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Preschool Classroom Processes as Predictors of Children's Cognitive Self-Regulation Skills Development

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This research focuses on the associations between interactive processes of early childhood classrooms and gains in children's cognitive self-regulation (CSR) across the preschool year. Data from 803 children (45.8% female; *M* = 54 months; 39.1% Caucasian, 26.3% African American, 24.6% Hispanic, 9.9% Other) were collected at fall and spring of the preschool year, and classroom observations were conducted three times throughout the year. Multilevel models tested associations between classroom behaviors of teachers and students using the Classroom Observation in Preschool and the Teacher Observation in Preschool and gains children made in a CSR composite score (Dimensional Change Card Sort, Peg Tapping, Head Toes Knees Shoulders, Copy Design, and Corsi Blocks) across the preschool year. After controlling for demographic covariates and children's pretest scores, both affective and cognitive classroom processes were associated with gains. More teacher behavior approving, less disapproving, and more positive emotional tone were associated with gains. The proportion of observed time teachers spent delivering instruction as well as the proportion of time children were involved with mathematics and literacy were also related to CSR gains, as was the quality of teacher instruction. Although exploratory, these results highlight the potential for modifications in classroom practices to aid in children's CSR development.

Keywords: classroom process, preschool, cognitive self-regulation

Self-regulation includes children's "ability to manage or modulate positive and negative emotions, to inhibit or control their behavior, and to shift and focus their attention" (Raver et al., 2012, p. 247). In the current study, we examined the development of cognitive self-regulation (CSR; also called executive functioning), which is a subset of skills that are less affectively driven, captured by inhibitory control, working memory, and attention flexibility. Greater CSR has been associated with academic achievement (e.g., Bull, Espy, & Wiebe, 2008; Duncan et al., 2007; Howse, Lange, Farran, & Boyles, 2003) and healthy behavior in adulthood (Moffitt et al., 2011). As early as kindergarten, many children experience problems with CSR. For example, 46% of teachers reported that at least half of the students in their class were having adjustment problems related to limited CSR skills (Rimm-Kaufman, Pianta, & Cox, 2000). Growing awareness of the importance of CSR for long-term outcomes emphasizes the need to un-

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derstand better how to facilitate young children's acquisition of these skills. In the current study, we explored associations between preschool classroom processes and children's CSR development.

CSR develops rapidly during the preschool period and coincides with maturation of the prefrontal cortex (e.g., Garon, Bryson, & Smith, 2008). Because the prefrontal cortex has an extended course of development, children's developing self-regulation skills are potentially more susceptible to environmental influences compared to other earlier developing cognitive skills (Johnson & Munakata, 2005). For example, Noble, Norman, and Farah (2005) found that children growing up in low-income homes had significantly lower CSR skills compared to their middle-to-high-income peers. However, Hackman, Farah, and Meaney (2010) assert that these early SES effects can potentially be buffered by environmental characteristics such as positive affective interactions with caretakers and cognitive stimulation (see also Bernier, Carlson, & Whipple, 2010). Preschool classrooms funded by Head Start, Title I, or state initiatives targeted to children from low-income families could possibly serve as a positive counterbalance for children who may be at risk for difficulties in CSR.

Converging evidence suggests an association between classroom characteristics and children's achievement gains across various preschool curricula (see Farran & Hofer, 2013), including associations between classroom emotional climate and quantity of instruction and academic gains (Pianta, Belsky, Vandergrift, Houts, & Morrison, 2008). Little is known, however, about how classroom processes affect children's development of self regulation. In kindergarten classrooms, Rimm-Kaufman, Curby, Grimm, Nathanson, and Brock (2009) found that higher quality classroom management was positively related to observer ratings of children's behavioral control and engagement and to teacher ratings of children's cognitive self-control. Cognitive stimulation (rated as "instructional support"), however, was related to neither set of ratings. Interpretation of the mixed findings is complicated by the limitation that teachers were providing the main source of information about their students' self-regulation and observations occurred only once.

Recently, improved CSR has been the primary focus of two preschool curricula. One is a complete curriculum designed to enhance children's CSR through Vygotskian-based activities, the *Tools of the Mind* (Bodrova & Leong, 2007). An initial evaluation suggested some support for a curriculum effect on children's CSR (Diamond, Barnett, Thomas, & Munro, 2007), but a more recent randomized control trial, from which the data for the current study were drawn, indicated no significant differences in children's self-regulation or early academic gains for children in *Tools of the Mind* classrooms versus "business as usual" (Wilson & Farran, 2012). Interpreting these findings as demonstrating that CSR is not malleable is premature without knowing in greater detail what occurred inside the classrooms, the focus of the current study.

Alternatively, the Chicago School Readiness Project (CSRP) (Raver et al., 2008; 2011) implemented teacher training and assistance to promote teachers' behavioral management skills and reduce teacher stress levels. Specifically, teachers participated in 30 hours of training using an adapted version of the Incredible Years teacher training program (Webster-Stratton, Reid, & Hammond, 2004), and mental health consultants provided weekly coaching to teachers in their classrooms. Raver and colleagues found that children in experimental classrooms had significantly greater gains in self-regulation skills across the preschool year compared to children in a control group as well as greater gains in preacademic skills in both literacy and mathematics. Raver and colleagues' work is one of the few instances where gains in CSR have been linked to a classroom intervention.

In the current study, we examined associations between specific classroom processes and gains in young children's CSR skills across the preschool year. We extended Raver and colleagues' work (2011) by including a more comprehensive battery of CSR measures widely used in the field. To investigate the influences of both affective quality and cognitive stimulation, we focused on three sets of classroom processes: classroom emotional climate, the proportion of observed time spent in learning opportunities, and the quality of instruction offered. We controlled for a set of background variables that were hypothesized to be associated with children's

CSR gains in preschool. These variables included gender, ethnicity, age, IEP status, and ELL status, as these background variables have been associated with young children's self-regulation skills in prior work using both direct child assessments (e.g., McClelland et al., 2007; Wiebe, Espy, & Charak, 2008) as well as teacher ratings (e.g., Cooper & Farran, 1998; Cooper & Speece, 1988; McClelland, Morrison, & Holmes, 2000).

Method

Participants

This study was approved by a University Human Subjects Review Board. Data came from 60 classrooms (32 experimental, 28 comparison) across five school systems in the Southeastern U.S. that were part of the first phase of a randomized control trial of the *Tools of the Mind* curriculum. Class sizes ranged from 14 to 20 students ($M = 18$; $SD = 2$). Teachers consented an average of 82% of students in their classrooms. Of the 828 students in the analytic sample (children who had at least one pre- and posttest measure at each time point), 25 children did not have complete data and were not included in the final sample of 803. Students who had a missing data point did not significantly differ from children with complete data on any demographic variable or pretest measure ($p > .05$), and because the cases with missing data constituted less than 5% of the sample, we only used complete cases for analyses.

The sample included a balanced number of males and females (46% female) who were 54 months ($SD = 4$ months) at the time of pretest. Students were ethnically and racially diverse (39.2% Caucasian, 26.5% African American, 24.7% Hispanic, 9.6% Other). Furthermore, 30.3% of the students were identified by the individual school systems as English Language Learners (ELL) and 14.2% of the analytic sample required an IEP at some point during the academic year. For the schools from which data on free and reduced-priced lunch status were obtained, 71.1% qualified; for all of the schools, income eligibility for FRPL was the primary criterion for enrollment. (Information on FRPL status for individual students was not provided to the researchers because of FERPA rules protecting privacy.)

Procedure and Study Design

Child assessments were administered in both the fall and spring of children's preschool year at the child's preschool in a quiet room. The battery of CSR measures was administered as part of a larger battery of measures, and thus, some of the measures were administered in the first testing session and others were administered in the second testing session. The average interval between fall and spring sessions was 7.34 months ($SD = .43$ months). Classroom observations lasting from the scheduled beginning of the classroom day to its scheduled end were conducted at three time points throughout the year (fall, midyear, and spring).

Measures

CSR. Extended descriptions of the five CSR tasks and scoring are available at https://my.vanderbilt.edu/toolsofthemindevaluation/. *Attention shifting* was measured using the Dimensional Change Card Sort (DCCS; Zelazo, 2006). The task required children first to sort a set of cards according to one dimension (red vs. blue color) and then according to another (star vs. truck shape). If they were successful in making that switch, children were then given a set of similar cards containing either a black border around the card or no border. Children were instructed to sort by color if the card had a border or to sort by shape if the card had no border. Children received a score of 0 if they did not pass the initial color sort task, a 1 if they passed the color sort but not the shape sort, a 2 if they passed the shape sort, and a 3 if they also passed the border version.

Sustained focus was assessed with the Copy Design task (Osborn, Butler, & Morris, 1984; Duncan et al., 2007). The task required children to copy eight simple geometric shapes that increased in difficulty. Children had two attempts to replicate each design and each attempt was scored either 0 if the shape did not meet a defined set of criteria or 1 if it did meet the defined criteria. Total scores could range from 0 to 16.

Working memory was assessed using the Corsi Block-Tapping task (Corsi, 1972). The task required children to point to a series of blocks on a board in an irregular order indicated by the examiner. Children were first asked to

repeat the pattern exactly as the examiner did (i.e., forward) then they were asked to reverse the pattern given by the examiner (i.e., backward). The task began with two blocks and difficulty increased by asking children to repeat increasingly longer block patterns. The child was given two attempts at each pattern length and continued until a child responded incorrectly on two consecutive trials for a given pattern length. The score for both the forward and backward versions was the longest pattern a child could correctly repeat.

Inhibitory control was assessed with two tasks: Peg Tapping (PT; Diamond & Taylor, 1996) and Head-Toes-Knees-Shoulders (HTKS; Ponitz, McClelland, Matthews, & Morrison, 2009). The PT task required children to tap once with a wooden peg when the examiner tapped twice and tap twice when the examiner tapped once. Children first received two practice trials with feedback for incorrect responses, then eight opportunities to successfully enact the rules. If successful, they then had 16 test trials with no feedback; if not, the task was terminated. Test trials were scored 0 for incorrect responses and 1 for correct with −1 assigned as the total score if the task was aborted. Final scores therefore ranged from −1 to 16.

HTKS required children to respond to two oral prompts, "touch your head" and "touch your toes," by doing the opposite in response to those prompts, touch their heads when the assessor says "touch your toes" and vice versa. Six practice trials with feedback were given followed by 10 test trials. For children who responded correctly to five or more of the test trials, two new prompts were added, "touch your shoulders" and "touch your knees," and then the instructions were again reversed so they were to touch their knees when the assessor said "touch your shoulders" and vice versa. Four practice trials with feedback were given followed by 10 test trials. Each trial was scored as 0 for an incorrect response, 1 for motion toward the incorrect response but a correction ending with the correct response, and 2 for a correct response. Final scores for the task were the sum of children's performance on the six initial practice items and the 20 testing items (range = 0 to 52). (The initial practice items were scored to create a better floor for the assessment.)

CSR data reduction. Based on prior empirical literature (e.g., Allan & Lonigan, 2011; Wiebe et al., 2008), the CSR assessments were assumed to represent a unitary construct, reflecting the lack of differentiation among component skills in early childhood. The measures chosen for this study are commonly used to assess CSR, and have been shown to have construct validity (e.g., Fuhs & Turner, 2012). Therefore, a principal components analysis (PCA) was conducted to determine component scores for each child at each time point as a means of reducing redundancy in measurement and preserving parsimony in results. Using a cut-off of retaining components with eigenvalues >1.0, a one-component solution emerged at both time points accounting for 40.95% of the variance at T1 and 42.31% of the variance at T2, and all loadings were > .40.

Classroom observations. The Teacher Observation in Preschool (TOP) (Bilbrey, Vorhaus, Farran, & Shufelt, 2010) and the Child Observation in Preschool (COP) (Farran & Son-Yarbrough, 2001; Farran, Son-Yarbrough, Silveri, & Culp, 1993) focus on teacher and child behaviors respectively in preschool classrooms. The TOP depicts the classroom environment in terms of the teacher's behaviors. Individual child scores in the COP are aggregated to the classroom level. During observations, observers first coded the teacher and then the assistant(s), followed by each child in the classroom before returning to the teacher to start the observation and coding process anew. Each was observed for 3 to 5 seconds, after which the observer immediately coded across nine categories. For the current study, only the primary teachers' data were included in analyses. Teachers and children were observed a maximum of 20 separate instances, or sweeps, per school day. Children and teachers were not coded when the class was out of the classroom (for meals, outdoor time, "specials," fire drills, or hallway bathroom visits) or during nap time. All observers achieved interrater reliability with an experienced anchor observer at each time point. TOP interrater reliability Kappa coefficients ranged from .82 to .86. Kappa coefficients for COP interrater reliability ranged from .82 to .87.

For the current study, all variables from TOP and COP were averaged across the three time points to create more stable estimates because a 1-day observation may not fully capture the

range of possible activities and quality of those activities. We did examine whether or not there were significant differences between scores across time, and most showed nonsignificant differences, although one of the few exceptions included literacy activities, as teachers and students spent more time in literacy at the end of the year, and emotional tone, where teachers were more negative toward the end of the year. Variables from behavior counts were computed as a proportion of sweeps in which the behavior occurred out of the total number of sweeps across three full-day observations. The teachers' emotional tone and level of instruction (TOP) were ratings instead of a behavioral count; scores were ratings averaged across all sweeps.

The *emotional climate* of the classrooms was characterized by the following TOP variables:

- Behavior Approving—proportion of sweeps teacher singled out a child to say that he or she liked what the child was doing and wanted the child to continue to engage in that behavior (e.g., "I like how you are sitting during story time."). This code is separate from classroom-level management behaviors.
- Behavior Disapproving—proportion of sweeps teacher singled out a child to say that he or she wanted the child to do something other than what the child was doing (e.g., "You need to stop getting out blocks and put them back in their bins.").
- Teacher Listening to Children—proportion of sweeps teacher listened to a single child or a group of children.
- Emotional Tone—average affective tone of the teacher across sweeps on a scale of 1 to 5 with 1 being *very negative* and 5 being *vibrant*; a score of 3 is neutral or flat.

To measure the *cognitive learning environment*, variables from both TOP and COP were used. The learning focus in COP and TOP is similarly defined as instances in which there was a specific learning area (mathematics, science, social studies, drama, literacy, code-based, reading or "other" [e.g., building with blocks]). The overall instruction variable was the proportion of sweeps in which instruction in any learning area (including "other") was coded. Three variables are related to reading readiness and require definition. Literacy was defined as instances in which words and their meanings were discussed simultaneously (e.g., scaffolded writing, a discussion of print). The code-based variable focused on learning discrete parts of the language (letters and sounds, or the names for shapes and numerals). Reading was defined as instances of children engaging with connected text either by being read to or reading on their own.

The fact that a teacher was focusing on a learning area did not necessarily indicate that the students were also attending. Likewise children were observed engaged in learning without intentional instruction from the teacher, as when children were in centers and reading books or constructing math puzzles. Thus, the TOP provided estimates of how often the teachers' instruction was focused on such things as literacy and mathematics as well as the total amount of instruction across all learning areas, whereas the COP provided estimates of the proportion of observed time children spent in each of the learning focus areas, whether or not the teacher was involved.

In addition to the proportion of sweeps spent in learning activities, we were interested in the overall *quality of instruction* across the learning areas as well as within mathematics, literacy, code-based, and reading activities. The teacher's instructional level was rated on a scale of 1 to 4, with 1 being *low* and 4 being *highly inferential*. A score of 1 was defined as teacher working with materials but not specifically teaching academic content (e.g., playing with blocks). A rating of 2 indicated basic skills instruction (e.g., "What letter is this?"), a 3 indicated some inferential instruction, or the teacher asking at least one open-ended question, and a 4 indicated a high degree of inferential instruction in which the teacher used open-ended questions and sustained focus on a topic.

Results

Analytic Approach

A series of multilevel models (children nested within classrooms, schools, and systems) was conducted to examine children's CSR gains across the preschool year related to classroom process variables (see Figure 1 for equations). The teacher and child-level variables were each entered individually into separate models as standardized variables so that the standardized estimates could be compared across models. A number of covariates were entered as fixed effects at the child level including age at pretest, the interval between pre- and posttest, gender, ELL status, IEP status, and ethnicity. All level 1

Level 1 (child level):

$$\text{Cognitive Self-Regulation POSTTEST}_{ijkl} = \beta_{0jkl} + \Sigma\beta_{1\ldots7jkl}X_{jkl} + \varepsilon_{ijkl}$$

Where X_{jkl} is the vector of student-level covariates including PRETEST (group-mean centered), INTERVAL, AGE, GENDER, ELL, IEP, ETHNICITY.

Level 2 (classroom level):

$$\beta_{0jkl} = \gamma_{00kl} + \gamma_{01kl}(\text{CLASSROOM PREDICTOR}) + \gamma_{02kl}(\text{CLASSROOM PRETEST}) + \eta_{0jkl}$$

$\beta_{1\ldots7jkl}$ are modeled as fixed effects.

Level 3 (school level):

$$\gamma_{00kl} = \pi_{000l} + \pi_{0011}\,(\text{CONDITION}) + \xi_{00kl}$$

$$\gamma_{01kl} = \pi_{010l}$$

$$\gamma_{02kl} = \pi_{020l}$$

Level 4 (system level)

$$\pi_{000l} = \mu_{0000}$$

$$\pi_{0011} = \mu_{0010}$$

Figure 1. Multilevel modeling equations used for conditional analyses.

covariates were grand-mean centered following the recommendations of Enders and Tofighi (2007). CSR pretest scores were also included at the child level as a group-centered variable. Self-regulation pretest means for the classrooms were entered at the classroom level, as we hypothesized that the classroom's average entering self-regulation skills would make an independent contribution to self-regulation outcomes. Because these data were taken from a large-scale randomized control trial of *Tools of the Mind*, condition was included as a fixed effect at the school level, although the evaluation did not indicate statistically significant differences between conditions on CSR gains.

Descriptive Statistics

Descriptive statistics for the CSR measures are presented in Table 1. Children made significant gains on each of the measures. Descriptive statistics for the classroom-level variables are presented in Table 2; it is clear that there is considerable variation across classrooms for each of the behaviors. Zero-order correlations between CSR at T1 and T2 and classroom process variables are presented in Table 3. The CSR component scores at both T1 and T2 were significantly positively correlated with several COP and TOP variables. These correlations emphasize the importance of examining gains in self-regulation and their relationship to classroom processes; it is possible that children's more regulated behaviors at pretest could be driving affective and instructional aspects of the classrooms.

Multilevel Models

Unconditional model. All multilevel models were run in IBM SPSS Version 19 using Mixed Models (IBM SPSS, Inc., IBM Corp., 2010). The fully unconditional model predicting children's spring CSR component scores without covariates determined the amount of variance accounted for by classroom, school, and system levels. The percentage of the variance in self-regulation outcomes attributable to between-classroom differences was 1.54%; 0.97% of the variance was attributable to between-school differences, and 6.14% of the variance was attributable to between-system differences. The variance in CSR outcomes attributable to between-classroom differences could be modeled by classroom-level predictors and the pretest classroom mean. The remaining 91.23% of variance was attributed to child-level differences and could be modeled with child-level covariates.

Table 1
Descriptive Statistics: Child-Level Assessments of Cognitive Self-Regulation

Variable	Min.	Max.	*Mean*	*SD*	*t*
T1 DCCS	0	3	1.31	0.57	
T2 DCCS	0	3	1.66	0.58	15.08**
T1 Copy design	0	10	1.08	1.57	
T2 Copy design	0	14	5.06	2.83	45.90**
T1 Forward digit span	0	6	2.53	1.26	
T2 Forward digit span	0	6	3.09	1.14	12.40**
T1 Backward digit span	0	5	1.14	1.15	
T2 Backward digit span	0	5	1.59	1.34	8.15**
T1 Peg tapping	−1	16	4.39	5.79	
T2 Peg tapping	−1	16	9.36	5.74	26.50**
T1 HTKS	0	52	10.15	13.07	
T2 HTKS	0	52	22.02	17.15	22.22**

Note. *t* values represent results of within-subjects *t*-tests of the difference between children's T1 scores and T2 scores on CSR measures.
** $p < .001$.

Covariates only model. The set of demographic and measurement covariates (condition, T1 to T2 testing interval, T1 age, gender, ELL status, IEP status, ethnicity [dummy coded]) were first entered into the model to predict children's spring self-regulation component scores, including children's pretest scores both group-mean centered at the child level and the pretest classroom means at the classroom level. As expected, condition was not a significant predictor of CSR outcomes. The standardized child-level CSR pretest scores ($\beta = .69$, $SE = .03$, $p < .001$), gender ($\beta = -.05$, $SE = .02$, $p = .024$), IEP status ($\beta = -.05$, $SE = .02$, $p = .029$), ethnicity (African American $\beta = -.11$, $SE = .05$, $p = .016$), and the standardized classroom-level CSR pretest means ($\beta = .63$, $SE = .09$, $p < .001$) were all significant predictors of CSR outcomes.

Conditional models. Individual standardized estimates for classroom-level process variables are presented in Table 4. Several classroom processes were significantly related to the gains children made in CSR across the year. In terms of the emotional climate, the proportion of time teachers spent in behavior approving was positively associated with children's CSR gains while behavior disapproving was marginally negatively associated with gains, and a more positive teacher emotional tone was marginally positively associated with gains.

Table 2
Descriptive Statistics: Classroom-Level Processes Averaged Across Three Observations

Variable	*N*	Min.	Max.	*Mean*	*SD*
Teachers' behavioral count proportions					
Behavior approving	60	0.00	0.12	0.04	0.03
Behavior disapproving	60	0.00	0.21	0.06	0.05
Listening to children	60	0.00	0.25	0.07	0.05
Overall amount of instruction	60	0.22	0.62	0.43	0.10
Instruction with math focus	60	0.00	0.25	0.07	0.05
Instruction with literacy focus	60	0.00	0.28	0.09	0.06
Instruction with code-based focus	60	0.00	0.18	0.06	0.05
Instruction with reading focus	60	0.00	0.18	0.06	0.03
Children's behavioral count proportions					
Activity with math focus	60	0.02	0.17	0.06	0.03
Activity with literacy focus	60	0.02	0.22	0.09	0.04
Activity with code-based focus	60	0.01	0.14	0.08	0.03
Activity with reading focus	60	0.00	0.11	0.05	0.03
Teacher behaviors—Average ratings					
Emotional tone	60	3.04	3.80	3.41	0.18
Overall level of instruction (LOI)	60	1.60	3.73	1.92	0.27
Math LOI	56	0.67	2.00	1.91	0.27
Literacy LOI	57	1.00	2.50	1.97	0.24
Code-based LOI	51	0.00	2.50	1.82	0.46
Reading LOI	57	1.67	3.33	2.08	0.25

Note. For a teacher to receive a level of instruction code within a specific academic content area, the teacher had to instruct in that content area. Thus, teachers who were not observed instructing in a particular content area at any of the observation time points did not receive a mean level of instruction score for that area.

Table 3
Zero-Order Correlations Between Cognitive Self-Regulation and Classroom Processes

	T1 SR	T2 SR
Teachers' behavioral count proportions		
Behavior approving	.048	.114**
Behavior disapproving	.014	−.024
Listening to children	.085*	.039
Overall amount of instruction	.053	.087*
Instruction with math focus	.161**	.196**
Instruction with literacy focus	−.029	−.017
Instruction with code-based focus	.030	.061
Instruction with reading focus	.122**	.161**
Children's behavioral count proportions		
Activity with math focus	.119**	.177**
Activity with literacy focus	.106**	.154**
Activity with code-based focus	−.064	−.011
Activity with reading focus	−.003	.050
Teacher behaviors—Average ratings		
Emotional tone	.006	.049
Overall level of instruction (LOI)	.021	.054
Math LOI	.072	.040
Literacy LOI	.059	.102**
Code-based LOI	.005	.022
Reading LOI	.011	.027

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

For the cognitive environment, the proportion of sweeps spent in instruction overall was positively associated with gains in children's CSR skills. Within the instruction category, the proportion of sweeps teachers instructed with a literacy focus was positively associated with children's gains. The effects on CSR gains were stronger for the children's learning foci. The proportions of sweeps children were focused on either mathematics, literacy, or code-based activities were each positively and significantly associated with gains in children's CSR outcomes. Finally, teachers' quality of instruction averaged across learning areas was positively associated with children's CSR gains, but instructional level within any particular learning area was not.

Discussion

The present study examined classroom correlates of the development of children's CSR skills. Specifically, we assessed the classroom emotional climate, the cognitive learning environment (instructional foci for teachers, learning foci for children), and the quality of teachers' instruction. We found significant associations between several classroom process variables and gains in children's CSR skills. Relating classroom process behaviors to developmental gains is a major contribution of this research to understanding effective classrooms for young children.

Before we examined associations between classroom processes and gains in children's CSR, we first calculated the percentage of variance in spring CSR scores that could be attributed to differences in the nesting levels and found that approximately 91% of the variance in spring CSR outcomes was attributable to child-level differences, with the remaining variance attributable to the nesting levels. This was similar to ICCs (.10, .11) reported for kindergarten academic achievement for low-achieving schools, and was lower than ICCs (.22, .22) reported for kindergarten academic achievement for low SES schools (Hedges & Hedberg, 2007). The ICCs for the nesting levels on preschool academic achievement in the large-scale study from which the current data were drawn were somewhat higher than CSR estimates, with a non-child-level ICC of .16. Unfortunately, we do not have the type of comparison data for CSR that we do for academic achievement (Hedges & Hedberg, 2007), and we do not have sufficient ICC data for preschool classrooms more generally. These lower ICCs are not entirely surprising, as academic skill content is often the explicit focus of preschool curricula. One possible interpretation is that teachers may have less influence on CSR than they have on early academic achievement in preschool. However, it could also mean that teachers do not yet know how to provide sufficient intentional instruction on CSR in a preschool learning environment, thus compressing the variance that would be due to teacher competence in this area.

We also examined the influence of demographic covariates on children's spring CSR scores prior to running conditional models. We found that gender, age, and ethnicity covariates were significantly associated with children's spring CSR when controlling for pretest and the testing interval between fall and spring assessments. Age differences were expected as age and maturational influences on CSR have been well documented (e.g., Garon et al., 2008). We found that girls had significantly higher CSR scores in the spring compared to boys in the

Table 4
Classroom Processes as Predictors of Children's Cognitive Self-Regulation Gains

Variables (Organized by category)	Standardized estimate	*t*-ratio	*p*
Teacher's emotional climate			
Behavior approving	0.06	2.05	.05
Behavior disapproving	−0.05	−1.70	.09
Teacher listening to children	−0.03	−1.03	.31
Emotional tone	0.06	1.88	.07
Proportion of sweeps in instruction			
Teachers' instructional foci			
Overall instruction	0.07	2.25	.03
Math focus	0.05	1.65	.11
Literacy focus	0.10	2.88	.01
Code-based focus	0.03	0.75	.46
Reading focus	0.03	0.95	.35
Children's learning foci (classroom average)			
Math focus	0.08	2.79	.01
Literacy focus	0.11	2.83	.01
Code-based focus	0.07	2.09	.04
Reading focus	0.05	1.57	.12
Teacher's quality of instruction			
Overall level of instruction (LOI)	0.06	2.00	.05
Math LOI	−0.01	−0.33	.74
Literacy LOI	0.05	1.51	.14
Code-based LOI	0.01	0.32	.75
Reading LOI	0.02	0.61	.55

current study, but overall, research is mixed concerning gender differences, with some studies finding significant differences (e.g., Wiebe et al., 2008) while others found no differences (e.g., Hughes, Ensor, Wilson, & Graham, 2010; Wiebe et al., 2011). Previous research in this area is largely cross-sectional and may contribute to these mixed findings, although more research is needed to explore these potential differences. Finally, we found differences by ethnicity, with students from minority backgrounds scoring significantly below their nonminority peers. Although speculative, this difference may be a proxy for SES differences in urban and nonurban samples or among minority and nonminority youth even among a group of children all likely to come from low-income homes. Unfortunately, we did not have access to parent income in this sample and cannot determine the level of poverty experienced by children in our study.

After we examined unconditional models with and without covariates, we entered classroom processes variables into separate models to examine their individual associations with children's CSR gains. Children made more CSR gains in classrooms where teachers more frequently expressed their approval of students' behavior, encouraged them to continue behaving in a desirable ways, and did less redirecting. With respect to the marginally significant finding for behavior disapproving, this code was more general than simple reprimands, though reprimands would count as behavior disapproving. Instead, disapproving represented a form of external control on children's behavior. It was a message from the teacher that said, "Whatever you have chosen to do, I would like you to do something different." Some may think this sort of teacher behavior inescapable in a classroom. However, four classrooms in this study were never observed behavior disapproving (by either teacher or assistant) at any of the three observations. Despite the fact that we observed a narrow range of affective tone in teachers (who were primarily observed to be neutral or flat in their affect), the degree of variation observed was at least marginally related to gains in CSR for children.

Indeed, previous research has indicated an association between a more positive emotional classroom climate and children's academic (e.g., Pianta et al., 2005) and social competence

(e.g., Curby et al., 2009). The results of the current study extend this line of work in two important ways. First, we utilized a classroom quality assessment that is designed to capture snapshots of teacher and student behavior throughout the day whereas much of the previous work on classroom quality has relied on global ratings; and second, we found associations between the classroom emotional climate and direct assessments of children's CSR, which extends previous work using teacher reports of children's classroom behavior. Particularly relevant to the current study findings, the emotional climate results are consistent with the experimental results of the CSRP (Raver et al., 2008; 2011). The results of the current study support the idea that teachers who communicate appreciation for children's efforts, who show more warmth and less often disapprove, create a classroom in which internal regulation is fostered in children. Children may feel more comfortable exploring new self-regulatory strategies in environments that are supportive, and they may receive more positive feedback on their attempts at self-regulation from teachers who engage in more behavior approving. This work also aligns with recent work on the associations between maternal behavior and children's development of CSR skills (e.g., Bernier et al., 2010), where mothers who offer more autonomy-support and show more positive emotional warmth and sensitivity have children with higher CSR skills, suggesting overlap between associated processes that promote CSR at home and in classroom environments.

In addition to emotional climate, our results suggest that the classroom cognitive environment is important for self-regulation gains, providing empirical support for the Hackman et al. (2010) assertion that CSR is responsive to a combination of positive caretaking and cognitive stimulation. Both the proportion of observed time spent in instruction delivered by the teacher and the proportion of observed time children spent in learning foci (regardless of teacher participation or instruction) were associated with children's CSR gains. Neither of these should be viewed as support for direct instruction. Instead, the amount teachers were focused on specific content and children were focused on learning activities are indicators of classrooms that are better managed and organized. The findings suggest that teachers had activities well-enough managed so that they could devote more time to engaging children in learning and that the materials and activities in the classroom held children's interest and kept them engaged even when working independently. Indeed, in previous research, classroom management has been associated with teacher reports of children's self-control and work habits in kindergarten (Rimm-Kaufman et al., 2009).

Results indicated an overall effect for quality of instruction, such that teachers who asked more open-ended questions and included conversational turns had students who made more gains in self-regulation across the school year. Higher levels of quality in instruction have been linked to achievement gains in young children (e.g., Curby et al., 2009); our study has shown the importance of this area for children's development of CSR. Engaging in more inferential questions might facilitate more complex thinking on the part of the children (Zucker, Justice, Piasta, & Kaderavek, 2010). Multiword, inferential responses require more planning and draw on working memory as children engage in higher-level reasoning about recently acquired information.

Limitations and Implications for Practice

Our classroom observational system is a snapshot approach. More fine-grained qualitative methods could be employed to investigate how teacher−child interactions and different types of classroom activities facilitate the type of behaviors we have linked to self-regulation. For example, assessing how conversational turns or verbal encouragement and elaboration influence children's behavior would provide more specific information on how emotional climate may be associated with students' self-regulation gains. In other words, building on the analysis of behavioral counts that drove the present analysis, investigating the content of teacher's verbal and nonverbal exchanges with students and sequences of interactions during different types of classroom activities might provide a more nuanced picture of classroom processes.

Overall, these results suggest that there are several key classroom variables, both teacher-driven and child-driven, that may foster greater gains in CSR for preschoolers. Importantly, our sample was diverse as it included children from varying race/ethnicity backgrounds and also a

mix of urban and rural school districts, which allows for a greater potential of generalizability of findings. These results suggest that interventions and professional development focusing on improving teachers' emotional tone and use of behavior approving, in addition to allowing more quality instructional time and child-directed activities that focus on academic content, are good candidates to make a significant impact on children's CSR gains across the preschool year. However, each of these variables in isolation had a small, albeit significant in many cases, effect on children's CSR gains. This may suggest that perhaps our indicators of emotional climate and cognitive stimulation might be proxies for more global classroom quality features. Perhaps a teacher who is more approving, has a more positive tone, and spends more time in quality instruction is also a teacher who, as suggested by CSRP results (Raver et al., 2011) is better able to manage stress in the classroom and has more behavioral management skills to allow for optimal learning conditions. Although previous research has suggested that preschool classrooms have, on average, a relatively positive emotional climate, the quality of the instructional climate (i.e., level of instruction) tends to be poor (Pianta et al., 2005). As these results are exploratory, future work is needed to address whether or not these classroom processes are malleable. Our work suggests that important classroom processes may reside at the level of more general interactions between children and teachers; whether or not those interactions can be experimentally altered is important to determine.

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