J. Child Lang. **29** (2002), 519–543. © 2002 Cambridge University Press
DOI: 10.1017/S0305000902005196 Printed in the United Kingdom

Processes in language acquisition: the roles of gender, attention, and maternal encouragement of attention over time*

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(*Received* 20 *October* 2000. *Revised* 26 *November* 2001)

ABSTRACT

This longitudinal study including 87 infant–mother dyads examined the relation between infant temperamental attention, maternal encouragement of attention, language, and the effects of gender. At ages 0;4, 0;8, and 1;0, global attention was assessed from Rothbart's (1981) IBQ; manipulative exploration was assessed with the Bayley (1969) IBR; and maternal verbal, visual and physical encouragement of attention were coded from 5 minutes of mother–infant free-play. At 1;0, language was measured using language items from the Bayley Mental Scale and parent-report items from Hendrick, Prather & Tobin's (1984) SICD-Revised. Multiple regressions indicated that gender, infants' manipulative exploration and maternal physical encouragement of attention at 0;4, and maternal verbal encouragement of attention at 1;0, were all positively related to language at 1;0. Interactions indicated that girls high in 0;8 or 1;0 manipulative exploration had more advanced language skills than girls low in manipulative exploration or than boys, regardless of their attention level. Additionally, maternal verbal encouragement of attention appears to be particularly salient in the development of language for boys.

INTRODUCTION

The purpose of this study is to examine the association between infant temperamental attention, maternal encouragement of attention, and the infant's subsequent language development and the effects of gender on these associations. Language development involves multiple factors, both within

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the infant and within the infant's social environment. To learn language, an infant must attend to the linguistic input in his or her environment in order to pair words with objects or events. Additionally, mothers engage in behaviours to facilitate language learning in infants, such as speaking motherese and object labelling. This study examines infant temperament (attention), maternal input (encouragement of her infant's attention), and how attention and maternal encouragement work together to foster language development. Finally, due to the wealth of research indicting gender differences in the rate and timing of language acquisition, the effects of gender on these relations will be examined.

Social interactions in infancy are highly influential in many areas of infant development. In particular, early mother–infant interactions set the stage for development in many areas and are particularly influential in early language acquisition (Bruner, 1983). For example, research on joint mother–infant attention has demonstrated a link between joint attention and language (e.g. Tomasello & Todd, 1983; Tomasello & Farrar, 1986; Desrochers, Morissette & Ricard, 1995; Mundy, Kasari, Sigman & Ruskin, 1995; Ulvund & Smith, 1996; Mundy & Gomes, 1998; Markus, Mundy, Morales, Delgado & Yale, 2000). Joint attention seems to provide the infants with predictable learning opportunities that set the stage for communicative development and development in broader cognitive domains (Bruner, 1975; Tomasello & Farrar, 1986; Vibbert & Bornstein, 1989). Infants experience these interactions repeatedly until the interactions become predictable, rendering the task of the infant of identifying and matching words with objects much easier, which makes the language environment more meaningful (Tomasello & Farrar, 1986). As these interactions recur often, the infant is allowed a wide range of opportunities to match words with objects that the child is attending to in the environment (Bruner, 1985).

Temperamental attention and language development

Research has shown that infants with higher levels of attention in infancy, either temperamental attention (Matheny, 1989; Slomkowski, Nelson, Dunn & Plomin, 1992) or attention studied in an information processing context (Tamis-LeMonda & Bornstein, 1989; Rose, Feldman, Wallace & Cohen, 1991), have more advanced cognitive development and language skills in toddlerhood and early childhood. According to Bloom (1993), both emotion and language draw from the same limited pool of cognitive resources in the infant. Thus, an infant can generally either express an emotion or communicate linguistically. Therefore, infants who spend more time in an attentive, interested state are expressing less emotion and thus have more cognitive resources available for language learning. Many studies have supported Bloom's ideas. For example, infants who were rated higher on task

orientation as assessed by the Infant Behavior Record (Bayley, 1969) performed better on concurrent Bayley Mental Tests at ages 1;0, 1;6, and 2;0 (Matheny, 1989). Children who were rated higher on attention/persistence by observers achieved higher concurrent IQ scores at 3;0, 4;0, 6;0, and 8;0 and higher concurrent scores on the verbal subscale of the IQ test at 12;0 (Matheny, 1989). Task orientation at 2;0 predicted concurrent receptive and expressive language, receptive language at age 3;0, and several indices of language development at 7;0 (Slomkowski *et al.*, 1992). Infants rated higher on attentiveness to task help, intensity and duration of task involvement, and alertness during a mother–infant teaching task at 1;0 and 2;0 years scored higher on receptive language at age 3;0 (Bee, Barnard, Eyres, Gray, Hammond, Spietz, Snyder & Clark, 1982). Maternal ratings of infant attention at ages 1;1 and 1;8 were found to be related to language production measures at age 1;8, and attention at 0;7 was related to language comprehension both concurrently and at age 0;10 (Dixon & Smith, 2000). Overall, attention span/persistence tends to be correlated with higher cognitive functioning across infancy and childhood and is more strongly related to the verbal components of these tests than to the performance components (Matheny, 1989).

This association between attention and language development has not, however, been universally supported. One study failed to find a association between concurrent measures of attention (operationalized as the mean duration of the two longest periods of uninterrupted attention to a toy) and language development at age 1;1, which could in part be accounted for by the moderate sample size of 36 infants (Bornstein & Tamis-LeMonda, 1997).

Maternal stimulation and language development

As language development must occur within the social context, the influence of the mother has also been examined in relation to language skills. Bruner (1983) emphasized the social interaction basis in early language development such that children's earliest language skills are achieved and fostered within a social context. The optimal language-learning environment occurs when adult language follows the child's focus of attention (Bloom, 1993). Empirical results are mixed, however, as to the effects of maternal stimulation in infancy on language development, partially due perhaps to the plethora of operationalizations for maternal stimulation. Maternal encouragement of attention in infancy (defined as physical or verbal direction of attention) has been found to predict later language comprehension and to partially mediate the relationship between early habituation and later language development (Tamis-LeMonda & Bornstein, 1989). That is, infants aged 0;5 who habituated more quickly had mothers who used more encouragement of attention, which in turn, led to better language comprehension at age 1;1. Maternal verbal responsiveness to her infant, defined as affirmations,

imitations or expansions, descriptions, questions, and play or exploratory prompts, was found to be a more robust predictor of the timing of the infant's achievement of language milestones through age 1;9 than the child's own behaviours, defined as bids or looks to the mother, exploration, vocalization, or play (Tamis-LeMonda, Bornstein & Baumwell, 2001). Although maternal direction of attention has been found to predict later cognitive outcomes, more global ratings of mother responsiveness have not. For example, maternal responsiveness at ages 0;5 and 1;1 (operationalized as responding promptly, contingently, and appropriately to the child's signals or vocalizations) were not found to be related to language development at age 1;1 (Bornstein & Tamis-LeMonda, 1997).

Maternal stimulation and infant attention have also been found to be related to each other. Maternal responsiveness to infants' distress and nondistress in infancy has been found to predict higher levels of infant attention in later infancy (Bornstein & Tamis-LeMonda, 1997). Additionally, maternal stimulation during toy play significantly increased infant attention to objects, but only for infants who were originally low in attention (Lawson, Parrinello & Ruff, 1992). Belsky, Goode & Most (1980) found that once mothers became aware of the effects of their behaviour, they became more directing and stimulating with their one-year-olds, and the infants then increased in exploratory competence in play.

Temperamental attention, maternal stimulation and language development

Although the above studies have used a variety of measures of temperamental attention, results from these studies seem to concur that attention and language development are related. Ruff (1990) distinguishes between MANIPULATIVE EXPLORATION and ANTICIPATORY ATTENTION AND RESPONSE PREPARATION. Manipulative exploration refers to the duration of infant's examination and manipulation of objects, usually toys; this conceptualization is commonly measured in tests of infant temperament, such as the Infant Behavior Record (IBR; Bayley, 1969) and the Infant Behavior Questionnaire (IBQ; Rothbart, 1986). Infants show considerable variability in the duration and style of their manipulative exploration (McCall, 1974). Anticipatory attention and response preparation refers to sustained attention in expectation of an impending event and is not a focus of the current study because there are not common measures to measure this construct.

Studies have also operationalized maternal stimulation in different ways. In one study, the most salient maternal predictors of two-year-olds' language/cognitive competence were object stimulation at 0;6 and teaching at 1;1 (Olson, Bates & Bayles, 1984). In another study, maternal encouragement of attention at ages 0;5 and 1;1, defined as maternal attempts to physically or verbally direct her child's attention, predicted greater language comprehension at age 1;1 (Tamis-LeMonda & Bornstein, 1989). In

a third study, mothers who encouraged their infant's attention at age 0;4 with such behaviours as handing or pointing to a toy had infants with larger speaking vocabularies at 1;0 (Ruddy & Bornstein, 1982). In another study, maternal verbal responsiveness to her infant (affirmations, imitations or expansions, descriptions, questions, and play or exploratory prompts) was found to predict the timing of later language milestones (Tamis-LeMonda *et al.*, 2001).

Different operational definitions of maternal encouragement of attention have been found to differentially predict later referential vocabulary (Pine, 1994). Specifically, maternal verbal encouragement of attention was categorized into BEHAVIOURAL DIRECTIVES (eliciting or constraining the physical behaviour of the child) and ATTENTIONAL DIRECTIVES (attempts to direct or change the child's focus of attention). Behavioural directives were negatively related to vocabulary in the child's second 50 words but not significantly related to vocabulary in the child's first 50 words nor to vocabulary at age 1;4. Attentional directives were negatively related to vocabulary at 1;4 but were not significantly related to vocabulary in the first or second 50 words. Thus, certain modalities of maternal encouragement of attention may differentially predict later language outcomes.

In summary, infants who can sustain longer bouts of attention tend to develop language earlier than their less attentive peers, perhaps due to limited cognitive resources available for expression of emotion versus linguistic expression (Bloom, 1993). Additionally, mothers can influence their infants' attention capacities (Belsky *et al.*, 1980; Lawson *et al.*, 1992; Bornstein & Tamis-LeMonda, 1997), and some research indicates that maternal encouragement of infant attention enhances language acquisition (Ruddy & Bornstein, 1982; Tamis-LeMonda & Bornstein, 1989). None of the previous studies, however, has examined the contributions of both infant temperamental attention and specific modalities of maternal encouragement of attention. Both of these constructs have been found to make unique contributions to language acquisition; however, by examining the relations between infant characteristics and maternal behaviours in predicting early language, the processes involved in language learning can be more fully explored.

Gender and language

Many studies indicate the presence of gender differences in early vocabulary growth (e.g. Fenson, Dale, Reznick, Bates, Thal & Pethick, 1994; Morisset, Barnard & Booth, 1995); girls tend to outperform boys. However, knowing that language develops in girls earlier and more quickly than it does in boys does not give us any insight into how language develops in each gender. Perhaps boys and girls acquire language in meaningfully different ways (Butterworth, 1995). For example, gender differences in handedness during

gestural communication have been found during the second year of life (Graupner, Butterworth & Franco, 1993; cited in Butterworth, 1995). This difference could reflect gender differences in brain development in infancy.

Additionally, differences in maternal interaction with girls than with boys could also contribute to gender differences in language skills. For example, mothers are differentially responsive to the emotions expressed by their infants aged 0;3 to 0;6 depending on the gender of the child (Malatesta & Haviland, 1982). Mothers of boys scored higher on optimal teaching behaviours (high positive messages, good timing and sensitivity, low negative messages and low intrusion) than mothers of girls did at ages 0;4 and 4;0, although no differences were found at ages 1;0, 1;2, or 3;0 (Bee *et al.*, 1982). Gender differences in maternal interactional styles in infancy could contribute to later gender differences in language acquisition. It is also possible that mothers are receptive to the unique language abilities of their infants and that they tailor their input based on their knowledge of their infant's linguistic level. For example, a recent study of mothers of infants aged 1;2 showed that mothers who perceive their child as understanding more tend to communicate more with them, both verbally and non-verbally (Rowe, 2000). Examination of gender differences in temperament attention and maternal encouragement of attention and their contributions to later language could help us better understand why girls progress more quickly in language acquisition than boys do.

The present study

Temperamental attention will be assessed in this study using two measures of temperament: the Infant Behavior Record (IBR; Bayley, 1969), which is completed by a trained observer after administration of the Bayley Scales of Infant Development, and the Infant Behavior Questionnaire (IBQ; Rothbart, 1981), which is completed by the mother. The task orientation dimension of the IBR (a composite of goal directedness, attention span, object orientation, and object manipulation) measures infants' manipulative exploration whereas the IBQ is a more global measure of attention, encompassing the manipulative aspects of the IBR, but also including other indices of attention, such as amount of time spent looking at pictures, the television, or a mobile. The global measure of attention is predicted to be more strongly and consistently related to language development than is the manipulative measure of attention, as attention in a language-learning context would incorporate dimensions of attention other than just object manipulation.

The present study examines three modalities of maternal encouragement of attention: verbal, visual, and physical. A developmental process in optimal maternal encouragement of attention is expected such that higher levels of visual and physical encouragement of attention in early infancy (i.e. age 0;4) would lead to more advanced language skills at age 1;0 whereas verbal

encouragement of attention at 0;4 would be unrelated to language skills at 1;0. Verbal encouragement of attention at age 0;4 would not impact the infant's processing of language as infants are less in-tune to their linguistic environments. However, higher levels of maternal visual and physical encouragement of attention with infants aged 1;0 might lead to less optimal concurrent language skills as this style of parenting at the end of the first year could be indicative of a more controlling style of stimulation, which has been found to be related to a smaller nominal vocabulary (Tomasello & Todd, 1983). Additionally, higher levels of verbal encouragement of attention at age 1;0 are expected to lead to more advanced concurrent language abilities because infants at this age can benefit from the linguistic input.

Furthermore, maternal encouragement of attention is predicted to play a role in the relationship between temperamental attention and language development. Thus, mediating and moderating relationships will be tested. Maternal encouragement of attention could mediate the relation between attention and language, such that infants with greater temperamental attention are predicted to have mothers who encourage attention to objects in developmentally appropriate modalities, which would lead to greater language development during the second year. Conversely, maternal encouragement of attention could moderate the relationship; perhaps maternal stimulation and infant attention are unrelated to each other but some combinations of attention and encouragement might be more adaptive in terms of language learning than others. For example, infants with low temperamental attention but with mothers who are actively encouraging of attention might show higher language ability than infants with low attention who receive less maternal encouragement of attention.

An additional goal not previously examined in the literature is to study the extent to which changes in infants and mothers predict language outcomes. Increases in infant attention during the first year might indicate neural circuitry maturation in the attention and/or attentional control systems (Rothbart & Bates, 1998). Changes in these attentional systems should be reflected in changes in attention dimensions of temperament (Dixon & Smith, 2000). In past research, short-term changes (i.e. three months) in duration of orienting of the first year of life were found to be positively related to noun production at 1;1 and all aspects of language production at age 1;8 (Dixon & Smith, 2000). In the present study, infants who increase in attention are predicted to show greater language abilities at one year than infants who do not show a similar rising trajectory. This increase in attention is expected to help infants in their engagement with their environment, and this engagement with the linguistic aspects of the environment is predicted to be beneficial as the infant's cognitive and neurological processes develop to the point where language begins to be acquired. Changes in maternal encouragement of attention are not expected to be predictive of later

language skills, since optimal maternal encouragement is predicted to differ by modality (i.e. verbal, visual, or physical) at each age.

Finally, the process involved among temperamental attention, maternal encouragement of attention, and language may operate differently for boys and girls; thus, associations among these constructs will be examined separately by gender. Perhaps early gender differences in temperament and maternal interaction will in part account for later differences in language acquisition. For example, given early gender differences in language acquisition, boys might benefit more from maternal verbal encouragement of attention than girls, who are already more in-tune with their linguistic environments, as evidenced in their higher early receptive language scores (Fenson *et al.*, 1994).

METHOD

Participants

Participants were 87 full-term infants (55·2% male) and their mothers recruited by mail from a middle-sized midwestern town. These mother–infant dyads were part of a larger study of infant development that examined the relations between socio-emotional, cognitive, and motor development and the environment longitudinally. Infants came from predominately white (97·7%), middle-class (median household income ≈ $35,000) homes. Mothers and infants visited the lab when the infants were ages 0;4, 0;8, 1;0, and 1;4 (plus or minus 10 days).

Due to the intense demands placed on the families of the participants in this study, missing data was common. Full participation in the study required mothers and infants to attend four laboratory assessments that lasted from $1\frac{1}{2}$ to 2 hours. Additionally, mothers were asked to complete 14 questionnaires before each assessment. From the original sample of 143 participants, only the 87 infants who had complete data were included in the present study. Nineteen participants had missing assessment data. Reasons for missing assessments included: family was out of town (1), phone was disconnected (2), illness (3), family too busy (2), family didn't show up for scheduled assessment (3), family moved out of the area (5), family personal reasons (2), and death in the family (1). Seventeen participants had partially missing assessment data due to infant fussiness (6), infant sleepiness (2), experimenter error (4), camera malfunction (3), and the father bringing the infant to the assessment instead of the mother (2). Additionally, twenty mothers did not turn in complete questionnaire data.

Analyses were performed to test for differences on demographic variables between dyads with complete data and dyads with missing data. Compared to dyads with complete data, those with missing data were more likely to be from single or divorced families, $t_{(64.24)} = 2{\cdot}91$, $p < 0{\cdot}01$, had mothers with

less education, $t_{(139)} = -2{\cdot}33$, $p < 0{\cdot}05$, and tended to have fathers with less education, $t_{(138)} = -1{\cdot}70$, $p < 0{\cdot}10$. Thus, the results from this study appear to be generalizable to dyads from maritally intact, more educated families.

Procedure

Before each visit, a consent form, a temperament questionnaire, and several other questionnaires that were not used in the present study were sent home to be completed by the mother before the visit. Lab visits consisted of an information-processing task, 3 emotion regulation procedures, 5-minute mother–infant free play, administration of the Bayley Scales of Infant Development (Bayley, 1969), physical measurements, and brief interviews with the mother about language development and socialization. Before the mother–infant free play, a variety of age-appropriate toys were scattered on the floor and mothers were instructed to play with their infants as they would at home. Only the data from the temperament questionnaire, the mother–infant free play, and the language portions of the Bayley administration and mother interviews were used for the present study.

Measures

Infant global attention. The Infant Behavior Questionnaire (IBQ; Rothbart, 1981) was filled out by the mother at ages 0;4, 0;8 and 1;0, rating the child's typical behavioural tendencies. Parents rate items on a Likert scale from 1 (never) to 7 (always). Because the questions are very specific, the IBQ is thought to allow mothers to more objectively rate actual infant characteristics. The IBQ has six subscales: Distress to Limitations, Distress to Novelty, Activity, Smiling and Laughter, Duration of Orienting, and Soothability. Convergence between maternal IBQ ratings and both home observations (Rothbart, 1986) and laboratory ratings (Bridges, Palmer, Morales, Hurtado & Tsai, 1993) have been reported, though they tend to be in the low to moderate range. Only the Duration of Orienting subscale was used for the present study. Coefficient alphas for the 8 items contributing to the subscale were 0·82 at age 0;4, 0·80 at age 0;8, and 0·76 at age 1;0.

Infant manipulative exploration. This observer-reported measure of infant attention was a composite of goal directedness, attention span, object orientation, and object manipulation from the Infant Behavior Record of the Bayley Scales of Infant Development. Each item was coded on a 9-point scale, and the composite was formed by calculating the mean of the four items. Coefficient alphas for the four items were 0·82 at 0;4, 0·65 at 0;8, and 0·71 at 1;0.

Maternal encouragement of attention. Mothers' verbal, visual and physical encouragement of attention were coded from videotapes of the 5-minute mother–infant free play. Each variable was coded on a 1 to 5 scale. Mothers who were weak on the encouragement modality or who engaged in that type

of encouragement only rarely were scored as a 1; mothers who were rich in the encouragement modality or used it frequently were given a 5. A mother who obtained a score of 5 for verbal encouragement was rich in her use of language to discuss and describe objects; this mother would name objects and talk about both global and local attributes of the objects. A visually encouraging mother used lots of demonstrations of toys for her infant, showing her infant the toys and displaying their functions. Finally, physical encouragement of attention involved giving the infant the opportunity to manually explore objects and assisting the infant in this exploration when necessary. Because mothers of infants at age 1;0 rarely used physical encouragement of attention, this variable was not coded at this age. Using Cohen's kappa to correct for agreement that occurs by chance, inter-rater agreement for 10 babies at each age ranged from 0·88 to 1·0 at 0;4, from 0·75 to 1·0 at 0;8, and from 0·62 to 0·87 at 1;0.

Linear change scores. Change scores for the two infant attention variables and the three maternal encouragement of attention variables were computed by subtracting the scores at age 0;4 from the scores at age 1;0. Since maternal physical encouragement of attention was not coded at age 1;0, the change score for this variable was computed by subtracting the scores at 0;4 from the scores at age 0;8.

Change scores are often criticized for their psychometric problems, in that they are unreliable because "the difference between two fallible measures is frequently much more fallible than either" (Lord, 1963, p. 32). The unreliability of change scores is greatest when the scores have equal reliabilities and equal variances; however, in such cases, the growth curves of individuals will be nearly parallel, indicating an absence of individual differences in change. Rogosa (1988) argues that difference scores are reliable when there are true changes in individual differences. Change scores cannot uncover individual differences in true change if no true change has occurred. Thus, if there is true change in our sample, linear change scores have adequate psychometric properties to measure these changes. If there is not true change in this sample, then the change scores will be unrelated to the other variables studied.

Language development. Language at age 1;0 was comprised of language items from the Bayley Mental Scale (Bayley, 1969) and parent-report items from the Sequenced Inventory of Communicative Development, Expressive and Receptive scales (SICD; Hendrick *et al*., 1984). Bayley language items included: listens selectively to words, says 'da-da' or equivalent, responds to verbal request, inhibits on command, jabbers expressively, imitates words, says 2 words, uses gestures to make wants known, shows object on request, names object, follows directions, uses words to make wants known, and points to parts of doll. SICD parent-report items included: understanding of words (toys, names of family members, clothing, verbs, names of acquaint-

TABLE 1. *Means, standard deviations, and MANOVA results*

	Boys ($n = 48$)		Girls ($n = 39$)		Multivariate and univariate tests (F)		
	Mean	S.D.	Mean	S.D.	Gender	Age	Gender × age (df)
Global attention					0·87	14·05***	1·12 (2, 84)
0;4	3·67	1·17	3·75	1·11			
0;8	3·06	1·09	3·15	1·07			
1;0	2·91	1·08	3·30	1·25			
Manipulative exploration					1·04	100·89***	0·72 (2, 84)
0;4	3·59	1·12	3·58	1·15			
0;8	5·49	0·87	5·59	0·59			
1;0	5·19	0·95	5·51	0·88			
Maternal verbal encouragement of attention					3·70†	12·56***	3·58* (2, 84)
0;4	3·06	1·21	2·97	1·14			
0;8	2·42	1·22	3·05	1·30			
1;0	3·12	1·12	3·72	1·23			
Maternal visual encouragement of attention					0·95	0·98	0·35 (2, 84)
0;4	3·96	0·82	3·72	0·92			
0;8	3·75	0·86	3·62	0·85			
1;0	3·62	1·08	3·64	1·01			
Maternal physical encouragement of attention					0·12	23·95***	0·33 (1, 85)
0;4	3·77	0·86	3·67	0·81			
0;8	3·19	0·73	3·21	0·61			
Language development					1·68**	na	na
1;0	−0·26	0·62	0·25	0·77			

†$p < 0·10$, *$p < 0·05$, **$p < 0·01$, ***$p < 0·001$.

ances, outdoor items, descriptive words, household tools, pronouns, buildings, games), response to certain words, points to body parts, responds appropriately to 'sit down' or 'stand up', using a question inflection, using or imitating intentional patterns, using consistent sound combinations for people or objects, saying 'hi' in response, pointing to request labels, and appropriate use of 'no'.

The average score on Bayley items and the average score on SICD items were standardized, then the mean of the standardized score became the language composite. The total Bayley language score was significantly correlated with the total SICD maternal report score, $r = 0·58$, $p < 0·001$.

RESULTS

Descriptive statistics

Table 1 presents the descriptive statistics by gender for the variables assessed in the present study for each age separately.

To determine whether levels of attention or maternal encouragement of attention differed as a function either of gender or age, five (2) gender × (3) age repeated measures MANOVAs were performed. Gender was the between-subjects factor and age was the within-subjects factor. No significant main effects for gender emerged for any of the attention or maternal encouragement variables; several other effects, however, were statistically significant. When examining global attention, there was a significant main effect for age. Follow-up contrasts indicated that there was a significant decrease in global attention from ages 0;4 to 0;8, $F_{(1,85)} = 27{\cdot}85$, $p < 0{\cdot}001$, and no significant change from ages 0;8 to 1;0, $F_{(1,85)} = 2{\cdot}21$, $p = 0{\cdot}14$. Similarly, a main effect for manipulative exploration emerged; a pattern different from global attention was found, however. There was a significant increase in manipulative exploration from age 0;4 to 0;8, $F_{(1,85)} = 211{\cdot}11$, $p < 0{\cdot}001$, and no change from age 0;8 to 1;0, $F_{(1,85)} = 2{\cdot}54$, $p = 0{\cdot}11$.

When examining maternal verbal encouragement of attention, there was a significant main effect of age as well as a significant interaction between gender and age. Follow-up cell means comparisons for each gender separately indicated that for boys, maternal verbal encouragement of attention decreased from age 0;4 to 0;8, $F_{(1,85)} = 11{\cdot}84$, $p < 0{\cdot}01$, and then increased from age 0;8 to 1;0, $F_{(1,85)} = 14{\cdot}99$, $p < 0{\cdot}001$. There was no significant change in maternal encouragement of attention from age 0;4 to 1;0, $F_{(1,85)} = 0{\cdot}87$, $p = 0{\cdot}77$.

For girls, there was no significant change in maternal verbal encouragement from age 0;4 to 0;8, $F_{(2,84)} = 0{\cdot}14$, $p = 0{\cdot}71$, but there was a statistically significant increase from age 0;8 to 1;0, $F_{(1,85)} = 10{\cdot}79$, $p < 0{\cdot}01$. There was also a statistically significant increase from age 0;4 to 1;0, $F_{(1,85)} = 9{\cdot}95$, $p < 0{\cdot}01$. No significant effects (i.e. gender, age, or age × gender) were found for maternal visual encouragement of attention. A significant effect for age was found, however, for physical encouragement of attention, which decreased from age 0;4 to 0;8.

Finally, a *t*-test was performed to examine possible gender differences in language development. Female infants scored significantly higher than male infants did on language at age 1;0.

Stability and relations between predictors

Table 2 presents correlations among all the predictor variables.

Global attention was found to be significantly stable between 0;4 and 0;8 and between 0;8 and 1;0. However, significant stability was not found for manipulative exploration between 0;4 and 0;8 and only marginal stability was found from 0;8 to 1;0. Mother verbal encouragement was significantly stable from 0;4 to 0;8 and 0;8 to 1;0. Visual encouragement of attention was not significantly stable from 0;4 to 0;8 but was found to be stable from 0;8

TABLE 2. *Correlations between global attention (GA), manipulative exploration (ME), and maternal encouragement of attention (Verbal, VE; Visual, VS; Physical, PE)*

	0;4				0;8					1;0			
	Infant	Maternal			Infant		Maternal			Infant		Maternal	
	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
0;4													
1. GA	−0·03	−0·07	0·07	0·20†	0·55***	0·02	−0·01	−0·08	−0·01	0·37**	−0·18	−0·20†	−0·15
2. ME		0·01	0·12	−0·07	−0·03	0·17	−0·15	−0·11	−0·03	−0·02	0·15	0·14	−0·13
3. VE			0·22*	0·02	−0·13	−0·07	0·41***	0·16	0·02	−0·09	−0·22*	0·20	0·05
4. VS				0·31**	−0·06	0·03	0·05	0·03	0·15	−0·19†	−0·19†	0·02	−0·11
5. PE					0·22*	−0·08	0·11	−0·06	0·16	0·06	−0·07	−0·10	−0·20†
0;8													
6. GA						0·09	−0·13	−0·12	0·03	0·66***	0·01	−0·17	−0·12
7. ME							−0·04	0·22*	0·13	0·10	0·18†	0·06	0·07
8. VE								0·20†	0·20†	−0·05	0·05	0·49***	0·13
9. VS									0·41***	−0·02	−0·08	0·17	0·27*
10. PE										0·05	0·04	0·02	0·12
1;0													
11. GA											−0·07	0·12	0·04
12. ME												0·08	−0·07
13. VE													0·36**
14. VS													

†$p < 0·10$, *$p < 0·05$, **$p < 0·01$, ***$p < 0·001$.

to 1;0. Mother physical encouragement was not found to be significantly stable from 0;4 to 0;8.

Global attention was not significantly related to any other infant or maternal encouragement variables. Manipulative exploration at 0;4 was not significantly related to any other infant or maternal variables; however, manipulative exploration at 0;8 was related to concurrent maternal visual encouragement of attention. Infants who were higher in manipulative exploration at 0;8 had mothers who were concurrently more visually encouraging of attention. Mother verbal encouragement at 0;4 was positively related to her concurrent visual encouragement of attention and negatively related to the infant's manipulative exploration at 1;0. That is, mothers who were more verbally encouraging of attention at 0;4 were also more visually encouraging of attention at 0;4 and had infants who were lower in manipulative exploration at 1;0. Mothers who were higher in verbal encouragement at 1;0 were also concurrently higher in visual encouragement of attention. Mothers who were higher in visual encouragement of attention at 0;4 were concurrently higher in physical encouragement of attention. Mothers who were higher in visual encouragement of attention at 0;8 were also higher in concurrent physical encouragement of attention. Mothers who displayed more physical encouragement of attention at 0;4 had infants who were higher in global attention at 0;8.

Predicting language : main effects and interactions

Correlations between the five predictors and language are presented in Table 3 for each gender separately.

For boys, manipulative exploration at 0;4 and maternal verbal encouragement of attention at 1;0 were significant predictors of language, such that boys who were higher manipulative exploration at 0;4 or who had mothers who were more verbally encouraging of attention at 1;0 had higher language scores. For girls, global attention at 0;8 and manipulative exploration at 1;0 were both positively and significantly related to early language. That is, girls who had higher levels of global attention at 0;8 or who had higher levels of manipulative exploration at 1;0 had more advanced language skills.

Although the correlations indicate relations between attention, maternal encouragement of attention, and language for each gender, these effects cannot be tested simultaneously with correlation analyses. Therefore, multiple regressions were performed. The relative contribution of gender, attention and maternal encouragement of attention and interactions between these variables in predicting language was examined at each age using hierarchical multiple regressions involving two steps. Hierarchical regression modelling enables one to look at potential moderating effects (i.e. interaction terms) and potential mediating effects (e.g. betas that had been significant in

TABLE 3. *Correlations between each predictor and language at 1;0 by gender*

	Boys	Girls
0;4		
Global attention	−0·22	0·16
Manipulative exploration	0·40**	0·32†
Maternal verbal encouragement	0·08	0·12
Maternal visual encouragement	0·03	0·07
Maternal physical encouragement	0·24	0·22
0;8		
Global attention	−0·06	0·38*
Manipulative exploration	0·16	0·19
Maternal verbal encouragement	0·04	0·08
Maternal visual encouragement	0·15	0·19
Maternal physical encouragement	0·16	0·15
1;0		
Global attention	0·18	0·17
Manipulative exploration	−0·08	0·37*
Maternal verbal encouragement	0·37*	0·09
Maternal visual encouragement	−0·03	−0·11

†$p < 0{\cdot}10$, *$p < 0{\cdot}05$, **$p < 0{\cdot}01$.

earlier steps become non-significant in later steps). In the first step, all six main effects were tested. Step 2 included the 11 two-way interaction terms. Three-way interactions were not examined because they are more difficult to interpret and because we have limited statistical power to detect them. These results are presented in Table 4.

At age 0;4, in step 1, gender, manipulative exploration and maternal physical encouragement of attention made unique contributions to later language, such that females or infants with more sustained bouts of manipulative exploration or with more physically encouraging mothers had higher language scores. None of the two-way interactions in step 2 were statistically significant, although each of the significant main effects from step 1 remained significant.

Next, the same two steps were run using the predictors at age 0;8. Gender was the only significant predictor in step 1. In step 2, gender was again a significant predictor; additionally, the interaction between gender and manipulative exploration was significant. Figure 1 presents a graph of this interaction according to the method advocated in Aiken & West (1991). Females who were high on manipulative exploration at 0;8 had the most advanced language skills.

Finally, the variables at age 1;0 were examined. Gender and maternal verbal encouragement of attention were the only significant predictors in step 1; girls had more advanced language skills than boys had, and infants whose mothers were more verbally encouraging at 1;0 had higher concurrent

TABLE 4. *Predicting language development at 1;0 from gender, infant attention and maternal encouragement at 0;4, 0;8, and 1;0*

	F	*df*	R^2	*Adj.* R^2	*β*
Predictors at 0;4					
Step 1	5·88***	(6, 80)	0·31	0·25	
Gender					0·36***
Global attention					−0·06
Manipulative exploration					0·36***
Maternal verbal encouragement					0·10
Maternal visual encouragement					−0·10
Maternal physical encouragement					0·28**
Step 2	2·06*	(17, 69)	0·34	0·17	
Gender					0·35**
Global attention					−0·08
Manipulative exploration					0·34**
Maternal verbal encouragement					0·08
Maternal visual encouragement					−0·07
Maternal physical encouragement					0·26*
Gender × global attention					0·18
Gender × manipulative exploration					0·00
Gender × verbal encouragement					0·06
Gender × visual encouragement					−0·03
Gender × physical encouragement					−0·05
Global attention × verbal encouragement					−0·05
Global attention × visual encouragement					0·11
Global attention × physical encouragement					0·02
Manipulative exploration × verbal encouragement					−0·02
Manipulative exploration × visual encouragement					0·04
Predictors at 0;8					
Step 1	3·12**	(6, 80)	0·19	0·13	
Gender					0·33**
Global attention					0·16
Manipulative exploration					0·11
Maternal verbal encouragement					0·05
Maternal visual encouragement					0·11
Maternal physical encouragement					0·07
Step 2	2·27**	(17, 69)	0·36	0·20	
Gender					0·27*
Global attention					0·19†
Manipulative exploration					0·20
Maternal verbal encouragement					0·08
Maternal visual encouragement					0·14
Maternal physical encouragement					−0·03
Gender × global attention					0·18
Gender × manipulative exploration					0·28**
Gender × verbal encouragement					0·02

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TABLE 4. (*cont.*)

	F	*df*	R^2	*Adj.* R^2	*β*
Gender × visual encouragement					0·05
Gender × physical encouragement					−0·01
Global attention × verbal encouragement					0·16
Global attention × visual encouragement					0·02
Global attention × physical encouragement					0·02
Manipulative exploration × verbal encouragement					−0·05
Manipulative exploration × visual encouragement					0·18
Manipulative exploration × physical encouragement					−0·21
Predictors at 1;0					
Step 1	4·71**	(5, 81)	0·23	0·18	
Gender					0·24*
Global attention					0·17
Manipulative exploration					0·12
Maternal verbal encouragement					0·26*
Maternal visual encouragement					−0·16
Step 2	2·70**	(13, 73)	0·33	0·21	
Gender					0·21†
Global attention					0·19†
Manipulative exploration					0·20†
Maternal verbal encouragement					0·29*
Maternal visual encouragement					−0·14
Gender × global attention					−0·01
Gender × manipulative exploration					0·22*
Gender × verbal encouragement					−0·13
Gender × visual encouragement					−0·02
Global attention × verbal encouragement					0·15
Global attention × visual encouragement					−0·04
Manipulative exploration × verbal encouragement					0·13
Manipulative exploration × visual encouragement					−0·03

†$p < 0·10$, *$p < 0·05$, **$p < 0·01$, ***$p < 0·001$.

language scores. When the two-way interactions were included in step 2, gender became only marginally significant. Additionally, the interaction between gender and manipulative exploration was statistically significant. This interaction is presented in Figure 2. Similar to the findings at 0;8, girls who were higher in manipulative exploration at 1;0 scored highest on concurrent language ability.

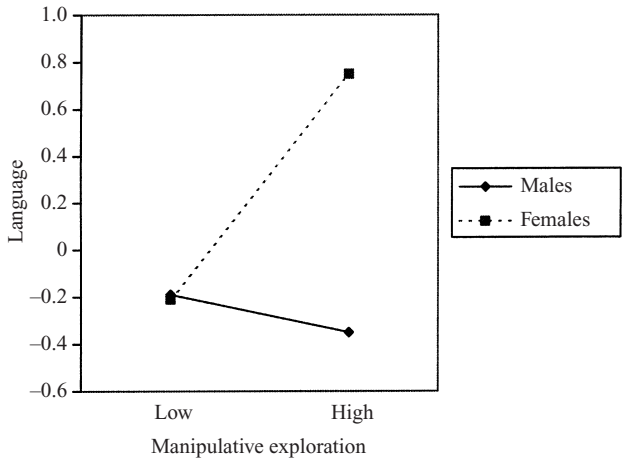

Fig. 1. Graph of the interaction between gender and manipulative exploration at 0;8.

Additionally, these three hierarchical multiple regression analyses were examined for possible mediating effects of maternal encouragement of attention on the association between infant attention and language. As none of the statistically significant beta weights in the first step of the regressions were significantly reduced in the second step, requirements for demonstrating mediating relationships were not met (Baron & Kenny, 1986).

Changes in attention and maternal encouragement of attention

Changes in infant attention and maternal encouragement of attention were also examined in relation to language development for each gender using regression analyses. Because change scores can be problematic due to their large, usually negative, correlations with initial status (e.g. Lacey & Lacey, 1962; Thorndike, 1966), the overall level across both time periods was controlled for statistically. Therefore, the relations of change in infant attention and maternal encouragement of attention with language were calculated while controlling for the participants' overall level on each variable (i.e. the sum of Time 1 and Time 2 measurements). Thus, the beta weights for each relation will be presented.

For boys, changes in global attention were related to language, such that the slower the rate of decline boys showed in global attention, the higher the language scores they obtained at one year ($\beta = 0{\cdot}35$, $p < 0{\cdot}05$). Increases in manipulative exploration were negatively related to language, such that boys who increased the most in manipulative exploration from 0;4 to 1;0 had lower language scores ($\beta = -0{\cdot}35$, $p < 0{\cdot}05$). Changes in the three maternal encouragement of attention modalities were unrelated to language. For girls,

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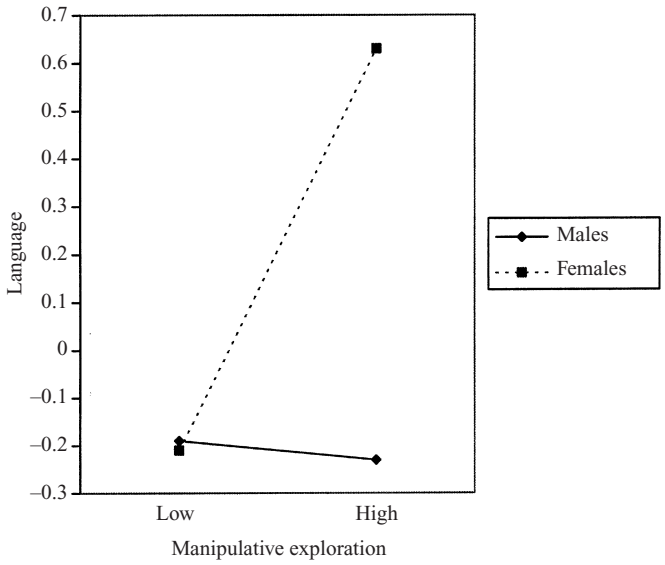

Fig. 2. Graph of the interaction between gender and manipulative exploration at 1;0.

changes in infant attention and changes in maternal encouragement of attention were all unrelated to language scores.

DISCUSSION

Overall, gender, manipulative exploration at age 0;4, maternal physical encouragement of attention at age 0;4, and maternal verbal encouragement at 1;0 were the strongest and most consistent predictors of early language abilities. Thus, infants who were female, who manipulated objects in their environments in early infancy, and whose mothers encouraged attention physically in early infancy and verbally at the beginning of the second year had the most advanced early language abilities. These findings are consistent with past research that indicates that gender (e.g. Fenson *et al.*, 1994; Morisset *et al.*, 1995), infant attention (e.g. Bee *et al.*, 1982; Matheny, 1989; Slomkowski *et al.*, 1992), and maternal encouragement of attention (e.g. Tamis-LeMonda & Bornstein, 1989), all contribute to language acquisition.

Perhaps infant temperamental attention and maternal encouragement of attention lay the groundwork for the development of joint attention. Given the importance of joint attention in cognitive and language development, researchers are now beginning to investigate the antecedents of joint attention. The duration of joint attention depends on the skills and abilities of the infant and the emotional resources and parenting abilities of the mother. Past research have found that infant cognitive abilities (e.g. Markus

et al., 2000) and gender (e.g. Raver & Leadbeater, 1995) both influence the duration and quality of mother–infant joint attention interactions. Additionally, maternal verbal behaviours during interactions with her infant have been found to affect the relationship between joint attention and language (e.g. Tomasello & Todd, 1983; Tomasello & Farrar, 1986). Mothers who label or describe objects that their infant is focused on (as opposed to trying to shift their infant's focus of attention to another object before labelling or describing it) have infants with larger overall vocabularies.

As predicted, gender differences emerged in the relationship between attention, maternal encouragement of attention, and language. For boys, both temperamental attention and maternal behaviours seem to play a role in early language development. Specifically, both global attention and verbal encouragement of attention were related to greater language skill. Thus, it appears that boys benefit from the attention-directing efforts of their mothers, at least in terms of learning language.

For girls, greater temperamental attention at ages 0;8 and 1;0 predicted later language skills. However, maternal encouragement of attention was not found to be related to language. As predicted, girls scored higher than boys on language at age 1;0, which is consistent with previous research (Fenson *et al.*, 1994, Morisset *et al.*, 1995). Perhaps girls are more in tune with the linguistic components of their environment, accounting for their greater facility at language acquisition, and are thus not in need of additional stimulation from the mother. It is interesting to note, however, that mothers of boys started out at age 0;4 with a moderate level of verbal encouragement, then decreased significantly in their level of verbal encouragement to boys only at age 0;8, but returned to previous levels of verbal encouragement at age 1;0. Mothers of girls did not show this decline in verbal encouragement at age 0;8, and by one year, mothers of girls were exhibiting more verbal encouragement than mothers of boys were. This drop in verbal encouragement is very interesting and should be further explored.

Why would mothers show such a decrease in verbal encouragement with their boys at an age when infants are beginning to develop receptive language skills? Perhaps this reflects changes in other domains of development that we have not examined, such as activity level. As children at 0;8 are making the transition to crawling, and since boys are generally found to be more active than girls (Bates, 1986; Eaton & Enns, 1986), perhaps mothers are sensitive to and encouraging of their sons' development in the motoric domain and are not emphasizing certain skills relevant to the language domain. There is recent empirical support that suggests that mothers differ in their expectations of girls' versus boys' motor development; they tend to underestimate the abilities of girls and overestimate the abilities of boys (Mondschein, Adolph & Tamis-LeMonda, 2000).

These findings, however, are not necessarily unidirectional. It is possible

that by age 0;8, gender differences in receptive language have been perceived by mothers, and that the gender differences in maternal encouragement of attention are the result of differences in emerging language abilities rather than the cause of these differences. Although previous research indicates that early language does not influence later temperamental attention (Dixon & Smith, 2000), individual differences in early language skills might influence maternal encouragement of attention. Future studies should employ a longitudinal design that measures language at more than one age to test this question of direction of effects.

When examining changes in infant attention and language development, additional gender differences emerged, such that for boys, less drastic declines in global attention and decreases in manipulative exploration were both related to more advanced early language. For girls, however, changes in infant attention were unrelated to early language. Perhaps these changes in attention also reflect boys' changes in other domains (e.g. activity level), such that boys who are able to focus on more aspects of the environment rather than simply a single object that they are playing with can attend to the linguistic aspects of the environment. This gender difference is also interesting to note in terms of the relations between directional changes in attention and theorized emergence of attentional control systems during the second half of the first year (Rothbart & Bates, 1998). Early attentional control seems to develop due to the maturation in posterior brain regions at around age 0;4. During the end of the first year, maturation in anterior brain regions is thought to facilitate infants in maintaining and controlling their attentional focus. Some research has shown that increases in temperamental attention during the second half of the first year were associated with early language production (Dixon & Smith, 2000) and thus could indicate the development of this second attentional system. More research is needed, however, to further explore possible gender differences in attentional development and relations with early language. Additionally, for both genders, changes in maternal encouragement of attention were unrelated to language, supporting the hypothesis of developmental trends in optimal modalities in maternal encouragement of attention.

Also interesting to note, global attention was unrelated to manipulative exploration at all three ages, indicating that the two measures of attention reflect unique constructs, which is consistent with Ruff's ideas (Ruff, 1990). This lack of congruence, of course, could be due to differences in raters and contexts: manipulative exploration was based on observer report during the administration of the Bayley Scales of Infant Development whereas global attention was reported by the mother from the Duration of Orienting scale of the IBQ. Manipulative exploration at all ages predicted language at age 1;0 – either by itself or in interaction with gender; however, early global attention was not related to later language. This finding contradicts the initial

expectation that global attention would be a more salient predictor than manipulative exploration. Additionally, manipulative exploration at age 0;4 was found to be unrelated to concurrent measures of maternal encouragement or global attention; it was also unrelated to manipulative exploration and global attention at other ages. Perhaps manipulative exploration reflects different characteristics of the child at different ages. For example, infants who are able to manipulate objects by age 0;4 may be more well developed biologically, emotionally, or cognitively; these various systems may also be more well-integrated.

As expected, some relationships between concurrent ratings of attention and maternal encouragement of attention were found, but they were rare. Global attention was marginally related to physical encouragement of attention at 0;4 and manipulative exploration was related to visual encouragement of attention at 0;8. Additionally, contrary to expectations and previous research (i.e. Tamis-LeMonda & Bornstein, 1989), maternal encouragement of attention was not found to mediate the relationship between attention and language, nor was it a moderator. Thus, these findings indicate that both attention and maternal encouragement of attention, at least how they were operationalized in this study, make unique and separate contributions to the child's developing linguistic competence.

It is also interesting to note a relative lack of stability in maternal behaviours between 0;4 and 0;8. Visual encouragement and physical encouragement at age 0;4 were not significantly related to their counterparts at age 0;8, indicating, perhaps, that mothers are sensitive to the development of their infants and are able to modify their interactions with their infants in ways that foster development. Maternal verbal encouragement of attention, however, showed significant stability across all three time points, perhaps reflecting personality characteristics in the mothers.

This study showed that gender, infant attention, and maternal encouragement of attention are all important factors in the process of language acquisition. More research that focuses on the causes and effects of the gender differences in maternal verbal encouragement of attention is needed to better understand the nature of the relationship between gender, maternal verbal encouragement and language. Specifically interesting to examine would be maternal perceptions of her child's language level and skill and her perceptions of innate gender differences in language ability in order to test the effects of these perceptions on her verbal behaviours.

Although the findings of this study are intriguing, caution must be used when generalizing from these findings to the process of language acquisition in high-risk or language delayed infants. This sample was predominately white and middle-class, and all of the infants studied were healthy. Examination of these relationships in more heterogeneous samples might lend important insight into the infant's language learning process. As in previous

studies, the effect sizes in the present study were moderate, indicating that early language learning is a complex process. Indeed, Hollich, Hirsh-Pasek, Golinkoff and colleagues (Hollich, Hirsh-Pasek, Golinkoff, Brand, Brown, Chung, Hennon & Rocroi, 2000) have proposed an EMERGENTIST COALITION MODEL for early language learning, arguing that word learning is multiply determined. Their theory emphasizes that language learning is a hybrid process involving cognitive constraints, social-interactive factors, and attentional mechanisms and that children use the available inputs differentially across development. Unexplained variance could thus be attributable to both cognitive constraints and attentional mechanisms, which were not part of this study.

Further research in this area would benefit greatly through the use of a more precise and sophisticated measure of language than was used in the current study. Additionally, in this study, maternal encouragement of attention was examined in a free-play setting. It would be interesting to examine the types of maternal encouragement in other types of situations, especially in situations where the mother is specifically instructed to try to teach her child new words, for example. In that way, assessments of mother's actual language-teaching strategies could be made; perhaps her attempts to actively teach her child language would provide crucial information into the social processes through which the child acquires language. Finally, it would be beneficial to study the relationships between temperamental attention, maternal encouragement of attention and language beyond infancy to explore the toddler and preschool years. Relationships between and among these variables might change in interesting and informative ways, as the child becomes a more equal partner in the language-learning process.

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