A study of language development and affecting factors in children aged 5 to 27 months

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Abstract

We conducted a study to assess the factors that affect language development in infants and toddlers using data obtained during developmental screening. Our study group consisted of 505 children—244 (48.3%) boys and 261 (51.7%) girls, aged 5 to 27 months. The children were divided into four age groups: group 1, which we designated as the "6 months" group (age range: 5 to 7 mo); group 2, designated as the "12 months" group (11 to 13 mo); group 3, designated as the "18 months" group (17 to 19 mo); and group 4, designated as the "24 months" group (23 to 27 mo). In addition to demographic data, we compiled data using the Denver II Developmental Screening Test, as well as neurologic examination findings and medical histories. At 6 months, the social item "Works for toy out of reach" was positively related to all language development items. Two gross motor development items—"Pull to sit, no head lag" and "Lifts chest with arm support"—were related to the "Turns to sound" and "Turns to voice" items, respectively. Overall, children whose mothers had higher education levels and who were living in higher socioeconomic areas showed significantly greater language development, as did boys, specifically. At 12 months, higher maternal ages, some gross motor development items, and some social items were related to better language development, and children living in higher socioeconomic areas had a significantly increased ability to pass the "4 words other than mama/dada" item. At 18 months, the ability of girls to pass the "4 words other than mama/dada" item increased, and children who passed the "4 words other than mama/dada" item did not pass the "Throws ball" gross motor item. At 24 months, children whose mothers were older had better "Combines 2 words" and "Speech half intelligible" items, girls had better "Comprehends prepositions (such as under/above)" skills, and boys had better "Shows 4 parts of doll" skills. We conclude that language items appear to change together with gross motor items and social development, and that they can be influenced by a family's socioeconomic level. However, as children get older, language development diverges from gross motor development.

Introduction

Children at risk of developing language delays benefit from educational intervention and family assistance. If detected at a young age when the chances for improvement are highest, language problems can be lessened and potential adaptive and academic problems can be prevented by appropriate intervention.[1,2]

The purpose of evaluating language and speech and success in education is to determine the correct language development level and, if any delay is present, to find the reason for a language delay. A delay in language development can occur if a child has not gained language skills in the expected age range. A delay in language and speech development may be a symptom of many disorders, such as mental retardation, hearing loss, an expressive language disorder, psychosocial deprivation, autism, attention disorders, distinctive voice disorders, disorders of listening and speaking, etc. On the other hand, a delay in speech development may be not a symptom, and a child's hearing, intelligence, and

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The study described in this article was conducted at the Hacettepe University Ihsan Doğramacı Children's Hospital.

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development may be normal. However, only the receptive or expressive language can be found as delayed.[3]

Language development at 1 to 24 months is summarized accordingly:

- 1 to 5 months: response to voice;
- 6 to 9 months: babbling;
- 10 and 11 months: imitation of sounds, says "mama/dada" without meaning (mama, dada nonspecific);
- 12 months: says "mama/dada" with meaning (mama, dada specific), often imitates two- and three-syllable words;
- 13 to 15 months: vocabulary of four to seven words in addition to jargon, <20% of speech understood by strangers;
- 16 to 18 months: vocabulary of 10 words, some echolalia and extensive jargon, 20 to 25% of speech understood by strangers;
- 19 to 21 months: vocabulary of 20 words, 50% of speech understood by strangers; and
- 22 to 24 months: vocabulary >50 words, two-word phrases, dropping out of jargon, 60 to 70% of speech understood by strangers.[4]

Speech and language development in children coincides with cognitive and oral motor skills and indirectly inform about a child's global development. Understanding the relationships between cognition, language, and speech motor development allows for a more precise assessment of any problems. Receptive language skills tend to be related to cognitive and perceptive abilities, while expressive language also relies on articulatory skills. The speed of lip and jaw movements in a child increases from 9 to 15 months, an age when children are beginning to pronounce their first words.[5]

Speaking tasks involving greater cognitive and linguistic processing are associated with faster articulatory speeds in children and adults.[6] Besides the biologic programming of the developing nervous system, environmental factors affect language development.[7]

This study was performed to assess factors that affect language development in infants and toddlers based on data obtained during developmental screening.

Patients and methods

The study group consisted of 505 children—244 (48.3%) boys and 261(51.7%) girls, aged 5 to 27 months—who were seen in the outpatient clinic at Hacettepe University Ihsan Doğramacı Children's Hospital for well-baby examinations, follow-up examinations, immunizations, or treatment of minor infections. Children who had fever, pain, a history of premature birth, a twin, perinatal complications, hospital admissions, or a family history of developmental delay were excluded. Most of the children were cared for at home by mothers or grandmothers, and none had been trained at preschool.

We standardized the Denver II Developmental Screening Test[8] for use in these Turkish children. It was administered in a quiet room with the mother or caregiver present. The children were divided into four age groups:

- group 1: 6 months (range: 5 to 7), n = 162;
- group 2: 12 months (11 to 13), n = 127;
- group 3: 18 months (17 to 19), n = 101; and
- group 4: 24 months (23 to 27), n = 115.

Questionnaire. After parents' consent was obtained, parents completed a questionnaire to ascertain the age and sex of each child along with other demographic and maternal data. This information included:

- mother's age group: ≤20 years, 21 to 25, 26 to 30, 31 to 39, and ≥40;
- mother's education: primary school, secondary school; high school, university;
- number of siblings;
- area of residence according to the Ankara, Turkey, census data, defined as the high, middle, and low socioeconomic areas of the city.

Table. Studied Denver II domains according to age group

Domain	6 (5 to 7)
Language skills	• Turns to sound • Turns to voice • Imitates speech sounds • Single syllables
Social skills	• Works for toy out of reach
Gross motor skills	• Pull to sit, no head lag • Lifts head 90º • Lifts chest with arm support
Fine motor skills	

Developmental testing with Denver II. The Denver II Developmental Screening Test was standardized for use in Turkey and administered by child development specialists and pediatric neurologists. The test contains 134 developmental items in 4 domains: language skills, social skills, gross motor skills, and fine motor skills.[8,9] We based our study on 27 of these items—13 language skills, 4 social skills, 8 gross motor skills, and 2 fine motor skills (table). Results were determined on a pass/fail basis.

Statistical analysis. For each age group and each language item, the chi-square (χ^2) test was used to compare the pass/fail status of boys and girls. The Pearson correlation test or the Spearman correlation rho efficient test was used for each group to examine correlations between language items and demographic or maternal factors, as well as to examine correlations among language and the other developmental items (social skills, gross motor skills, and fine motor skills). Linear regression analysis (backward linear regression) was performed to evaluate the confounding factors that affect language development parameters using Step-by-Step analysis. Statistical analysis was performed with the Statistical Package for the Social Sciences software, v. 16.0, and statistical significance was defined as $p < 0.05$.

Results

Some supporting documentation in the form of tables can be obtained by email directly from the author upon request where noted.

Most mothers were aged 20 to 30 years, had a primary or secondary education, either 1 or 2 children, and were in the middle income bracket. The relationship between each mother's education level and socioeconomic status was analyzed by the Spearman correlation rho efficient test; we found a significantly positive correlation ($p < 0.001, r = 0.163$). As socioeconomic status increased, the mothers' education level also increased. Characteristics of children and families are available in table 2 (available from the author).

At 6 months, boys were more likely than girls to pass the "Turns to sound" item ($p = 0.020$, $\chi^2 = 5.454$). At 24 months, girls were more successful at passing the "Comprehends prepositions (such as under/above)" item ($p = 0.004$, $\chi^2 = 8.221$). Boys and girls did not differ in other language items. Correlations among demographic parameters, sex, and language development are shown in table 3 (available from the author).

At 6 months, boys were more likely to pass "Turns to sound" ($p = 0.023$, $r = 0.186$), and at 24 months, girls were more successful at "Comprehends prepositions (such as under/above)" ($p = 0.001$, $r = -0.304$).

As maternal age increased, the "Mama, dada specific" ($p = 0.034$, $r = 0.191$) and "Mama, dada nonspecific" ($p = 0.013$, $r = 0.224$) skills increased significantly at 12 months; and the expressive language items "Combines 2 words" ($p = 0.003$, $r = 0.350$) and "Speech half intelligible" ($p = 0.012$, $r = 0.237$) increased significantly at 24 months. There was a negative correlation between "Combines 2 words" skills and a mother's education ($p = 0.006$, $r = -0.328$) at 24 months.

Age groups, mo (range)		
12 (11 to 13)	**18 (17 to 19)**	**24 (23 to 27)**
• Imitates speech sounds	• 4 words other than mama/dada	• Shows 4 parts of doll
• Mama, dada specific		• Combines 2 words
• Mama, dada nonspecific		• Speech half intelligible
• 4 words other than mama/dada		• Comprehends prepositions (such as under/above)
• Indicates needs (not crying)	• Helps in house with simple tasks	• Uses spoon/fork
• Stands holding on	• Throws ball	• Runs
• Stands alone 10 seconds	• Climbs stairs	
• Puts cube in cup	• Dumps raisin when shown	

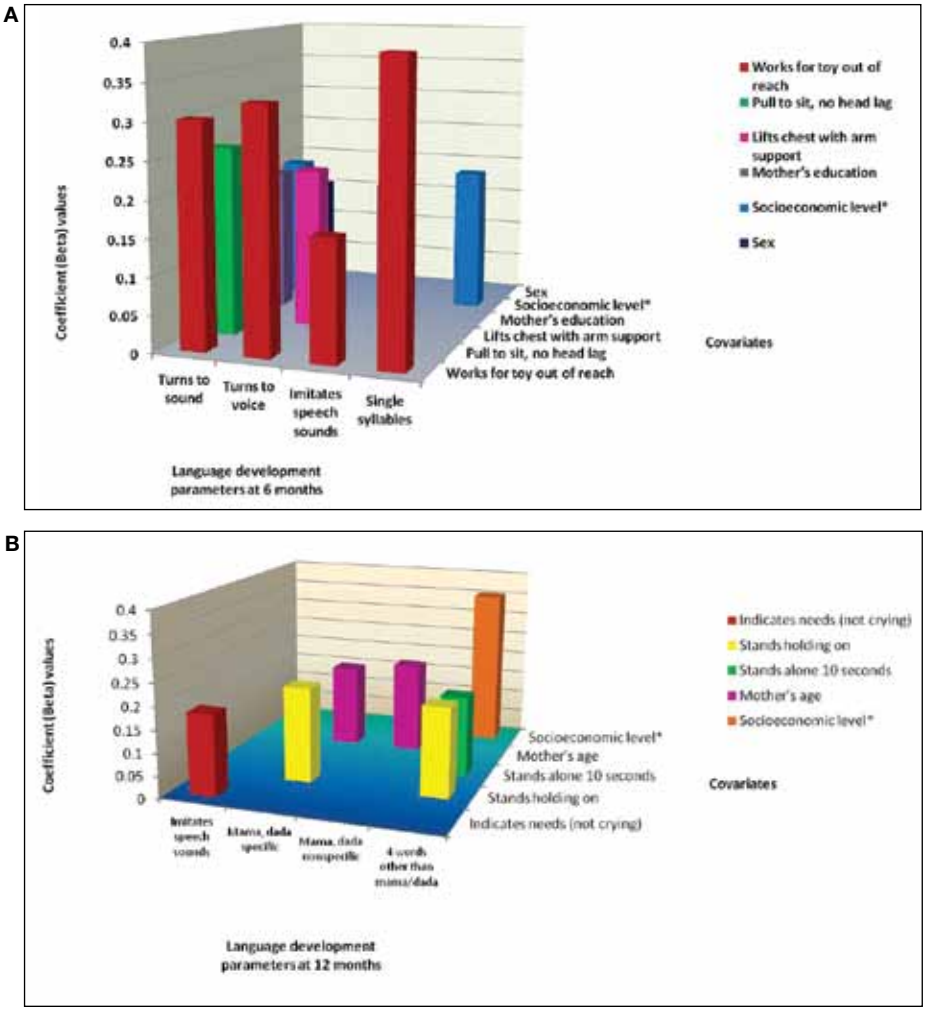

*Figure 1. Charts show statistically significant coefficient (β) values by linear regression analysis (backward) at 6 months (**A**), and 12 months (**B**). Asterisk signifies that coefficient β values were present.*

"Turns to sound" ($p = 0.003$, $r = -0.242$) and "Single syllables" ($p = 0.028$, $r = -0.184$) skills at 6 months, and "4 words other than mama/dada" ($p < 0.001$, $r = 0.052$) skills at 12 months were all significantly better in children of higher socioeconomic status.

Correlation between language items and other developmental domains are shown in table 4 (available from the author). Language items were mostly correlated with each other in the 6-, 12-, and 24-month groups. Language items showed associations with social and gross motor items in the 6-month-old group; the "Works for toy out of reach," a social item, was correlated with the "Turns to sound" ($p < 0.001$), "Turns to voice" ($p < 0.001$), "Imitates speech sounds" ($p = 0.036$), and "Single syllables" ($p < 0.001$) items.

Most of the language parameters were positively correlated with gross motor items ($p < 0.05$). In the 12-month-olds, gross motor items ("Stands holding on" and "Stands alone 10 seconds") were positively correlated with the language items "Mama, dada specific" and "4 words other than mama/dada." In the 24-month-old group, the language parameter "Combined 2 words" correlated negatively with "Uses spoon/fork," a social item ($p = 0.042$, $r = -0.247$).

Demographic and maternal factors and developmental items were examined by linear regression analysis (backward) (table 5, available from the author). Covariates were analyzed in terms of their effects on each of the language development items and by Step-by-Step analysis, and the significant affecting confounding factors were detected.

Findings at 6 months. At 6 months, the social item "Works for toy out of reach" was positively correlated with all four language development items: "Turns to sound" ($p < 0.001$, $\beta = 0.302$), "Turns to voice" ($p < 0.001$, $\beta = 0.326$), "Imitates speech sounds" ($p = 0.045$, $\beta = 0.164$), and "Single syllables" ($p < 0.001$, $\beta = 0.393$) (figure 1, A).

The gross motor development items of "Pull to sit, no head lag" ($p = 0.001$, $\beta = 0.255$) and "Lifts chest with arm support" ($p = 0.011$, $\beta = 0.216$) were related to the "Turns to sound" and "Turns to voice" items, respectively (figure 1, A).

Overall, children whose mothers achieved higher education and socioeconomic levels and boys, specifically, showed significantly better language development ($p < 0.05$).

Findings at 12 months. At 12 months, the social item "Indicates needs (not crying)" was correlated with the "Imitates speech sounds" item ($p = 0.048$, $\beta = 0.180$) (figure 1, B).

The gross motor development item "Stands holding on"

was related to the "Mama, dada specific" (p = 0.018, β = 0.211) and the "4 words other than mama/dada" (p = 0.026, β = 0.198) items. "Stands alone 10 seconds" was also related to "4 words other than mama/dada" (p = 0.044, β = 0.180) (figure 1, B).

As maternal age increased, the "Mama, dada specific" (p = 0.039, β = 0.184) and "Mama, dada nonspecific" (p = 0.026, β = 0.203) items increased (figure 1, B).

Children who lived in higher socioeconomic regions did significantly better on the "4 words other than mama/dada" item (p < 0.001, β = –0.353) (figure 1, B).

Findings at 18 months. The "4 words other than mama/dada" item was significantly higher in girls (p = 0.048, β = –0.189). The "4 words other than mama/dada" item was negatively correlated with the "Throws ball" gross motor item (p < 0.001, β = –0.352) (figure 2, A).

Findings at 24 months. As maternal age increased, the "Combines 2 words" (p = 0.003, β = 0.420) and the "Speech half intelligible" (p = 0.025, β = 0.276) items increased.

The "Shows 4 parts of doll" (p = 0.028, β = 0.716) item was significantly higher in boys, and the "Comprehends prepositions (such as under/above)" item was significantly higher in girls (p = 0.032, β = –0.269). In children whose mothers had less education, the "Combines 2 words" skills increased (p = 0.007, β = –0.379) (figure 2, B).

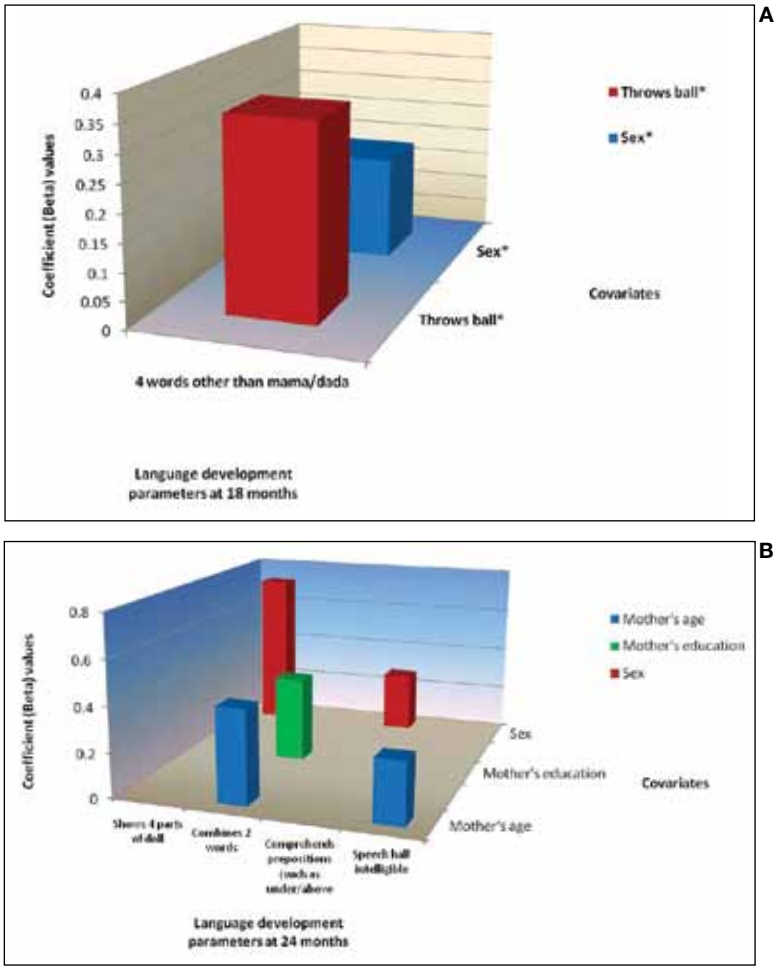

*Figure 2. Charts show statistically significant coefficient (β) values by linear regression analysis (backward) at18 months (**A**), and 24 months (**B**). Asterisk signifies that coefficient β values were present.*

Discussion

Children with developmental language disorders are at high risk for not achieving proper cognitive, social, and emotional development. Therefore, they should be identified and treated as early as possible, although this is not always easy. The precursors and first steps of language acquisition correlate with later language abilities, but the relationship is weak and predicting further language development in an individual child is not possible. At the end of the second year of life, however, late talkers can be identified, and we do know that these children are at risk of language impairment.[10]

A family history of speech or language delay, male sex, and perinatal factors are known risk factors for language delay. Other less consistently described factors are the educational level of the mother and father, family size, childhood illnesses, and birth order.[2] In our study, we observed that male sex, family size, the mother's age, and the mother's education all had an effect on several language functions. We did not study the effect of perinatal complications or family history of developmental delay because these factors were among the exclusion criteria for our study.

Sex has previously been correlated with subtests of expressive language, attention, and memory; specifically, girls have had higher scores than boys in these subtests.[1] The capacity of working memory is an underlying factor in the acquisition of language and gesture; it maintains auditory input while speech movements for novel words are planned.[11-13] Working memory capacity enlarges with age, thereby allowing for more efficient motor speech planning and movements of higher speed and smaller ranges.[1]

Our study group included patients no older than 27 months. We observed an effect of sex at 6 and 24 months. Boys were more likely to pass "Turns to sound" at 6 months and girls were more successful at passing "Comprehends prepositions (such as under/above)" at 24 months. In the literature, it has been reported that a high prenatal testosterone level is a risk factor for language delay in boys and that it may be a protective factor for girls.[14]

Maternal factors also influenced language development. At 12 months, "Mama dada specific" and "Mama, dada nonspecific" skills were better in children with older mothers; the same was true at 24 months with respect to the expressive language items "Combines 2 words" and "Speech half intelligible."

Language development was better in children from higher socioeconomic areas, which might be related to the higher maternal education levels in those areas. The income level, education level, and intellectual level of our patients were positively related with each other, and care of the children was primarily performed by mothers. Therefore, the maternal education level is an important factor in language development of children.

We found that language items were mostly correlated with each other at 6, 12, and 24-months. Both "Imitates speech sounds" and "Single syllables" had an association with social and gross motor items at 6 months. At 12 months, the gross motor item "Stands holding on" was positively correlated with the language items "Mama, dada specific" and "4 words other than mama/dada," and the "Stands alone 10 seconds" item was also positively correlated with "4 words other than mama/dada."

At 6 months, the social item "Works for toy out of reach" was positively correlated with all four language development items. The gross motor development items "Pull to sit, no head lag" and "Lifts chest with arm support" were correlated with the "Turns to sound" and "Turns to voice" items, respectively. Children whose mothers had more education and a higher socioeconomic level achieved significantly more successful language development, as did boys.

At 12 months, greater maternal age, gross motor development items, and social items were all correlated with better language development levels. Children of a higher socioeconomic status had a significantly greater ability to pass the "4 words other than mama/dada" item.

At 18 months, girls' "4 words other than mama/dada" ability increased. Children who passed the "4 words other than mama/dada" item could not pass the "Throws ball" gross motor item.

At 24 months, the "Combines 2 words" and "Speech half intelligible" items were correlated with greater maternal age. The "Comprehends prepositions (such as under/above)" skills were better in girls, and the "Shows 4 parts of doll" skills were better in boys.

On multifactorial analysis, socioeconomic status was the only environmental factor found to correlate with language items, which occurred at 6 and 12 months. At 6 months, the language development of children with a higher maternal education level and a higher socioeconomic status were better. This can be explained by more mother-child interaction in this group than in other groups. A higher socioeconomic level allows a mother to better support her child's needs, and this has a positive effect on language development.

A previous study in Turkey by our group found a marked effect of maternal education and sociocultural factors, especially in preschool children, suggesting that the effects observed in our study would be more pronounced if we had examined older age groups.[7]

The reason that different domains of development correlate with each other, especially in infants, is mainly attributable to the fact that development is a global process resulting from the programmed maturation of the central nervous system. Language and fine motor skills are related to and influenced by general cognitive abilities. For instance, the association between faster jaw opening speeds and perception and concepts may reflect the role of embodied cognition in development.[1]

The fact that speech movement generally becomes faster with age[6,15] might reflect the maturation of the speech motor system. Nip et al investigated the associations between articulatory kinematics and the development of skills in various domains thought to support the development of early communication.[1] They longitudinally and periodically followed 24 children aged 9 to 21 months. They used a three-dimensional motion-capture system to record movements of the upper lip, lower lip, and jaw and found age-related changes in speed and range of movement.

Nip et al also identified significant associations between orofacial kinematics and the standardized measures of language and cognitive skills, even when age served as a covariate.[1] Their findings support the interaction among cognition, language, and speech motor skills during the early development of communication skills.

In our study, the gross motor items were positively correlated with language items at 6 and 12 months. At 18 months, the gross motor item "Throws ball" was negatively correlated with the language item "4 words

other than mama/dada." According to our findings, interactions among developmental domains tend to become less important as children age; at 24 months, linear regression analysis (backward) showed that there was no significant correlation between gross motor items and language development. At 6 and 12 months, on the other hand, we did detect a significant relationship between motor development and language development. This difference may be attributable to the substantial completion of brain development and myelination at the early ages of life.

Our group's previous study demonstrated that environmental effects on test results become more pronounced at later ages.[7] One possible explanation for this may involve the close topographic localization of certain areas in the cerebral cortex and their maturation at similar ages.

Another reason for the correlation among the different developmental domains is the influence that one domain can have on another. For example, gross motor abilities foster an opportunity to acquire experience and facilitate learning, thereby affecting social and language development. Gallagher suggested that neonates' spontaneous facial movements provide them with an understanding of facial movements at the time they are born, resulting in awareness of facial expressions, and this can facilitate language development.[16]

The results of our study showed the interactions between language and motor development skills. Knowledge of these interactions can help us identify other missing or underdeveloped aspects that can lead us to perform supportive interventions in these areas.

In conclusion, language items appear to change along with gross motor items and social development in infants, and they can be influenced by a family's socioeconomic level. We would like to conduct a follow-up study to determine if we can replicate our findings. In the future, more studies should be done on this matter, and their protocols should include an examination of more confounding factors on language development levels.

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