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COGNITIVE DEVELOPMENT

Factors associated with the early emergence of intense interests within conceptual domains☆

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Abstract

Cognitive, home, and family factors that theoretically could influence whether or not preschoolers' interests were focused on domains characterized by the acquisition of knowledge concerning object concepts (e.g., *dinosaurs, horses*) were assessed in a short-term longitudinal investigation of 211 4-year-olds. Boys were six times as likely as girls to manifest such interests. Logistic regression analysis indicated that children's cognitive skills in conjunction with the degree to which families emphasized consistency, communication, educational activities, and provided time for free play were important in determining whether preschoolers would sustain their interests and begin to develop knowledge about conceptual domains. Implications of gender differences in interests aligned with conceptual domains for both the development of childhood expertise and the development of science literacy are considered.

Keywords: Knowledge; Concepts; Interest; Gender

1. Introduction

Young children who acquire high levels of domain-specific knowledge are of interest to both cognitive developmentalists investigating childhood expertise (Chi, Hutchinson, &

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Robin, 1992; Gobbo & Chi, 1986) and to social cognitive researchers considering the role of interest in learning, activity choice, and the emergence of gender-typed play (Renninger & Wozniak, 1985). However, neither group of researchers typically has considered the developmental precursors to such interests, particularly among very young children. The aim of the present study was to begin to bridge these two fields by exploring the child-specific and family-specific factors that predict preschoolers' short-term maintenance of intense interests in conceptual domains (domains characterized by object concepts such as *trucks* and *dinosaurs*, as defined by Johnson & Mervis, 1998). We begin by briefly reviewing research on the emergence of children's interests and their consequences for cognition and behavior. We then address research on childhood expertise (a potential outcome of intense early interests), followed by a consideration of the potential role of the home environment in interest support.

1.1. Interests in childhood

Interests are relationships with objects or domains that are personally meaningful (Fink, 1994) and that can be fostered through either internal factors (e.g., prior knowledge, subjective value) or external factors (e.g., family support, world experiences). Researchers have delineated two kinds of interests that can strengthen a child's motivation to interact with particular objects or to engage in particular activities (e.g., Krapp, Hidi, & Renninger, 1992). *Situational interests* increase the likelihood that a particular event or object will trigger a response at a particular moment in time due to its elicitation of curiosity or a sense of enjoyment (Hidi, 1990; Mitchell, 1993). However, such interests are transient, are not always associated with positive affect, and typically do not promote substantial knowledge gains. *Individual interests*, on the other hand, are ongoing, deepening relations with particular domains that are characterized by full engagement, positive affect, predictable attention, and an increasingly consolidated and enriched declarative knowledge base (Renninger, 1990, 2000).

Renninger (Renninger, 1990, 2000; Renninger & Leckrone, 1991) has explored individual interests in children and has provided a compelling social cognitive analysis of the means by which such interests influence play behaviors. Interests affect the quality of attention and memory for items (Renninger & Wozniak, 1985) as well as affecting what (or who) the child chooses to play with. Furthermore, interests can increase the flexibility of the child's interactions with a particular play object and consequently support the discovery of new object properties (Renninger, 1992). Renninger (2000) stipulates that individual interests "lead development" by exerting pervasive influences on multiple facets of information processing.

While the role of interest in facilitating classroom learning has been well studied (e.g., Alexander, Jetton, & Kulikowich, 1995; Hidi, 1990; Renninger, Hidi, & Krapp, 1992), less is known concerning individual differences in preschoolers' individual interests. Existing studies have entailed observations of small samples of children during periods of free play in nursery school classrooms (Fink, 1994; Krapp & Fink, 1992; Renninger, 1992; Renninger & Leckrone, 1991). One goal of the present study was to extend this literature by investigating a relatively large cohort of 4-year-olds in order to establish the prevalence of relatively intense, individual interests, with particular emphasis on interests aligned with domains that could support the acquisition of domain-specific conceptual knowledge.

1.2. Interests and domain-specific learning

Few cognitive developmentalists studying the impact of knowledge on information processing have focused on affective or emotional factors that support children's attraction to particular domains. Instead, researchers have studied child experts on domains such as chess (Chi, 1978; Horgan & Morgan, 1990), dinosaurs (Gobbo & Chi, 1986; Johnson & Eilers, 1998; Johnson, Scott, & Mervis, in press), and birds (Johnson & Mervis, 1994; Mervis, Pani, & Pani, 2003) to test the extent to which knowledge can account for changes in information processing that typically emerge as a function of development. Because knowledge and development generally are confounded, the availability of children with levels of domain-specific knowledge that exceed those of most adults helps to provide a direct test of which facets of development are rooted in acquiring knowledge about the world.

Researchers interested in the impact of expertise on categorization have focused on conceptual domains that support mastery of *subordinate* categories through perceptual learning and the acquisition of knowledge (e.g., Johnson & Eilers, 1998; Johnson & Mervis, 1994, 1997, 1998; Medin, Lynch, Coley, & Atran, 1997; Tanaka & Taylor, 1991). Such domains may begin to be mastered even by very young children since learning about subordinate kinds occurs naturally through play with related groups of objects or through reading topical books devoted to domains such as *trucks* or *dinosaurs*. Young experts represent networks of interrelated domain-specific concepts hierarchically (Chi, Hutchinson, & Robin, 1989; Chi & Koeske, 1983; Mervis et al., 2003), which subsequently enhances encoding and retrieval of domain-relevant information. Such children tend to be highly verbal (Alexander, Johnson, & Schreiber, 2002; Johnson & Eilers, 1998). Interestingly, the majority of experts on conceptual domains have been male. Table 1 summarizes participant information from 12 studies for which the gender of experts was indicated. Across studies (many of which

Table 1
Percentage of male participants recruited for studies of expertise on conceptual domains

Domain	Participants[a]	Source
Birds	20 adults (50%)	Bailenson, Shum, Atran, Medin, and Coley (2002)
Birds	32 adults (72%)	Johnson (2001)
Birds	1 41/2-year-old male (case analysis)	Johnson and Mervis (1994)
Birds	20 adults (65%)	Johnson and Mervis (1997)
Birds	12 adults (58%)	Tanaka and Taylor (1991)
Dinosaurs	36 4–9-year-olds (88%)	Alexander et al. (2002)
Dinosaurs	10 5–6-year-olds (60%)	Chi et al. (1989)
Dinosaurs	1 41/2-year-old male (case analysis)	Chi and Koeske (1983)
Dinosaurs	14 7-year-olds (100%)	Gobbo and Chi (1986)
Dinosaurs	42 5–9-year-olds (79%)	Johnson and Eilers (1998)
Dogs	12 adults (25%)	Tanaka and Taylor (1991)
Fish (sport)	30 adults (100%)	Boster and Johnson (1986)
Fish (tropical)	12 adults (83%)	Johnson and Mervis (1997)
Pokémon	11 children (73%)	Lavin, Gelman, and Galotti (2001)

[a] Percentage of male participants is presented in parentheses.

included both intermediate and advanced experts), a mean of 71% of the expert participants were male. A secondary goal of the present research was to determine whether these cognitive and gender differences are artifacts of the small samples recruited in studies of expertise, or whether they also apply to younger children who are just beginning to acquire knowledge aligned with high-interest conceptual domains.

1.3. External influences on individual interests in childhood

While individual interests certainly could emerge spontaneously from situational interests, it seems likely that external forces aligned with the home environment and parental attitudes help to maintain preschoolers' individual interests. Both types of factors are considered extensively in the literatures on talent development and teenagers' undivided interests (e.g., Kulieke & Olszewski-Kubilius, 1989; Rathunde, 2001). In this study, we consider the effects of five external factors on the likelihood that intense interests in conceptual domains will emerge:

(1) *Free play time*. Free play may be necessary, but not sufficient, for children's pursuit of individual interests. Preschoolers who spend much of their time in free play generally possess a fair degree of control over who and what they play with.
(2) *Educational emphasis*. Parents' attitudes toward achievement and success are reflected in the degree to which educational activities are emphasized in the home. These attitudes may ultimately influence children's social behaviors, achievement levels, and academic performance in complex ways (e.g., Barber, 2000; Bloom, 1985; Goldsmith, 1990; MacKinnon, 1965; McGillivray, 1964).
(3) *Consistency*. The extent to which parents emphasize consistency, structure, and order has been shown to positively affect the development of individuals with talent (Brooks, 1973; Kulieke & Olszewski-Kubilius, 1989; McGillivray, 1964).
(4) *Child prioritization*. Parents' prioritization of children's interests and activities is necessary for the development and maintenance of play interests (Bloom, 1985). Feldman and Piirto (1995) note that sustained prioritization of a child's interests promotes talent development.
(5) *Communication*. Children who develop interests in conceptual domains during early childhood are apt to be heavily dependent on others to provide them with domain-specific information. Such interests may be fueled through conversations about kinds of things and their interrelations, as well as through discussions sparked during sessions of book reading or by curiosity questions (Renninger, 2000). Of course, children's conceptual interests also may influence family communication by providing parents with salient topics to discuss and debate with their child. We hypothesize that the valuing of communication and the subsequent degree to which parents engage in discussions and conversations with their child may moderate relations between other external factors and the emergence of conceptual interests.

This study was intended to help connect the childhood expertise literature with research devoted to interest development by first assessing the prevalence of intense, individual interests in conceptual domains among preschool boys and girls, and then evaluating the degree to which individual and home variables were related to the short-term maintenance

of such interests. Since parents of child experts visiting our laboratory frequently report that their child's interest had emerged by age 3 years, we recruited 4-year-olds in order to maximize the proportion of children beginning to develop intense interests. Any preschooler manifesting an interest focused on a conceptual domain was presumed to be at an early stage of knowledge acquisition.

2. Method

2.1. Participants

Participants included 215 children (90 girls, 125 boys) recruited between the age of 4.0 and 4.6 ($M = 4.2$). Participants were seen at a baseline testing session during which children and their parents visited a laboratory either on an urban university campus (77% of the sample) or in a rural university town. Parents were contacted by phone 2 and 4 months later. A total of 211 child–parent pairs completed all three contacts (87 girls and 124 boys). Most of the sample was Caucasian (86%), with 6% African American, 3% Hispanic/Latino, and very small percentages of Asian and Native American children. The median income of participating families was between US$ 55,000 and US$ 65,000, and the mean level of education for both mothers and fathers was 16 years (i.e., on average, both parents had completed a baccalaureate degree). All children were native speakers of English, and none had ever been diagnosed with a receptive language or learning disorder. Two enrolled children received speech therapy for production deficits, but neither child showed a deficit in language comprehension. Families were recruited through brief articles placed in local newspapers, flyers posted in preschools and doctors' offices, or through electronic Listservs. Parents were informed that the study was focused on exploring the types of play interests developed by preschool boys and girls, but were not told anything about the objective of exploring factors that predicted the acquisition of interests in conceptual domains. Children were presented with small gifts in return for their participation.

2.2. Measures

Parents were provided with questionnaires containing items related to demographic factors, home environment and parental attitudes, and the child's play behaviors. Children completed a set of cognitive measures that were theoretically relevant to the development of knowledge in conceptual domains.

2.2.1. Home environment and parental attitudes

We administered a *Home Environment Questionnaire*[1] to assess factors that we theorized would potentially be relevant to the support of preschoolers' interests within conceptual domains. The questionnaire included 21 questions from the Family as Educator Questionnaire (Olszewski, Kulieke, Willis, & Krasney, 1985) that was used to investigate the home

[1] The measurement instruments used in this research may be accessed via the Internet at http://www.psych.iupui.edu/cogdevlab/measures.pdf.

environments of gifted and talented children. Parents rated on a Likert scale four items that reflected the degree to which they *emphasized educational activities* within the home. They also estimated the number of books in the home and rated the frequency of reading as well as several different educational activities outside the home (later averaged). Parents also rated five Likert-scale items that reflected their *value of consistency/structure* and five items that reflected their *value of communication*. In addition, parents answered two questions related to how often they changed their plans based on their child's interest or put their child's interest first in setting family agendas (which we term *child-prioritization*). Parents also quantified the amount of free play time available to a child and rated the value of free play time in their home.

2.2.2. Socioeconomic status

Socioeconomic status was determined using statistical measures similar to those employed by the U.S. Bureau of the Census. The following parent data were used: father's education level, mother's education level, occupation of the primary income earner (coded based on the Duncan Socioeconomic Index of Occupations; Duncan, 1961), and household income. Scores were standardized and retained as an SES Index.

2.2.3. Play behaviors

Parents provided a detailed description of their child's play and leisure time through the *Play Behavior Questionnaire*,[1] responding to questions about preferred play activities, favorite playthings, games, and pretend play themes. Additional questions were added as fillers intended to deflect parents' attention from the research questions focused on predictors of particular kinds of interest. To identify the presence of individual (intense) interests, parents were asked if their child's interests appeared very focused, with the child tending to keep the same play interest for more than a week at a time, or if the child seemed to be interested in lots of different things, with his or her interests seeming to change often. If a child's interest was described as focused, parents were asked to identify the particular topic or domain of play, and then to rate both the child's interest in the domain and the child's knowledge about the domain (compared to same-age peers) along an 8-point scale, where 1 = no interest/knowledge, and 8 = extremely high level of interest/knowledge for a child this age. Parents also indicated their own hobbies and interests, as well as those of any older siblings or any significant playmates.[2]

2.2.4. Cognitive abilities

Three tests were administered to children during the baseline testing session. Tests were selected based on their relevance to the acquisition of conceptual knowledge. In particular, children with higher levels of verbal intelligence and larger working memory capacity were presumed to be more apt to benefit from information presented through books, videotapes,

[2] We chose not to ask children directly about their play interests because we reasoned that they would be less likely to talk to a relatively unfamiliar experimenter about their favorite books and toys, particularly in a laboratory setting devoid of their favorite playthings. Preschoolers also have difficulty in self-assessments related to psychological traits (Harter, 1988) and we were concerned that children would have difficulty evaluating the degree to which their interests remained stable or not over time.

and conversations related to the conceptual domain. Children who were more reflective and analytic in their processing of information were expected to be more adept at acquiring the bases for differentiating among subordinate kinds. Each of the cognitive measures is described below.

1. The Peabody Picture Vocabulary Test—III (PPVT-III; Dunn & Dunn, 1997) was used to assess receptive vocabulary size and also to provide an index of verbal intelligence. The PPVT-III involves aural presentations of words accompanied by sets of four pictures. The child is asked to point to the picture associated with the word provided. Standard scores on the PPVT-III correlate from 0.82 to 0.92 with standard scores on the Wechsler Intelligence Scale for Children—Third Edition (WISC-III; Wechsler, 1991), indicating that the PPVT-III provides a reasonable estimate of verbal intelligence.
2. The Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP; Wright, 1971) was used to measure cognitive style. The KRISP includes 10 trials, each of which entails presenting the child with a target picture and then asking the child to find an identical picture from an array of perceptually similar distractors. The total number of correct trials was recorded. Mervis, Johnson, and Mervis (1994) reported that 3-year-olds adept at acquiring labels for subordinate categories (which often are learned by children highly interested in conceptual domains) tended to make fewer errors on the KRISP than children who learned subordinate concepts less readily, presumably due to their more analytic style of visual processing. Haynes and Miller (1987) also reported that children with more reflective cognitive styles, as assessed through the KRISP, were more successful on incidental recall tasks.
3. Working memory span was assessed through the SHAPE SPAN 2 test, which was developed by Miller and Vernon (1996). Series of green triangles and squares were presented on a computer screen, with series length ranging from 2 to 7 shapes. Display time was a function of the number of shapes in the series, with 750 ms allowed per shape. Following a series of practice trials, two trials at each series length were presented. The experimenter pointed to the left hand side of the monitor and asked the child to, "start here and tell me what shapes you saw." Testing stopped when recall for both series of a given length was incorrect, and the number of correct series completed was recorded for each child. Performance on working memory span tests is positively correlated with 4-year-olds' performance on the WPPSI-R, accounting for significantly more variance on intelligence scores than processing speed (RT) tasks (Miller & Vernon, 1996).

2.3. Procedure

Children and parents were seen once in the laboratory for a baseline testing session that lasted 60 min, including two scheduled breaks. The parent (typically the mother) completed the questionnaires described above and provided basic demographic information. After playing briefly with a trained research assistant to establish rapport, the cognitive measures were presented in the following order: PPVT-III, KRISP, SHAPE SPAN 2. Means and standard deviations were as follows: PPVT-III, $M(204) = 111.32$, S.D. $= 13.04$; KRISP M errors $(207) = 4.98$, S.D. $= 3.08$; SHAPE SPAN $M(209) = 1.82$, S.D. $= 1.72$.

Parents were contacted 2 and 4 months later by telephone to provide updates on their child's play interests and the degree to which they were focused. Interviews took from 5 to 10 min and involved a subset of questions from the *Play Behavior Questionnaire*. In addition, parents were asked to provide details concerning any family activities engaged in to support the child's interest. Interviews were conducted by trained research assistants and parents' responses were typed directly into an Access database.

Children who sustained interests in conceptual domains across all three contacts received a home visit within 2 weeks of the third contact. During the home visit, children's domain-specific knowledge was assessed. Resources within the home that were related to the child's interests also were inventoried, as reported by Leibham, Alexander, Johnson, and Reis-Henrie (2003). Children first were asked to list "as many kinds of X as you can think of" (where X was the basic level category aligned with the domain of interest). Children then were asked in reference to each of the first 10 subordinate categories generated, "What's special about ___? or "What can you tell me about ___?" Responses were transcribed and separated into propositions, where each proposition was defined as the smallest unit of meaning that could be verified as true (e.g., the response "it had sharp teeth to eat meat" was separated into the two propositions, "had sharp teeth," and "eats meat"). Home visits also were scheduled for a comparison group of 20 additional children (15 boys, 5 girls) with comparably intense interests in other areas (e.g., piano, basketball, Barbies).

3. Results

The results are divided into three sections. We first describe the classification of children into groups based on interest type. Second, we describe relations among the variables assessed and present results from a logistic regression analysis that evaluated which variables were related to the emergence of intense individual interests in conceptual domains. Finally, a detailed description of the subgroup of children manifesting intense individual interests in conceptual domains is provided, along with comparisons to a group of children who expressed equally intense interest in other domains.

3.1. Interest profiles at baseline

The majority of children were characterized as displaying focused (rather than generalized) interests across the three contacts. Focused interest were manifested an average of 66% of the time by girls, and 72% of the time by boys. Parents listed an average of 1.92 different interests per child over the course of the three contacts (range: 0–5). Parents of 10.4% of the children (11.5% of girls, 9.7% of boys) consistently reported that their child's interest was never focused.

The child's most frequently listed focused interest across the three contacts was classified by type. *Conceptual* interests were characterized by knowledge of networks of associated object concepts and features (e.g., *dinosaurs, trains, horses*). While interests in such domains support pretend play with toy models and replicas of domain exemplars, they primarily are characterized by the pursuit of information related to subordinate concepts. *Procedural*

Table 2
Summary of most frequently listed interests across the three contacts

Interest type	Proportion of children with reported interest[a]	
	Boys	Girls
Conceptual	41.9	12.6
Procedural	9.7	8.0
Constructive	4.8	1.1
Creative	3.2	19.5
Sociodramatic	16.1	28.7
Other	14.5	18.4
No reported focused interests	9.7	11.5

[a] $\chi^2(6) = 35.06$, $P < 0.001$.

interests were characterized by the acquisition and practice of skills (e.g., *basketball*, *piano*). *Constructive* interests involved building or constructing things (e.g., *Legos*, *puzzles*). *Creative* interests involved activities related to drawing, arts, and crafts, and *sociodramatic* interests entailed pretend play (with or without props). Classification of interests was conducted independently by two raters, with 96% agreement. Disagreements were resolved through discussion between the first two authors.

Consistent with the findings of Renninger and Wozniak (1985), the focus of children's interests differed substantially as a function of gender at age 4 years (see Table 2). Chi-square analyses revealed significant relations between interest types and gender, $\chi^2(6) = 35.06$, $P < 0.001$ with the majority of variance attributable to differences for *conceptual*, *sociodramatic*, and *creative* interests. While boys were more likely to manifest interests within conceptual domains, girls were more likely to manifest creative and sociodramatic interests.

We were particularly interested in the short-term maintenance of conceptual interests as potential candidates for subsequent development of domain-specific knowledge (Chi & Koeske, 1983; Johnson & Mervis, 1994). Forty-two children maintained the same conceptual interest across all three contacts, triggering the scheduling of a home visit (36 boys; 6 girls). The majority of those interests were focused on dinosaurs (43%), followed by cars, trucks, or construction vehicles (22%), trains (14%), Pokemon (7%), other types of animals (7%), and other science domains (7%).

3.2. Patterns of interrelations among variables

The *Home Environment Questionnaire* was designed to assess five home environment and parental attitude factors: (1) educational emphasis, (2) the value of consistency, (3) degree of child-prioritization, (4) the extent to which parents valued communication, and (5) both the amount of free play time and the value of free play in the home. Significant inter-correlations for items within each hypothesized factor suggested the existence of common underlying factors (range: 0.13–0.60, all Ps < 0.05). Confirmatory principal axis factor analysis with promax rotation provided further confirmation of the existence of the five factors (accounting for 53% of the variance with a Kaiser–Meyer–Olkin $= 0.76$ with values >0.6 required), with each individual item loading on the appropriate hypothesized

Table 3
Standardized means and standard deviations for variables entered into the logistic regression

Standardized variable	Children with other interests ($N = 169$)		Children with intense conceptual interests ($N = 42$)	
	M	S.D.	*M*	S.D.
Cognitive Ability	−0.02	0.63	0.20	0.57[a]
Value of Consistency/Structure	−0.08	0.94	0.28	0.81[a]
Educational Emphasis	−0.06	0.86	0.21	0.61[a]
Value of Communication	−0.03	0.93	0.11	0.73
Child-Prioritization	−0.03	0.82	0.10	0.63
Free Play factor	0.04	0.91	−0.13	1.10
SES Index	0.05	0.69	−0.16	0.70

Note. Levene's adjustment for equality of variance was used when appropriate.
[a] $t(209) < 0.05$.

factor. One item (importance of reading) did not load on any of the six factors and was excluded from further analysis.

A principal axis factoring of the child cognitive data yielded one cohesive factor that explained 40.29% of the variance. Individual children's scores on the cognitive factor and home environment factors were computed, standardized, and retained for use as predictors in subsequent analyses. For the small number of children who were missing one score within the cognitive battery (no child was missing more than one), factor scores were computed based on available scores. Descriptors of the factor scores are presented in Table 3.

Initial *t*-tests revealed differences between the cohort of 42 children with intense conceptual interests and the remainder of the sample ($N = 169$) on: (1) Cognitive Ability: $t(209) = 1.98$, $P < 0.05$. Children in the conceptual interest group tended to score significantly higher on the battery of cognitive assessments we administered, (2) Value of Consistency/Structure: $t(209) = 2.31$, $P < 0.05$, with parents of children in the conceptual interest group reporting a significantly higher valuing of consistency, structure, and order within the home, and (3) Educational Emphasis: $t(209) = 2.28$, $P < 0.05$, with children in the conceptual interest group residing within homes that placed a significantly higher emphasis on education. Although these group differences pertaining to individual factor scores were intriguing, we turned next to the development of a more comprehensive model of conceptual interest development that included the full range of individual and home environment factors assessed.

3.3. Determinants of sustained interests aligned with conceptual domains

A logistic regression analysis was completed with the entire sample of 211 children. In logistic regression, the dependent variable is dichotomous. Thus, the analysis allowed us to model the likelihood of a child sustaining an interest aligned with a conceptual domain across all three contacts ($N = 42$) compared to all other interest profiles ($N = 169$). The model used as predictors the computed factor scores for Educational Emphasis, Value of Consistency/Structure, Child Prioritization, Free Play, and Value of Communication. Gender and the child's standardized score on the Cognitive Ability factor and SES Index

Table 4
Logistic regression model predicting intense conceptual interests sustained for 6 months

Variable	Estimate slope coefficient	Standard error	Wald χ^2 (P-level)	Estimated odds ratio
Gender	1.79	0.51	12.56 (<0.001)	5.98
Cognitive Ability	0.64	0.32	3.90 (<0.05)	1.90
SES Index	−0.35	0.28	1.57 (0.21)	0.71
Consistency/Structure	0.49	0.24	4.05 (<0.05)	1.63
Free Play Time × Communication	0.73	0.27	7.13 (<0.01)	2.07
Educational Emphasis × Communication	−0.84	0.38	4.88 (<0.05)	0.43
Child Prioritization × Communication	0.49	0.38	1.70 (0.19)	1.63
Constant	−4.56	0.97	22.07 (<0.001)	0.01

were also entered. Tests for multicollinearity revealed that there were only small correlations among the factor variables. Although a few significant correlations emerged, the bivariate correlations were not greater than 0.70 (Tabachnick & Fidell, 2001) and thus the set of factors was considered viable for use in the logistic regression. Our sample size of 211 exceeded recommended sample size power rules for testing individual predictors and interactions in multiple regression models (Green, 1991).

We hypothesized that any relations between the emergence of children's intense interests in conceptual domains and external factors (parents' emphasis on Consistency/Structure, Education, Free Play, and Child-Prioritization) could depend on the Value of Communication in the home. The presence of these moderating effects was tested through preliminary hierarchical logistic regressions. Changes in the −2 log likelihood were assessed after the addition of each interaction term to a model containing its main effects. Significant enhancements to prediction were made ($P < 0.10$) with the inclusion of the interaction term in each of the preliminary analyses, with the exception of the Consistency/Structure × Communication interaction. As a result, only three interaction variables (Educational Emphasis × Communication, Free Play × Communication, and Child-Prioritization × Communication) were created for use in the logistic regression analysis.

For the final model, a logistic regression on seven variables (Gender, Cognitive Ability, SES profile, value of Consistency/Structure, and the three interaction terms listed above) was conducted to model the dichotomous outcome of short-term maintenance of conceptual interests. The model, depicted in Table 4, yielded an adequate fit to the data, Hosmer–Lemeshow goodness of fit statistic = 5.32 (8 d.f.), $P = 0.723$ (non-significant results are required); Negelkerke $R^2 = 0.26$. Examination of the ROC Curve (a graphic display of predictive accuracy) suggested that a 0.2–0.3 cut value was appropriate for our data, as the odds of being classified within the intense conceptual interest group was not equivalent to the odds of inclusion in the comparison group. Before data collection began, we had anticipated that interests aligned with conceptual domains were not common. Surveys of preschool teachers suggested that approximately 15–20% of our sample would develop these types of interests (Kohler, 2000). Examination of the resultant ROC curve led us to adjust the cut point for classification into this group to 0.25. This meant that the odds of an interest being classified as focused on a conceptual domain within a sample of 100 children is approximately 25%. The model was examined to determine its predictive accu-

racy. Better models have higher values for sensitivity (correct classifications; 75.7%) and specificity (correct non-classifications; 71.4%) and lower values for false positives (28.6%) and false negatives (24.3%). Our model clearly fits these guidelines.

The estimated odds ratio in Table 4 represents the increase (or decrease, if the ratio is less than 1) in the odds of being in the conceptual interest outcome category when the value of the predictor increases by one unit. The estimations are made after adjusting for all other predictors in the model. The odds that a child would adopt an interest aligned with a conceptual domain were six times higher for boys than for girls with other predictors held constant. Children who scored higher on the Cognitive Ability factor were 1.9 times more likely to be classified in the conceptual interest group. In addition, children from homes in which consistency and structure were highly valued were 1.6 times more likely to express a conceptual interest.

Two of the three predicted interactions emerged as significant in the overall model. In order to understand the complex interaction of two continuous variables, each was dichotomized based on median splits. Thus, Fig. 1 illustrates a simplified version of the interaction between the communication factor and the free play factor when predicting the probability of a child having a conceptual interest (as indicated on the *Y* axis). Comparisons at each of the dichotomized levels of free play revealed that the difference between high and low communication was only significant at the highest levels of the Free Play factor, $t = 2.95$, $P < 0.01$. As anticipated, conceptual interests were less apt to be sustained when children had relatively little time for free play. However, more free play was only predictive of sustained conceptual interests when it was coupled with a home environment in which communication was highly valued. It makes sense that providing preschoolers with ample time to explore domain-related information through play is not sufficient for developing play interests that entail learning conceptual information about categories of objects and their interrelations. Rather, free play opportunities need to be accompanied by family discussions and the communication of ideas in order for such interests to flourish.

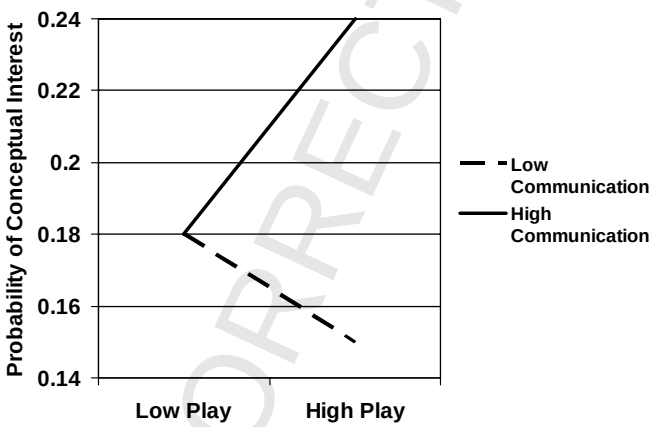

Fig. 1. Interaction between availability of Free Play Time and Value of Communication in determining the likelihood of intense conceptual interests.

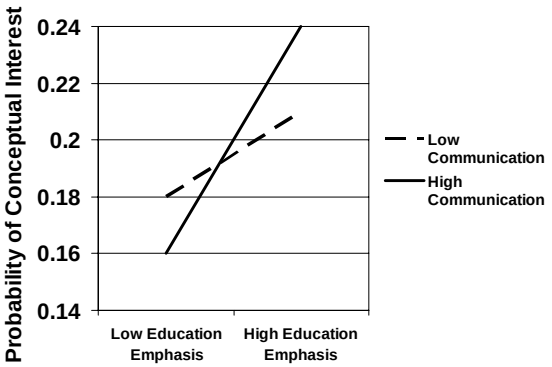

Fig. 2. Interaction between Child-Prioritization and Value of Communication in determining the likelihood of intense conceptual interests.

Second, a significant interaction between Communication and Educational Emphasis emerged. A similar dichotomized depiction of the interaction appears in Fig. 2. Follow-up comparisons at each of the levels of educational emphasis illustrated that the likelihood of sustaining a conceptual interest differed between high and low communication emphases only at the highest levels of the Educational Emphasis factor, $t = 2.64$, $P = 0.009$. Again, we had anticipated that emphases placed on education and learning within the home would be important for sustaining children's interests in conceptual domains. Yet this factor was predictive of such interests only when in conjunction with a high value of communication within the home.

3.4. Other characteristics aligned with short-term maintenance of conceptual interests

3.4.1. Assessments of knowledge and interest

During the home visit, children were first asked to list as many kinds of X (where X was the basic level domain of interest) as they could. Children generated a mean of 10.8 subordinate kinds (S.D. = 4.05). For the first 10 instances listed, children also were asked to elaborate on what they knew about the subcategory. Gobbo and Chi (1986) used a benchmark of naming 10 dinosaurs correctly (in a picture naming task) as a criterion for inclusion in the "expert" group in their study of 7-year-olds' dinosaur knowledge. They also reported that their experts listed a mean of 2.81 explicit (observable) propositions and a mean of 5.22 implicit (unobservable) propositions in reference to pictures of familiar dinosaurs. Children in our sample produced an average of 4 propositions per instance even when pictures of those kinds were not available, and 22 children produced at least 10 instances of concepts included within the domain, although they were generally three years younger than the children studied by Gobbo and Chi (1986). These children were clearly beginning to build a knowledge base containing domain-specific concepts and their related features.

Parents' ratings of their children's relative levels of interest averaged 6.09 and ratings of knowledge averaged 5.79 (both on the same 8-point scale) across the three contacts. Several parents commented that since the onset of the interest, their child had exhibited a "hunger

Table 5
Interest support activities by focused interest type

Support activity	Children with intense conceptual interests ($N = 42$)		Children with other-focused intense interests ($N = 20$)	
	Yes	No	Yes	No
Trips	29	13	5	15[a]
Reading	20	22	1	19[a]
Videos/TV	14	28	1	19[a]
Playing with child	12	30	14	6[a]
Discussions	25	17	12	8
Collecting things	8	34	0	20[b]
Family member shares identical or related interest	30	12	13	7

[a] $\chi^2(1) > 8.7$, $P \leq 0.01$.
[b] $\chi^2(1) > 5.0$, $P < 0.05$.

for knowledge" about the domain, and that when given a choice of books to read, videos to watch, or toys to play with, many would almost invariably select activities that were aligned with the conceptual domain of interest.

3.4.2. Types of interest support

We contrasted the responses to questions regarding interest support activities made by parents of children with sustained conceptual interests ($N = 42$) and parents of children in a comparison group ($N = 20$; 15 boys, 5 girls) that sustained comparably intense interests on nonconceptual domains (e.g., basketball, drawing, Barbies) across the three contacts to explore whether support activities were related to the child's type of interest. Support activities reported by parents were classified as trips, reading, watching videos/TV, playing with the child, having discussions, or collecting things. Responses were coded by two independent raters with 99% agreement. Within each category, children were credited with a 1 if the activity was explicitly mentioned by a parent and a 0 if it was not, and then scores were summed.

The family systems of children with conceptual interests appeared to support children's pursuit of information (through trips, reading, collecting things, and viewing relevant videotapes or television programs; see Table 5). Parents of children with equally intense, but nonconceptual interests were more apt to support the child's interest through playing with them. Sixty-nine percent of children across both groups had another family member who shared the same or a related interest (e.g., a father interested in collecting residing with a child passionate about collecting Pokémon cards).

4. Discussion

Our results provide the first detailed analysis of the prevalence of particular play interest profiles in preschoolers, and help us to understand the complex interplay of factors related to sustained intense interests in domains characterized by the acquisition of object concepts.

As expertise researchers have reported, cognitive abilities of children clearly are related to the manifestation of interest profiles aligned with conceptual domains. We also replicated the substantial gender difference found in studies of experts reviewed in Table 1. Preschool boys were six times more likely than girls to manifest such interests. Interestingly, the extent to which parents reported valuing consistency and structure within the home was positively related to children's maintenance of conceptual interests. This is in keeping with previous research indicating that parenting styles and the degree to which structure is emphasized affect the development of individuals with talent (Kulieke & Olszewski-Kubilius, 1989). Finally, opportunities for free play and the degree to which educational activities were emphasized within the home interacted with the degree to which communication was valued within the home. Higher quantities of free play and greater educational emphasis were predictive of sustained conceptual interests, but only when the emphasis on communication also was high.

The role of the home environment in fostering children's early play interests is not surprising, given how dependent preschoolers are on their parents for exposure to information. Without committed parents, preschoolers cannot readily acquire conceptual knowledge through the asking of "curiosity" questions aligned with the domain of interest (Renninger, 2000; Wigfield & Eccles, 1992). Our results suggest that home and family factors should be considered more carefully in analyses of the emergence of expertise in childhood. Below, we first consider potential implications of conceptual interests, particularly in regard to emergent science literacy and expertise acquisition. We then provide possible explanations for the consistent pattern of gender differences in this type of interest and suggest directions for future research.

Conceptual interests clearly lay the foundation for subsequent knowledge acquisition (Johnson & Mervis, 1994). Acquiring expertise on any domain of information is a manifestation of cognitive competence, which becomes a very important determiner of level of self-esteem in middle childhood (Cauce, 1987; Cole, 1991). Thus, having more knowledge about a domain may make a child more confident about learning new information. Interestingly, the majority of conceptual interests fell within the realm of science, with many biological (e.g., bugs, dinosaurs) and mechanical (trains, cars) domains represented. Acquiring substantial levels of this type of domain knowledge presumably would be advantageous for children once formal science instruction begins. Such interests would enable children to construct more elaborate naïve scientific theories related to biological and physical phenomena and could enhance children's interest in science and achievement motivation once formal science instruction begins.

Boys were six times more likely than girls to maintain short-term intense interests in conceptual domains. It is important to point out that girls were equally focused in the interests they maintained. However, these interests generally were aligned with domains related to the arts (drawing, painting) or activities pertinent to the formation and elaboration of social relationships (pretend play, dolls). While such interests clearly are quite valuable and equally deserving of study, our focus on conceptual domains replicated earlier research that suggests that boys tend to gravitate toward domains that entail the learning of facts associated with subordinate level kinds.

Conceptual interests represent classic instances of *systemising*, or the drive to construct and analyze systems of phenomena that are lawful, finite, and deterministic (Baron-Cohen,

2002, 2003). Systemising has been argued by Baron-Cohen and his collaborators to be one basis for human sex differences: most males express strengths in systemising whereas most females express strengths in empathising. Acquiring subordinate concepts is a form of "fact collecting" characteristic of systemisers (Baron-Cohen, 2003). Interestingly, parents of boys with conceptual interests frequently reported that their child simply demanded to be read "factual" science books that helped them to learn new information about the high-interest domain. Such a preference for nonfiction books rarely was reported by parents of 4-year-old girls, presumably because of the tendency for girls to prefer activities aligned with empathising over those aligned with systemising (Baron-Cohen, 2002).

Another explanation for the gender difference may come through differential exposures to interest-aligned activities. For instance, preschoolers are exposed to science largely through informal contexts (e.g., museum exhibits, book reading, collecting objects) of the sort frequently described by parents of children with conceptual interests. Parents are more likely to explain scientific concepts to boys than to girls while engaged in interactive science exhibits (Crowley, Callanan, Tenenbaum, & Allen, 2001). Such differences were found among children as young as 1–3 years of age, suggesting that different patterns of communication between the genders are entrenched well before children enter school. It is impossible to tell whether these communication differences are based solely on gender, or whether parents were reacting to differences in the levels of boys' and girls' interest in the science-related content.

Societal imposed gender typing at the level of the individual *reference objects* may also play a role in determining whether or not a child will become interested in a conceptual domain. *Reference objects* are usually the first introduction a child has to an *interest object*. They can determine the boundaries and primary content of the interest itself (Krapp & Fink, 1992). A major component of the play interests observed in this study were the toys associated with the domains. Gender-typed toy preferences emerge at an early age and persist even during play within gender-mixed groups (Moller & Serbin, 1996). Conceptual domain reference objects such as dinosaur models, toy cars, train sets, and bug collecting kits are male-associated items, which may lead girls to see these items as either personally undesirable or prescriptively "off limits." Interestingly, such toys frequently are sold as collections or sets, which may provide an additional impetus for boys to learn to differentiate subordinate kinds.

While studies of interest development and studies of the early acquisition of expertise in childhood have traditionally been carried out by researchers from very different theoretical perspectives, the present data suggest that research in either area could substantially benefit from adopting a more holistic view of the process through which intense interests emerge in young children. One potentially fruitful avenue for research concerns the impact that children's interest profiles might have upon the transition to school. It seems possible that children with intense interests might thrive in child-centered classrooms where they could use their focused interests to explore related areas in school. However, intense interests could potentially be distracting in classrooms facilitated by teachers that are highly directive and whose personal interests are not well aligned with the child's.

Another important future direction concerns the factors that promote the sustained manifestation of intense interests throughout the preschool and early elementary school years. Sustained interests would be most likely to promote the acquisition of rich networks of

knowledge indicative of relative expertise. Examining whether a relation continues to exist between children's cognitive abilities and the degree to which interests are sustained over long periods of time will help us to better understand the basis for previously reported relations between expertise in children and intelligence (Johnson & Eilers, 1998). For example, we may find that higher aptitude children are naturally drawn to more complex domains, acquire knowledge about those domains faster, and benefit more from that knowledge when processing domain-relevant information than lower aptitude children. Longitudinal investigations are crucial for understanding the mechanisms through which intense interests are sustained and how such interests impact learning throughout the early elementary school years.

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