108$, $p = .047$.

Checks on the representativeness of the derived samples were made. First, the skew and kurtosis statistics reflecting the shape of the GRTR standard score distribution were roughly normal. Observed skewness overall was small and negative (–0.206) overall with a few more children scoring above rather than below the mean. Kurtosis indicated a degree of flatness (–0.917) where skew = 0 (tailness) and kurtosis (flatness) = 0 in the normal distribution. Somewhat similar distribution values were seen in each year, skew = −0.536 versus 0.154, kurtosis = –.579, vs. –1.09, respectively, between year cohorts. Second, the grand and classroom-level means and SDs in the majority of cases approximated the GRTR (M = 100 and SD = 15; see Table 1). Third, tests of differences by classroom and year were not significantly different. Fourth, tests of divergence in GRTR quartile and IEP status groups produced significant mean differences as expected with no differences by year (see Table 1).

We also examined whether or not these literacy risk groups were also divergent in Child Academic Engagement (CAE) and the Teacher Literacy Focus (TLF) they received. CAE quartile means were in the right direction at 28.2 (SD = 17.5), 30.4 (SD = 21.4), 32.1 (SD = 14.7) by low, mid, and high literacy risk groups (quartiles), respectively, but not significantly. Similar means for IEP status groups were 31.0 (SD = 18.5) for the no-IEP group versus 28.2 (SD = 17.0) for the IEP group and also not significantly different. TLF quartile group means were 30.4 (SD = 21.6), 28.0 (SD = 22.1), 31.0 (SD = 17.3) by low, mid, and high literacy risk groups (quartiles), respectively, and not significantly different. TLF means for IEP status were 29.9 (SD = 19.9) for the no-IEP group versus 29.3 (SD = 22.1) for the IEP group and not significantly different.

Measurement

EBA measurement. The CIRCLE (Version 2.0) is an ecobehavioral observational measure of the alterable instructional processes that occur in classrooms including measures of

Table 1. Sample Stratification on GRTR Early Literacy Skills Standard Scores.

	Year 1 (Cohort 1)			Year 2 (Cohort 2)		
		GRTR			GRTR	
Variable	*N* children	*M*	*SD*	*N* children	*M*	*SD*
Teachers/classes						
1	3	93.0	24.3	–	–	–
2	3	101.3	14.6	–	–	–
3	3	105.7	16.2	–	–	–
4	3	95.7	18.8	–	–	–
5	3	105.3	16.6	–	–	–
6	2	94.5	29.0	3	96.7	21.6
7	3	104.0	19.5	3	95.7	21.5
8	3	103.7	19.3	3	98.7	16.3
9	3	89.3	31.9	3	94.7	18.2
10	3	103.0	13.0	3	100.0	12.5
11	3	105.7	20.0	–	–	–
12	3	100.0	17.5	3	96.0	19.7
13	3	95.7	12.1	–	–	–
14	3	99.0	25.0	–	–	–
15	3	105.0	18.2	–	–	–
16	3	99.0	19.7	3	101.3	17.1
17	3	96.0	12.8	–	–	–
18	3	97.3	20.6	–	–	–
19	3	99.7	15.6	3	97.0	21.1
20	3	98.0	24.3	–	–	–
21	–	–	–	3	107.0	15.1
22	–	–	–	3	96.0	13.7
23	–	–	–	3	101.7	28.1
24	–	–	–	3	98.3	18.9
25	–	–	–	3	102.3	23.0
26	–	–	–	3	101.7	21.1
27	–	–	–	3	97.3	21.0
28	–	–	–	3	88.7	11.0
29	–	–	–	3	93.0	15.9
30	–	–	–	3	92.0	10.5
31	–	–	–	4	88.3	13.9
Quartile groups[a]						
Low ≤89	18	78.1	8.3	21	80.1	5.6
Mid >89, <110	21	101.4	4.9	21	98.3	5.4
High ≥110	20	117.2	3.8	16	117.6	5.2
IEP groups[b]						
None	43	103.9	15.7	42	100.0	15.6
IEP	16	88.1	14.6	16	89.3	14.5
Overall						
Teachers	20			19		
Children	59	99.6	16.9	58	97.2	15.9
Total teachers	39					
Total children	117	98.8	16.4			

Note. Count: 20 District 1 teachers Year 1 only, 8 District 1 teachers overlapped both years, 11 in Year 2. GRTR = Get Ready to Read; IEP = Individualized Education Plan; – = not participating.
[a]Quartile main effect $F(2, 111) = 4.287$; $p = .0001$. [b]IEP main effect = $F(2, 113) = 17.266$, $p = .0001$.

Table 2. CIRCLE Descriptives by Year.

Construct	Year 1 Frequency	Year 1 Probability	Year 2 Frequency	Year 2 Probability	Composites
Academic Content					
1-Literacy	554	.23	634	.27	Academic
2-Numeracy	127	.05	88	.04	Content
3-Science/Social Studies	186	.08	90	.04	
4-Other	1,550	.64	1,500	.65	Other Content
Activity Structures					
01-Center	1,061	.44	769	.33	Academic
02-Story Time	157	.06	207	.09	Activities
03-Large Group	738	.31	712	.31	
04-Small Group	308	.13	109	.05	
05-Individual Activity	7	.00	126	.05	Other
06-Eating	5	.00	175	.08	Activities
07-Transition	134	.06	207	.09	
08-Personal	3	.00	2	.00	
09-Therapy	0	.00	1	.00	
10-Restricted	4	.00	4	.00	
11-None of Above	0	.00	0	.00	
Teacher Literacy Focus (Yes/No)					
1-Phonological Awareness	28	.01	53	.02	Yes
2-Alphabet	91	.04	54	.02	
3-Story Comprehension	56	.02	67	.03	
4-Other Comprehension	194	.08	95	.04	
5-Vocabulary	72	.03	36	.02	
6-Reading	52	.02	92	.04	
7-Literacy	207	.09	312	.13	
8-Other Focus	1,717	.71	1,603	.69	No
Child Behavior					
02-Writing[b]	28	.01	19	.01	Academic
03-Reading Aloud[b]	20	.01	10	.00	Engagement
04-Academic Manipulation[b]	69	.03	51	.02	
05-Academic Verbal[b]	119	.05	92	.04	
06-Academic Attention[b]	496	.21	524	.23	
07-Play[c]	63	.03	61	.03	Other
08-Sing, Perform Music[c]	36	.01	49	.02	Engagement
09-Nonacademic Manipulation[c]	628	.26	531	.23	
10-Gross Motor[c]	308	.13	147	.06	
11-Eating[c]	19	.01	124	.05	
12-Nonacademic Attention[a]	150	.06	122	.05	
13-None of Above	468	.19	572	.25	Other
01-Competing Behavior[a]	13	.01	10	.00	Behavior
Total	2,417	1.00	2,312	1.00	

Note. CIRCLE = *Code for Interactive Recording of Children's Learning Environments*.
Composites are [a]Competing and Other Behaviors, [b]Academic, and [c]Other Engagement.

children's academic engagement (Greenwood et al., 2003; Greenwood & Kim, 2012; Watson et al., 2010). CIRCLE provides fine-grained data on young children's engaged behavior given opportunities that are provided to learn language, literacy, numeracy, and science (Diamond, Justice, Siegler, & Snyder, 2013). CIRCLE is the outgrowth of a line of *ecobehavioral* observational research (Atwater, Lee, Montagna, Reynolds, & Tapia, 2009b; Greenwood & Kim, 2012). CIRCLE is predicated on the fact that child behavior is malleable and responsive to situational variations provided by teachers in the classroom environment (Fredricks, Blumenfeld, & Paris, 2004).

CIRCLE provides a window on what individual children are doing, what the teacher is doing, and how the classroom is arranged during instruction, in the effort to promote desired academic outcomes through instruction (Neuman & Carta, 2011). For example, CIRCLE findings can report the likelihood of a child's behavior in the context of (a) classroom Activity Structure (AS) (e.g., Centers, Story Time, Small Group), (b) Academic Content (AC) (e.g., Literacy, Numeracy, Science), and (c) TLF (e.g., Phonological Awareness, Vocabulary, etc.), among others. Thus, CIRCLE overcomes limitations of most preschool measures of classroom quality measures (Sabol, Soliday-Hong, Pianta, & Burchinal, 2013), and it is helpful in informing efforts to differentiate instructional interventions for children with and without disabilities (D. R. Powell et al., 2008). We used context and teacher and child constructs from the CIRCLE (see Table 2) to produce data on AC (five events, for example, Language, Numeracy), AS (11 events, for example, Centers, Large Group), and TLF (eight events, for example, Vocabulary, Alphabet).

Children's preliteracy screen. The GRTR measure was used (Phillips, Lonigan, & Wyatt, 2009; Whitehurst & Lonigan, 2001). GRTR is a brief, 24-item screener that measures print knowledge, emergent writing, and phonological awareness with alpha coefficient (.78), reliability (.80), and validity (.58–.69) (Phillips et al., 2009).

Child and family characteristics. Sociodemographic characteristics of the children and their families were assessed using a 25-item parent survey. For the child, date of birth, age, gender, race/ethnicity, disability status (IEP) were collected along with the primary caregiver's educational attainment and the languages spoken in the home.

Procedures

This targeted sample was observed on multiple occasions in each of two years (Greenwood et al., 2016). For purposes of this investigation, however, only the first fall pretest occasion was used in each year as a baseline estimate. Observational data were collected during optimal times for implementation of academic activities according to teacher interview reports. Trained observers collected the data using tablet computers running data collection software (Atwater, Lee, Montagna, Reynolds, & Tapia, 2009a; Greenwood et al., 2012). Observations lasted for 90 min on the same day for about half (~180 minutes) of the program day experience—30 min per child for three focal children per classroom.

To include representative contexts during 90 min, each child was observed for 10-min blocks. After observing one child for 10 min, the observer moved to the next child and then the third child. The observer then returned to the first child to start another block 20 min later. This produced a stratified sampling of events over the 90-min observation.

During a live observation, observers' recording of CIRCLE events was paced using momentary time sampling (Kennedy, 2005). Of the several time sampling methods, momentary time sampling is reportedly the best estimator of occurrence frequency (Ary, 1984; J. Powell, Martindale, & Kulp, 1975). In momentary time sampling, observers record events observed at the moment of an unobtrusive signal, with signals spaced at 15-s time intervals. CIRCLE data are recorded on an Android-based phone or tablet computer using a data entry program developed for this purpose. The software paced data entry by timing the intervals. The observer selected the event that best described the teacher's behavior at the moment of the interval signal intervals from a drop-down entry screen. Context and child events were recorded in a similar manner. The sequence of Context, Teacher, and Child events was repeated until the end of the observation segment.

Observers were trained by the developer of CIRCLE (the third author) and supervised by an observer coordinator (fifth author). Training included a combination of learning the CIRCLE taxonomy and associated event/behavior definitions to 90% mastery, developing fluency using the CIRCLE software to enter observed classroom information, and certifying by passing three live interobserver reliability checks with the trainer at 90% overall agreement. Percentage of interobserver agreement was used as an indicator of reliability. An agreement was defined by an exact match between O1's and O2's record of occurrence in each 15-s momentary time sample. The percentage agreement was calculated as (100 [number of agreements / total intervals recorded in each observation]). Overall agreement averaged 96.5% (range, 88%–100%) across all 50 paired checks. The mean agreement for the composites reported in this investigation was 98.3% (range, 75%–100%) for AC, 99.0% (range, 90%–100%) for AS, 96.6% (range, 75%–100%) for TLF, and 92.3% (range, 70%–100%) for CAE. There were no significant differences between these estimates in Year 1 (n = 26) versus Year 2 (n =24).

Statistical Analysis

The constructs in CIRCLE were measured, analyzed, and interpreted as manifest variables (see Table 2), those that can be observed, measured, and manipulated by teachers to influence learning outcomes (Yoder & Symons, 2010). To address research questions, we analyzed the data preserving co-occurrence as the focal variable (Kontos, Burchinal, Howes, Wisseh, & Galinsky, 2002). Individual children's CIRCLE co-occurrence records consisted of the Context, Teacher, and Child behaviors/events in 45 s (three 15-s intervals). The combined Year 1 (2,417 records) and Year 2

(2,312 records) CIRCLE measurement occasions included a total of 4,729 momentary records.

We consolidated the 13 child behaviors into three theoretical composites including CAE, OE, and OB as shown in Table 2. CAE was the sum of writing, reading words or letters out loud, academic manipulation, academic verbal response, and academic attention frequencies. The OE composite was the sum of play, singing/music, nonacademic manipulation, gross motor, eating/drinking, and nonacademic attention. OB was a composite of inappropriate behaviors (e.g., aggression, noncompliance, etc.) and any other child behaviors not otherwise defined in CIRCLE. Consolidation also helped limit small cell sizes.

Simple descriptive analyses (frequencies, mean/*SD*, proportions, and graphical displays) were used to characterize the sample in terms of child, teacher, and program characteristics. Univariate ANOVA based on the general linear model was used to test differences between classroom, GRTR quartile, IEP groups, and year cohorts, where score metrics were parametric.

We used two-way marginal frequency tables for analyses of the CIRCLE data to address Questions 1 and 2. Tables contained frequency counts and probabilities (conditional and/or unconditional) of occurrence. To address Research Question 2, we also conducted chi-square tests of independence to examine differences in ecobehavioral relations. When significant, binary pairwise comparisons were made. Probabilities in Table 2 reflected the unconditional (base) occurrence of single variables as well as the conditional probability (co-occurrence) of events/behaviors (Tables 3-5). The general stated form of the conditional probability was as follows, where the outcome (e.g., CAE) was preceded by the expression given (e.g., TLF), the condition. For example, this conditional probability reflected the likelihood of CAE occurring given that TLF occurred, or the probability (CAE/TLF). Conditional probabilities helped understanding of how teachers organized instruction and child response.

Table 2 provides the CIRCLE raw descriptive frequencies and probabilities of occurrence and how they were combined to form composites used in subsequent analyses. Tables 3 and 4 describe the variability in children's opportunity to learn AC (see Table 3) and the TLF provided (see Table 4) given variation in the daily AS provided by the teacher. The last rows and columns in the tables provide the total count and unconditional probabilities. Table 5 similarly describes the probability of children's behaviors (i.e., CAE, OE, and OB) co-occurring given AC, AS, or TLF. Table 6 provides the binary pairwise comparisons between these relationships.

We used generalized linear mixed modeling (GLMM) to address Research Question 3. GLMM uniquely addressed features of the data that included lack of independence created by multiple observations per classroom (Kontos et al., 2002) and sparseness in the occurrence of some events and behaviors. The approach also enabled modeling multiple sources of dependence due to child characteristics, without requiring that all events were experienced by all children to be included in the model. Additional advantages included the testing of main effects and interactions among predictors at any level of analysis, permitting the inclusion of incomplete child- or teacher-level data under the assumption of missing at random, and allowing for unbalance in the number of observations per sampling unit. The levels in the analysis were Child Records (N = 4,729 at Level 1), Child (N = 117, intraclass correlation coefficient [ICC] = 0.17 at Level 2), and Classroom (N = 39, ICC = 0.06 at Level 3) using binary outcomes and with pairwise comparisons.

We examined the extent that CAE was predicted by co-occurring AC (or AS or TLF) at Level 1, also varied systematically by child literacy risk or IEP status. Literacy risk (GRTR, M = 98.4, SD = 16.4, range, 55–128) was centered at 100.0 in the models. IEP status was defined by either Yes (records = 1,289) or No (records = 3,440). We also included the effect of Year in the statistical models to examine replication. Because of overlap in risk groups, a degree of collinearity between the two moderators was observed; children without an IEP had significantly higher GRTR literacy scores (M = 102.13, SD = 15.51) than children with IEPs (M = 88.37, SD = 14.32), $t(2{,}490) = 28.77$, $p < .01$, $r_{pb} = -.50$. Alpha values for pairwise tests were set to Bernoulli-corrected levels based on the number of comparisons. The outcome variable was CAE versus the composite of OE plus OB. The reference context in each model was the variable least associated with the occurrence of CAE as a basis for comparison with other variables. These reference contexts were Other Content, Other Activities, and TLF = No.

Results

How Was the Opportunity to Learn Embedded in Daily Activity Structures?

Teachers organized children's preschool day by Activity Structures reflected in the Total columns of Tables 3 and 4 for each year. The proportion of time that children spent in daily activities was Centers (.44), Large Groups (.31), Small Groups (.13), Other Activities (.06), and Story Time (.06) in Year 1. This distribution was nearly identical in Year 2 (see Tables 3 and 4).

Academic Content given Activity Structures. In general, children spent the majority of time in Centers not focused on learning academic content or literacy (see Table 3). In contrast, children experienced the greatest opportunities to learn academic content and literacy during Story Time. Unfortunately, it occurred for the smallest amount of daily time compared with the other activities. The content

Table 3. Probability of Academic Content Exposure Given Activity Structures.

		Year 1					Year 2				
		Academic Content					Academic Content				
Activity Structures	Indicator	Literacy	Numeracy	Science/Social	Other Content	Total	Literacy	Numeracy	Science/Social	Other Content	Total
Center	Prob (AC/C)	0.06	0.05	0.05	0.84		0.07	0.03	0.01	0.89	
	Count	64	54	48	895	1,061	55	23	4	687	769
Large Group	Prob (AC/LG)	0.38	0.05	0.11	0.47		0.39	0.08	0.08	0.45	
	Count	278	35	80	345	738	278	57	60	317	712
Small Group	Prob (AC/SG)	0.18	0.12	0.19	0.51		0.39	0.00	0.00	0.61	
	Count	56	38	58	156	308	42	0	0	67	109
Story Time	Prob (AC/ST)	0.98	0.00	0.00	0.02		0.90	0.03	0.07	0.00	
	Count	154	0	0	3	157	186	6	14	1	207
Other	Prob (AC/OA)	0.01	0.00	0.00	0.99		0.14	0.00	0.02	0.83	
Activities	Count	2	0	0	151	153	73	2	12	428	515
Total	Prob (AC)	0.23	0.05	0.08	0.64	1.00	0.27	0.04	0.04	0.65	1.00
	Count	554	127	186	1,550	2,417	634	88	90	1,500	2,312

Note. Table data are sorted on Year 1 total occurrence of Activity Structures to assist visual inspection. AC = Academic Content.

Table 4. Probability of Teacher Literacy Focus Given Activity Structures.

		Year 1			Year 2		
		Teacher Literacy Focus			Teacher Literacy Focus		
Activity Structures	Indicator	No	Yes	Total	No	Yes	Total
Center	Prob (TLF/C)	.89	.11		.93	.07	
	Count	949	112	1,061	717	52	769
Large Group	Prob (TLF/LG)	.51	.49		.51	.49	
	Count	375	363	738	364	348	712
Small Group	Prob (TLF/SG)	.74	.26		.69	.31	
	Count	227	81	308	75	34	109
Story Time	Prob (TLF/ST)	.13	.87		.06	.94	
	Count	20	137	157	13	194	207
Other Activities	Prob (TLF/OA)	.95	.05		.84	.16	
	Count	146	7	153	434	81	515
Total	Prob (TLF)	.71	.29	1.00	.69	.31	1.00
	Count	1,717	700	2,417	1,603	709	2,312

Note. Table data are sorted on Year 1 total occurrence of Activity Structures to assist visual inspection. TLF = Teacher Literacy Focus.

children were most likely to experience during Year 1 was Other Content (p = .64, Year 1; p = .65, Year 2). The probability of experiencing Literacy Content overall in both years was only .23 (year 1) and .27 (year 2), followed by Numeracy and/or Science/Social Studies, which ranged below .10 in both years. The vast majority of Literacy Content exposure occurred during Story Time followed by Large and Small Groups particularly in Year 1 (see Table 3). Children were mostly likely to experience Nonacademic Content not only during Other Activities in both years but also during Center, Large Group, and Small Group.

Teacher Literacy Focus given Activity Structures. It was also the case that children experienced low levels of TLF, only .29 in Year 1 and .31 in Year 2 (see Table 4). Children were most likely to experience TLF during Story Time activities (.87), followed by Large Group, Small Group, Center, and Other Activities in Year 1. This pattern was largely the same in Year 2.

Was Children's Academic Engagement Significantly Associated With Variations in the Opportunity to Learn?

Probability of CAE given Academic Content. The probability of CAE varied significantly given differences in Academic Content types (χ^2 = 1,691.4, df = 3, p < .01; see Tables 5 and 6, upper panels). There was no significant difference by year. The overall probability of CAE during these opportunities to learn was only .30 in both years (see Table 5, Total rows). This compared with .50 for OE and .20 for OB, respectively. The probability of CAE was significantly more likely given that Literacy (.73), Numeracy (.72), or Science/Social Studies (.47) were taught, compared with Other Content (.10) (βs = 3.29, 2.94, and 2.13, respectively, ps < .01; see Table 6). CAE was equally occurring and not significantly different between Literacy and Numeracy, while Science/Social Studies co-occurred with CAE significantly less than with either Literacy or Numeracy (see Table 6).

Probability of CAE given Activity Structures. The probability of CAE also varied significantly given differences in Activity Structures (χ^2 = 1,067.7, df = 4, p < .01; see Tables 5 and 6, middle panels). CAE was significantly more likely co-occurring during Story Time, Large and Small Groups, than Other Activities. CAE occurred infrequently in Center and Other Activities (see Table 5). These values replicated in Year 2. CAE was significantly more likely in Story Time, Large Groups, and Small Groups than Center Time (see Table 6). However, CAE was less likely to occur in Large and Small Groups than Story Time, and in Small Groups than in Large Groups. CAE was highest in Story (.83), and much lower in Large Group (.47), Small Group (.31), Center Time (.15), and the very lowest in Other Nonacademic Activities.

Probability of CAE given Teacher Literacy Focus. The probability of CAE also varied significantly given differences in TLF (χ^2 = 1,461.5, df = 1, p < .01; see Tables 5 and 6, Lower Panels). CAE was significantly more likely to occur when the teacher was literacy focused than not-literacy focused (see Table 6). The occurrence of academic engagement was highest (.68) given TLF as compared with only .15 given No TLF (see Table 5).

Table 5. Probabilities of Child Behavior Given Contexts.

			Year 1				Year 2			
			Child behavior composites				Child behavior composites			
Category	Variable	Indicator	Academic Engagement	Other Engagement	Other Behaviors	Total	Academic Engagement	Other Engagement	Other Behaviors	Total
Academic Content	Literacy	Prob (CB/L)	.73	.15	.13		.69	.11	.20	
		Count	403	81	70	554	437	72	125	634
	Numeracy	Prob (CB/N)	.72	.16	.13		.63	.20	.17	
		Count	91	20	16	127	55	18	15	88
	Science/Social Studies	Prob (CB/SS)	.47	.37	.17		.50	.24	.26	
		Count	87	68	31	186	45	22	23	90
	Other Content	Prob (CB/O)	.10	.67	.23		.11	.61	.28	
		Count	151	1,035	364	1,550	159	922	419	1,500
Activity Structures	Story Time	Prob (CB/ST)	.83	.05	.11		.81	.04	.15	
		Count	131	8	18	157	167	8	32	207
	Large Group	Prob (CB/LG)	.47	.30	.23		.49	.20	.31	
		Count	346	222	170	738	347	144	221	712
	Small Group	Prob (CB/SG)	.31	.48	.21		.37	.43	.20	
		Count	95	149	64	308	40	47	22	109
	Center	Prob (CB/C)	.15	.69	.16		.11	.70	.18	
		Count	155	737	169	1,061	87	540	142	769
	Other Activities	Prob (CB/OA)	.03	.58	.39		.11	.57	.32	
		Count	5	88	60	153	55	295	165	515
Teacher Literacy Focus	Yes	Prob (CB/TLF)	.68	.20	.12		.71	.12	.17	
		Count	477	142	81	700	501	87	121	709
	No	Prob (CB/TLF)	.15	.62	.23		.12	.59	.29	
		Count	255	1,062	400	1,717	195	947	461	1,603
	Total	Unconditional Prob (CB)	.30	.50	.20	1.00	.30	.45	.25	1.00
		Count	732	1,204	481	2,417	696	1,034	582	2,312

Note. Table data are sorted on Year 1 probability of Academic Engagement given Contexts to assist visual inspection.

Table 6. Pairwise Differences in the Probability of Child Academic Engagement Given Academic Content, Activity Structures, and Teacher Literacy Focus.

Academic Content → Child Academic Engagement					
	χ^2	*df*	*p*		
Chi-square test of independence	1,691.40	3	<.01		
Pairwise comparison	β	*SE*	*z*	*p*	Odds ratio
Literacy vs. Other Content	3.29	0.11	31.18	<.01	26.96
Numeracy vs. Other Content	2.94	0.18	16.15	<.01	18.85
Science/Social vs. Other Content	2.13	0.16	12.95	<.01	8.44
Numeracy vs. Literacy Content	−0.36	0.19	−1.93	.20	0.70
Science/Social vs. Literacy Content	−1.16	0.17	−6.74	<.01	0.31
Science/Social vs. Numeracy Content	−0.80	0.22	−3.63	<.01	0.45
Activity Structure → Child Academic Engagement					
	χ^2	*df*	*p*		
Chi-square test of independence	1,067.70	4	<.01		
Pairwise comparison	β	*SE*	*z*	*p*	Odds ratio
Center vs. OtherActivities	0.45	0.18	2.53	.08	1.56
StoryTime vs. OtherActivities	4.43	0.23	18.96	<.01	83.88
LargeGroup vs. OtherActivities	2.59	0.17	15.31	<.01	13.33
SmallGroup vs. OtherActivities	1.73	0.21	8.17	<.01	5.62
StoryTime vs. Center	3.98	0.19	20.58	<.01	53.65
LargeGroup vs. Center	2.14	0.11	19.87	<.01	8.52
SmallGroup vs. Center	1.28	0.17	7.44	<.01	3.59
LargeGroup vs. StoryTime	−1.84	0.18	−10.15	<.01	0.16
SmallGroup vs. StoryTime	−2.70	0.23	−11.73	<.01	0.07
SmallGroup vs. LargeGroup	–0.86	0.16	−5.32	<.01	0.42
Literacy Focus → Child Academic Engagement					
	χ^2	*df*	*p*		
Chi-square test of independence	1,461.5	1	<.01		
Pairwise comparison	β	*SE*	*z*	*p*	Odds ratio
Yes vs. No	2.92	0.09	31.18	<.01	18.56

Note. Year was not significant in any analysis.

Did Children's Personal Characteristics Moderate Their Instructional Response Dependencies?

IEP status proved to be the more active of the two moderators. Both significantly moderated the size of the CAE difference between Story Time and Other Activities. Children with greater literacy skills were significantly more likely to be academically engaged (β = 0.04, $p < .01$), whereas children with an IEP were significantly less likely to be engaged (β = −1.17, $p = .02$). IEP status also was observed to weaken other instruction-engagement differences. Children with an IEP were significantly less likely to be academically engaged when Literacy versus Other Content was taught (β = –0.81, $p < .01$), and when the teacher was versus was not literacy focused (β = –0.54, $p = .01$). No other comparisons were significant.

Discussion

Closing the gap in the information needed to guide instructional intervention decision making is a particular need for children who are not responsive to instructional intervention. Our purpose was to advance what we know about the potential use of EBA (the CIRCLE) in preschool MTSS/RT decision making by shedding light on "Why a child is not responsive to intervention?" "What should be done about it?" and "Is it being implemented?"

To address these decision-making questions, information is needed on the number and sufficiency of the opportunities to learn language and literacy in the preschool classroom. Results based on observations of 50% or more of a half-day session indicated that children in both years were not experiencing instruction that was particularly strong overall in terms of the opportunity to learn AC, or the TLF support teachers provided. Like previous reports, classroom teachers were providing a weak focus on academic instruction (Carta & Driscoll, 2013; Greenwood et al., 2013; Guo et al., 2013; Justice et al., 2008; Neuman & Dwyer, 2009). The vast majority of time in these half-day classrooms was spent in Center Time where AC, TLF, and CAE were minimal. Teachers also provided activities for children that were mostly whole group and not known to promote high CAE. Small Group and Individual Activities known to promote CAE in more intensive MTSS/RTI interventions (Tiers 2 and 3) were used infrequently by teachers or, in the case of Individual Activities, rarely at all (see Table 2). These findings were consistent with other reports indicating a preschool teacher's preferences for providing instruction in Large Groups and Story Time compared with Small Group or Individual settings (D. R. Powell et al., 2008).

Data such as these are important to MTSS/RTI decision making in a number of ways. One is evaluation of individual children not making progress on screening and progress monitoring measures who may benefit from greater opportunity to learn and teacher support. For example, the teacher could arrange a Tier 2 or 3 experience for a child to add more content intensity to instruction received in Tier 1. Another is an effort to strengthen the Tier 1 core literacy program. Yet another is providing professional development to include an intentional content emphasis to increase children's opportunity to learn literacy skills. And, one more is heightened focus on evidence-based strategies. For example, decision makers might well consider introducing evidence-based strategies and procedures known to increase teacher–student interactions and child engagement with academic content (Greenwood et al., 2016). For example, embedding content instruction during Center and Large Group activities (Spencer, Goldstein, & Kaminski, 2012; Woods, Kashinath, & Goldstein, 2004) and making instruction more explicit and interactive (August & Shanahan, 2006; Goldenberg, 2008) help provide greater support.

To address these decision-making questions, information also is needed on the extent that CAE is frequently occurring given the opportunities and supports provided by the teacher. Results indicated that CAE covaried widely given differences in AC, AS, and TLF. CAE was significantly more likely to occur during Literacy, Numeracy, and Science/Social Studies content instruction and least likely to occur in Nonacademic Contexts. Conversely, children's other engaged behaviors were significantly more likely during Nonacademic, Other Activities, and No TLF.

CAE was occurring mostly in Story and Large Group activities but not in Centers, Small Group, Individual, or Other Activities. These findings were replicated in a second year strengthening the evidence that what teachers did and how they arranged the classroom activity systems actually made a difference in the occurrence of academic behavior of children. These results add to our confidence in the inferences that can be made based on CIRCLE data. The data serve as a starting point for the development of comparative benchmarks in a representative sample for use in individual decision making. For example, CIRCLE informs the question, "What is the problem?" by providing the evidence needed to rule in or out low opportunity and academic engagement as the problem. CIRCLE data informs the question, "What should be done?" by suggesting procedures and strategies most likely to address the problem. Last, CIRCLE informs the question, "Is it being implemented?" by supplying evidence that planned changes have been made and are increasing opportunity to learn and academic engagement.

To address decision-making questions, information also is needed regarding whether or not children's literacy risk and IEP status moderate response to instruction. Findings indicated moderation in several cases. Children with an IEP risk moderated three of the eight possible comparisons, while higher literacy risk moderated only one of these. Both risks adversely affected the relationship of CAE given the Story Time Activity. Children with IEPs additionally had significantly weaker CAE relationships given Literacy Content and TLF = yes. These findings were particularly relevant to identifying instructional problems and also targeting intervention strategies likely to provide additional supports where higher levels of attention and academic responding are needed. Implications were that children with IEPs in particular need more intensive content-focused instruction than do typically developing children that is longer in duration and greater in frequency.

Strengths of the Study

This research produced detailed information on how preschools, teachers, and children actually operated in authentic settings in a sample of children with representative literacy skills attending half-day programs. Initial results indicated no measurable differences in CAE or in TLF support between risk groups divergent in GRTR literacy skills even though their instructional needs were different. Most of the field's current information in this area is based on results from aggregated daily observations, rather than the rich detail provided by momentary co-occurrence data within observations. These data confirmed that teachers were not differentiating children's experiences during the time observed.

It was also a strength that the momentary results revealed typically unseen variations in classroom ecobehavioral constructs helpful in addressing MTSS/RTI decision making. Findings provided insights into the content and amount of academic instruction children received, the responsiveness of children to instruction, and how these teacher and child behaviors were moderated by children's level of GRTR literacy and IEP status risk. These were important findings because they provided new knowledge that the momentary instructional interactions that teachers arranged for these children appeared to be less effective than with children not at risk. Moreover, the consistency of results across 2 years was notable and indicative of the representativeness of these teaching practices and their impact of children's engagement.

Limitations

We only used the first observation occasion in this extant sample in the beginning (fall) of each year. One observation per year, however, one is not likely representative of an entire preschool year. Yet, the degree of stability seen in these estimates at the beginning of the year, one year to the next, suggested uniformity in the system of instruction provided by teachers in both years, and its relationship to children's response to instruction. However, because a majority of the data was collected in the same school district with some teachers repeating in both years, even though student cohorts were different, this was a competing explanation.

The instruction-response dependencies operationalized in this research were temporal correlations and were not causal estimates of ecobehavioral relationships. The conditional probabilities reflected the temporal association (lag = 0, probability of occurrence) within a 45-s time window (three consecutive 15-s intervals of ecology, teacher, and child recording). This was the best level of precision possible given the momentary time sample procedures used in CIRCLE. Clearly, a greater level of temporal precision would be desired; however, reliable use by observers is always a psychometric and practical limitation given the complexity reflected in the taxonomy of events to be monitored and recorded. Given the large number of events/behaviors reliably coded in CIRCLE, the challenge in using a more frequent, real-time sampling method remains to be overcome (Dorsey, Nelson, & Hayes, 1986).

A degree of collinearity between our two moderators was observed, likely due to the low literacy skills shared by both groups. Children without an IEP had significantly higher GRTR literacy scores compared with children with IEP status. This overlap centered on the children's weaker language, literacy, and cognitive skills measured by the GRTR. Thus, additional contributions of developmental delay or disability to this issue are not known. While low literacy risk and IEP status were included as moderators in the current study, it was not possible to include children with dual-language learner (DLL) status because they were not sufficiently represented in this extant sample. Thus, this widely known moderator of children's response to instructional intervention relationship has yet to be investigated using CIRCLE.

Future Research and Directions

Future research could profitably examine these questions in different districts with different curricula and early literacy goals, while also sampling additional child characteristics (e.g., DLLs, etc.). Based on these findings, CIRCLE observation data appeared to fill the previously mentioned gaps between progress monitoring indication and treatment formulation/implementation for children not responding to an instruction intervention. However, more research and demonstration is warranted. A next step could be to employ CIRCLE data in the MTSS/RTI decision-making cycle for indicated individuals. These can be single case and/or group experimental (causal) design studies focused on demonstrating that intervention changes made given CIRCLE information actually lead to better response and learning outcomes. More work also is needed to replicate the current descriptive CIRCLE findings in other samples of programs and children, with more frequent assessment occasions, different years adding incrementally to benchmark estimates. Such cross-validating work will extend the generality of the ecobehavioral observed relationships between instruction and children's response. Work also is needed to untangle child moderators when they share a common construct, for example, low literacy English skills, as do children with IEPs and who are DLL.

Implications for Practice

A primary implication of this investigation is that preschool teachers need to devote more time and precision to their academic instruction and literacy support, and they need to do so differentially to ensure that children with higher risk status are receiving more intensive instruction. It is reasonable to assume with the right supports that classroom teachers can raise classroom-level averages by intentionally embedding the use of evidence-based instructional practices in daily schedule of activities. Such support may well come from CIRCLE data in terms of making changes to core instruction with a greater likelihood of benefiting an individual child as well as all the children in the class and program.

Conclusion

These results add to our knowledge of how preschool instructional factors are associated with children's engagement in learning academic content in inclusive classrooms, and how that information may help solve cases of response to intervention. This lens that the CIRCLE provides on children's experiences has implications for planning individualization of specific children (including the IEP process), addressing the lack of response to instructional intervention, and evaluating the strength of the core instruction received by all children. The success of this proposed use of

CIRCLE remains to be demonstrated in future research and practice.

Authors' Note

The opinions presented in this article are solely those of the authors, and no official endorsement from the U.S. Department of Education should be inferred. Additional information concerning the *Code for Interactive Recording of Children's Learning Environments* (CIRCLE) observation system is available online at http://ebass.ku.edu/observational-instrument/circle/.

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