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Executive Function is Associated with Social Competence in Preschool-Aged Children Born Preterm or Full Term

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Abstract

Background—Executive function (EF), defined as higher-order cognitive processes used in planning and organizing actions and emotions, is often impaired in children born preterm. Few studies have assessed social competence, the processes and resources required to meet social demands and achieve social goals, in children born preterm. The relations between EF and social competence in preterm and full term preschoolers have not been well characterized.

Aims—To characterize social competence and assess the relationship between EF and social competence in preschool-aged children born preterm or full term.

Study design—Cross-sectional study.

Subjects—Study subjects had a history of preterm birth (< 34 weeks gestation) and birth weight < 2500 g (n = 70). Controls were born full term (> 37 weeks) (n = 79).

Outcome measures—Children completed a battery of EF tasks; a mean age-adjusted z-score for the battery was generated for each child. Parents rated child EF on one scale and child social competence on two standardized scales.

Results—Compared to full term children, preterm children showed a lower mean EF battery z-score, poorer parent-rated EF, and poorer scores on the two social competence scales. In hierarchical multiple regression models, EF battery z-score and parent-rated EF made independent contributions to both measures of social competence. Preterm birth explained additional variance for one measure of social competence.

Conclusions—Standard assessment of EF skills and social competence in young preschool children, including children born preterm, may identify at-risk children for long-term social difficulties and may also provide targets for intervention.

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Keywords

premature birth; preterm birth; executive function; social competence; Behavior Rating Inventory of Executive Function; preschool

Introduction

Executive function (EF) has been defined as “higher-order cognitive processes involved in the self-regulation of thought, action, and emotion” ((1) page 1). EF is necessary for purposeful, goal-directed activity (2). The EF skills that are developing in the preschool-aged child include inhibitory control, set shifting, planning and working memory (3–6). Deficits in EF are seen in young child clinical populations, such as children with histories of prematurity (4, 5, 7, 8), attention-deficit/hyperactivity disorder (ADHD) (4, 9), aggression (2) or brain injury (10). Poor EF skills are related to difficulties in important areas of function, including cognitive and academic domains (2, 11). It also has been proposed that poor EF has a role in social problems, from early childhood onward. However, published studies have focused on general social skills (1, 12), and are challenging to interpret as they measure a wide variety of psychosocial constructs spanning cooperative behavior and social functioning.

Social competence is one important facet of children’s social-emotional development (1). Social competence can be defined as “active and skillful coordination of multiple processes and resources of the child to meet social demands and achieve social goals in a particular type of social interaction (e.g., parent-child, peer relations) and within a specific context (e.g., home, school)” ((13), page 13). Social competence emerges gradually through childhood and adolescence and reflects a dynamic interplay between the individual and his/her environment (14). Social competence can be assessed using child interviews, direct observations, or parent and teacher questionnaires (15–20). Social competence has important implications for public health from infancy to adulthood because it is associated with mental health, academic performance, and work place functioning (19, 21).

Studies of children born preterm have shown increased likelihood of adverse developmental, cognitive, and behavioral outcomes (4, 5, 7, 8, 22–24). Further, researchers have shown that, compared to peers born at term, youth born preterm have greater difficulty with social relationships (22, 25, 26). However, very few studies have specifically assessed the social competence of children born preterm (27, 28), particularly at young ages. Studies have shown that EF contributes to social outcomes in older preterm children (29, 30). Studies of typically developing young children suggest that emerging EF skills may facilitate children’s social competence (1, 3, 11). An understanding of the associations of EF and social competence in young preschool children born preterm might inform intervention strategies to improve their EF and social competence early in life. The overall goal of this study was to determine if executive function (EF) skills play a role in the social competence of preschool-aged children born preterm.

Sociodemographic factors, such as socioeconomic status and age, may also affect the development of both social competence and EF. Socioeconomic status has been associated

with a wide array of socioemotional, cognitive, and health outcomes in childhood (31), including preterm birth (32). Poor EF skills have been associated with economic disadvantage in children (33, 34). A longitudinal study of preterm and full term children followed from birth to thirty-six months showed that higher SES was predictive of better cognitive and social development for all children (35). Age is another important factor in the development of social competence and EF as both typically improve from childhood through adolescence (36).

Study Objective and Hypotheses

The objective of our study was to characterize the relationship between EF and social competence in preschool-aged children who were born preterm or full term. We previously have demonstrated EF differences between full-term and preterm children (37). In this study, we focused on children born preterm as a model of biomedical risk for both impairments in EF and problems in social competence. We had three main hypotheses. Hypothesis 1 addresses social competence differences between full term and preterm children: Compared to full term children, preterm children show poorer parent-rated social competence. Hypothesis 2 addresses links between EF and social competence in both preterm and full term children: EF, whether assessed using performance-based measures or parent rating, is associated with social competence. These associations persist after controlling for maternal education and child age. Hypothesis 3 addresses contributions of preterm birth to social competence: Given the increased risk of adverse outcomes in children born preterm, gestational group contributes additional variance, beyond the effect of EF, to social competence.

Methods

Participants

Participants were 3- to 5-year-old children recruited from Palo Alto, CA, and surrounding counties. Gestational age (GA), birth weight (BW), and medical complications were gathered from parent report and medical records. Study subjects had a history of preterm birth (< 34 weeks gestation) and BW < 2500 g (n = 70). Controls were born full term (> 37 weeks) and had no major medical complications (n = 79). Exclusion criteria for all participants included sensory impairments (i.e., blind or deaf), identified genetic syndrome or congenital heart disease, and inability to comprehend task instructions.

The study population consisted of a convenience sample of children born 2004 to 2009. Preterm subjects were recruited by letters sent to families of children who were evaluated at High Risk Infant Follow-up Services at Lucile Packard Children's Hospital Stanford in Palo Alto, CA, and by postings on local parent message boards. Control children were recruited by postings on parent message boards, by flyers in general pediatric clinics, and by word of mouth. Controls were group-matched to children born preterm for age, gender, ethnicity, and race. The study was approved by the Stanford Institutional Review Board. A parent or legal guardian provided informed consent. Participants were compensated for participation.

Procedure

Parents completed a demographic questionnaire and standardized EF rating scales. Children completed a battery of EF tasks that were administered by trained research assistants. Parents also completed two standardized measures of social competence.

Measures and Variables

Demographics and health information—A demographics and health questionnaire collected information addressing child age, gender, ethnicity, race, and school participation (attending daycare, preschool, or kindergarten). Maternal education (< 4 years college, 4 years college, master's degree) was used as an indicator of SES for this relatively high SES population. Health information included gestational age at time of delivery (preterm 34 weeks gestation; full term 37 weeks gestation), birthweight, and medical conditions. Information concerning receipt of early intervention services also was collected.

Performance-based EF—Tasks were selected to represent core EF constructs based on the developmental literature on EF in typical and preterm preschoolers (4, 5, 38). Children completed a behavioral battery of EF tasks that included:

1. Three- and Six-Boxes task, a measure of working memory and planning. Six stationary boxes with different color lids are baited with a treat in view of the child. The child's task is to efficiently find all treats by keeping track of the boxes that have already been searched. The dependent variable was the total number of reaches to find all treats.
2. Day/Night task, a measure of complex response inhibition. The child should respond "night" when shown a picture of the sun and "day" when shown a picture of moon and stars. The task requires the inhibition of a prepotent verbal response in the presence of competing visual information. The dependent variable was the number of correct responses reverse scored by subtracting the number of practice trials.
3. Bird/Dragon task, a modified Simon Says task, a measure of complex response inhibition and working memory. The child must hold a rule in mind and respond while inhibiting a prepotent response. The dependent variable was the number of correct responses reverse scored by subtracting the number of practice trials.
4. Dimensional Change Card Sort, a measure of cognitive flexibility/task switching and attention shifting. The child is shown cards depicting colored shapes that can be sorted by color or shape. The child must sort according to one dimension and then shift to sort according to the other dimension. The dependent variable was the number of correct responses on the post-switch phase.
5. Verbal Fluency task, a measure of verbal productivity with language and organizational components. The child is asked to generate as many words as possible within specific categories (i.e., animals, foods) in one minute. The dependent variable was the total number of words that were unique and correct (belongs to the category).

We have reported on differences between preterm and full term groups on each of these tests, with a detailed description of the tasks (37). We converted continuous outcome measures from the performance-based EF tasks to z-scores derived from performance (mean, SD) of full term subjects in the three age groups of 3, 4, and 5 years. As outlined in the original study, we found significant small to moderate correlations among all performance-based EF measures (37). Given the correlations among the tasks, for our analyses, we used an average z-score for the five EF tasks as a summary measure of child EF performance.

Parent-rated EF—Parents completed the Behavior Rating Inventory of Executive Function-Preschool version (BRIEF-P), a standardized parent-rating scale of behavioral manifestations of EF in children 2.0–5.11 years of age within the context of everyday environments (39, 40). Sixty-three items address five EF constructs: Inhibit, Shift, Emotional Control, Working Memory, and Plan/Organize. Items are rated on a 3-point scale of “never”, “sometimes”, or “often”. Three broad indices (Inhibitory Self-Control, Flexibility, Emergent Metacognition) and a composite score (Global Executive Composite, GEC) are generated. Index scores are reported as T-scores (mean of 50, SD of 10); higher scores indicate greater executive dysfunction. Scores at or above 65 are considered clinically significant. The measure is normed for gender and age by two groupings: 2:0 to 3:11 and 4:0 to 5:11. Content validity is based on factor analysis of clinical and normative samples, convergence/discrimination with preschool rating scale measures, and on the ability to detect EF deficits in children with risk factors or disorder (40). Examples of items from the BRIEF-P that tap specific EF constructs are:

- Inhibit—“acts too wild or out of control”
- Working memory—“cannot stay on the same topic when talking” and “has trouble remembering something, even after a brief period of time”
- Plan/organize—“has trouble thinking of a different way to solve a problem or complete an activity when stuck” and “when instructed to clean up, puts things away in a disorganized, random way”

Similar to the EF battery, we found significant correlations among the BRIEF GEC and all indices (37), therefore, we used the GEC as a summary measure of parent-rated EF skills.

Social competence—Parents completed the Vineland-II and the Social Competence and Behavior Evaluation-Short Form (SCBE-30):

1. Vineland-II is a standardized parent-rating scale of adaptive behavior from birth to adulthood (41). Items are rated on a 3-point Likert scale (0 = never, 1 = sometimes or partially, 2 = usually). It generates standard scores ($M = 100$, $SD = 15$) reflecting the following domains: Communication, Daily Living Skills, Socialization, Motor Skills and Maladaptive Behavior. The Socialization Scale includes the following subscales: Interpersonal Relationships, Play and Leisure Time, and Coping Skills. Examples of Vineland items for the Socialization scale are: interpersonal relationships--“shows interest in children the same age”; play and leisure time--“plays cooperatively with one or more children for 5 minutes”; and coping skills--

“responds appropriately to reasonable changes in routine”. The questions are different from those in the BRIEF-P. We used the Socialization Scale standard score as a summary rating of social competence, a decision in keeping with other studies (20).

2. SCBE-30, Research Edition, is a well-validated 30-item questionnaire that assesses emerging pro-social behaviors and interactions in the preschool period (16–19). Items are rated on a 6-point Likert scale (1 = never, 2 or 3 = sometimes, 4 or 5 = often, 6 = always) and yield three scales: Social Competence, Anxious/Withdrawn, Anger/Aggression. The Social Competence scale items reflect emotional expressions, social interaction with peers, and social interaction with teachers; exemplar items include: “comforts or assists another child in difficulty”, “cooperates with other children in group activities”, and “helps with everyday tasks”. The questions in the SCBE-30 are distinct from the questions in both the BRIEF-P and the Vineland-II. We used the Social Competence scale raw score as a second measure of social competence.

Statistical Analyses

Descriptive analyses and group differences—Means and proportions were used to describe the sample with regard to demographic variables. To compare full term and preterm groups on demographic variables, EF scores, and social competence variables, we used t-tests for continuous variables and Pearson chi-square for dichotomous outcomes. Data from the BRIEF was missing for 4 preterm children. Data from the Vineland was missing for 5 full term and 9 preterm subjects. Data from the SCBE-30 was missing for 2 full term and 4 preterm subjects. Data were missing from the EF battery as follows: one preterm child for the bird/dragon task (would not play); one preterm and one full term for the day/night task (technical failure); 14 preterm and 6 full term for the verbal fluency task (change in testing protocol).

Regression analyses—Hierarchical multiple regression was conducted on the entire sample to determine which demographic (maternal education; child age) and EF (performance-based EF – EF Tasks z-score; parent-reported EF – BRIEF GEC) variables were related to social competence (Vineland Socialization and SCBE Social Competence). We entered maternal education in the first step to account for potential contributions of SES, as lower SES has been associated with several of the factors measured in the study, including preterm birth, impaired EF skills, and social outcomes (33). For the first model predicting Vineland Socialization score, child age was not entered; the Vineland covers the lifespan and is normed for age (41). For the second model predicting SCBE Social Competence score, child age was entered in the first step, as the SCBE-30 is designed for use across a narrow age range (30 to 78 months) and is not normed for age (16, 18). EF scores were entered into the regression models after demographic variables. We chose to enter the performance-based EF score (EF Tasks z-score) before parent-rated EF score due to the potential of shared method variance contributing to the outcome (i.e., BRIEF, Vineland and SCBE-30 are based on parent report). Gestational group status (preterm vs.

full term) was entered in the final step, after maternal education and EF measures, to capture additional variance attributable to group differences.

Results

Descriptive Analyses and Group Differences

Demographics and health—One hundred forty-nine participants were enrolled: 70 born preterm and 79 born full-term (see Table 1). Across gestational groups, child age, gender, race, and ethnicity distributions were similar. Overall, the mean participant age was 4.5 years ($SD = .79$), 50% male, 60% white, and 9% Latino. The two groups differed, by study design, with regard to birth weight and gestational age. Medical complications at birth in the preterm group included: 11 had abnormal findings on head ultrasound or MRI (at least grade 2 intraventricular hemorrhage or IVH, echodensities, or cystic lesions) and 10 had mildly abnormal findings (grade 1 IVH or choroid plexus cyst); 40 had RDS and 7 developed chronic lung disease; 5 had necrotizing enterocolitis; and 8 were small for gestational age (defined as lying at or below the 3rd percentile in birth weight for gestational age). The proportion of mothers with an educational level less than a college degree was larger for the preterm group compared to the full term group (30% vs. 9%, $p < .003$). There were no differences between groups in the proportion of children attending daycare, preschool, or kindergarten. As expected, the proportion of participants with a history of receiving early intervention services was larger in the preterm group compared to the full term group (41% vs. 0%, $p < .001$).

Executive function—As previously reported, we found significant differences on all tasks in the EF battery and the BRIEF composite, indices, and scales, with the preterm group having poorer performance or higher scores (more EF problems) than the full term group (37). For this study, we include the differences between groups on summary EF measures (see Table 2). On average, preterm children had significantly lower EF Task z-scores and higher BRIEF GEC scores, indicating more EF problems, than did full term children. The correlation between average EF Tasks z-score and parent-rated GEC was modestly but statistically significant ($r = -.176$, $p = .034$).

Social competence—The mean Vineland-II Socialization score, and all Vineland social subscale scores were significantly lower, indicating poorer social competence, for the preterm group compared to the full term group (see Table 2). The mean Vineland-II socialization score for the full term group was at the high end of the average range and almost one standard deviation higher than the preterm group. The mean SCBE Social Competence score was also significantly lower, corroborating poorer social competence, for the preterm group compared to the full term group. The correlation between SCBE Social Competence scores and Vineland Socialization scores was statistically significant ($r = .509$, $p < .001$).

Models Predicting to Social Competence

In the first set of models (Table 3), parent-rated social competence as measured by the Vineland-II Socialization scale was examined as a function of maternal education, EF, and

gestational group variables. Maternal education was entered in step 1 and did not make a significant contribution to the model (R-squared change = .002). EF variables were entered in steps 2 and 3. Results demonstrated that the performance-based EF skills variable (EF Tasks z-score) accounted for 10.2% of the variance in social function. The parent-rated EF variable (BRIEF GEC) added 7.8% to the total explained variance. In step 4, gestational group accounted for another 9.1% of the variance in social function; the BRIEF GEC remained significantly associated with the socialization score, but the EF Tasks z-score did not. This model accounted for a total of 27.3% of the variance in parent-rated social competence, as measured by the Vineland-II Socialization scale.

In the second set of models (Table 4), parent-rated social competence as measured by the SCBE Social Competence scale was examined as a function of maternal education, child age, EF, and gestational group variables. Maternal education and child age, entered in steps 1 and 2, did not make significant contributions to the model (R-squared changes = .021 and .017, respectively). EF variables were entered in steps 3 and 4. Results demonstrated that the performance-based EF skills variable (EF Tasks z-score) significantly accounted for 10.7% of the variance in social competence. The parent-rated EF variable (BRIEF GEC) added another 14.2% to the total explained variance. In step 5, gestational group did not add significantly to the total variance (R-squared change = .002); both performance-based and parent-rated EF remained significantly associated with social competence. This model accounted for a total of 29.0% of the variance in parent-rated social competence as measured by the SCBE Socialization scale.

Discussion

This study of three- to five-year old preterm and full term preschool children found that compared to full term children, preterm children showed poorer social competence on two parent rating measures that assess different components of social competence. As previously reported, preterm children compared to full term children had poorer EF skills on both performance-based and parent-rated EF measures (37). Our investigation of the association between EF and social competence showed that both performance-based and parent-rated measures of EF made independent contributions to social competence. Gestational group contributed additional variance to social competence measured by the Vineland-II, but not the SCBE.

The social competence results are consistent with previous studies of preterm children that found that preterm compared to full term groups have poor social outcomes (27, 28). One major contribution of this study is its use of multiple measures of social competence. The study of social competence is important because problems in the social domain contribute to psychological distress, social isolation, and reduced self-esteem and may impact greatly on quality of life (14). Poor social competence is associated with behavior problems, conduct disorder, internalizing disorders (such as depression), cognitive impairments, and developmental and neurological conditions (e. g., ADHD, schizophrenia, brain injury) (14, 42, 43).

The EF results are consistent with previous studies on children born preterm that used an administered EF battery or parent report of EF skills (2, 5, 7, 8). This study adds to the literature by examining the association between EF and social competence using both performance-based and parent-rated EF measures. Parent report and direct observation appear to capture overlapping as well as distinctive aspects of EF (37); these variables were significantly but only modestly correlated ($r = -.18$). In addition, as discussed below, these two variables made independent contributions to social competence, suggesting that they assess distinct subcomponents of EF.

A second contribution is the focus on preschoolers. A large longitudinal follow-up study of adolescents born preterm showed persistence of social difficulties (25), suggesting that identifying children with poor social competence during preschool and intervening early may improve long-term outcomes.

A third contribution of this study is that it demonstrates that EF, whether assessed using performance-based measures or parent rating, is associated with social competence. Using regression models, we found that these relations persist after controlling for maternal education and child age. With the addition of gestational age group in the final steps of the models, performance-based EF was no longer significant in predicting to Vineland-II socialization score, but remained significant when predicting to SCBE social competence score. In the final model predicting to the Vineland Socialization score, gestational age group also made an independent contribution to the outcome measure. In the final model predicting to SCBE Social Competence score, gestational age group made no independent contribution to the outcome. These findings may indicate that prematurity is associated with the development of skills in social competence, as measured by a developmental measure, such as the Vineland-II, whereas the contributions of EF to social and emotional functioning, as measured by the SCBE are very similar in preterm and full term preschoolers.

The differences in contribution of gestational age group to social competence outcomes may also relate to how the two measures of social competence were validated and subtle differences in the underlying theoretical constructs being measured under the broader umbrella of social function. Standardization of the Vineland-II included a normative sample consisting of 20 age groups covering the age range from birth through 90 years (41). In addition, eleven clinical groups (i.e., attention-deficit/hyperactivity disorder; autism; specific learning disability; intellectual disability) were studied to validate identification of adaptive deficits in those populations. Criterion-related validity studies compared Vineland-II scores to other instruments assessing behavior and ability, such as the Adaptive Behavior Assessment System, Second Edition; the Behavior Assessment System for Children, Second Edition; and the Wechsler Intelligence Scale for Children, Third Edition (41). In contrast, the SCBE is used for children across a narrow age range (30–78 months) (16, 18). It was compared to the Child Behavior Checklist/Teacher Report Form to establish convergent and discriminant validity but not the Vineland. Criterion validity for the SCBE was established using peer sociometrics and direct observation of social participation; the short form of the SCBE utilized a structured, directly observed compliance task (16, 18). The social competence factor of the SCBE taps a range of items designed to assess the positive

qualities of the child's adaptation, rather than specific behavioral competencies. Social competence in the context of the SCBE refers to a well-adjusted, flexible, and generally prosocial pattern of adaptation (16). Given these differences in the two measures, the Vineland may have been more sensitive to group differences in a clinical population of preterm children compared to full term children, whereas the SCBE may be more sensitive to prosocial patterns of behaviors observed across all children.

Our findings are consistent with a recently published study addressing social competence in preschool-aged children born very preterm (28). In their study, Jones et al. found that cognitive ability, as measured by IQ, mediated the effects of brain injury on social competence; however, the study did not examine EF (28). Loe et al. found that, compared to 9- to 16-year-old youth born at term, same-aged youth born preterm had lower performance-based EF and lower parent-rated child function, a composite comprised of child activities, school and social function; EF contributed to parent-rated child function, which included aspects of social competence (30). Taylor et al. found that 8 year old preterm children had lower scores than term children on academic achievement and adaptive functioning, which included socialization measured on the Vineland (28). In that study, neuropsychological skills assessed using a standardized measure of EF skills, including planning and memory, mediated the effects of neonatal risk on academic and functional outcomes (29). Other studies of clinical populations such as children with traumatic brain injury (10) and children with fetal alcohol exposure (44) also found relationships between parent-rated EF using the same measures as our study (BRIEF) and social outcomes. The study of children with traumatic brain injury also examined performance-based measures of EF, but did not find significant associations with social outcomes (10).

The clinical assessment of EF and its association with functional outcomes such as social competence is an important area of applied research focus, particularly in at-risk populations such as children born preterm. Given the links between EF skills and social competence, we suggest that EF skills and social competence may serve as targets for intervention to improve overall outcomes, including social competence in children born preterm. A few studies have explored the potential of neuropsychological interventions in preterm children, including computer-based working memory intervention that targets EF skills (45). Preschool curricula targeting multiple EF skills have shown improvements in EF; the Head Start REDI (Research Based, Developmentally Informed) intervention was tested in a randomized-controlled trial of 356 preschoolers and demonstrated EF gains (46). The possibility of interventions in the reverse direction also could be considered: that is, effecting change in social competence in order to improve EF. In this vein, a study of 27 students (11–14 years) with high functioning autism showed significant improvement on parent reports of social skills and EF after administration of a group-based Social Competence Intervention that used cognitive behavioral principles (47). While studies with larger samples and application in naturalistic settings are warranted, Social Competence Intervention appears promising and may be useful in other at-risk populations.

Our study had limitations. The mean maternal education of the sample was high, consistent with the geographic area, and may not be representative of the preterm and full term population with lower SES. High maternal education may have limited the ability to identify

contributions of SES to outcomes. In addition, the full term group had a mean socialization score on the Vineland at the high end of the average range compared to the preterm group, which also may have limited the ability to identify contributions of SES. Nonetheless, even with the resources and access to services accompanying higher maternal education, the preterm children in our study showed impairment in EF and social competence compared to full term children. We did not collect teacher reports of EF skills or social competence, as not all children were in school programs. Future work that includes teacher or non-parent caregiver reports would decrease the shared response bias attributable to parent ratings of both EF and social competence. The measurement of social competence through direct assessment and/or standardized observation rather than parent report would also allow further examination of the associations with reduced response bias among predictor and outcome variables. Longitudinal study of the development of EF and social outcomes would allow for better understanding of the developmental trajectory of skills in preterm children.

In summary, this study found that parent-rated and performance-based measures of EF were associated with two different measures of social competence. These results contribute to our understanding of the links between EF, as a cognitive domain of function, and social competence, another important but less well studied domain of function in children born preterm. We propose standard assessment of EF skills and social competence in young children in the preschool period, especially in children born preterm, in order to identify children at-risk for long-term social difficulties. EF and social competence measures may also provide targets for intervention and opportunities to assess change after treatment.

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Abbreviations

BRIEF	Behavior Rating Inventory of Executive Function
BW	birth weight
EF	executive function
GA	gestational age
GEC	global executive composite
SCBE	Social Competence and Behavior Evaluation
SD	standard deviation
SES	socioeconomic status

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Table 1

Demographic characteristics of preterm and full term participants

Gestational Group	Total (N=149)	Preterm (N=70)	Full Term (N=79)	<i>t</i> or χ^2	<i>p</i>
Age (years), Mean (SD)	4.5 (.79)	4.6 (.76)	4.4 (.82)	-1.5	.135
Birth characteristics, Mean (SD)					
Gestational age (weeks)	34.7 (5.2)	29.6 (2.6)	39.3 (1.4)	27.4	< .001
Birth weight (grams)	2409 (1097)	1365 (455)	3331 (507)	24.8	< .001
Race, n (%)				.064	.867
White	91 (39)	42 (60)	49 (61)		
Nonwhite	58 (61)	28 (40)	31 (39)		
Ethnicity, n (%)				1.6	.453
Nonhispanic/Nonlatino	108 (72)	47 (67)	61 (76)		
Hispanic/Latino	14 (9)	8 (12)	6 (8)		
Mixed	28 (19)	15 (21)	13 (16)		
Gender, n (%)				2.4	.141
Male	75 (50)	40 (57)	35 (44)		
Female	74 (50)	30 (43)	44 (56)		
Maternal Education, n (%)				12	.003
< 4 years college	28 (19)	21 (30)	7 (9)		
4 years college	50 (33)	23 (33)	27 (34)		
Master's degree	71 (48)	26 (37)	45 (57)		
Child care/School, n (%)					
Daycare	23 (16)	11 (16)	12 (15)	.009	.926
Preschool	113 (87)	57 (84)	56 (91)	1.8	.177
Kindergarten	17 (13)	7 (10)	10 (13)	.23	.635
Early Intervention, n (%)				65	< .001
Yes	41 (27)	41 (59)	0 (0)		

Gestational Group	Total (N=149)	Preterm (N=70)	Full Term (N=79)	t or χ^2		p
No	108 (73)	29 (41)	79 (100)			

Table 2

Executive Function and Social Competence

Gestational Group		Preterm (N=70)	Full Term (N=79)		
		Mean (SD) or N (%)	Mean (SD) or N (%)	<i>t</i> or X^2	<i>p</i>
Executive Function measures					
Performance-based EF Tasks					
Z-score		-.81 (1.1)	-.01 (.6)	5.5	< .001
BRIEF					
GEC		54.3 (15)	43.6 (8)	-5.2	< .001
Social Competence measures					
Vineland-II					
Socialization		97.0 (13)	110.3 (13)	5.8	< .001
Interpersonal	Relationships	14.2 (3)	16.8 (3)	5.7	< .001
Play and Leisure Time		13.3 (3)	15.9 (2)	5.5	< .001
Coping Skills		16.3 (3)	18.1 (3)	3.4	.001
SCBE					
Social Competence		37.6 (8)	42.3 (7)	3.6	< .001

Abbreviations: BRIEF—Behavior Rating Inventory of Executive Function; GEC—Global Executive Composite; EF—executive function; SCBE—Social Competence and Behavior Evaluation

Table 3

Hierarchical Multiple Regression Model Predicting to Social Competence as Measured by the Vineland-II Socialization Scale

Outcome	Predictors	R ²	p (model)	B	SE B	β	p (predictor)	R ²
Vineland-II Socialization ^a		.002	.663					
	Maternal Education			-.76	1.7	-.039	.663	.002
Vineland-II Socialization ^b		.104	.001					
	Maternal Education			-.90	1.7	-.046	.586	
	EF Tasks z-score			4.78	1.3	.320	< .001	.102
Vineland-II Socialization ^c		.182	< .001					
	Maternal Education			-1.59	1.6	-.081	.320	
	EF Tasks z-score			3.57	1.3	.239	.005	
	BRIEF GEC			-.33	.096	-.294	.001	.078
Vineland-II Socialization ^d		.273	< .001					
	Maternal Education			-2.77	1.5	-.142	.074	
	EF Tasks z-score			1.90	1.26	.127	.135	
	BRIEF GEC			-.21	.096	-.188	.028	
	Gestational I Group			-10.4	2.64	-.356	< .001	.091

Outcome is the Vineland-II Socialization score. B indicates unstandardized coefficient; SE B, standard error of B; β , standardized coefficient; EF—executive function; BRIEF GEC —Behavior Rating Inventory of Executive Function Global Executive Composite.

^aFirst Model. Step 1, Maternal Education; Maternal Education was not significantly associated with the Socialization score.

^bSecond Model. Step 1, Maternal Education; step 2, EF Tasks z-score. EF Tasks z-score was significantly associated with Socialization score.

^cThird model. Step 1, Maternal Education; step 2, EF Tasks z-score; step 3, BRIEF GEC. Both EF measures (BRIEF GEC and EF Tasks z-score) were significantly associated with Socialization score.

^dFourth model. Step 1, Maternal Education; step 2, EF Tasks z-score; step 3, BRIEF GEC; step 4, Gestational Group. After Gestational Group is added to the model, one EF measure (i.e., BRIEF GEC) remains significantly associated with Socialization score; EF Tasks z-score no longer contributes significantly. There is an independent contribution of Gestational Group to Socialization score.

Table 4

Hierarchical Multiple Regression Model Predicting to Social Competence as Measured by the Social Competence and Behavior Evaluation (SCBE)

Outcome	Predictors	R ²	p (model)	B	SE B	β	p (predictor)	R ²
SCBE Social Competence ^a	Maternal Education	.021	.085	1.52	.882	.145	.085	.021
SCBE Social Competence ^b	Maternal Education	.038	.068	1.76	.89	.167	.049	
	Child Age			1.33	.85	.132	.120	.017
SCBE Social Competence ^c	Maternal Education	.145	< .001	1.61	.843	.153	.057	
	Child Age			1.53	.805	.152	.059	
	EF Tasks z- score			2.71	.653	.329	<.001	.107
SCBE Social Competence ^d	Maternal Education	.287	< .001	.96	.782	.091	.221	
	Child Age			1.73	.739	.173	.020	
	EF Tasks z- score			1.83	.621	.222	.004	
	BRIEF GEC			-.25	.048	-.399	< .001	.142
SCBE Social Competence ^e	Maternal Education	.290	< .001	.86	.800	.081	.281	
	Child Age			1.75	.741	.174	.020	
	EF Tasks z- score			1.68	.665	.203	.011	
	BRIEF GEC			-.24	.050	-.383	< .001	
	Gestational Group			-.91	1.39	-.056	.642	.002

Outcome is the Social Competence and Behavior Evaluation (SCBE) Social Competence score. B indicates unstandardized coefficient; SE B, standard error of B; β , standardized coefficient; EF—executive function; BRIEF GEC—Behavior Rating Inventory of Executive Function Global Executive Composite.

^aFirst Model. Step 1, Maternal Education. Maternal Education was not significantly associated Social Competence score.

^bSecond Model. Step 1, Maternal Education.; Step 2, Child Age. Child Age was not significantly associated with Social Competence score.

^cThird model. Step 1, Maternal Education; Step 2, Child Age; Step 3, EF Tasks z-score. EF Tasks z-score was significantly associated with Social Competence score.

^d Fourth model. Step 1, Maternal Education; Step 2, Child Age; Step 3, EF Tasks z-score; Step 4 BRIEF GEC. Both EF measures (EF Tasks z-score and BRIEF GEC) were significantly associated with Social Competence score. There is an independent contribution of Child Age to Social Competence score.

^e Fifth model. Step 1, Maternal Education; Step 2, Child Age; Step 3, EF Tasks z-score; Step 4, BRIEF GEC; Step 5, Gestational Group. Both EF measures (EF Tasks z-score and BRIEF GEC) were significantly associated with Social Competence score. There is an independent contribution of Child Age to Socialization and no contribution of Gestational group.