# Simple Sentences Aren't All the Same: Variation in Input and Acquisition

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## 1. Introduction

Since the early nineties, with the groundbreaking research of Huttenlocher et al. (1991) and Hart and Risley (1995), it has been clear that vocabulary growth in children is related to the amount of talk that parents direct to their toddlers. Subsequent research has refined this general finding, showing that vocabulary diversity in input, not just the amount of talk, is an active ingredient in promoting vocabulary growth (Hoff & Naigles, 2002; Hsu, Hadley & Rispoli, 2017; Rowe, 2012).

Several new findings point to the facilitative effect of lexical diversity in acquiring grammar. An experimental study by Krok (2017) reports that children who were inconsistent in their production of auxiliary *is* showed increases in production of the auxiliary in experimental conditions of high verb diversity but not in conditions of low verb diversity. In a clinician-implemented treatment study, Plante et al. (2014) have reported that children with specific language impairment improved their production of target morphemes when those morphemes were presented in a high verb diversity condition as opposed to a low verb diversity condition. In a parent implemented intervention, Hadley et al. (2017) and Hadley, Rispoli and Holt (2017) have found that parent subject diversity predicted their children's subsequent sentence diversity and production of tense / agreement marking. The findings of Hadley and colleagues raise the question of whether subject diversity alone, to the exclusion of verb diversity, is facilitative of subsequent sentence diversity. This is the main motivation for the current study. In the current research we ask the following research question: *Do children benefit from parent input with structurally-specific lexical diversity within the simple clause*?

The research approach was observational. Parent input to children who were homogenous in their production abilities was sampled, thus controlling for individual child differences in syntactic production at the point at which input was assessed. The children included in the study produced some word combinations at the time input was sampled, but all had a mean length of utterance (MLU) ≤ 1.25 at 1;9, putting them below the mean for their age (Miller & Chapman, 1981).

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Without this important control, unanticipated bi-directional effects originating with the children's own sentences might mask real input-outcome relationships. The outcome variable, sentence diversity, was assessed 9 months later at 2;6, giving sufficient time for differences between children to appear.

## 2. Method

This study used archival, longitudinal data from the DeKalb (Rispoli, Hadley, & Holt, 2009) and Champaign corpora (Hadley, Rispoli, Holt, Fitzgerald, & Bahnsen, 2014). One-hour language samples of the children interacting with their parents in a lab-playroom were collected every 3 months from 1;9 to 2;9 (DeKalb) or 3;0 (Champaign). The earliest data point, 1;9, was chosen for the measures of parent input and children's initial vocabulary abilities. The 2;6 data point was chosen as the outcome sample because this data point maximized the number of child participants, as several families discontinued participation at later time points.

Parent input measures were based on 30 minutes of parent-child interaction in both corpora. Parents produced an average of 396 utterances (*SD* = 137) in 30 minutes. Child measures were based on one hour of sampling drawn from 60-min of parent-child interaction in the DeKalb corpora and 30-min of parent-child interaction and 30-min of semi-structured examiner-child play in the Champaign corpora. Children produced an average of 223 utterances (*SD* = 98) at 1;9 and an average of 368 utterances (*SD* = 116) at 2;6.

Child participants were selected on two criteria: 1;9 syntactic development and 2;6 vocabulary development. The syntax criterion increased the homogeneity of the children when input was sampled. At 1;9 all children had an MLU $\leq 1.25$. At this MLU level, children were not producing SV structures or tense, agreement, and aspect morphology. The vocabulary criterion ensured that children were developing typically. Parents in both cohorts filled out the *MacArthur-Bates Communicative Development Inventory* (CDI; Fenson, et al. 2007). To be included, children's total vocabulary score had to be at or above the $10^{th}$ percentile on the CDI per parent report.

This study focused on two primary measures of sentence diversity: child sentence diversity at 2;6, and parent sentence diversity at 1;9. We hypothesized that parent input sentence diversity at 1;9 would predict variation in child sentence diversity at 2;6. To test this hypothesis, a hierarchical multiple regression was conducted with child sentence diversity as the dependent variable. The independent variable was parent sentence diversity at 1;9. There were six control variables: parent subject diversity, parent verb diversity, parent NDW and child NDW at 1;9 and child MLU and child NDW at 2;6.

The sentence diversity measures were operationalized as the number of unique subject + verb combinations produced in active, declarative sentences. Sentences were required to have overt subjects and a main verb. Subjects were pronouns or the head noun of a subject noun phrase. Existential *there* and *here,* used with the copula, were included. Differences in the number of the head noun (i.e., singular vs. plural) did not constitute a difference in subject. Similarly, different tense, aspect, or agreement inflections did not constitute a difference in the main verb. Each unique subject + verb combination was counted only once. Repetitions of the same combination of subject + verb were not counted.

For example, consider a child aged 2;6 who produced the five sentences in (1). The subject diversity is 2: *I, he*. The verb diversity is also 2: *want, need*. The sentence diversity is 3: *I want, I need, He need*. Note that despite differences in verb complement, (e.g. *I want the tiger, I want blow bubble*), the combination *I want* is only counted once. Note also that, despite the inflectional difference between *he needs* and *he need*, the combination *he need* is only counted once.

(1) Sentence diversity = 3, subject diversity = 2, verb diversity = 2.

| | |
|---|---|
| I want the tiger. | He needs take his clothes off. |
| I want blow bubble. | He need boots. |
| I need my plate. | |

To capture more general linguistic differences between the children at 2;6, the children's MLU and NDW were also measured. These two control measures ensured that the outcome measure of child sentence diversity was not merely a by-product of the child's general syntactic ability or vocabulary size. Because input effects for vocabulary are well documented, a control measure of parent vocabulary, parent NDW at 1;9, was also obtained. Lastly, the child NDW at 1;9 was also measured. Although children's MLUs were restricted (i.e., ≤ 1.25), their vocabulary was free to vary. The inclusion of child NDW at 1;9 allowed us to control for between-child differences in vocabulary size and sort out the potential for bidirectional effects of child vocabulary diversity on parent NDW at 1;9. Note that child and parent NDW at 1;9 were based on the same 30 minutes of conversation.

The hierarchical regression was designed to isolate the unique predictive relationship between parent sentence diversity at 1;9 with child sentence diversity at 2;6. Independent variables were entered in two blocks. Parent input sentence diversity at 1;9 was entered first in stepwise fashion, $p < .05$. This means that parent sentence diversity could not enter without a significant zero order correlation to the dependent variable. All control variables were then forced to enter in the second block. The two-block design in this ordering ensured that parent sentence diversity at 1;9 would remain a significant predictor only if it had a robust relationship with child sentence diversity at 2;6 even after all other control variables were taken into account. Inspection of the semi-partial correlations in the final model was used to determine the size of the contribution of all significant independent variables.

# 3. Results
## 3.1. Statistical Analyses

Let us first review the descriptive statistics for the parent and child variables.

**Table 1. Descriptive Statistics**

| Variable Type | Dyad Member | Variable Name | Range | *M* | *SD* |
|---|---|---|---|---|---|
| | | | | | |
| Control | Parent | NDW 1;9 | 163-370 | 254 | 49 |
| Control | | Subject Diversity 1;9 | 7-25 | 15 | 4 |
| Control | | Verb Diversity 1;9 | 9-38 | 23 | 6 |
| Independent Variable | | Sentence Diversity 1;9 | 18-80 | 42 | 14 |
| Control | Child | NDW 1;9 | 7-57 | 25 | 12 |
| Control | | MLU 2;6 | 1.71-3.66 | 2.65 | .47 |
| Control | | NDW 2;6 | 49-219 | 129 | 32 |
| Dependent Variable | | | | | |
| Outcome | | Sentence Diversity 2;6 | 7-67 | 37 | 15 |

As can be seen in Table 1, parents varied in the structurally specific measures of lexical diversity. Subject diversity was lower than verb diversity: subject diversity (*M* = 15, *SD* = 4) and verb diversity (*M* = 23, *SD* = 6). Importantly, they varied in the independent variable of interest, parent sentence diversity at 2;6. The number of unique subject + verb combinations in active, declarative sentences ranged from 18 to 80 (*M* = 42, *SD* = 14). In essence, lower scores on these structurally specific measures of lexical diversity meant that parents produced high frequency pronouns in the subject position and high frequency main verbs that generally lacked semantic specificity (e.g., *you did it*). Higher diversity measures meant that parents were producing more common nouns as subjects (which on the whole are of lower frequency than pronouns) and lower frequency main verbs that had greater semantic specificity.

Recall that children at 1;9 had an MLU of ≤ 1.25. Nevertheless, at 1;9, considerable between-child variation was apparent in children's NDW, ranging from 7 to 57 (*M* = 25, *SD* = 12). The between-child differences in NDW increased at 2;6. Child NDW at 2;6 ranged from 49 to 219 (*M* = 129, *SD* = 32). There were considerable between-child differences in structurally specific lexical diversity at 2;6 as well. Child sentence diversity at 2;6 exhibited a large range of values across children. It ranged from 7 to 67 (*M* = 37, *SD* = 15). Thus, as expected, the between-child differences in the dependent variable showed ample variation, making it possible to investigate its predictors through regression analysis. The components of sentence diversity, subject and verb diversity, are not reported in Table 1, as they are not part of the regression analysis. They followed a pattern similar to that seen in parent input, with subject diversity lower than verb diversity. The child subject diversity at 2;6 ranged from 4 to 22 (*M* = 12, *SD* = 4). As with adults, children with the least subject diversity were limited to pronominal subjects and children with the greatest subject diversity produced inanimate common nouns as subjects. Child verb diversity at 2;6 ranged from 5 to 36 ($M$ = 22, $SD$ = 7). Mirroring adults, the greater the verb diversity, the lower the frequency and greater semantic specificity of the verbs produced.

Zero-order correlations between all independent variables and the dependent variable were calculated and inspected prior to performing the planned hierarchical regression analysis. A Bonferroni correction for six correlations resulted in an adjusted alpha of $p$ = .05/6 = .008. Only two correlations were significant. The relationship of interest, parent sentence diversity at 1;9 with child sentence diversity at 2;6 was significant, $r$ (27) = .532, $p < .003$. In addition, child NDW at 2;6 was significantly related to the dependent variable, $r$ (27) = .551, $p <$ .002. These two significant relationships are graphically displayed in Figures 1 and 2.

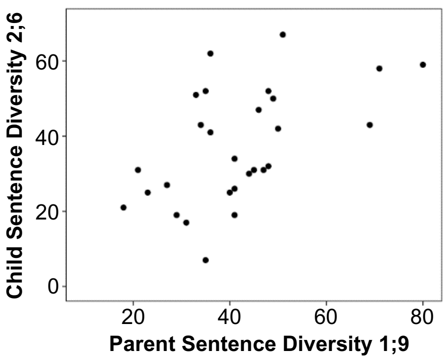


**Figure 1. Child Sentence Diversity 2;6 by Parent Sentence Diversity 1;9**

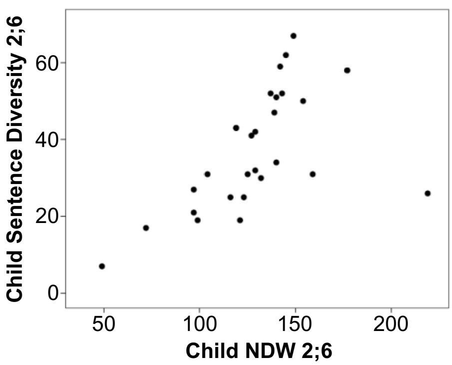


**Figure 2. Child Sentence Diversity 2;6 by Child NDW 2;6**

Perhaps of greater importance is that the two independent variables significantly related to child sentence diversity at 2;6 were not related to one another. The zero-order correlation of parent sentence diversity at 1;9 and child NDW at 2;6 was not significant, $r = .340$, $p = .077$.

Hierarchical regression was conducted to test the main hypothesis that parent sentence diversity at 1;9 accounted for a significant portion of the unique variance in child sentence diversity at 2;6. The independent variable of interest, parent sentence diversity at 1;9 entered in the first block ($p$ to enter < .05), The regression at step 1 was significant, $R^2 = .290$, $F_{(1, 26)} = 10.6$, $p < .003$ (see Table 2).

All six control variables were forced to enter in the second block. The overall model at step 2 was significant, $F_{(7, 20)} = 3.734$, $p = .010$. The addition of the control variables increased the amount of variation in child sentence diversity accounted for, $R^2 = .567$, but the change in the model was not significant, $F\Delta_{(6, 20)} = 2.128$, $p = .095$.

**Table 2. Regression Summary**

| Model | Variables | $R^2$ | $F$ | $P$ | $F\Delta$ | $P$ |
|---|---|---|---|---|---|---|
| Block 1 | Parent Sentence Diversity 1;9 | .290 | 10.67 | .003 | | |
| Block 2 | Control Variables | .567 | 3.734 | .010 | 2.128 | .095 |
| Variables in Final Model | | Correlations | | | | |
| | | zero | partial | part | $t$ | $p$ |
| | Parent Sentence Diversity1;9 | .538 | .458 | .339 | 2.304 | .032 |
| | Child NDW 2;6 | .556 | .471 | .352 | 2.388 | .027 |

An analysis of the semi-partial correlations revealed only two independent variables uniquely accounted for significant portions of the variation in child sentence diversity at 2;6. The two variables were parent sentence diversity at 1;9 and child NDW at 2;6. The semi-partial correlation of parent sentence diversity at 1;9 and child NDW at 2;6 with child sentence diversity at 2;6 were $r = .339$, $t = 2.304$, $p = .032$, and $r = .352$, $t = 2.388$, $p = .027$, respectively. These semi-partial correlations indicate that prior parent input and concurrent child vocabulary accounted for 11% and 12% of the unique variance in child sentence diversity at 2;6, respectively.

To recapitulate, parent sentence diversity at 1;9 predicted a significant portion of the variation in child sentence diversity at 2;6. The contribution of parent sentence diversity at 1;9 was approximately equal to the contribution made by child NDW at 2;6, and large enough to be detected even after the contribution of all other control variables had been taken into account.

### 3.2. Case Examples

To illustrate the role of parent input, beyond the contribution of children's concurrent lexical diversity, we present data from two cases. The two cases were selected because of mismatches in the relationship between child NDW at 2;6 and child sentence diversity at 2;6. The largest over-estimation of child sentence diversity based on NDW was found for Child 1. This child had an NDW at 2;6 of 159, which represents a z-score of .96. Despite an NDW nearly one full standard deviation above the mean, Child 1's sentence diversity was 31. This represents a z-score of –.40. In the opposite direction, the largest underestimation of child sentence diversity was found for Child 2. This child had an NDW at 2;6 of 119, representing a z-score of -.30. Despite Child 2's NDW in the low average range, his sentence diversity at 2;6 was 43, representing a z-score of +.37. The sentence diversity of both children is listed in the Appendix.

Parent sentence diversity exhibited a similar difference, albeit more exaggerated. The parent of Child 1 produced 12 different subjects and nine different verbs, giving rise to a sentence diversity score of 20, corresponding to a z-score of -1.45. In contrast, the parent of Child 2 produced 25 different subjects and 30 different verbs giving rise to a sentence diversity of 69, or a z-score of 1.9. In other words, the parent of Child 2 had a sentence diversity score about three times greater than the sentence diversity score of the parent of Child 1. The data from these parents provide an explanation for why parent sentence diversity explains a portion of the variance in children's sentence diversity above and beyond children's concurrent NDW. Parent sentence diversity for both dyads is also displayed in the Appendix.

The differences in the parents' sentence diversity brought with them noticeable differences in the semantic composition of the input sentences. The parent of Child 1's subjects were limited to pronominal and proper noun subjects, whereas the parent of Child 2 produced six inanimate, common noun subjects: *bubble*, *bun*, *stovetop*, *mustard*, *mud,* and *tractor*. The predicates formed by the parent of Child 1 were mainly states (e.g. *he doesn't fit*) and occasionally achievements (e.g. *she fell out again*). In contrast, the parent of Child 2 complemented her extended array of subjects with a large variety of predicates, including states (e.g. *the bunny has a carrot*), processes (e.g., *they get dirty in the mud*), and accomplishments, which included both entailments of causation and result (e.g. *your bear knocked over the ball*). In sum, the difference in sentence diversity between these two parents corresponded to a difference in the type and complexity of subject + predicate combinations they used while conversing with their children.

## 4. Discussion

Our analyses indicate that there was in our sample a specific input-outcome relationship between parent sentence diversity and child sentence diversity. The relationship did not reduce to the input-outcome relationship that is known to exist for vocabulary. Rather, the input-outcome relationship was found in the lexical diversity localized to a specific structure, that of the simple sentence. The lexical diversity displayed by parents in the subject and main verb positions when the children were 1;9, gave rise to the diversity of unique combinations of subject + verb produced by the parents. This input sentence diversity was reflected in between-child differences in child sentence diversity nine months later at 2;6. The input-outcome relationship of sentence diversity was detectable even after the general vocabulary diversity of both parent and child were taken into account.

Children's lexical diversity within a syntactic structure has been argued to be an indicator of the acquisition of that structure (Pine, Freudenthal, Krajewski & Gobet, 2013; Valian, Solt & Stewart, 2009; Yang, 2013). The greater the child's lexical flexibility within a structure, the stronger the evidence that the structure itself is abstract. That is, the structure exists independently of specific lexical items. Recall that child sentence diversity at 2;6 ranged substantially. The child with the lowest sentence diversity produced seven unique combinations of subject and verb, a rate of one new sentence every ten minutes. The average number of unique sentences produced was 37, approximately one uniquely different sentence every two minutes. Six of the children produced 52 or more unique subject + verb combinations, representing a new combination of subject and verb almost every minute. These children produced new sentence combinations at a rate ten times faster than the child with the lowest productivity. We think it plausible that such children could be said to have an abstract subject + predicate relationship in their syntax. At very least, it can be said that children with such high sentence diversity appeared to be more adept at integrating their lexicon into the subject + predicate relationship in real time than children with very low diversity.

The syntactic structure that combines subject to main verb is the structure of predication itself. This structure is coupled with a semantic reading that is quite minimal. It is an "aboutness" relation. The predicate conveys something about the subject: a property, an attachment to a state, or an engagement in a process (Bowers, 1993; Chierchia, 1985). Input sentence diversity could help the acquisition of the structure of predication through transitional probabilities, which have been argued to be a cue to constituent structure (Thompson & Newport, 2007). High sentence diversity would imply low transitional probabilities between the subject and the predicate. Sentence diversity could also increase cross-sentential cues that have been argued to provide evidence for syntactic structure in input (Hoff-Ginsberg, 1985; Morgan, Meier & Newport, 1989). High subject diversity, in particular, could potentially increase the cross-over of nouns and pronouns which typically appear in verb complement positions, to the subject position, thus providing stronger evidence for a discrete subject constituent. If either or both of these explanations were true, then input sentence diversity would aid the division of the subject and the predicate into different constituents.

We should also consider why such a fundamental syntactic structure would need anything more than the most minimal environmental trigger. One consideration is in the hidden complexity of the specifier-subject + verb-head combination. This complexity has been of the focus of what has been called Lsyntax (Hale & Keyser, 2002) or first phase syntax (Ramchand, 2008). Ramchand has argued that a simple clause may contain as many as three verb heads, corresponding to the complex event structure of causal initiation, process, and resultant state. In English, a single verb may merge two heads and, with the aid of a particle or small clause, encode a result, as in *I squished the dough ball flat*. The subject of these simple sentences depends on this first phase of syntactic derivation. Despite universal constraints, there is still considerable variation across languages in allowable patterns of head merging. What English accomplishes with verb particles and zero derivation, another language will accomplish with verb inflection and light verbs. Recall that in our case examples, Parents 1 and 2 did not only differ in the diversity of their sentences; mono-clausal predicate complexity differentiated them as well. The input-outcome relation we observed may be pointing to a different role for input sentence diversity. Input must provide the learner with evidence for the syntactic devices that encode cause, process and result.

Once these syntactic devices have been mapped out, there remains variation at the lexical level within a given language (Pinker, 1989). For example, English has a great many verbs that alternate between transitive and intransitive (e.g., the *water poured into the sink; I poured the water into the sink*). Nevertheless, some highly frequent transitive verbs that have causal initiation and result components do not alternate (e.g., *I dragged the trash to the dumpster*; ** the trash dragged to the dumpster*). Many de-adjectival verbs alternate (e.g. *The people cleared out of the room*; *The police cleared the people out of the room*). Nonetheless, not all de-adjectival verbs alternate (e.g., *I dirtied my shirt, *My shirt dirtied*). Without sentence diversity in the input, the learner cannot know how likely an alternation might be.

Our study underscores the message that simple sentences are not all the same. All mono-clausal sentences fit a fundamental pattern of subject + predicate that has little semantic content other than a general aboutness relationship. Input sentence diversity may facilitate the acquisition of this structure through the mechanisms of statistical learning and cross-sentential cues. At the same time, however, linguistic inquiry has revealed new levels of complexity within a single clause, and input sentence diversity may serve to demonstrate to the learner how surface structure maps to this complexity.

## 5. Conclusion

This study was an initial attempt to understand the role of input in the acquisition of basic clause structure. The input-outcome relationship documented here points to a greater role for lexical diversity in the acquisition of syntax. Importantly, however, the lexical diversity must be structurally specific. We are left asking more questions than we have answered about the exact mechanisms through which input sentence diversity helps to build knowledge of basic clause structure in the learner. However, we are convinced that exploring the role of input for this fundamental syntactic structure has the potential to help children with the transition from the one-word stage to syntax. We hope that the research reported here will orient other researchers in the field of developmental psycholinguistics to examine input-outcome relationships that bear on the acquisition and development of simple sentences.

**Appendix**

Child 1: NDW = 159, MLU = 2.76, Subjects = 11, Verbs = 16, NDS = 31

| subject | verb | subject | verb | subject | verb |
|---|---|---|---|---|---|
| I | do | you | have | he | be |
| I | eat | Cname | get | he | fall |
| I | get | baby | go | he | fit |
| I | have | mommy | have | he | get |
| I | know | mommy | want | he | have |
| I | like | people | take | he | look |
| I | love | potato(head) | fall | it | be |
| I | pop | | | it | fit |
| I | sing | | | it | pop |
| I | take | | | that | be |
| I | want | | | that | look |
| | | | | this | be |
| | | | | this | go |

Parent 1: NDW 197, MLU 2.48, Subjects = 12, Verbs = 9, NDS = 20

| Subject | verb | subject | verb | subject | verb |
|---|---|---|---|---|---|
| I | have | Bigbird | go | it | be |
| I | think | Ernie | fall | that | be |
| you | be | he | be | that | go |
| you | do | he | fit | they | be |
| you | get | he | go | they | go |
| you | put | she | fall | this | be |
| | | here | be | those | be |

Child 2: NDW = 119, MLU = 3.66, Subjects = 16, Verbs = 22, NDS = 43

| subject | verb | subject | verb | subject | verb |
|---|---|---|---|---|---|
| I | be | you | go | here | be |
| I | cut | we | have | it | be |
| I | get | baby | go | that | be |
| I | have | pooh | see | that | have |
| I | jump | he | be | that | make |
| I | make | he | eat | these | be |
| I | play | he | get | these | work |
| I | put | he | go | this | be |
| I | ride | he | have | hat | blow |
| I | see | he | need | shampoo | be |
| I | turn | he | say | twister | come |
| I | want | he | see | wind | blow |
| I | warm | he | talk | | |
| I | wash | he | want | | |
| | | she | be | | |
| | | she | see | | |
| | | she | want | | |

Parent 2: NDW 335, MLU 3.30, Subjects = 25, Verbs = 30, NDS = 69

| subject | verb | subject | verb | subject | verb |
|---|---|---|---|---|---|
| I | build | he | drive | here | be |
| I | find | he | feed | it | be |
| I | go | she | be | it | break |
| I | have | she | cry | it | come |
| I | put | she | have | it | fall |
| I | scoot | she | say | it | get |
| I | see | Oname | work | it | go |
| I | think | bear | knock | one | be |
| you | be | bunny | have | one | have |
| you | fall | cow | eat | that | be |
| you | find | cow | fall | that | look |
| you | get | cow | say | there | be |
| you | have | horse | go | they | be |
| you | knock | horse | say | they | fall |
| you | make | pig | like | they | get |
| you | twirl | | | they | go |
| you | use | | | they | have |
| we | close | | | they | love |
| we | feed | | | this | be |
| we | go | | | this | look |
| we | have | | | those | be |
| we | knock | | | bubble | go |
| we | open | | | bubble | pop |
| we | pretend | | | bun | be |
| we | put | | | mud | be |
| | | | | mud | make |
| | | | | mustard | be |
| | | | | stovetop | be |
| | | | | tractor | come |

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