

Network Connectivity in Early and Late Talkers

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Introduction

Children seem to learn words that add to the connectivity of their word network. Hills et al. looked at various models of word learning and found that models that included this way of learning were able to predict age of acquisition for early word learners. In addition, these models showed the order of acquisition for words for children up to 30 months. (Hills et al.)

Beckage et al. studied networks for Late and Average talkers and found that Late talkers take longer to develop the small world model (clusters are highly interconnected), indicating a preference for “oddball” words. It appears that the words they learn do not necessarily add to the connectivity of their networks, rather they do the opposite and create “islands” in their network.

Late talkers frequently have persistence in being behind. This extends to a risk of being behind when they enter school. Their language skills are also related to other developmental problems (eg. the development of social skills) starting at a young age. (Desmarais et al.)

We are looking at Early and Late talkers in order to see the differences in their networks and connectivity. Early talkers are ahead of the average of their age, and looking at their networks allows us to have a clear difference between them and the Late talkers. Our networks are built of noun and verbs pairs that are the result of adult connections of the words (the words appear in the same environment, see Methods for details on how these were determined).

We predicted that Late talkers would have less connected networks than Early talkers for the same vocabulary size. Also, we expected to see differences in the composition of the vocabularies (differences in how many nouns and verbs children know for a given vocabulary size).

Methods

Definitions

- Count: the number of something (eg. Nouns) in the network
- Degree: the number of edges (connections) that a node (word) is a part of
- Distance: shortest path between two nodes (smallest number of edges that can connect to make a path between the two nodes) (Borge-Holthoefer & Arenas)

Materials

MacArthur-Bates Communicative Development Inventory (MCDI) from 27 Early talkers (top 25% on the MCDI) and 27 Late talkers (bottom 25% on the MCDI). They were vocabulary-size matched across the two groups, with vocabulary sizes between 120 and 350 words (mean word count 239.0870 for Early talkers and 239.6087 for Late talkers).

Procedure

Maouene, Laakso and Smith collected adult free-response to a random order of MCDI transitive verbs (ones more than 50% of 30 month-olds know). Participants were asked to give the first object that came to mind as their response to the verb. We took these responses and found the subset of them that were MCDI nouns. We then combined the counts of responses for singular and plural forms of the word (eg. foot and feet). These responses were put into a matrix with the counts of the number of times adults associated a particular noun with a particular verb.

Each child had a matrix created that was a subset of the initial MCDI matrix, based on the words the child knows. We then wrote a program using JUNG for Java (O'Madadhain et al.) that will take these matrices and creates a graph (Figure 1) of the child's connections as well as output relevant statistics (noun, verb, edges, and singleton counts and average noun degree, average verb degree and average distance).

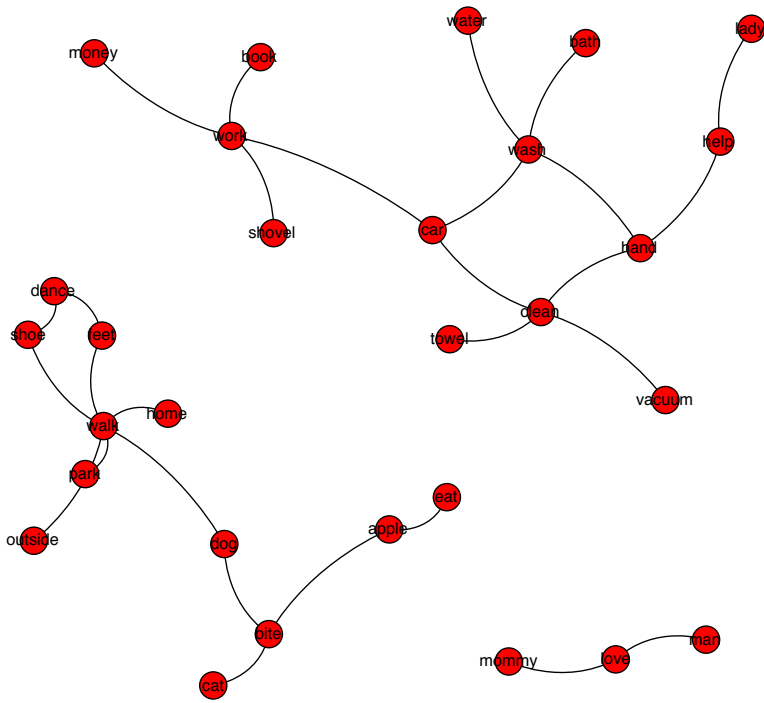


Figure 1.A: Early Talker

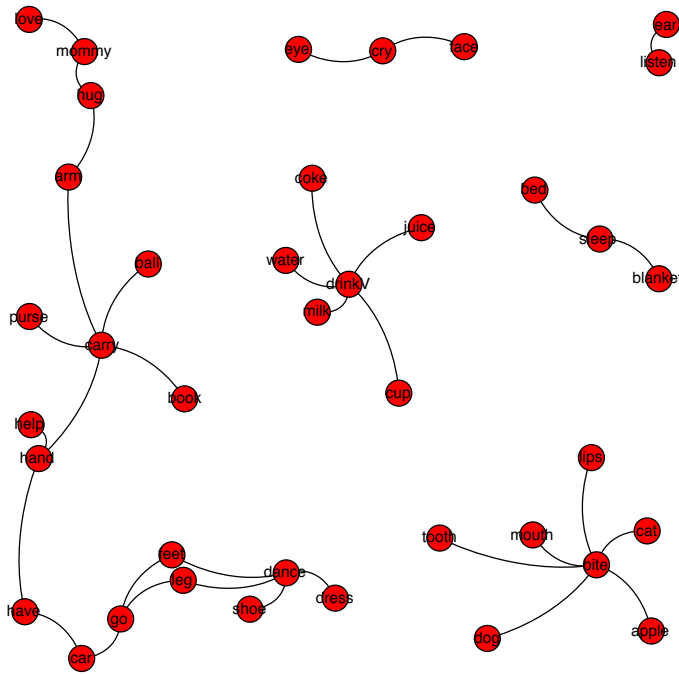


Figure 1.B: Late Talker

Figure 1: Early and Late talkers vocabulary matched (~150 words)

We then averaged each of these values across the Early and Late talker groups and ran a mixed ANOVA.

Results

There is a moderately significant difference between Nouns and Verbs is greater for Late talkers than for Early talkers (43.797325 for Early talkers and 51.866763 for Late talkers) (Figure 2).

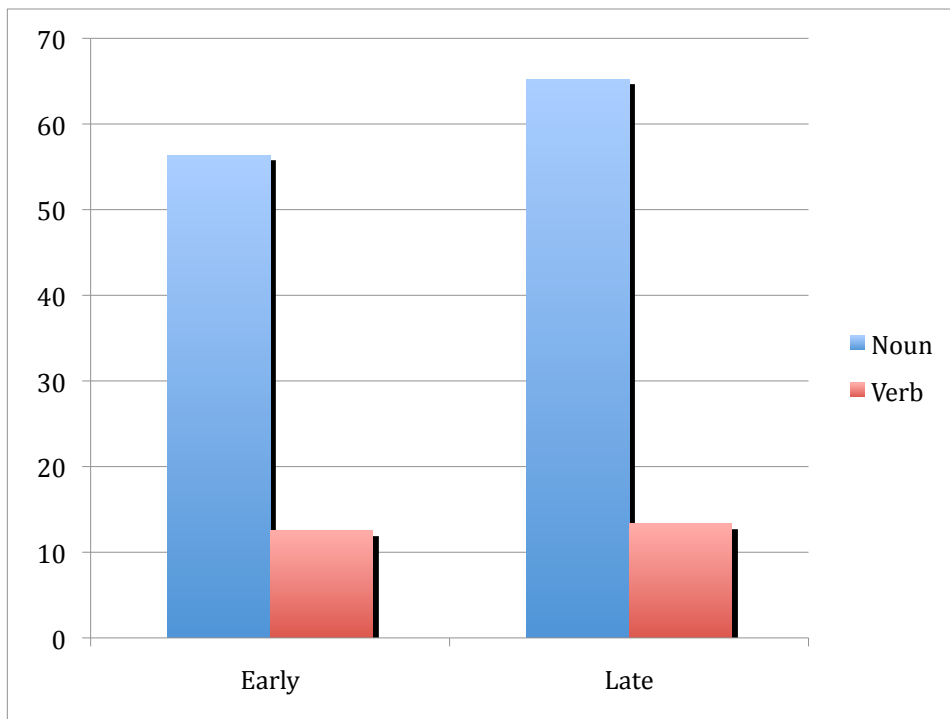


Figure 2: Noun and Verb by Language Group ($F(1, 43) = 3.824, p = 0.057$)

The difference between count and degree for Early and Late talkers is also different. Late talkers have a greater difference than Early talkers between these two measures (64.439669 for Early talkers and 73.8152811 for Late talkers) (Figure 3).

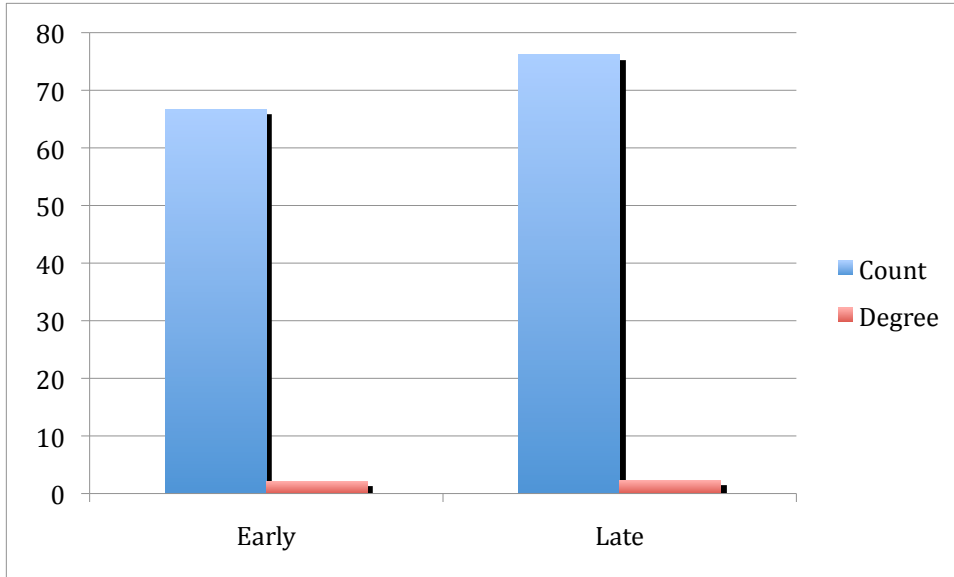


Figure 3: Count and Degree by Language Group ($F(1, 43) = 3.724, p = 0.060$)

There's always a bigger difference between Nouns and Verbs for Late talkers (for both count and degree) than for Early talkers, but the direction of the difference is opposite for count and degree (Figure 4).

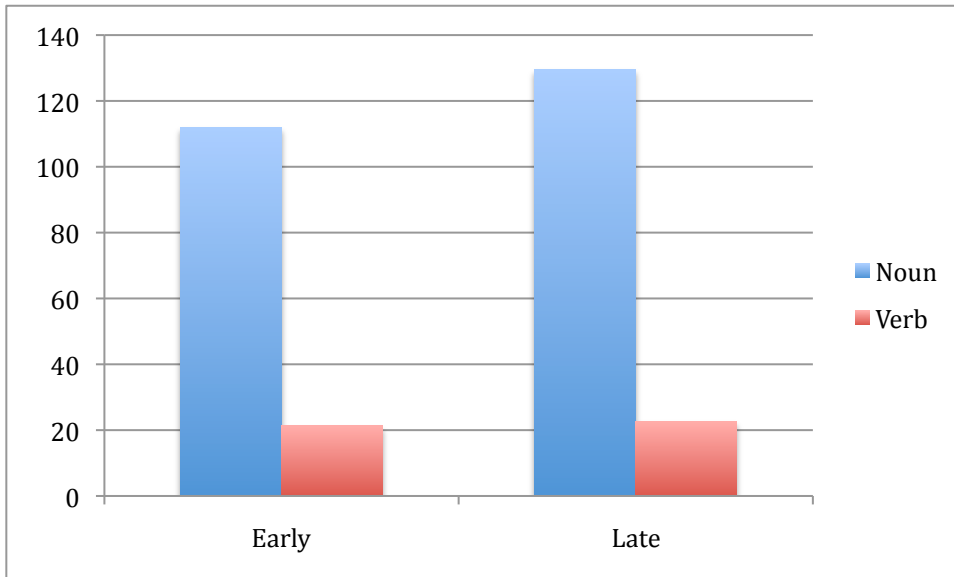


Figure 4.A: Count

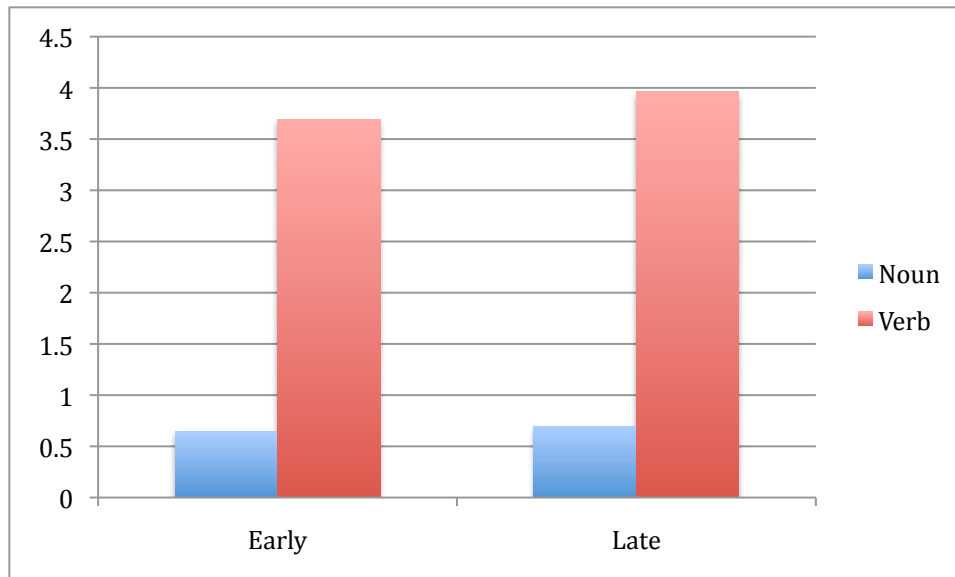


Figure 4.B: Degree

Figure 4: Noun and Verb Count and Degree in Early and Late Talkers ($F(1, 43) = 4.064, p = 0.050$)

Discussion

Based on the differences between Nouns and Verbs for Early and Late talkers, as well as the difference between these in both Count and Degree across the two groups indicates that Early talkers have a relatively more balanced vocabulary. Late talkers seem to have fewer non-noun-and-verb words, exemplified by the higher difference between Nouns and Verbs for this group versus the Early talkers. Early talkers learn other words that make up the remainder of their vocabulary, since the vocabulary size is matched across the two groups. Because Early talkers are learning other words, they may be better able to learn more words to continue to grow their networks. Having the knowledge about adjectives, for example, would allow them to narrow down the options of objects that could be being named by a new word, because they can find only objects that have the characteristic described by an included adjective. In addition, they may be learning more social words (eg. "Hi") which could help them when they are developing social skills (an issue for many Late talkers).

The larger difference between Count and Degree for Late talkers than for Early talkers shows that Late talkers have more nouns and verbs, but a similar connectivity (as measured by Degree). This is not what we originally hypothesized, and this shows that the differences in the networks are due to the differences in the Count, not the differences in connectivity as we anticipated. This shows that Late talkers are able to understand relationships between nouns and verbs, but they do not learn the other words that could help them build a more balanced vocabulary (as discussed above).

Based on this, we suspect that there is another measure that we have not yet looked at that can show the differences between Early and Late talkers. When looking at the images of the networks, we see that there seem to be differences in the shape and number of clusters found in the networks (see Figure 1 for an example). This appeared in many of the images we looked at, when comparing children with equally sized vocabularies. None of the measures that we have initially looked at quantify this difference. Due to this, in the future we will be looking at various measures of the individual clusters in the networks of the children. These will include average diameter (the longest distance in the cluster) across the clusters within a network as well as possibly a cluster count. These measures will allow us to quantify the differences we see and determine whether they are significant or just a result of the human nature to find patterns.

References

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