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Do Infant Temperament Characteristics Predict Core Academic Abilities in Preschool-Aged Children?

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Abstract

Examined relationships between temperament, measured via parent report at 4 months and structures laboratory observations at 12 months of age, and a school readiness battery administered at about 4 years of age (N=31). Scores on the School Readiness Assessment of the Bracken Basic Concept Scale (BBCS) were related to infant Positive Affectivity/Surgency (PAS), with infants described as demonstrating higher levels of PAS at 4 months of age later demonstrating greater school readiness in the domains of color, letter, and number skills. Regulatory Capacity/Orienting (RCO) at 4 months also predicted color skills, with more regulated infants demonstrating superior pre-academic functioning in this area. Analyses involving laboratory observations of temperament provided additional information concerning the importance of infant Positive Affectivity/Surgency, predictive of overall letter skills and overall school-readiness scores later in childhood. Results are discussed in the context of implications for theory and research, as well as early education settings.

Keywords

School Readiness; Individual Differences; Temperament; Infancy

The concept of school readiness has become a significant social and political concern because of its strong contribution to children's adjustment and overall wellbeing later in life (NICHD, 2003). In 2002, a nationally representative survey of over 3,000 teachers provided support for this concern, in so far as 30% of kindergarten teachers identified at least half of the children in their class as lacking necessary academic skills and showing difficulty following directions and working as part of a group (Raver, 2002). Importantly, early school readiness predicts later academic success, suggesting continuity for children's functioning in

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this domain (Duncan et al., (2007). Entwisle and Alexander (1993) argued that schooling-entry and the transition into full-time education in first grade represent a “critical period” for children’s academic development, wherein students showing limited success at the start continue to struggle, with few opportunities to change the trajectory. In response to these troubling reports, there has been a call for early intervention services that can alter the trajectory of academic performance in a meaningful way (e.g., Shonkoff & Phillips, 2000), and many teachers, parents, and researchers have begun to appreciate the importance of identifying risk and protective factors influential with respect to early academic functioning.

The National Education Goals Panel (NEGP), an executive branch of the federal government responsible for monitoring progress toward nationally mandated educational goals, has formulated a definition of school readiness that places emphasis on cognition and general knowledge as the essential components of school readiness (Mehaffie & Fraser, 2007). Although multiple factors may be reflected in whether or not a particular child presents as “ready” or “not ready” for school, a teacher survey indicated that skills including the ability to make comparisons, recognize numbers, and problem-solve are particularly critical for school success (Pavelchek, 2005), and represent the aspects of school readiness assessed in the current study.

Studies of developmental precursors of school readiness have generally considered cognitive skills, such as executive functions (e.g., working memory) (Fitzpatrick & Pagani, 2012; Monette, Bigras, Guay, 2011; Welsh et al., 2010). It is important to recognize, however, that the social-emotional domain is not orthogonal to the academic realm, but rather provides crucial input with respect to the development of cognitive capacities, and uniquely contributes to academic success (Duncan et al., 2007). That is, academic success, or lack thereof, is shaped by the child’s ability to adapt to the school setting, the demands and expectations of her teachers and peers, as well as the challenges inherent in mastering new skills. This adaptation is in part a function of child temperament, with different reactive and regulatory attributes serving to either facilitate adjustment, or hinder children in the educational setting. Temperament attributes represent a particularly important set of early predictors for pre-academic skills, as this domain of individual differences comes online shortly after birth (some would argue prenatally; e.g. DiPietro, Hodgson, Costigan, & Johnson, 1996), and can be reliably measured via parent-report and behavioral observations in the beginning of the first year of life (Gartstein, Bridgett, & Low, 2012).

Rothbart and Bates (2006) define temperament as “constitutionally based individual differences in reactivity and self-regulation, in the domains of affect, activity, and attention” (p. 2). Structurally, temperament in childhood has been defined in terms of three major domains (Gartstein & Rothbart, 2003; Putnam, Ellis & Rothbart, 2001). The first domain is labeled Negative Emotionality (NE), which is similar to the Neuroticism factor identified in adult personality research and is often described as a child’s general proneness to distress. In infancy, this domain includes the sub-constructs of fear, sadness, anger, and slow recovery from distress. Another domain of temperament, Positive Affectivity/Surgency (PAS), represents early manifestations of Extraversion and broadly relates to a child’s sociability and capacity to experience positive emotions. In infants, this domain includes the expression of pleasure, particularly during intense activities, rapid approach to objects, positive

anticipation, high activity level and social engagement. In infancy, the third domain of temperament is labeled as Regulatory Capacity/Orienting (RCO), and consists of attributes such as persistence of orienting attention, soothability, cuddliness and enjoyment of low-intensity activities. These three overarching domains of temperament are generally thought of as working in tandem to shape a variety of developmental outcomes (Rothbart & Bates, 2006).

Rothbart and Hwang (2005) provide a valuable theoretical framework for considering these temperament dimensions in relation to competence and motivation in school settings. These authors argue that the reactive temperament dimensions are directly linked to motivation, governing the child's approach, withdrawal, and interest to both novel and familiar stimuli, and shaping their emotional responses when goals are blocked. Regulatory attributes are seen as capacities that can work in the service of different motivations, enabling persistence in the pursuit of difficult goals and attention to goal-relevant stimuli.

Of the three domains of temperament, regulation-related attributes have been most thoroughly explored with respect to school readiness (Belsky et al., 2001; Howse, Lange, Farran, & Boyles, 2003; McClelland et al., 2007; Newman et al., 1998; Schoan & Nagle 1993). For instance, McClelland et al. (2007) investigated relationships between behavioral regulation abilities (including attention, working memory, and inhibitory control) and early academic skills of preschoolers, with assessments conducted in the fall and spring of the pre-kindergarten year. Children's attention abilities in the pre-kindergarten year were predictive of reading and math achievement, with children who demonstrated superior behavioral regulation performing at higher levels on emergent literacy, math and vocabulary scores (McClelland et al, 2007). Belsky et al. (2001) also provided support for the importance of early attentional skills, viewed as the foundation of the regulatory domain of temperament (Rothbart & Bates, 2006), in predicting school readiness. Importantly, attentional persistence assessed at 15 months through play observations (focused attention on a single object), was predictive of children's knowledge of basic academic concepts at 36 months of age. Although the Belsky et al. (2001) findings were based on analyses of the NICHD Study of Early Child Care (N = 1,038) dataset, with enrollment/screening initiated within 48 hours after birth, temperament related predictors of school readiness were not available until 15 months of age. Thus, to our knowledge, the current sample is the first enabling temperament dimensions (including attention-based regulation) assessed early in the first year of life to be considered as predictors of later school readiness.

Negative emotionality has also been connected, both longitudinally and concurrently, to school readiness (e.g., Denham et al., 2012), with preschool negative emotionality/ behavioral reactivity predicting lower levels of concurrent and kindergarten school success. Importantly, aspects of negative emotion have been shown to predict variance in academic skills not accounted for by attention measures. For instance, Coplan, Barber, and Lagacé-Séguin (1999) examined links between temperament and preschoolers' language and numeracy skills, demonstrating that 45 to 58-month-old children described by mothers as exhibiting greater attention spans and lower negative emotionality exhibited superior literacy and numeracy skills seven months later. Similarly, negative emotionality evident in the context of other traits associated with impulsivity (e.g., low attentional persistence)

negatively contributed to letter knowledge and print concept skills in a cross-sectional study of preschool children (42- to 68-months-old) attending Head Start (Fuhs, Wyant, & Day, 2011).

To date, few studies have linked the positive approach tendencies associated with Surgency to school readiness, perhaps because early perspectives on temperament failed to consider positive affectivity as separate from negative emotionality (see Goldsmith et al., 1987), and/or due to the salience of negative emotions as a detrimental influence on classroom behavior. Conceptually, Rothbart and Hwang (2005) proposed a model in which tendencies to engage with the environment reflected in surgency promote an eagerness to learn. Consistent with this notion, Rudasill, Gallagher and White (2010) found activity level at 4 years to be predictive of high academic performance in middle childhood. Also suggestive of such a relationship are longitudinal findings in which PAS in infancy was predictive of toddlers' effortful control (regulation-related temperament factor linked with executive functions; Rothbart & Bates, 2006), over and above prediction from infant RCO (Putnam, Gartstein & Rothbart, 2006), and a study wherein aspects of motivation were associated with reading achievement in 5 to 8 year-old children (Howse et al., 2003).

1.1 The Present Study: Goals and Hypotheses

Although connections between temperament characteristics and school readiness have been examined in previous investigations, a number of unanswered questions remain. Importantly, infancy predictors of school readiness have not been included in prior research, which has also been limited in the scope of temperament assessment. Although a number of large-scale projects have been conducted to address school readiness, starting as early as the first year of life (e.g., NICHD Study of Early Child Care), temperament has not been measured early in infancy, and larger samples have been limited with respect to methodology, often relying on a single operationalization (e.g., observation or caregiver report), and largely neglecting positive affectivity/surgency. Since early intervention is thought to be a necessary part of preventing future academic problems (Raver, 2002), it is important to identify the contributing temperament characteristics at the earliest age possible, so that we can better prepare any children facing additional risk in terms of academic functioning. In addition, findings conferring specificity for prediction of risk with respect to certain domains of school readiness/basic skills, but not others, could be helpful in this context.

The first goal of the present study was to identify mother-reported infant temperament characteristics most closely tied to the examined domains of basic knowledge/skills: Colors, Letters, Numbers/Counting, Sizes, Comparisons, and Shapes, as well as overall school readiness. We anticipated significant associations between early temperament attributes and core pre-academic skills, with the three over-arching temperament factors (NE, PAS, and RCO) expected to make significant contributions to subsequent school readiness. Based on recent theory and the results of previous research in older children, high RCO, high PAS, and low NE in infancy were expected to predict superior school readiness at preschool age. We additionally addressed associations between observed indicators of temperament obtained in the laboratory when the children were 12 months of age, to determine

consistency with the results obtained at 4 months via parent-report. Thus, manifestations of temperament observed early in the first year of life, and those gleaned later in infancy, were considered as predictors of school readiness skills, as temperament undergoes considerable development during this time (e.g., Gartstein & Rothbart, 2003: Gartstein et al., 2010). It was hypothesized that laboratory-based indicators of temperament and those obtained via parent-report earlier in the first year of life would demonstrate parallel patterns of associations with the school readiness outcomes.

2 Materials and Methods

2.1 Participants

All participants were recruited in the Eastern Washington/Northern Idaho area and included healthy, typically developing children. At the time of the initial assessments, infants were 4 months old, and the children/families were followed longitudinally until school readiness measures were administered when the children were about 4 years of age.

The original sample from which temperament data was obtained consisted of 123 mothers of 4-month-old infants. Participants were recruited through birth announcements released by hospitals and published in the local newspaper, as well as the primary prevention program First Steps. The program provided details about this study, along with a variety of developmental information aimed at preventing child maltreatment, to all parents of newborn infants in the local hospitals. None of the potential participants recruited through the help of the First Steps program declined participation, whereas seven families contacted based on the published birth announcements decided not to take part in this research. Of this original sample, 105 children participated in the 12-month laboratory evaluation of temperament, with 18 families not able to come to the laboratory during the available 2-week window (i.e., from a week prior to a week later than the child's first birthday). School readiness measures were collected from 31 children at about 4 years of age, after attempts were made to contact everyone originally recruited into the study (N=123). From this original sample, 17 families chose not to participate because of time constraints or change in location of residence, and 71 could not be reached because either the phone number had been disconnected or they did not respond to recruitment calls. Also, three children could not be included because they did not meet the age requirements of the school readiness assessment instrument, and one child's data was excluded because an incorrect version of the record form was used during administration of the school readiness assessment. Thus, the final sample included 31 children (18 males and 13 females). Analyses were conducted to compare this final sample to the original group of participants. Specifically, 17 independent groups t-tests were performed examining all of the continuous variables related to the hypotheses addressed in this study, with these results failing to reach statistical significance. A trend was observed ($t=1.71$, $p<.10$), wherein children participating in this investigation received somewhat lower Negative Emotionality scores at 4 months of age (Mean=−.78, SD=2.57), compared to their non-participating counterparts (Mean=.20, SD=2.75). In addition, differences between responders and non-responders were considered for the demographic variables, with no significant effects observed for SES, education, or income. A chi-square test was conducted to evaluate potential differences in the gender

distributions of the original sample and the participants recruited for the purposes of this study, also failing to produce significant results.

When children were 4 months old, mothers reported a mean age of 28.63 (*SD* = 5.31); a mean family socioeconomic index (SEI; Stevens & Featherman, 1981) of 37.62 (*SD* = 26.98), which is indicative of predominantly service, farming, and construction oriented occupations; and 15.85 mean years of education (*SD* = 2.29; 10–20). Most caregivers indicated being Caucasian (92.3%), and 46.1% of caregivers reported a family income between $30,000 and $75,000 a year. Only families with healthy full-term 4-month-old infants were eligible to participate; families with infants who were premature, experienced significant medical difficulties or birth complications, or were identified as being developmentally delayed or disabled were not eligible.

2.2 Infant Behavior Questionnaire-Revised (Gartstein & Rothbart, 2003)

This 191-item parent-report questionnaire yields 14 scales that have been demonstrated to form three over-arching factors: Positive Emotionality/Surgency (PAS: Activity Level, Smiling and Laughter, Vocal Reactivity, Approach, High Intensity Pleasure, and Perceptual Sensitivity), Negative Affectivity (NE: Fear, Distress to Limitations, Sadness, and negatively loading Falling Reactivity), and Regulatory Capacity/Orienting (RCO: Duration of Orienting, Soothability, Cuddliness/Affiliation, and Low Intensity Pleasure). Reliability and validity of the IBQ-R scales has been supported for samples from different cultures, with Cronbach's alphas ranging from 0.77 to 0.96 (Gartstein & Rothbart, 2003; Gartstein, Slobodskaya, & Kinsht, 2003). In addition, inter-rater reliability was demonstrated for mother and father-report (Gartstein & Rothbart, 2003; Parade & Leerkes, 2008) with validity of this instrument supported by studies incorporating the IBQ-R and laboratory indicators of temperament (Aureli, Coppola, Picconi, Grazia & Ponzetti, 2015; Gartstein et al., 2010; Gartstein & Marmion, 2008; Parade & Leerkes, 2008). Factor scores represent sums of relevant standardized scale scores (in z-score form).

2.3 Observed Temperament

Tasks adapted from the widely used Laboratory Temperament Assessment Battery (Lab-TAB; Gagne, et al., 2011; Goldsmith & Rothbart, 1996) were administered to elicit manifestations of reactive and regulatory aspects of temperament. All coders were blind to the purpose of the investigation, used a predetermined set of criteria to judge infant behaviors, and took part in a comprehensive training program in order to be able to do so. Specifically, a team (2–3) of coders was assigned to each episode and provided ratings for training cases (N=20) in order to obtain adequate agreement, demonstrating inter-rater reliability correlations ranging from .60 to .98. All codes were assigned every 5 seconds, subsequently averaged across epochs.

2.3.1 Arc of Toys—This task represents a modified version of the Lab-TAB "Basket of Toys." During this procedure, an infant is presented with several toys arranged in an arc around him or her. At the beginning of the task, the infant was placed on a couch in the laboratory. The mother was seated next to the infant throughout the procedure, but was instructed to refrain from intervening. All of the toys were arranged in a circular formation

around the infant and were comfortably within reach. For the current study, the following toys were arranged in this order, from the baby's left side to the right: duck, rattle, soft small pig, a soft ball, and nesting cups.

Information was recorded on the following: (1) latency (in seconds) to approach the first toy; (2) latency (in seconds) to look away from the first toy; (3) change in toy (overall frequency); (4) average duration (in seconds) of looking at or manipulating toys (calculated across all toys); and (5) average facial interest (calculated across all toys). Coding of latency and duration reflected the time (in seconds) it took an infant prior to completing an action and following an action, respectively. Lower latencies to look away and changes of toy suggest low levels of attention, whereas longer duration intervals reflect more time spent engaging with materials (i.e., looking at or manipulating them), consistent with an interpretation as an indicator of high RCO. The change in toy codes represent frequency counts of each behavior with a different toy; thus, higher frequency counts are representative of greater variability in activity with the toys, as indicated by the infant switching materials. The facial interest score was assigned based on observer judgments of the infant's degree of interest (assessed via facial cues). To standardize coding, the following 3-point scale was used in assessments of facial interest: 0 = infant is not looking at the toys or no facial region displays codable interest; 1 = identifiable interest, which is low intensity (i.e., child is attending to the toys); and 2 = a definite facial indication of strong interest, or a coder has an impression of a high degree of facial interest (e.g., child's mouth falls open, eyebrows raise up and towards each other). As a result, higher scores on this scale are characteristic of greater observed levels of interest on the part of the infant. This behavior is reminiscent of the low-intensity pleasure component of RCO. Inter-rater agreement indices for these codes ranged from .60 to .95 (Mean Interclass r=.77). Simple correlations between the indicators were computed next for data reduction purposes, in an effort to develop a observation-based RCO factor. These analyses were performed with an entire available sample, including children who did not complete the school readiness portion of the study (N=105). Duration of looking was significantly correlated with facial interest (r=.52; p<.01) and change of toy (r=−.20; p<.05), with all other correlation coefficients failing to reach statistical significance. Thus the orienting attention composite was based on these three scores, combined after each indicator had been standardized into a z-score.

2.3.2 Masks—The "Masks" episode from the Lab-TAB was used to elicit fear responses. In this episode a series of 4 masks (witch, old man, vampire, and gas mask) were presented to infants sequentially, for a period of 10 seconds each. Infants were seated in a high chair positioned inside of an enclosure, with a curtain directly in front of them. During each presentation, the curtain was lifted to reveal the individual masks. Throughout the episode mothers were seated next to, but slightly behind, the infants. Similar to the "Arc of Toys" protocol, mothers were instructed to refrain from commenting on the masks or intervening, unless necessary (e.g., infant is experiencing significant distress).

For this procedure, trained research assistants coded the following information: (1) intensity of fear expression; (2) intensity of distress vocalizations; (3) intensity of bodily fear; (4) and intensity of escape. Intensity of body and facial fear, distress vocalizations, and escape behaviors were rated according to a predetermined set of criteria. Intensity of facial fear was

judged based on the following scale: 0= no facial region shows codable fear movement; 1= only one facial region shows codable movement, identifying a low intensity fear, or expression is ambiguous (i.e., eyes widen slightly, mouth opens slightly with corners retracting back - child appears to be mildly afraid facially); 2= only 2 facial regions show codable movement, or expression in one region is definite (i.e., eyes widen, brows may be raised; mouth open or closed, with corners retracted straight back; nasal root narrowed, jaw drops); 3= an appearance change occurs in all 3 facial regions, or coder otherwise has impression of strong facial fear (i.e., eyes definitely widen, mouth corners retracted straight back, jaw may drop, eyebrows straight or raised up, may be a horizontal wrinkle above the child's nose and near the inside of the eyebrows). Intensity of distress vocalizations utilized the following scale: 0= no distress; 1= mild vocalization that may be difficult to identify as hedonically negative; 2= definite whimpering, limited to a short (1–2 seconds) duration; 3= longer whining, fussing, mild protest, or low-intensity cry (cry has extended or rhythmic quality); 4= definite non-muted crying; 5= full intensity cry/scream. The following scale was used for determining the intensity of body fear: 0 = no sign of body fear; 1 = decreased activity: an apparent and/or sudden decrease in the activity; sense of body apprehension and ambiguous body fear; 2 = tensing: visible tensing of the muscles, associated with decreased activity; 3 = freezing or trembling: tensing of the entire body with no motion, or trembling due to extreme muscular tension. Finally, the following scale was utilized in ratings of escape intensity: 0 = no escape behavior; 1 = mild avoiding behavior (1–2 seconds); 2 = moderate (3–4 seconds); 3 = vigorous escape behavior (4–5 seconds). In the current sample, inter-rater reliability was deemed adequate, with coefficients ranging from .62 to .98 (Mean Interclass r = .79). Significant correlations were observed between all four ratings (mean r=. 57; p<.01), thus the composite score was a sum of standardized indicators (z-scores) of these scores.

2.3.3 Peek-a-Boo—The Lab-TAB "Peek-a-Boo" procedure was used to elicit smiling, laughter, and manifestations of high intensity pleasure in the infants. As in the "Masks" procedure, infants were placed in a high chair. Mothers were given directions to disappear behind a screen and re-appear through a series of windows while simultaneously saying "peek-a-boo" and smiling. For the first three trials, mothers appeared when directed. The subsequent 4^{th} and 5^{th} trials included unsuccessful attempts by the researcher to "find" the mother. Finally, the mothers were instructed to re-appear for one last "peek-a-boo" on the sixth trial. During this procedure, trained research assistants coded for: (1) intensity of smiling; (2) the presence/absence of laughter; (3) presence/absence of positive vocalizations; and (4) presence/absence of positive motor activity (e.g., clapping, waving arms, banging table). To standardize coding, the following 4-point scale is used in assessments of intensity of smiling: 0= no smiling; 1= small smile, with lips only slightly upturned, little or no involvement of cheeks, and no crinkling about eyes; 2= medium smile, with lips visibly upturned, mouth perhaps open, some bulging of the cheeks, and possible light crinkling about eyes; and 3= large smile, with lips stretched and quite upturned or perhaps mouth open, cheeks bulging, and definite crinkling around the eyes. For the variables of smiling, laughter, positive vocalizations, and positive motor activity, coding was binary, with scores reflecting either the presence or the absence of the behavior: 0 = absent (e.g., no laughter, smiling not present); 1 = present (e.g., presence of smiling or laughter). Inter-rater

agreement was satisfactory for the present sample, with coefficients ranging from .80 to .92 (Mean *r*=.87). Significant correlations emerged between intensity of smiling, presence of laughter, and intensity of positive vocalizations (mean r=.59; p<.01), which were subsequently summarized in a composite score - a sum of their individual z-scores.

2.4 School Readiness Assessment: the Bracken Basic Concept Scale (BBCS; Bracken, 2002)

The BBCS was designed to assess knowledge of foundational concepts among children between the ages of 2 and 7 and has been identified as an intellectual screening measure for children's preparation for formal schooling (Bracken, Howell, & Crain, 1993). The School Readiness component is organized into six sub-areas: Colors, Letters, Numbers/Counting, Sizes, Comparisons, and Shapes. The subtest scores are summed to create the School Readiness Composite (SRC), converted to a standard score (Mean=100; SD=15). The BBCS was individually administered, with each subtest containing 11–20 items in which the examiner asked the child to identify a specific concept or term by pointing to pictures presented on a stimulus board. Several practice questions were first administered to familiarize the child with the testing process and the expected form of response. The scale and summary scores for the BBCS have been shown to be highly internally consistent (split-half reliabilities > .86; Bracken, 1984), and the BBCS has exhibited convergent validity with multiple comprehensive measures of children's intelligence, including the Woodcock-Johnson Broad Cognitive Ability, the Stanford-Binet-IV, the Peabody Picture Vocabulary Test-Revised, and the WPPSI-R (see Laughlin, 1995). The SRC, as well as individual scale scores, were considered in this study, as we were interested in specific domains of pre-academic skills, as well as the overall level of mastery. An examination of correlations between the 6 subscales resulted in a pattern of mostly moderate, albeit not consistently significant correlations (range .09 to .82; mean r=.48), and internal consistency the SRC was satisfactory (α=.82).

2.5 The Demographic Questionnaire

Questions about marital status, ethnicity, education, income and occupation were also administered during the baseline assessment.

2.6 Procedure

When children were four months old, mothers were asked to complete the IBQ-R along with the demographic form. When the children were about to turn 12 months, participants were asked to come into the laboratory for an observation of temperament. After a brief warm-up period, participating children took part in the episodes described above. When children were between 3 and 5 years of age, families were asked to return to the laboratory for the assessment of school readiness. Participants' parents were sent feedback letters that explained their child's performance, specifically how s/he scored in relation to same-aged peers, as an incentive.

3 Results

Descriptive statistics were computed first (Table 1).

3.1 Parent-report

Pearson's product moment correlations were computed to examine associations between the continuous variables examined in this study, with point-biserial correlations computed for gender (a naturally dichotomous variable; Table 2). The Demographic Composite represents a sum of standardized maternal education and income indicators. A number of significant and marginal correlations were observed for the Positive Affectivity/Surgency (PAS) and Regulatory Capacity/Orienting (ORC) factors of the IBQ-R. Specifically, high scores on mother-reported PAS at 4 months of age predicted better performance for preschoolers on the Color, Letter, and Numbers scale of the BBCS, with a marginal correlation between PAS and the School Readiness Composite. For the RCO factor, higher early regulatory capacity translated into superior performance with respect to color-related skills, with marginal prediction to Letter, Number, and Composite scores. No other significant or marginal associations were observed.

Hierarchical multiple regression analyses were subsequently conducted for school readiness outcomes significantly correlated with the three temperament factors (i.e., Color, Letter, and Number) to examine unique contributions of PAS, NE, and RCO, after controlling for potential age and gender effects (Table 3), given that age and gender differences have been reported for temperament attributes (e.g., Else-Quest et al., 2006; Kochanska, Coy, & Murray, 2001). In addition, a Demographic Composite score (sum of standardized family socio-economic status and income indicators) was included as a covariate, because socio-demographic factors have been linked with school readiness (e.g., Entwisle & Alexander, 1993).

Significant effects were observed in regression equations predicting Color and Letter Recognition only, with 4-month PAS predicting both school readiness indicators in positive direction, after controlling for the influence of infant gender, age, demographic factors, and other temperament attributes. IBQ PAS, or other temperament factors, did not emerge as significant predictors of Numbers/Counting.

3.2 Observed Temperament

No significant associations emerged between observation-based composite for RCO, measured in the context of the Arc-of-toys episode, or the NE factor based on responses to the presentation of Masks, and school readiness outcomes (Table 4). Significant correlations with the Letter Recognition component of BBCS, as well as the School Readiness Composite, were noted in the analyses of the observation-based PAS score, derived from the ratings assigned in the context of the Peek-a-boo episode. Marginal positive correlations also emerged between the PAS and Comparison Skills scores, and between observed RCO and the School Readiness composite. Hierarchical multiple regression analyses were subsequently conducted to examine unique contributions of the three observation-based infant temperament factors (PAS, NE, and RCO) to the school readiness outcomes for which significant simple correlations were observed, after controlling for potential age and gender effects (Table 5).

Results indicate that the composite based on observations of infants' responses in the Peek-a-boo episode made a unique significant contribution in predicting overall school readiness. Lab-TAB PAS did not emerge as a significant predictor of Letter Recognition, nor did other observation-based temperament factors.

4 Discussion

The present study is one of the first to address relationships between infant temperament and core pre-academic skills in the preschool period. A nuanced pattern of results was obtained, with positive affectivity emerging as the only temperament factor uniquely contributing to aspects of school readiness including color, letter and number skills, but not children's understanding of size, comparison, and shape. We hypothesized that a high level of Negative Emotionality (NE) in infancy would predict lower school readiness scores at preschool age. In addition, we expected that higher levels of characteristics associated with the Regulatory Capacity/Orienting (RCO) and Positive Affectivity/Surgency (PAS) domains of infant temperament would predict higher levels of core academic skills. Our hypotheses were supported in part, with children who received higher ratings on the Positive Affectivity/Surgency and Regulatory Capacity-Orienting factors of the IBQ-R at 4 months of age earning higher scores on components of the BBCS as preschoolers. Importantly, analyses conducted with observational temperament data also indicated that higher PAS composite scores were predictive of superior letter-related, as well as overall pre-academic skills. Effect sizes associated with these findings were generally in the moderate to large range (Cohen, 1988).

These results in part confirm, as well as extend prior research. Observed positive associations between mother-reported RCO and performance on the Color Recognition BBCS subtest underscore the vital role early attention-based regulatory skills play in the development of school related competencies. Previous research has demonstrated a similar association between regulatory capacities and academic ability in older children, finding that higher behavior regulation in pre-kindergarten children was linked with higher levels of emergent literacy, vocabulary, and math skills (McClelland et al., 2007). The current findings suggest that the relationship between attentional tendencies and the acquisition of color skills – an important domain of basic knowledge linked to successful school entry, begins at a very early age. Although RCO did not make a unique contribution when considered along with other temperament factors, its role in shaping school readiness skills should be investigated in the future. If further demonstrated as important, early screening for attentional capacity may be useful in identifying children potentially at risk academically because of limited basic skills, and may benefit from interventions designed to enhance regulatory capacity, such as "Tools of the Mind" (Diamond, Barnett, Thomas, & Munro, 2007).

Our results also revealed predictive associations from both laboratory and questionnaire indicators of PAS and children's pre-academic abilities, with parent-report predicting letter recognition, and observation-based composite predicting overall school readiness, independently, with other temperament factors in the equation, and controlling for child age, gender, and socio-economic factors. As suggested by Rothbart and Hwang (2005), early

tendencies to approach and demonstrate enjoyment of novel situations may indicate emerging forms of effectance and mastery motivation, likely resulting in the growth of competencies reflected in school readiness. The benefits of such a predisposition may be particularly important during infancy, leading surgent children to engage and persist in a wide range of tasks that enhance their cognitive development, in comparison to infants who are less compelled to explore. Whether surgent characteristics continue to confer analogous benefits following entry to formal schooling is less clear; some suggested that excess activity level and extraversion could interfere with the restraint required by traditional educational settings (Shiner, 2000; Schoen & Nagle, 1994). The current results may be informative for preschool programming, suggesting the importance of curricula allowing self-directed learning opportunities that allow the benefits of early surgency to be actualized, rather than inclusion of teacher-directed activities that mirror common grade school classroom practices.

Surprisingly, significant effects were not observed for NE, failing to provide support for prior research showing links between this set of temperament traits and school readiness (e.g., Denham et al., 2012). The lack of significant associations with laboratory-based observations derived from the Masks Lab-TAB episode could be interpreted in the context of studies that address questions of optimal stimulus intensity for tasks designed to elicit individual differences in fearful reactions (Buss, 2011; Buss, Davidson, Kalin, & Goldsmith, 2004). Buss (2011) noted that a pattern characterized by high fear in benign or low-threat situations represents dysregulated fear, associated with social wariness and anxious behaviors in preschool and transitioning to kindergarten. Future studies should supplement the traditional approach, wherein behavior ratings across highly novel/objectively threatening situations are averaged (Garcia-Coll et al., 1984; Goldsmith & Campos, 1990), examining reactions across stimuli that vary in intensity and provide an opportunity to address responses to more novel/intense vs. mundane/benign situations.

Significant associations with temperament were observed for the overall School Readiness Composite, as well as Color, Letter, and Number skill domains, yet on the whole, multiple statistical tests did not result in statistically significant results. For example, no significant links between temperament factors and Size, Comparison, and Shape related components of the BBCS were noted. Although the relatively small sample size limited our statistical power, and the ability to detect small and medium effects, it should be noted that the results of this study do not suggest a uniform pattern of relationships between early manifestations of temperament and later performance on school readiness tasks. Rather, positive affectivity emerging as the only temperament factor uniquely contributing to the overall level of school readiness, as well as Color, Letter, and Number sub-areas. Future studies should continue to focus on links between temperament and narrowly defined dimensions of school readiness in order do replicate this pattern of results. If confirmed, these findings could indicate that size, comparison, and shape knowledge in the preschool period may be largely a product of factors other than child temperament attributes (e.g., parent-child interaction dynamics). Thus, the observed pattern of results may have implications for screening/early intervention efforts, enabling these to be administered in a more targeted manner with respect to the basic knowledge skill sets.

Consideration of infant temperament in the context of the emergence of basic knowledge/pre-academic skills holds promise for applications relying on temperament to screen children at risk for difficulties at school entry, and possibly to identify those most likely to benefit from intervention. Temperament-based services have recently been demonstrated as beneficial in reducing problematic behavioral/emotional reactivity for school-age children (McClowry & Collins, 2012). "INSIGHTS into Children's Temperament" was designed for parents and teachers to learn about temperament and how it contributes to the child's overall social/emotional functioning, and offers specific strategies to parents and teachers individualized for different temperament types to facilitate social-emotional development. The benefits of this school-based program have been demonstrated, with children whose temperament profiles were described as "high maintenance" exhibiting the greatest decreases in disruptive behaviors (O'Connor, Rodriguez, Cappella, Morris, & McClowry, 2012). Yet, earlier preventative services may be more effective, in so far as intervening in the first years of life can help children succeed during the transition to formal education, critical in setting the stage for later academic functioning (Shonkoff & Phillips, 2000). Such preventative services would not be designed to change the infants' temperament, rather to help their caregivers improve the "goodness-of-fit", ensuring that their demands and expectations match the profile of their infant, and that the parenting efforts are consistent with what existing research suggests is optimal for children with that particular profile (McClowry & Collins, 2012).

4.1 Limitations of the Current Study/Directions for Future Research

Several limitations impacting the present study deserve a mention. First, the small number of participants that completed all portions of the investigation considerably limits our ability to generalize these findings beyond our sample, especially since our sample lacked ethnic diversity. The small sample size can be partially attributed to the longitudinal nature of the study, which resulted in the loss of a number of participants due to a change in location or a loss of interest. Future research efforts in this area should attempt to recruit and retain a larger, more diverse sample that is more representative of the general population. Importantly, future studies should replicate the results obtained in the present investigation, demonstrating these effects generalize, given the relatively large number of statistical tests. Additional cautionary notes have to do with our use the School Readiness Assessment of the Bracken Basic Concept Scale (Bracken, 2002), which was designed as a general screening tool and does not produce scores indicative of serious maladaptive academic functioning, and the fact that the Color scale of this instrument was likely subject to ceiling effects, and a restricted range, although the latter did not prevent us from identifying significant effects involving this domain of pre-academic skills.

4.2 Conclusions

Results of the current study suggest that aspects of infant temperament measured as early as 4 months of age predict some school readiness skills. Although a number of associations between infant temperament and school readiness skills were not statistically significant, positive emotionality emerged as a unique, and more consistent predictor of these pre-academic competencies. Importantly, parent-reported PAS in early infancy, and observation-based positive affectivity assessed at the end of the first year of life, both positively

contributed to a subset of school readiness skills evaluated in this study. The processes through which temperament, primarily positive affectivity in this study, confers protection with respect to pre-academic skills are likely transactional in nature, wherein child's temperament evokes beneficial responses from caregivers, translating into gains in school readiness, and identification of early temperament markers holds promise with respect to a number of practical implications. If replicated in future research, low PAS, identified as a potential temperament risk factor in this study, could be utilized as a marker in screening, targeting children for preventative services. The importance of identifying early biologically based factors that represent meaningful predictors of later developmental outcomes has been emphasized in numerous investigations (Duncan et al., 2007), and infant temperament attributes may prove to be important early markers of school readiness. That is, children presenting with a temperament profile signaling risk with respect to academic functioning could be identified as early as the first year of life, and provided with targeted services, aimed at improving their school readiness and transition to an educational setting.

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Highlights

1. Temperament measured at 4 months of age via caregiver report predicts performance-based indicators of school readiness obtained between 3–5 years of age.
2. Positive emotionality and regulatory capacity domains of temperament appear particularly important in explaining school readiness.
3. Temperament indicators based on laboratory observations at 12 months of age support the importance of positive emotionality in understanding emerging school readiness.

Table 1

Descriptive Statistics: Independent and Dependent Variables

Variable	Mean	Range	Standard Deviation
IBQ-R (4 months of age)			
Positive Affectivity/Surgency (PAS)			
	−.77	−8.75 – 7.23	4.02
Negative Emotionality (NE)			
	−.78	−5.14 – 6.58	2.57
Regulatory Capacity/Orienting (RCO)			
	.22	−5.27 – 4.44	.92
Variable	Mean	Range	S.D.
Lab-TAB (12 months of age)			
Positive Affectivity/Surgency (PAS)			
	.00	−3.29 – 5.89	2.56
Negative Emotionality (NE)			
	17.00	−4.80 – 7.97	3.29
Regulatory Capacity/Orienting (RCO)			
	−.02	−5.23 – 5.70	2.13
BBCS (3–5 years of age)			
Color			
	10.00	6.00 – 11.00	1.41
Letter			
	10.41	1.00 – 16.00	5.12
Number			
	9.86	.00 – 19.00	6.97
Size			
	8.10	2.00 – 12.00	2.92
Comparison			
	4.17	.00 – 9.00	2.82
Shape			
	12.34	5.00 – 19.00	3.66
School Readiness Composite			
	118.55	85.00 – 148.00	16.17

Table 2

Simple correlations between 4-month IBQ-R factors and BBCS indicators (N=31).

Variable Name	IBQ-R Positive Affectivity/Surgency	IBQ-R Negative Emotionality	IBQ-R Regulatory Capacity Orienting
Color	.39*	−.25	.49*
Letter	.44*	−.17	.33#
Number	.37*	−.18	.31#
Size	−.03	−.10	.15
Comparison	.08	.01	.06
Shape	.05	.08	.08
School Readiness Composite	.33#	−.14	.32#
Child Gender	−.15	.16	.13
Child Age	.11	−.03	.18
Demographic Composite	−.27	−.17	−.01

* p<.05;

# p<.10.

Table 3

Multiple Regression Analyses: Parent-reported temperament predicting school readiness.

Variable	R	R^2	R^2change	F change	Beta
BBCS Color Recognition					
Model 1	.43	.19	.19	1.46	
Child's Age					−.12
Child's Sex					−.38
Demographic Composite					.08
Model 2	.79	.63	.44	5.86**	
Child's Age					−.08
Child's Gender					−.17
Demographic Composite					.11
IBQ-R PAS					.64**
IBQ-R NE					−.30
IBQ-R RCO					−.15
BBCS Letter Recognition					
Model 1	.43	.19	.19	1.53	
Child's Age					.30
Child's Gender					−.39
Demographic Composite					.02
Model 2	.70	.49	.30	3.36*	
Child's Age					.36
Child's Sex					−.26
Demographic Composite					.04
IBQ-R PAS					.48*
IBQ-R NE					−.30
IBQ-R RCO					−.11

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** p<.01;

* p<.05.

Table 4

Simple correlations between 12-month Lab-TAB factors and BBCS indicators (N=31).

Variable Name	Lab-TAB Positive Affectivity/Surgency	Lab-TAB Negative Emotionality	Lab-TAB Regulatory Capacity Orienting
Color	.04	−.09	.26
Letter	.46*	−.29	.28
Number	.29	−.26	.22
Size	.20	−.09	−.23
Comparison	.32#	−.26	−.20
Shape	.10	−.09	.03
School Readiness Composite	.48*	.10	.31#
Variable Name	Lab-TAB Positive Affectivity/Surgency	Lab-TAB Negative Emotionality	Lab-TAB Regulatory Capacity Orienting
Child Gender	−.30*	.14	−.22
Child Age	.27*	−.04	−.13
Demographic Composite[1]	.06	.06	−.14

* p<.05;

# p<.10.

Table 5

Multiple Regression Analyses: Observed temperament predicting school readiness.

Variable	**R**	**R^2**	**R^2change**	**F change**	**Beta**
School Readiness Composite					
Model 1	.35	.12	.12	.56	
Variable	R	R^2	R^2change	F change	Beta
Child's Age					−.08
Child's Sex					−.17
Demographic Composite					−.24
Model 2	.68	.46	.34	1.89	
Child's Age					−.19
Child's Gender Demographic Composite					−.45
Lab-TAB RCO					−.02
Lab-TAB PAS					.60*
Lab-TAB NE					−.30

*p<.05.

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