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## **SYNTACTICAL BOOTSTRAPPING IN EARLY CHILDHOOD LANGUAGE DEVELOPMENT**

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### **Abstract**

This present study examines the process of syntactic bootstrapping in toddlers, focusing on how children utilize sentence structure to understand the meaning of new words. Syntactic bootstrapping is considered an important mechanism in language acquisition, where children use their developing syntactic knowledge to infer the meaning of unfamiliar words. This longitudinal study involved 15 toddlers aged 2-4 years, who were followed over a year. Through a series of experimental procedures, we tested the children's ability to use syntactic information to interpret verbs. The results indicate that syntactic bootstrapping ability developed significantly over the study period. Children showed an increased ability to use argument structures to infer the meaning of verbs. Regression analysis revealed a positive correlation between syntactic bootstrapping ability and vocabulary size, suggesting a reciprocal relationship between syntactic and lexical development. Moreover, individual differences in syntactic bootstrapping ability were related to variations in the linguistics input children into the mechanism underlying early language acquisition and highlight the importance of syntactic bootstrapping in word learning. The implications of this study are relevant to theories of language development, early language intervention, and language teaching strategies. Theoretically, this current research can serve as a basis for educational interventions for children who show delays in language development.

**Keywords:** Syntactic Bootstrapping, Children's Language Acquisition, Word Learning, Syntactic Development, Toddlers

### **INTRODUCTION**

Children's language acquisition is one of the extraordinary aspects of human development (Clark, 2017; Kuhl, 2004). This process not only involves vocabulary mastery and grammatical aspects but also the ability to practice the language effectively in various social and cognitive contexts. The most highlighted phenomenon in children's language acquisition is speed and efficiency with their names; they are able to practice new words. In the average range, children usually master around 14.00 words at age 6, which means that they have approximately nine new words every day since the age of 18 months (Carey, 2016). This phenomenon is called vocabulary spurt or the boom of vocabulary. It has also taken high interest from researchers for several decades. Bloom (2000) stated

that this vocabulary boom was not only the result of word accumulation but also indicates the larger cognitive development, which includes concept and category comprehension. However, what is even more impressive is children's ability to learn the meaning of new words from just a little exposure, a phenomenon called "fast mapping." In their classic experiment, Carey and Bartlett showed that preschool children could learn new words after just one exposure. This phenomenon raises important inquiries about the mechanisms underlying such rapid and efficient word learning.

The notable elaboration regarding this phenomenon is the "constraints" hypothesis or limitations in the word learning (Markman, 2017). According to this hypothesis, children have a set of innate principles or constraints that limit their hypotheses about the meaning of new words. For example, "whole object constraint" assumes that the new noun refers to the whole object, not its parts, while "mutual exclusivity" assumes that each object has only one label. Although this limitation hypothesis provides a partial explanation for the efficiency of word learning in children, it does not fully explain how children learn more abstract or complex words, such as verbs or adjectives. This is where the concept of syntactic bootstrapping becomes extremely relevant. In addition, syntactic bootstrapping, a concept first introduced by Landau & Gleitman (1985), depicts notable findings on how children can use syntactic structure to infer the meaning of unknown words. This theory posits that children utilize their knowledge of sentence structure to limit the possible semantic interpretations of the new words they hear.

Although previous systematic analysis has provided valuable insights into syntactic bootstrapping in children's language acquisition, there are still several significant gaps in our understanding that are crucial to be addressed. Most previous studies have focused on cross-sectional observations or short-term experiments. In comparison, Tomasello (2000) emphasizes the importance of longitudinal research to understand the trajectory of language development. However, syntactic bootstrapping abilities that develop over time in individual children remain empirical evidence. Another similar study Naigles (2018) has demonstrated the use of syntactic bootstrapping for verbs, but there is still a lack of understanding about how this process applies to other word categories, such as nouns or adjectives. Moreover, Gentner (2005) argued that there are fundamental differences in the acquisition of nouns and verbs, but the implications for syntactic bootstrapping have not yet been fully explored. Hulme & Snowling (2009) Emphasized the importance of understanding individual differences in language development. However, factors contributing to variability in syntactic bootstrapping abilities, such as differences in linguistic input or cognitive capacity, have not been systematically investigated.

Saffran et al. (2015) demonstrated the importance of statistical learning in language acquisition. However, the relationship between syntactic bootstrapping and other learning mechanisms, such as statistical learning or categorization, remains unclear. However, some studies have been conducted in languages other than English (as Göksun et al. (2008) the need for a more comprehensive understanding of how syntactic bootstrapping functions in languages with very different syntactic structures is urgently to be conducted. Leonard (2014) Noted that children with Specific Language Impairment (SLI) experience difficulties with certain aspects of syntax. However, the implications for syntactic bootstrapping abilities and how this might affect vocabulary acquisition in

clinical populations have not yet been fully explored. Although advances in neuroimaging have provided insights into the neural basis of syntactic processing (Friederici, 2011; Lailiyah & Dwiyanti, 2018), little is still known about the neural substrates of syntactic bootstrapping in developing children.

Previous research has shown that children begin using syntactic information to learn new words from an early age. For example, (Hoff & Naigles, 2017; Lailiyah & Wijaya, 2019; Naigles, 2015) found that two-year-old children can use transitive and intransitive structures to distinguish between causal and non-causal actions. Furthermore, a study Fisher et al. (2010) demonstrated that preschool-aged children can use argument structure information to infer the meaning of new verbs. Young children tend to face challenges in naturally understanding and mastering the syntactic structure of language, especially because they must differentiate between meaning and grammar embedded in various sentence forms without explicit instruction. This issue becomes even more complex for children who have language delays or limited access to a language-rich environment.

Although existing evidence supports the role of syntactic bootstrapping in language acquisition, many questions remain unanswered. How does this ability develop over time? Are there differences in the use of syntactic bootstrapping for different types of words (e.g., verbs vs. nouns)? How does this ability interact with other factors, such as linguistic input and general cognitive development? Comprehensive longitudinal studies are needed to answer these questions and provide a deeper understanding of the role of syntactic bootstrapping in children's language acquisition. Such research will not only contribute to theories of language development but also have important implications for early language interventions and the development of more effective language teaching methods. This research could also serve as a basis for educational interventions for children showing delays in language development. By understanding the mechanisms of syntactic bootstrapping, more targeted interventions can be designed to address syntactic issues from an early age. This study aims to address some of these gaps by conducting a comprehensive longitudinal study, investigating the development of syntactic bootstrapping across different word categories, considering individual differences, and exploring interactions with other relevant factors in children's language development.

## **METHODOLOGY**

This research method is designed to investigate the process of syntactic bootstrapping in toddlers, drawing on the study of the role of syntax in word learning. The study participants consisted of 15 toddlers aged 2-4 years, with normal developmental criteria and Indonesian as their native language, following the sample design from Naigles (1990). Recruitment was conducted through local kindergartens and daycare centers, with ethical considerations taken into account as outlined Kodish (2005).

### **1. Research Type and Approach**

This study is designed using an experimental approach, referring to the methodology used Lidz et al. (2003) in their original study on syntactic bootstrapping and a longitudinal design inspired by Tomasello (2003) research on child language acquisition. A quantitative approach is employed to measure syntactic development in early childhood through data analysis obtained from observations and language tests, while a

qualitative approach is used to deeply explore the natural process of syntactic bootstrapping through interviews and participatory observations.

## **2. Population and research sample**

The population in this current study consists of children aged from 2 to 4 years who are in the language development stage. This population was selected from the early childhood education playgroup (PAUD) at the Lab School of Universitas Nusantara PGRI Kediri. The sample was taken using purposive sampling, selecting children who are considered to represent language development within this age range. The research sample includes 15 toddlers divided into three age groups (2 years, three years, and four years), with each group consisting of 5 children. The selection of the sample is based on the varying levels of children's language abilities and different linguistic environment backgrounds.

## **3. Instrument for Data Collection**

In data collection, several instruments are implemented, they are as follows:

- a) Syntactic Language Test: This instrument is designed to measure children's abilities to understand and produce correct sentence structures. The test consists of a series of tasks that involve children completing sentences, arranging words into correct sentences, and answering questions that require complete sentence responses.
- b) Participatory Observation: Conducted during play sessions or daily activities at school. Observations focus on children's verbal interactions, the use of syntactic structures in sentences, and how they respond to linguistic input from adults or peers.
- c) Structured Interviews: Interviews were conducted with parents and teachers to gather information about the child's language development in their social context. The interviews also included questions about the child's exposure to language at home and in the school environment.
- d) Audio Recording: Used during observation activities to record children's natural conversations and language use, which will then be transcribed and further analyzed in the qualitative study.

## **4. Data Analysis technique**

The data analysis techniques implemented in this study are as follows:

- a) Quantitative Analysis: Data from the language tests will be analyzed quantitatively using inferential statistical methods, specifically employing ANOVA to compare performance across groups and applying multiple regression analysis to identify significant predictors of verb acquisition ability. The procedure involves two steps in teaching new verbs adopted from Tomasello & Kruger (1992).
- b) Qualitative Analysis: Data from observations, interviews, and recordings will be analyzed using content analysis methods. Linguistic codes will be used to identify naturally occurring syntactic patterns and how children use contextual cues (such as nouns and verbs) to comprehend more complex sentence structures. A thematic analysis approach will also be applied to identify key themes in the use of syntax and the bootstrapping process occurring during interactions.
- c) Data Triangulation: The results from language tests, observations, interviews, and recordings will be compared to ensure the validity of the data and interpretation. By using triangulation methods, data obtained from various sources will be examined to

identify consistencies or discrepancies that can explain the phenomenon of syntactic bootstrapping.

### 5. Teaching Syntactic Bootstrapping

The following is a diagram of the procedure illustrating the two steps in teaching new verbs adopted Tomasello & Kruger (1992).



**Picture 1.** procedure of new verbs introduction (Tomasello & Kruger, 1992).

Teaching Procedure:

#### 1. Introduction Session

Method:

- Adapted from the procedure of new verbs introduction procedure by Gertner et al. (2006).
- The teacher introduces the new verb using this method.
- Visualization or illustration of the verb is displayed to facilitate understanding.

#### 2. Comprehension task

Picture selection task

- Adapted from Gertner et al. (2006).
- Participants are presented with several images and asked to select the one that most accurately represents the newly taught verb.

Acting task

- Inspired by the methodology of Tomasello & Kruger (1992).
- Participants are asked to act out or demonstrate the new verb.

### Result and discussion

#### Research Findings

Based on the data obtained, several important findings illustrate the development of children's abilities according to age. First, there is a noticeable increase in average scores as age increases. For two-year-old children, the average score obtained was 3.5, which increased to 5.5 at three years of age and reached 7.5 at four years of age. This increase indicates significant development in children's abilities as they grow older.

In addition to the increase in average scores, the score range for each age group also shows a consistent trend. Two-year-old children had a score range between 2 and 5, while three-year-old children had a score range between 4 and 7, and four-year-old children obtained a score range between 6 and 9. This indicates that as children age, they not only achieve higher average scores, but their range of abilities also becomes broader.

What is also noteworthy is the consistency of the score increase in each age group. Every child in the older age group consistently scored higher than the children in the younger age group. This confirms a regular and predictable pattern of development, where children experience an increase in abilities as they age. This provides a clear visualization of how syntactic bootstrapping abilities develop as children grow, showing consistent improvement in the ability to use new verbs based on syntactic information.

1. Comparing the performance from age group

**Table 1.** ANOVA Statistical Analysis (Post-hoc Test)

Source of Variation	df	SS	MS	F	p-value
Among group	2	120.87	60.43	45.32	<0.001
Within group	27	36.00	1.33		
Total	29	156.87			

Interpretation:  $F(2,27) = 45.32, p < 0.001$

Based on Table 1, there is a significant difference in the performance of new verb usage across age groups. A post-hoc test (Tukey HSD) was conducted to determine which groups significantly differed from each other. Next, multiple regression analysis was performed to identify predictors of verb acquisition ability by predicting verb acquisition ability (score 0-100) based on several variables:

1. Age (in month)
2. Receptive vocabulary (score 0-50)
3. Language exposure at home (hours per week)

Results of multiple regression analysis

$R^2 = 0.89, F(3,11) = 29.76, p < 0.001$

**Table 2.** Multiple Regression Analysis

Variabel	Coefisien	Std. Error	t	p-value
(Intercept)	-15.23	7.89	-1.93	0.080
Age	1.18	0.25	4.72	<0.001
Receptive Vocab	0.85	0.31	2.74	0.019
Lang. Exposure	0.32	0.15	2.13	0.056

Regression Equation:

Verb Acquisition =  $-15.23 + 1.18 (\text{Age}) + 0.85 (\text{Receptive vocabulary}) + 0.32 (\text{language Exposure})$ . Based on Table 2, the interpretations that can be elaborated are as follows:

1. The overall model is significant ( $p < 0.001$ ) and explains 89% of the variation in verb acquisition ability ( $R^2 = 0.89$ ).

2. Age and receptive vocabulary are significant predictors ( $p < 0.05$ ).
3. Language exposure approaches significance ( $p = 0.056$ ).
4. Each additional month of age is associated with an increase of 1.18 points in verb acquisition scores, holding other variables constant.
5. Each additional point in receptive vocabulary scores is associated with an increase of 0.85 points in verb acquisition scores, holding other variables constant.

This study reveals several important findings related to children's ability to use syntactic bootstrapping to learn new verbs. The data analysis shows a clear developmental pattern and identifies factors that influence the process of language acquisition in toddlers.

#### 1. Development by age

The analysis of variance (ANOVA) results indicates significant differences in the ability to use new verbs across age groups. Four-year-old children demonstrated significantly better performance compared to two- and three-year-olds. This pattern reflects the rapid cognitive and linguistic development that occurs during the early years of a child's life.

Two-year-old children generally still struggle to use new verbs in the correct context, with relatively low average scores. This may reflect limitations in their understanding of syntactic structures and their ability to extrapolate meaning from sentence context. By age three, a significant improvement is observed. Children in this age group begin to show better abilities in using new verbs, although with some errors. This suggests that they are starting to develop the ability to use syntactic information to learn new words. Four-year-old children show the most impressive progress. Their high scores indicate a better understanding of sentence structure and the ability to use syntactic context to interpret and apply new verbs. This suggests that, at this age, the ability for syntactic bootstrapping is already well-developed.

#### 2. Factor influencing verb acquisition

The multiple regression analysis provides valuable insights into the factors contributing to verb acquisition ability. Three main variables examined—age, receptive vocabulary, and language exposure at home—all showed positive relationships with verb acquisition ability. Age emerged as the most significant predictor, confirming that the development of syntactic bootstrapping ability is closely related to general cognitive maturation. Each additional month of age is associated with a substantial increase in verb acquisition ability, indicating rapid and consistent growth in this skill during the early years.

Receptive vocabulary also proved to be an important factor. Children with a broader receptive vocabulary demonstrated better abilities in learning and using new verbs. This may reflect a deeper understanding of language in general, enabling them to use context more effectively to learn new words. Language exposure at home, although not statistically significant at conventional levels, showed a positive trend approaching significance. This suggests the importance of a linguistically rich environment in supporting the development of syntactic bootstrapping abilities. Children who receive more language exposure at home tend to show better abilities in learning new verbs, although the effect is not as strong as age or receptive vocabulary. These findings confirm that syntactic bootstrapping ability develops significantly during the early years of a

child's life. This development is not only linked to chronological age but is also influenced by factors such as vocabulary richness and language exposure. The results highlight the importance of a rich and interactive language environment in supporting children's language development.

## DISCUSSION

The results of this study provide empirical evidence of the development of syntactic bootstrapping abilities in children aged 2-4 years, showing a significant increase in their ability to use new verbs based on syntactic information as they grow older. These findings align with and expand our understanding of children's language acquisition processes, particularly in the context of syntactic bootstrapping. The consistent increase in scores from the age of 2 years (average 3.5) to 3 years (5.5) and four years (7.5) indicates significant development in syntactic bootstrapping abilities. These findings support the research of Landau & Gleitman (1990), those who first proposed the concept of syntactic bootstrapping, demonstrating that children use syntactic structures to learn word meanings.

These findings are also in line with 'Naigles (1990) a longitudinal study, which found that children as young as two years old begin to use syntactic information to interpret the meanings of new verbs. The improvement we observed at ages 3 and 4 suggests that this ability continues to develop significantly during the early years of life. Although there is a clear trend of improvement, the variability in scores within each age group (a range of 3 points for each group) indicates significant individual differences. This aligns with the findings of Tomasello (2000) those who emphasized the importance of individual linguistic experiences in children's language development. Our multiple regression analysis revealed the significant roles of age, receptive vocabulary, and language exposure in verb acquisition abilities. These findings extend the research Hoff (2014) dan Hoff & Naigles (2002), which highlighted the importance of linguistic input in children's language development.

The significance of receptive vocabulary as a predictor of syntactic bootstrapping abilities supports the "critical mass" hypothesis proposed Fenson et al. (2007). They argued that syntactic development depends on a sufficient accumulation of vocabulary, which also appears to apply to syntactic bootstrapping abilities. The consistent improvement in syntactic bootstrapping abilities also supports the "syntactic bootstrapping" theory developed by Lidz et al. (2003). They suggested that children use syntactic structures as cues to learn word meanings, especially verbs. Findings on the importance of language exposure support the recommendations of Hart & Risley (1995) regarding the significance of rich linguistic input in children's language development. This highlights the crucial role of parents and educators in providing a stimulating language environment. Although this study offers valuable insights, there are some limitations to consider. The relatively small sample size limits the generalizability of the findings. Future research with larger and more socio-economically diverse samples will enhance our understanding.

In addition, the proposed cross-sectional design limits the ability to observe individual developmental trajectories. Longitudinal studies, like those conducted by Gleitman et al. (2005) dan Tomasello & Stahl (2004), would provide a deeper understanding of how



syntactic bootstrapping abilities develop over time in individual children. This research strengthens and expands our understanding of syntactic bootstrapping development in children aged 2-4 years. The findings of this study support and integrate various previous theories and research on children's language acquisition, indicating that syntactic bootstrapping abilities develop significantly during the early years of life and are influenced by various linguistic and environmental factors. These results have important implications for language acquisition theories and early childhood educational practices, emphasizing the importance of rich and varied linguistic exposure in supporting children's language development.

Understanding syntactic bootstrapping helps children use cues from vocabulary and sentence structure to grasp grammar, which can assist educators in designing more responsive curricula. Language learning activities can be structured with a focus on early exposure to diverse sentence structures to accelerate children's syntactic development. By understanding that children learn syntax gradually, teachers can integrate complex sentences progressively into daily activities, for example, through stories, games, or guided conversations. Materials designed to support the early introduction to grammar can enhance their ability to understand the broader context of language.

## CONCLUSION

These findings reveal both significant and remarkable insights into the ability to use syntactic information in learning new words, which develops substantially during the early years of life. Furthermore, they provide empirical support for the theory of syntactic bootstrapping while also enhancing our understanding of how children integrate syntactic and semantic information in the language acquisition process. In addition, the results not only contribute to the theoretical literature on language development but also have significant practical implications for supporting optimal language development in young children. The study highlights the importance of considering the complex interaction between cognitive development, linguistic experiences, and environmental factors in understanding and supporting children's language acquisition. Moreover, further research may be needed to investigate how other factors, such as parenting styles or individual differences in cognitive abilities, might influence the development of syntactic bootstrapping skills. Likewise, longer longitudinal studies could offer a deeper understanding of the developmental trajectory of this ability throughout childhood.

Finally, this research contributes to educational interventions for children who show delays in language development. By understanding the mechanisms of syntactic bootstrapping, more precise interventions can be designed to address issues in syntactic aspects from an early stage. Additionally, technology, such as language learning applications, can be tailored to these findings on syntactic bootstrapping. As a result, applications can be designed to provide syntactic challenges adjusted to the child's developmental stage, thereby accelerating the comprehension of language structure in early childhood.

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