The Acquisition of Verbs by English-learning Infants*

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This paper starts by introducing the debate between the nativist account and the learning account of language acquisition. It participates in the debate by addressing three questions concerning verb productivity. First, do young children have abstract syntactic knowledge of the verb category? Second, is vocabulary size a good predictor for a child’s syntactic productivity? Third, is children’s speech correlated with adults’ speech with regard to verb productivity? It is predicted that, if the limited scope learning account is right, the following should be expected: (1) frequent verbs and infrequent verbs are expected to have different productivity in children’s speech; (2) verb productivity in child speech is significantly lower than that in adult speech; (3) frequent verbs and infrequent verbs behave differently in terms with the correlation between verb productivity and an individual’s vocabulary size; (4) children and adults are correlated with regard to verb productivity. The analyses based on large longitudinal data in this paper confirm all the above predictions, suggesting that a learning approach of language acquisition for verb usage is supported.

1. Introduction

This paper addresses the puzzle of infants’ early acquisition of syntactic structures. Chomsky (1975) mentioned that ‘creativity’ is one unique property of human language – the capacity of infinitively combining words to form well-formed sentences. The puzzle of language acquisition is that, despite such complexity, all infants are able to acquire their native language successfully within a period as short as a couple of years. A question that arises is what constitutes language users’ abstract knowledge of sentences and enables them to make grammatical novel utterances. Two approaches have addressed this issue from very different angles. According to Generative Linguistics (Chomsky, 2002, 1965), linguistic competence is understood as a set of innate phrase structural rules. According to Cognitive Linguistics (Lakoff, 1987; Tomasello, 2003), the abstract representation of sentences is understood as constructions that are associations between forms and the corresponding meanings.

This paper participates in this debate by re-investigating the verb usage in both the child and adult production based on data from the English CHILDES (Child Language Data Exchange System) corpus (MacWhinney, 2000). The following three questions are addressed in this paper. First, do children under three have more limited knowledge of sentence structure than adults? Second,
for an individual adult or child speaker, is vocabulary size a good predictor for the verb usage in the production? Third, to what degree does child production reflect adult input? In the following sections, a brief introduction of different theories about language acquisition is presented, followed by two specific heated debates about whether innate syntactic categories are needed for young children during first language acquisition (for both determiner acquisition and verb-argument acquisition). Due to the controversy about different findings on both sides of the debate, this paper provides a novel analysis based on a few measurements of verb productivity. In order to distinguish both sides of the debate, in this paper, it is predicted that verb frequencies should have an effect on verb productivity, if young children’s acquisition of verb usage is based on a limited scope learning mechanism rather than innate syntactic structure. Specific predictions of this paper can be found in section 4 of this paper.

2. Theoretical Background

This section provides a brief introduction to three major approaches suggested for how a child may acquire his/her first language.

2.1 The Syntactic Approach

According to the syntactic approach for language acquisition, sentences bear underlying structures. Such underlying structures constitute the innate language faculty specifically unique to humans, facilitate infants learning of a sophisticated language system, and allow language users to creatively generate potentially infinite numbers of sentences (Chomsky 1975).

One piece of evidence for the underlying syntactic structures is the phenomenon of syntactic categorization. In other words, the usage of a verb is constrained by the idiosyncratic properties of that particular lexical item specified in the lexicon. For example, the usage of transitive verbs requires the appearance of direct objects, as observed by the contrast between examples (1) and (2), while the usage of intransitive verbs prohibits the occurrence of direct objects, as shown by examples (3) and (4). So the verb ‘hit’ is a transitive verb, the verb ‘smile’ is an intransitive verb, whereas the verb ‘walk’ is a mix of both. We can refer to such constraints as the rule of transitivity or the rule of intransitivity. Such rules apply productively. In other words, any nominal arguments (theoretically speaking) can be combined with a verb, as long as the rule of transitivity or the rule of intransitivity is fulfilled. If the rule is violated, it will lead to an ungrammatical/bad sentence.

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October 30 - November 1, 2009
(1) The boy hits the ball.

(2) *The boy hits.

(3) The boy smiles.

(4) *The boy smiles a joke.

(5) The boy walks.

(6) The boy walks a dog.

Theories supporting this approach to language acquisition suggest that such underlying structures are formal devices of Universal Grammar (UG), and such underlying structures facilitate children’s acquisition of their native language. For example, the theory from Radford (1990) suggests that X-bar theory is part of UG. Another example framework is proposed by Valian (1991), in which the innate device includes knowledge of clause structure.

2.2  The Semantic-bootstrapping Hypothesis

The semantic-bootstrapping hypothesis is driven by the observation that the underlying syntactic structure of a sentence is consistent with its semantic structure. One way of representing the semantic structure of a sentence is referred to as the verb-argument structure. For example, the verb ‘hit’ in example (1) takes two arguments--the agent ‘the boy’ and the theme ‘the ball’. The agent is the volitional actor of the activity denoted by the verb, whereas the theme is the object undergoing the activity. According to the semantic-bootstrapping hypothesis, children develop the knowledge of real word concepts, map objects onto the syntactic category ‘noun’ and map actions onto the syntactic category ‘verb’. Theories supporting the semantic basis of language acquisition suggest that children make use of conceptual knowledge in order to know if a direct object is needed, and the observation of the semantics from the real world triggers the corresponding innate syntactic structure during language acquisition (Pinker, 1984).

This hypothesis, also called the Generalization Hypothesis in the literature, has been tested by comprehension experiments. For example, Naigles (1990) used sentences containing novel verbs such as those in (7-8), and had children watch act-out scenarios. Naigles found that 25 month olds hearing sentence (7) looked longer at a scene in which Big Bird did a novel action on Cookie Monster than the one in which both animals did actions independently. The listening time was reversed when the children listened to...
stimuli like (8). These results suggest that children as young as two already have sophisticated knowledge of distinguishing transitive from intransitive verbs.

(7) Big Bird is kradding Cookie Monster.

(8) Big Bird and Cookie Monster are kradding.

2.3 The Limited-scope Formulae Learning Approach

The above two approaches are both nativist views, since both assume that a formal device is important for language acquisition. An alternative perspective is the usage-based piecemeal learning mechanism proposed by Tomasello (2003). This alternative suggests that there is no need to resort to the innate acquisition device. What constitutes the abstract representation of sentence is the proposed construction grammar. According to construction grammar, sentences are understood as a set of form-meaning correspondences that exist at all levels of the lexicality-schematicity continuum. Furthermore, this approach suggests that patterns from the input provide sufficient cues for the acquisition of sentence structures as mapping from meaning and forms via intentional learning.

According to this approach, the learning process is considered as involving ‘pre-emption’ and ‘entrenchment’. Pre-emption refers to the evidence provided by encountering a particular verb construction: if the sentence form ‘John makes the apple disappear’ occurs in the input instead of the form ‘John disappears the apple’, the latter must be ungrammatical, otherwise it could have occurred in the input. Entrenchment, according to Braine and Brooks (1995), refers to the idea that encountering a verb frequently in the input ‘entrenches’ its usage and resists extending the generalization onto novel constructions. For example, children were found less likely to overgeneralize on frequent verbs (*He came me to school.) than on the infrequent forms (*He arrived me to school.). Instead of having full competence from the very beginning, young children start with gradual learning of the usage of individual verbs. The abstract knowledge of sentence structures comes from gradual learning from concrete instances. Due to the piecemeal nature of this learning, it has been called the Verb-island Hypothesis.

One corpus study that supports the learning approach of language acquisition is Lieven, Pine, and Baldwin (1997). Lieven et al. (1997) adopted the lexical-based positional analysis of roughly the first 400 multiword utterances produced by 11 children aged from 1-3. This analysis divides children’s multiword utterances into three categories – frozen phrases, intermediate utterances and constructed utterances. Lieven et al. (1997) found that the latter two categories were able to account for 60% of children’s total production; the majority of the rest were accounted for by frozen phrases. Furthermore, it was
found that correct and incorrect pronoun forms co-occur in the production of the same child during the same period. This undermines the account of children making use of underlying syntactic rules for utterance production. In addition, both prototypical and non-prototypical verb argument structures were found in early production, suggesting that semantic structures are less likely to be the governing mechanism for the acquisition of syntactic categories. Lieven et al. (1997) concluded that children’s early development of sentence production is item-based, which does not require underlying syntactic or semantic generalizations.

3. Specific Debates

There have been heated debates based on each of the above theoretical accounts. This section will review two specific debates – one about the determiners and the other about verb-argument structures.

3.1 The ‘Determiner’ Debate

Valian (1986) argued for the fact that young children before 2 and a half have abstract knowledge of determiners. From all the speech production of the 6 investigated English children, she found that determiners were positioned correctly (as opposed to incorrect noun-determiner or adjective-determiner sequences) with a very few exceptions. There was no production of the ungrammatical determiner-determiner sequences except for those that could be interpreted due to reasons such as a missing copula, speech hesitations or repetition, and there were no determiners produced in isolation except for a few errors. Since all the criteria used in her study were distributional regularities, no semantic correlate existed. The semantic-bootstrapping hypothesis was not supported. This leads to her conclusion that young children must have innate syntactic categories as young as a little over 2.

Pine and Martindale (1996) re-examined Valian (1986)’s adult-like account of children’s acquisition of determiners. First, Pine and Martindale (1996) pointed out that some utterances that are neither nouns or noun + adjective sequences were not treated as errors by Valian (1986). Second, Valian (1986)’s criteria were too lax for children to pass, and an alternative learning approach based on limited scope formulae of verb paradigms would also reach the criteria. Finally, in order to distinguish the two opposing accounts of determiner acquisition, Pine and Martindale (1996) conducted the overlap measures. The predictions were that if the syntactic account were right, the behavior of using the determiner ‘a’ should be immediately available to the other determiner ‘the’, resulting in a large overlap of contexts. In other words, a large number of different nouns would be observed to be combined with both determiners. On the other
hand, if the limited scope formula account were right, no large overlap would be expected in the child speech, and the overlap of adult speech as a control would be expected to be significantly larger than the overlap of child speech. For most of the noun overlap (the proportion between the type and token number of the different nouns co-occurring with both determiners for an individual speaker) and predicate overlap (the proportion between the type and token number of the different predicates including prepositions, verbs, copula co-occurring with both determiners for an individual speaker), they found that adults had significantly larger overlap than children, supporting the limited scope formula account.

Valian, Solt, and Stewart (2009) re-addressed the issue of ‘determiner’ acquisition by investigating 21 children and corresponding adult speech. Instead of being restricted to singular count nouns, Valian et al. (2009) considered all noun types. The methodologically changed overlap measurement for nouns was defined in the following manner. The numerator was ‘the number of nouns that occurred with both ‘a’ and ‘the’ in the individual’s corpus’, and the denominator was ‘the number of nouns that occurred at least once with either a or the in the individual’s corpus.’ With this analysis, Valian et al. (2009) found that children and their mothers were not significantly different in noun overlap. Further analysis extended into noun overlap among all determiners, where the denominator was ‘the number of nouns that occurred at least once with any determiner’, and again children and their mothers were not significantly different in this measurement. When noun overlap was analyzed as the function of opportunity (the number of times noun appears with any determiner) and as the function of the number of determiner types, only opportunity was a significant predictor for noun overlap for both children and mothers. Valian et al. (2009) further controlled difference of opportunity between adults and children that might affect the overlap measurement. By selecting a subset of adult production that matches child production in determiner types, noun types and opportunity, the result again showed a non-significant difference between adults and children. Valian et al. (2009) also found that noun overlap was not correlated with use of frames (percentage of determiner tokens used in frames out of all occurred, where a frame was defined as a scheme that occurred more than 3 times in the individual’s speech corpus), when MLU is partialled out. The errors found in all children’s production were also very few. With all the analyses above, Valian et al. (2009) concluded that children begin talking with abstract syntactic categories.

3.2 The ‘Verb-argument’ Structure Debate

Another debate focuses on children’s acquisition of verb-argument structures. Valian (1991) found that children use more verbs with direct objects than not in early production. The explanation was that transitive verb frames were
preferred due to performance limitation. In other words, transitive verb frames require less memory load.

Theakston, Lieven, Pine, and Rowland (2001) argued against such a performance limitation account. Theakston et al. (2001) pointed out that in their analysis, although Valian (1991)’s finding was replicated for the child speech in the aspects that a larger proportion of intransitive verbs were used in stage 1 than in stage 3, and a larger proportion of transitive verbs were used in stage 3 than in stage 1, and in both transitive verbs and mix verbs, a larger proportion of verbs were used with a direct object during stage 3 than stage 1, the performance limitation account was an over interpretation of such data. First, most mixed verbs were used in a single verb frame in child speech. Furthermore, for those mixed verbs used in both frames, there is little evidence to show a bias towards the intransitive frame. Second, when analyzing from the perspective of individual verbs, a strong predictor for the verb frame usage in child speech was the adult usage of the verb frames. Verbs acquired in stage 1 have significantly higher relative frequencies in the adult input than the verbs that have not been acquired until stage 3. A performance limitation account would not predict these findings. Finally, for individual verbs, there is little evidence to show a shifting bias from intransitive frames to transitive frames. What Theakston et al. (2001) concluded was that a lexical-learning account is a better interpretation of the data.

4. Research Questions and Predictions

The present study attempts to participate in such debates by asking how productive the verb usage is in both child and adult production. Following the debate above, the following three questions are addressed with predictions from each side given.

First, do children under three have more limited knowledge of sentence structure than adults? According to the nativist approach of language acquisition, children are born with a set of underlying rules as formal devices for language acquisition. From the onset of language acquisition, children are predicted to have full adult linguistic competence – namely a set of phrase structural rules. If all that constitutes as language acquisition device is an inventory of rules, it would be expected that all verbs are equally likely to be productive in both adults’ and children’s production. It is thereby expected that all verb types are used in roughly equal amount of utterance types. The learning approach, on the other hand, predicts that children under three have more limited competence of verb usage compared to adults. Children’s knowledge of sentence structure at the onset of language acquisition is based on cases of specific verb items, later extending onto more verb types via slow, gradual and incremental learning. This approach predicts that syntactic productivity differs across different verb types.
The syntactic productivity will bias towards the more entrenched verbs. In other words, more frequently used verbs in adult input are more productively used in their children’s speech than less frequent verbs are.

Second, for an individual adult or child speaker, is vocabulary size a good predictor for the verb usage in the production? According to both the nativist and the learning approaches, vocabulary size is expected to be a good predictor for syntactic productivity. According to the nativist approach, competence and performance are distinct concepts. A smaller vocabulary size, as performance limitation, will restrict verb usage in speech production. The learning approach predicts that such a correlation is found as well, due to the fact that the more vocabulary a child has, the more speech input the child has been likely to be exposed to, thereby resulting in more productive verb use. However, as stated above, the learning approach specifically gives distinct predictions for frequent and infrequent verbs respectively. The learning approach explicitly predicts that frequent verbs and infrequent verbs will differ with respect to not only syntactic productivity, but also whether and how such a correlation is realized. The nativists, on the other hand, predict that frequent verbs and infrequent verbs are not different in this respect.

Third, to what degree does child production reflect adult input? According to the learning approach, children’s production is predicted to be mimicking his/her parents’ production to a large extent. The innate approach, on the other hand, predicts that all children have similar syntactic productivity from birth. Therefore, the learning approach predicts that features of child production and one of his/her parents’ production are necessarily correlated, because the knowledge of syntactic generalization is input driven; on the contrary, the innate perspective predicts that features of child production are not necessarily correlated with those in their parents’ production, due to the capability of infinitely forming different utterances given a set of formal rules.

5. Method

5.1 Corpus Analysis

A corpus analysis was conducted to answer the above three questions. The utterances produced by 15 children under 3;5 and the utterances produced by one of their parents/babysitters from the same recordings were respectively selected from the CHILDES corpus (MacWhinney, 2000) for analysis. The information of the speakers is shown in Table 11.

1 Notice that the Valian (1991) corpus is constructed based on 21 children arranged chronologically determined by MLU (mean length of utterance). This paper treats this corpus as equivalent to the rest of the corpora listed in Table 1, namely a set of longitudinal data from a single child.
The data extraction and analysis involve the following steps: (1) extracting child and adult utterances into a single text file per speaker by using the grep command of UNIX. (2) running a python script that cleans the extra tags of the utterances and provides frequency counts.

5.2 Dependent Variables

The following dependent variables for each of the 30 subjects (15 children and 15 adults) were measured: Degree of Syntactic Productivity, Size of Construction Type, Revised Productivity, and Vocabulary Size. The first three measurements aim at measuring the productivity of verb usage from different perspectives. The higher the scores for the first three measurements, the more productive the verb is in the speaker’s production.

Degree of Syntactic Productivity measures how possible a child is capable of combining a verb with new nouns to form novel constructions. The productivity of each verb, $p$, is similar to the measurement of morphological productivity of a stem in forming compounds suggested by Baayen and Lieber (1991):

$$ p = \frac{n_1}{N} $
In this paper, the verb is analogous to the morphological base/stem; an utterance containing the verb is analogous to the morphologically inflected compound. The value $p$ of a verb here is computed by dividing the number of count-one types of utterances containing the target verb with the token number of all the utterances containing the same target verb. Here is a toy example of how the computation works. From all the utterances collected from a particular speaker A, for example, 7 utterances containing the verb ‘think’ were found, listed as follows.

(10) I think so.
(11) I think so.
(12) She thinks that you are nice.
(13) She thinks that you are nice.
(14) She thinks so.
(15) She thought hard.
(16) She likes to think about stars.

In this case, the count-one variable ‘$n_1$’ for the verb ‘think’ is equal to 3, because there are 3 utterances (utterances 14, 15, 16) that occur once in the whole production of this speaker. The token number of the utterances containing the verb ‘think’ is 7 (utterances 10-16), referred to as $N$. The measurement Degree of Syntactic Productivity of the verb ‘think’ for speaker A is therefore $3/7$. The mean value of Degree of Syntactic Productivity is computed over two groups of verbs for every speaker – the frequent verbs and infrequent verbs, referred to as Mean Degree of Syntactic Productivity. The frequent verbs are a list of verbs taken from the questionnaire of MacWhinney (2000), attached in the appendix. The infrequent verbs are the rest of the verbs produced by each speaker. An electronic dictionary of verbs (from Dainon Woudstra, personal communication) and their inflections are used in the python script to recognize utterances containing verbs and verbs with different tense and number features. For certain verbs for a particular speaker, both the type and token frequency of the utterance are 1, generating 1 as its $p$ value. Verbs like these were excluded for the computation of the mean Degree of Syntactic Productivity for the speaker, due to the fact that such high $p$ values do not tell us anything about the productivity of the verb.
Size of Construction Type, ‘n’, measures the variety of utterances a verb occurs in a speaker’s production. As for the example given above, Size of construction Type for the verb ‘think’ for speaker A is 5, because 5 different utterances containing ‘think’ are produced. The mean values of ‘n’ for each speaker over both the frequent and infrequent verbs are computed, referred to as Mean Size of Construction Type.

Revised Productivity is computed as n1/n. In the example given above, the Revised Productivity for the verb ‘think’ is 3/5. The mean of Revised Productivity is computed for the frequent and infrequent verbs for each speaker, referred to as Mean Revised Productivity.

Vocabulary Size is the number of unigram types from all the collected utterances for each speaker, as the measurement for the vocabulary size of a speaker. It is computed as the number of word types in all the collected utterances produced by that speaker.

6. Results

6.1 Do young children have more limited knowledge of sentence structure than adults?

The following statistical tests were conducted to answer this question. A between-subjects ANOVA on Vocabulary Size with AGE (child vs. adult) as the factor revealed a trend [F(1, 28) =3.84, p = 0.059]. The graph corresponding to this test is given in Figure 1a, which shows that adults have bigger vocabulary sizes than children do.

Figure 1b shows the mean values of Mean Degree of Syntactic Productivity under each condition, given a 2×2 design with AGE (child vs. adult) and VERB TYPE (frequent vs. infrequent verbs) as factors. Degree of Syntactic Productivity was found to be higher in the adult production than in the child production and in the infrequent verb group than in the frequent verb group. The ANOVA test showed a significant main effect of VERB TYPE [F(1, 28) = 81.8, p < 0.001], AGE [F(1, 28) = 4.44, p = 0.04], and the interaction between the two [F(1, 28) = 7.59, p = 0.01]. The simple effect of VERB TYPE was found to be significant in the adult group [F(1, 14) =51.5, p < 0.001] and in the child group [F(1, 14) = 30.42, p < 0.001]. The simple effect of AGE was found to be significant in infrequent verb group [F(1, 28) = 13, p = 0.001] but not the frequent verb group [F(1, 28) < 1]. In general, adults showed higher Mean Degree of Syntactic Productivity than children did for the infrequent verbs, but not for the frequent verbs.
Figure 1c shows the mean values of Mean Size of Construction Type under the same AGE×VERB TYPE design. Adults showed higher Mean Size of Construction Type than children, but different from Mean Degree of Syntactic Productivity, frequent verbs showed higher Mean Size of Construction Type instead. The difference between adults and children mostly were in the frequent verb group rather than the infrequent verb group. Adults had much bigger utterance varieties than children did for frequent verbs, but adults and children had similar utterance varieties for infrequent verbs. Again in the ANOVA test, significant effects of VERB TYPE \[F(1, 28) = 37.6, p < 0.001\], AGE \[F(1, 28) = 4.47, p = 0.04\], and the interaction between the two \[F(1, 28) = 5.57, p = 0.025\] were found with Mean Size of Construction Type. The simple effects
of VERB TYPE were found to be significant for both the adult \[ F(1, 14) = 20.59, p < 0.001 \] and the child \[ F(1, 14) = 28.43, p < 0.001 \] groups. The simple effect of AGE was found to be significant for the frequent verbs \[ F(1, 28) = 4.92, p = 0.035 \], but the effect of AGE was not significant for the infrequent verbs \[ F(1, 28) = 1.9, p = 0.18 \]. To summarize, adults had much higher Mean Size of Construction Type than children for the frequent verbs, but not for the infrequent verbs.

From the above results, the following conclusions can be made. From both the measurements of Mean Degree of Syntactic Productivity and Mean Size of Construction Type, adults were productive than children in verb usage. Second, the productivity for frequent verbs and that of infrequent verbs were significantly different. However, a conflicting finding was that frequent verbs showed higher Mean Size of Construction Type but lower Mean Degree of Syntactic Productivity than the infrequent verbs. The suspected reason is that for frequent verbs, the N is in general much higher than the infrequent verbs, causing a lower Mean Degree of Syntactic Productivity.

An alternative measurement is coined to further measure the productivity of verbs, namely Mean Revised Productivity. This measurement eliminates the effect of high token frequency, but by looking at how many count-one construction types are in proportion to Size of Construction Types, it still reflects the productivity of the usage of that verb. Figure 1d shows the mean values of Mean Revised Productivity for each condition. Adults showed higher Revised Productivity for both the frequent and infrequent verbs than children, and frequent verbs showed higher Revised Productivity than infrequent verbs. The effect of verb frequency was bigger for the child group than the adult group. With the same ANOVA test on Revised Productivity, significant effects of AGE \[ F(1, 28) = 14.56, p < 0.001 \], VERB TYPE \[ F(1, 28) = 7.08, = 0.01 \] and the interaction between the two \[ F(1, 28) = 5.25, p = 0.03 \] were found. The simple effect of VERB TYPE was found to be significant for the child group \[ F(1, 14) = 7.64, p = 0.015 \] but not the adult group \[ F(1, 14) < 1 \]. The test of Mean Revised Productivity further confirmed the effect of AGE and VERB TYPE. To summarize, both the AGE and VERB TYPE effects found in this section conform to predictions based on the learning approach.

6.2 Is vocabulary size a good predictor for verb productivity?

The following linear regression tests were applied to answer this question, with each of the three measurements for verb productivity as the dependent variable and the vocabulary size of each speaker as the independent variable.
Figure 2: Regression Fittings on Syntactic Productivity with Vocabulary Size as the Predictor for the frequent (solid) and infrequent (dashed) verbs for the adult group (the left graph) and the child group (the right graph) separately: Size of Construction Type (e, f); Degree of Syntactic Productivity (g, h); Revised Productivity (i, j)
6.2.1 Size of Construction Type.

For the frequent verbs produced by adults, the correlation of Size of Construction Type and Vocabulary Size was found to be significant \( r^2 = 0.86, P < 0.001 \); the linear regression line is the solid line shown in the figure 2e; for the infrequent verbs by adults, the correlation of the same variables was also significant \( r^2 = 0.74, p < 0.001 \), shown as the dashed line in 2e. In order to test whether the slopes of the two regression lines are significantly different, the following model was used to fit the adult production data:

\[
Productivity = b_0 + b_1 \text{ Voc. Size} + b_2 \text{ Verb Type} + b_3 \text{ Voc. Size} \times \text{Verb Type}
\]

A significant interaction was found \( t(1, 26) = -7.484, p < 0.001, r^2 = 0.9 \), suggesting that frequent verbs and infrequent verbs are significantly different in the fitted regression line slope in the adult production. The same set of tests was applied to the child production. For the frequent verbs produced by children, the correlation of Size of Construction Type and Vocabulary Size was also significant \( r^2 = 0.51, P = 0.003 \); the linear regression line is the solid line shown in the figure 2f; for the infrequent verbs by children, the correlation of the same variables was also significant \( r^2 = 0.47, p < 0.005 \), shown as the dashed line in 2f. Again a significant interaction was found between Vocabulary Size and Verb Types \( t(1, 26) = -2.81, p = 0.009, r^2 = 0.69 \), suggesting that verb frequency has a significant effect in the correlation between Size of Construction Type and Vocabulary Size.

To summarize, the above tests show that Vocabulary Size was a significant predictor for Size of construction Type for both the adult and the child group. In addition, frequent and infrequent verbs were significantly different with respect to the slope of the regression models fitted.

6.2.2 Degree of Syntactic Productivity.

A similar analysis on the correlation between Degree of Syntactic Productivity and Vocabulary Size was conducted. For the adult frequent verbs, a significant negative correlation was found \( r^2 = 0.74, P = 0.003 \) shown as the solid line in figure 2g; for the adult infrequent verbs, a similar negative correlation was found \( r^2 = 0.66, p < 0.001 \), indicated by the dashed line in figure 2g. A significant difference between the slopes of the two fitted lines was also found \( t(1, 26) = 2.76, p = 0.01, r^2 = 0.81 \). For the child group, no significant correlation between Vocabulary Size and Degree of Syntactic Productivity was found in either the frequent verbs \( r^2 < 0.1, p = 0.3 \) (the solid line in 2h) or the infrequent verbs \( r^2 < 0.1, p = 0.7 \) (the dashed line in 2h). No interaction
between Vocabulary Size and Verb Type was found \[t(1, 26) = 0.59, r^2 = 0.16, p = 0.55\] either.

6.2.3 Revised Productivity.

The same analysis was conducted for Revised Productivity, with the fitted lines shown in figure 2i and 2j. The correlation between Vocabulary Size and Revised Productivity was found to be trending for the adult frequent verbs \[r^2 = 0.22, p = 0.07\], significant for the adult infrequent verbs \[r^2 = 0.29, p = 0.03\], and not significant for either the child frequent verbs \[r^2 < 0.1, p = 0.34\] or the child infrequent verbs \[r^2 < 0.1, p = 0.6\]. No interaction between the effect of Vocabulary Size and Verb Type was found in either the adult production \[t(1, 26) = -0.46, p = 0.65, r^2 = 0.26\] or the child production \[t(1, 26) = -0.38, p = 0.7, r^2 < 0.1\].

6.2.4 Section Summary.

The correlation between Vocabulary Size and syntactic productivity was found to be opposite for the measurement of Size of Construction Type (positive correlation) and for the measurement of Degree of Syntactic Productivity (negative correlation), and no such correlation was found for Revised Productivity. For those where a significant correlation was found, the slopes of the fitted lines were significantly different for the frequent vs. the infrequent verb types.

6.3 Is verb usage similar in both child and adult speech?

Linear regression models were fitted between Child and Adult production. For the dependent variable Size of Construction Type, significant correlations were found between child and adult production for the frequent verbs \[r^2 = 0.29, p = 0.037\] and the infrequent verbs \[r^2= 0.4, p =0.01\] respectively. For the dependent variable Degree of Syntactic Productivity, the correlation between child and adult production was not significant for the frequent verbs \[r^2 < 0.1, p = 0.25\], but trending for the infrequent verbs \[r^2 = 0.2, p = 0.08\]. For the dependent variable Revised Productivity, the correlation between child and adult production was not significant for the frequent verbs \[r^2 < 0.1, p = 0.5\], but significant for the infrequent verb \[r^2 = 0.35, p = 0.02\]. Finally, the correlation between adult and child in terms of vocabulary size was found to be significant \[r^2= 0.64, p < 0.001\].
7. General Discussion

The present study participated in the nature vs. nurture debate about language acquisition by investigating verb usage in both child and adult speech. This paper started with the question of what constitutes a speaker’s abstract knowledge of verb usage and how to interpret verb productivity. The paper then presented the opposing positions about children’s language capability – namely the innate adult-like competence vs. the limited scope formulae learning account – by reviewing two ongoing debates about the determiners and verb-argument structures.

The paper then addressed the three following questions. First, we asked whether it is necessary for young children to have adult-like syntactic categories. We predicted that, in order to distinguish the two theoretical positions, it is important to investigate two factors. The first factor is VERB TYPE which distinguishes frequent verbs and infrequent verbs in natural speech. If the learning approach were right, the verb productivity for the two kinds of verbs would be expected to be different for child speech. The second factor is AGE which distinguishes adults from children. If the learning approach were right, the verb productivity shown in adult speech would be expected to be higher than the verb productivity in child speech. Three measurements of verb productivity were applied, and the results support all the predictions, except for the effect of VERB TYPE on Degree of Syntactic Productivity. Frequent verbs were found to have lower Degree of Syntactic Productivity than infrequent verbs. This finding was not surprising due to the way the measurement was obtained by putting the token number of utterances (N) in the denominator. Since frequent verbs are more likely to have bigger N values, a smaller Degree of Syntactic Productivity is more likely to be obtained. To summarize, the results of this study suggests that frequent verbs have higher productivity than infrequent verbs for both child and adult speech, and that adults use their verbs more productively than children do.

Second, we asked whether verb productivity can be predicted by individual vocabulary size, and whether the interaction between VERB TYPE and vocabulary size was significant. If the learning approach were right, the interaction between VERB TYPE and vocabulary size would be expected. For both adult and child speech, this prediction was evidenced by Size of Construction Type. Degree of Syntactic Productivity was found to be negatively correlated with vocabulary size, which was not expected for both acquisition approaches. Again this negative correlation is due to fact that speakers with larger vocabulary size tend to have higher token numbers of utterances (N). The Revised Productivity showed a ceiling effect for both adult and child (close to 1), which might contribute to the non-significant interaction between VERB TYPE and vocabulary size. The results for the second question again support the predictions.
based on the learning account.

Finally, to see if the child production reflects the adult production, we asked whether a child and the corresponding adult are correlated with regard to verb productivity and vocabulary size. The measurement of Size of Construction Type confirmed this prediction. Since the other two measurements of verb productivity are either heavily affected by the token numbers of utterances (N) or reach a ceiling effect, the non-significant correlation can be explained. Degree of Syntactic Productivity fails to capture the verb productivity, due to the overwhelming effect of N. Revised Productivity showed a homogeneity data structure, violating the null assumption for the correlation test. The correlation results therefore support the conclusion that child productions are similar to one of their parents’ productions. This is compatible with what the learning theory predicts.

One contribution of the current study was that the measurement of verb productivity does not assume a hierarchical structure of phrase structural rules. Rather, it is compatible with any domain-general theory of language, such as cognitive linguistics or the so-called sequential cognition of language (Dominey, Hoen, Blanc, & Lelekov-Boissard, 2003). Dominey et al. (2003) found that two predictions based on sequential cognition were evidenced by data from psycholinguistic experiments. First, degree of syntactic processing impairments (agrammatical aphasia) was found to be correlated with impairments of the corresponding non-linguistic cognitive sequencing tasks. Second, similar neurophysiological processes were found for both linguistic syntactic processing and non-linguistic cognitive sequencing tasks.

One limitation of the present study was that correlations found between adult and child production could be due to the way the data were collected. Both adult and child speech were collected in same tape recordings under the same context. This could be a confound for testing the similarity between input and child production. As Valian (1986) and Theakston et al. (2001) have both pointed out, discourse similarity could be a potential factor for the similarity found between adult and child. One possibility is that sharing the same discourse is crucial for language acquisition, and the similarity of the distributional regularity of linguistic forms is a by-product of the sharing of discourse. Another possibility is that the young infants are born with sensitive faculties that are good at sensing the distributional regularity, rather than sharing discourse context with adults. In both cases, the theory of innate grammar for syntactic acquisition is not supported.

References


Appendix

Table 2:: The list of frequent verbs (MacWhinney, 2000)

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<tr>
<th>bite</th>
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<th>buy</th>
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<th>catch</th>
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