Vocabulary Trajectories of Late Talking Toddlers

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Vocabulary Trajectories of Late Talking Toddlers

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Undergraduate Honors Thesis

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Introduction

Word learning is an aspect of childhood development that is highly variable among different children; some children acquire words more quickly while other children acquire words more slowly. For example, an 18-month-old girl who is in the 5th percentile for language growth knows about 17 words, whereas an 18-month-old girl who is in the 99th percentile knows about 471 words (Fenson et al, 2000). Children who are slower at developing language can be at a disadvantage to their typically developing peers if they have persistent language problems when they are older. Therefore, it is important to specifically target late talking toddlers who are less likely to catch up to their peers so early interventions can be implemented. Currently, there are no methods to differentiate between late talkers who are likely to catch up to their peers and late talkers who are likely to remain behind their peers. This is because the number of words that a child knows when they are a toddler is not indicative of persistent language problems. However, the types of words that a toddler knows may be more indicative of future language problems. The present study seeks to answer two questions: In general, do late talkers know different types of words than their peers and do late talkers who catch up their peers know different words than late talkers who do not catch up?

Late Talkers

In the literature, late talkers are defined as toddlers with language delays who have no known underlying causes for their language delay, such as a hearing deficit (Desmaris et al, 2008). There are several factors that have been associated with late talkers but none of these factors are predictive of whether an individual child will be a late talker or will have persistent language delays in the future. Examples of familial influences that are associated with language
delays are parental stress, low socioeconomic status, and low level of parental education (Desmaris et al, 2008). One explanation for these findings is that parents in these populations are less available to their child and less likely to provide an environment that facilitates their language acquisition (Desmaris et al, 2008). Since children from these already vulnerable populations are at an increased risk of becoming late talkers it is especially important to provide early interventions because increasing their word learning could help improve other aspects of their development.

One aspect of development that has been closely associated with language delays is the development of social skills. A study by Horwitz et al (2003) found that late talking toddlers had significantly lower scores than their typically developing peers on standardized socialization scales. One explanation for this finding is that toddlers who develop language more slowly are less likely to be motivated to socialize with their peers, which in turn reduces their desire to better hone their language skills (Paul, 1991). This cycle puts late talking toddlers at a significant disadvantage to their peers because as they grow older the effect can snowball and late talkers may lag further and further behind their peers in both their social and language skills. A child’s language trajectory can have an impact on other aspects of their development so it is important find measures that can differentiate between late talking toddlers who are likely to have future language delays and those who will not.

**Word Learning**

In order to understand why late talkers and early talkers may have vocabularies that are structured differently, it is beneficial to understand how children learn words. One pattern of word learning that exists is a bias, which helps children categorize new objects. Biases allow
children to easily learn new words because they enable children to extend the name of an object based on its characteristics (Smith 2002). Two well documented biases in the literature are the shape bias and the material bias. The shape bias is used to learn new names for solid, concrete objects based on their shape. For example, with the help of a shape bias a child will know that the word “spoon” refers to all spoon-shaped objects regardless of their color or material. The material bias is used to learn new names for non-solid, non-concrete substances based on material. For example, with the help of the material bias children know that the word “jello” refers to the material and not the color or shape of jello.

One way to study biases in the laboratory is through a novel noun generalization task. The novel noun generalization task is a laboratory experiment in which a child is shown a novel object with a novel name (such as “dax”). After that, the child is shown other novel objects that match the original object in one characteristic, such as shape or material. The child is then asked which one of the novel objects is also a dax. If the child chooses the objects that match the original object in shape then they are said to show a shape bias and if they choose the objects that match in material then they are said to show a material bias (Gershkoff-Stowe and Smith, 2004).

It is proposed that there is an association between a child’s biases and their vocabularies (Samuelson, Smith, 1999). One reason for this suggestion is that there exist differences between the development of the shape bias and the material bias. Typically developing children acquire the shape bias before the material bias. Also, the majority of the first 300 nouns that children learn tend to be for solid objects organized by shape (Samuelson, 1999). Since typically developing children acquire the shape bias before the material bias and since the majority of the first words they learn are shape based, this suggests that there is a link between a child’s biases and the types of words that they know. There is much debate about whether the shape bias
causes children to learn the names of more solid objects or whether learning the names of solid objects causes children to develop a shape bias. However, it is known that this process acts as a feedback loop; the more names for solid objects a child learns, the stronger the shape bias becomes and vice-versa (Gershkoff-Stowe and Smith, 2004).

Late talkers and word learning biases

If biases are related to vocabularies then a child who does not show the correct biases might show different patterns in the types of words that they know. Previous studies have shown that late talking children between 2-3 years of age do not demonstrate shape biases in extending names to solid objects and they actually show a stronger material bias than typically developing children in their age group (Jones 2003). A stronger material bias may hinder early word learning because it could cause children to attend to incorrect characteristics when categorizing objects and extending the names of known objects to novel objects. There are several explanations for why some children develop a stronger material bias: one explanation is that late talkers perceive objects differently than other children and another explanation is that the first nouns that these children learn tend to be for more material based words rather than shape based words (Jones, 2003). Since late talkers do not attend to the correct characteristics when categorizing objects, the question is if their vocabularies reflect their biases.

It would be expected that children with smaller vocabularies would know different words than their peers because they are more likely to demonstrate different word learning biases. For example, a typically developing toddler with a robust shape bias should be more likely to know more names of solid, shape based words because these words fit into their previous assumptions about how objects are categorized (Samuelson, Smith, 1999). One way to compare the
vocabularies of children is to calculate the proportion of shape based nouns (such as ball) and material based nouns (such as glue) that the child can produce. Their vocabularies can then be broken down even further by whether the shape and material based nouns are solids or non-solids. Solids are defined as discrete objects with fixed boundaries and non-solids are defined as continuous substances that do not have fixed boundaries (Samuelson, Smith, 1999). Since solid objects have fixed boundaries they are usually categorized by shape and since non-solid substances do not have fixed boundaries they are usually categorized by material. However, according to adult judgments of different types of nouns, there are many nouns that do not follow this general pattern (Samuelson & Smith, 1999). In the literature, nouns can be divided into five categories: solid shape, solid material, solid both, non-solid material, and non-solid both. Nouns for solid shape objects refer to solid objects that are distinguishable by their shape (for example, all balls are ball shaped). Whereas, solid material objects are solid objects that are distinguishable by their material (for example, not all cheeses have the same shape but they all consist of the same material) and solid both are distinguishable by both their material and shape (for example, all crayons have the same shape and consist of the same material). Nouns for non-solid materials refer to non-solids that are distinguishable by their material (for example, glue is not always in the same shape by it always consists of the same material) and nouns for non-solid both refer to non-solids that are distinguishable by both their shape and material (for example, in general, all bubbles have the same shape and consist of the same material).

The Present Study

The present study consisted of two experiments. The first experiment had a cross-sectional design and it compared the vocabulary compositions of late and early talking toddlers between 18-30 months of age. The purpose of comparing late talkers to early talkers (as opposed
to any typically developing toddler) is that they are at opposite ends of the word learning spectrum so if any differences do exist they should be more salient. The vocabularies of the participants were specifically broken down by the types of nouns that they could produce; solid shape, solid material, solid both, non-solid material, or non-solid both. The second study had a longitudinal design and compared the vocabulary compositions of persistent late talkers and late talkers who caught up to their peers. The subjects in this study had their vocabularies examined bimonthly between the ages of 18-26 months.

The previous research has focused on children between the ages of 2-3 but the present study is with children between 18-30 months. The benefits of researching children this young are the fact that the shape bias is well established in typically developing children by 24 to 30 months of age (Jones, 2003). Therefore the typically developing 18 month old would not be expected to have a shape bias. Another justification for starting the research with 18 month olds is that it is this age in which fast-mapping occurs (Desmaris et al, 2008). Before fast-mapping occurs, for the first 50-100 words a child learns, word learning is an arduous process where children individually map a particular word to their correct referent (Desmaris et al, 2008). However, once a child’s categorizations and associations are well honed, they are able to acquire words at a more rapid pace. Previous research has shown that late talkers show deficits with fast-mapping, which further suggests that they have difficulties with categorization. (Desmaris et al, 2008).

For this study, only the productive vocabularies of children were examined because the measurements for productive vocabularies are more reliable than the measurements for comprehensive vocabularies since it is easier to list all the words a child can produce (Gershkoff-Stowe et al, 2004). The current study used the MacArthur Communicative Development
Inventory (MCDI) to assess the productive vocabularies of the participants. The MCDI is a parent-report checklist consisting of 674 words in which parents check off all the words that their child can produce (Fenson et al, 2000). The MCDI has been shown to be a reliable and predictive way to measure the variability in language development among individual children (Desmaris et al, 2009). In Experiment 1, late talkers were defined as children who scored below the 25th percentile for their age group in the MCDI and early talkers were defined as children who scored above the 75th percentile in the MCDI for their age group. In Experiment 2, late talkers were defined as children who scored below the 30th percentile in the MCDI.

Predictions

It was proposed that for the first study there would be an interaction between the MCDI percentile and the types of words that a child would know. Specifically it was proposed that early talkers would know more words that would support a shape bias than late talkers. It was also proposed that for the second study, late talkers who eventually caught up to their peers would have vocabularies that were structured similarly to typically developing children (they would have more words that support a shape bias). Whereas late talkers who remained in the bottom percentile would have vocabularies that were structured differently. Therefore, the vocabulary structures, rather than the percentiles, could be more indicative of future language delays. If patterns do emerge, early interventions could be targeted towards children who are at a greater risk of having persistent language delays later in life.
Methods

Experiment 1

Participants

Participants were recruited from an online database of children in the Boulder/Denver metro area and were compensated for their participation with $5 and a book. The participants were selected based on whether they were in the top 75th percentile in the MCDI (early talkers) or in the bottom 25th percentile in the MCDI (late talkers). All of the participants were from middleclass families and spoke English as their primary language. There were a total of 29 participants and the age range was 17.1 months-31.3 months ($M=25.7$ months). There were 19 late talkers ($M=26.8$) and 10 early talkers ($M=23.8$).

Materials

The MCDI/ Words and Sentences form was used to calculate the number of words that each child could produce. The MCDI/ Words and Sentences is a normative checklist intended for children between the ages of 16 to 30 months (Feldman, 2000). Because it is a normative checklist, children from all the age groups used the same checklist.

Procedure

The parents of each of the participants filled out the MCDI one time, either in the laboratory or online at home. Each participant’s MCDI percentile was then calculated based on their age, gender, and number of words produced. Participants who scored in the 25th percentile or below were defined as late talkers and participants who scored in the 75th percentile or above were defined as early talkers. The data from the participants who scored in the $30^{th}$-70th
percentile was not analyzed. After the participants were separated into late talkers and early talker, an excel program (Samuelson, et al 1999) was used to calculate how many of each of the following types of nouns that the late talkers and early talkers knew: solid shape, solid material, solid both, non-solid material, and non-solid both. After that, the proportion of each type of noun was calculated by dividing the noun type by the total number of nouns. These proportions were then used to calculate the proportion of pro-shape bias and the proportion of pro-material bias words each participant knew.

**Experiment 2**

*Participants*

Participants were recruited from the same database as Experiment 1 and received the same compensation for their participation. The participants were selected from a larger study\(^1\) based on whether they were in the bottom 30\(^{th}\) percentile in the MCDI (late talker) on their first visit when they were 18-months-old. All of the participants came from middle class families and all but one of the participants spoke only English as their primary language. There were a total of 11 participants and 5 of the participants remained late talkers (persistent late talkers), while 6 of the participants caught up to their peers by the time they were 26-months-old (non-persistent late talkers). One of the non-persistent late talkers was separately classified as bilingual due to the different language trajectories of monolingual and bilingual children. Table 1 shows the mean age of the participants during each visit.

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\(^1\) The larger experiment consisted of a one year longitudinal study with 34 participants who came in once a month. Each month the participants performed a Novel Noun Generalization Task where they were asked to categorize objects and the parents completed the MCDI checklist.
Late Talking Toddlers

<table>
<thead>
<tr>
<th></th>
<th>18-months</th>
<th>20-months</th>
<th>22-months</th>
<th>24-months</th>
<th>26-months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent</td>
<td>18.4</td>
<td>20.08</td>
<td>21.75</td>
<td>24.16</td>
<td>25.50</td>
</tr>
<tr>
<td>Non-persistent</td>
<td>18.08</td>
<td>19.94</td>
<td>21.75</td>
<td>23.88</td>
<td>25.13</td>
</tr>
</tbody>
</table>

Table 1.

Materials

Materials were the same as Experiment 1.

Procedure

The participants were recruited from a database when they were 18-months-old. The parents of each of the participants filled out the MCDI either in the laboratory or online at home. The participants who scored at the 30th percentile or below for 18-month-olds were then separated from the other participants. The parents of the participants filled out the MCDI every two months until the participants were 26-months-old. The participants who were still in the bottom 30th percentile at 26 months of age were labeled as persistent late talkers, while the participants who were in the 35th percentile or above at 26 months were labeled as non-persistent late talkers. The proportions of words were calculated the same way as they were in Experiment 1. The purpose of tracking the same participants over time was to examine the individual vocabulary trajectories and compare the vocabularies of the late talkers who eventually caught up to their peers and those who did not.
Results

Experiment 1

For Experiment 1, the proportion of each type of noun produced by late talkers and early talkers was compared. The purpose of comparing the proportions instead of the raw scores is that the raw scores would be expected to be significantly different between the late talkers and the early talkers. For example, a child with a vocabulary of 100 words would invariably know more solid-shape words than a child with a vocabulary of only 5 words. Therefore, different proportions between late and early talkers, rather than different raw scores, would suggest differing vocabulary structures. Two ratios were examined: a pro-shape bias ratio and a pro-material bias ratio. The pro-shape bias ratio was calculated by dividing the proportion of solid shape nouns by the proportion of solid material nouns. The reasoning behind calculating the pro-shape bias ratio this way is that the solid shape nouns would support a shape bias for solids and the solid material nouns would support a material bias for solids, which would be an incorrect bias. Similarly, the pro-material bias proportion was calculated by dividing the proportion of non-solid material nouns by the proportion of non-solid both nouns. The reasoning behind calculating the pro-material bias this way is that the non-solid material nouns would support a material bias for non-solids while the non-solid both nouns would support a shape bias for non-solids. The non-solid both nouns were used in place of non-solid shape nouns because there are no non-solid shape nouns in the MCDI. The pro-shape bias ratio and pro-material bias ratio were calculated for each participant.

There was a marginal difference in the means of early and late talkers in the pro-shape bias ratio. Early talkers had a higher pro-shape bias ratio ($M=5.24, SD=1.04$) than late talkers.
Late Talking Toddlers

(M=3.42, SD=3.98), t(22.22)=1.88, p=0.074. A Levine’s Test for Equality of Variance indicated that there were unequal variances between late and early talkers. There was not a significant difference between early and late talkers in the pro-material bias ratio. Early talkers only had a marginally higher pro-material bias ratio (M=1.01, SD=0.31) than late talkers (M=0.70, SD=0.83), t(25.3)=1.46, p=0.157.

The following figures show the pro-shape bias and pro-material bias ratios for early and late talkers.

![Figure 1. Pro-material bias ratio and pro-shape bias ratio for early talkers](image-url)
Figure 2. Pro-shape bias ratio and pro-material bias ratio for late talkers

As figure 1 shows, for early talkers, all of the scores tended to be clustered in the same area (a pro-shape bias between 3.8-6.9 and a pro-material bias between 0.5-1.5). However, as figure 2 shows, the late talkers were much more variable. Six of the late talkers had similar ratios as the early talkers (a pro-shape bias between 3.8-6.9 and a pro-material bias between 0.5-1.5) and thirteen of the late talkers had ratios that deviated from this pattern. Of the thirteen late talkers who had deviating ratios, there were eight who had ratios of zero for both their pro-shape and pro-material biases. The five other late talkers who deviated from the pattern either had pro-material bias ratios that were bigger than their peers or pro-shape bias ratios that were bigger or smaller than their peers. This data suggests that the two children who had pro-material bias ratios that were higher than their peers had more robust material biases, whereas the two children who had pro-shape bias ratios had more robust shape biases and the one child who had a smaller pro-shape ratio had a weaker shape bias.
This data suggests that late talkers have a wide variability in the composition of their vocabularies. Since some of the late talkers had vocabularies that were structured similarly to the early talkers and others did not, this raised the question for Experiment 2, which was whether persistent late talkers and non-persistent late talkers have differences in the structures of their vocabularies. This question was addressed by longitudinally looking at the language trajectories of toddlers between the ages of 18-26 months.

**Experiment 2**

Only a qualitative analysis was done on vocabulary structure for Experiment 2 because there were so few participants in each category: persistent and non-persistent late talkers. Persistent late talkers were still in the bottom 30\textsuperscript{th} percentile when they were 26-months-old and non-persistent late talkers were in the 35\textsuperscript{th} percentile or above when they were 26-months-old. One of the non-persistent late talkers was graphed separately because she was bilingual and when the study began her primary language was not English. The proportion of each type of noun (solid shape, solid material, solid both, non-solid material, and non-solid both) was graphed for each participant when they knew 50-100 words on the MCDI. The purpose of comparing the noun proportions when all of the participants knew about the same number of words, as opposed to comparing the proportions at a given month, is that there was so much variability in the number of words that persistent and non-persistent late talkers knew at the same month (see Appendix A for graphs at each month).

The following figures show the proportions of words for persistent late talkers, non-persistent late talkers, and the bilingual participant. The participants’ ages are listed under their code.
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Figure 3. Proportion of words for non-persistent late talkers at 50-100 words

Figure 4. Proportion of words for persistent late talkers at 50-100 words
Figure 5. Proportion of words for bilingual participant at 50-100 words

As seen in figure 3, all the non-persistent late talkers had vocabularies that were structured similarly, but persistent late talkers had more variability. Of the persistent late talkers, ltp13, ltp158 and ltp195 had vocabularies that were structured similarly to the non-persistent late talkers but ltp117 and ltp166 had different vocabulary structures. Also, ltp117 and ltp166 tended to have their vocabularies skewed towards certain types of words. For example, ltp117 had a large proportion of words that were categorized by both shape and material (solid both nouns and non-solid both nouns) compared to the other participants and ltp166 tended to have more solid nouns than the other participants. The bilingual participant had a vocabulary that was structured similarly to the non-persistent late talkers except she did not have any non-solid material words.
The pro-shape and pro-material biases were also calculated the same way as in Experiment 1. Figures 6, 7 and 8 show the ratios for persistent late talkers, non-persistent late talkers, and the bilingual late talker.

Figure 6. Pro-shape and pro-material bias ratios for persistent late talkers at 50-100 words

Figure 7. Pro-shape and pro-material bias ratios for non-persistent late talkers at 50-100 words
The non-persistent late talkers and persistent late talkers had pro-shape bias ratios and pro-material bias ratios that were structured differently. In general, the persistent late talkers had smaller pro-shape bias ratios than the non-persistent late talkers and the bilingual late talker. Also, all of the persistent late talkers had pro-material bias ratios, whereas only three of the persistent late talkers (ltp131, ltp166, ltp195) had pro-material bias ratios.

Discussion

The purpose of this study was to examine the vocabulary structures of toddlers and see if the vocabulary structures could be used to predict future language delays. For Experiment 1, the vocabulary structures of two opposite ends of the word learning spectrum, late talkers and early talkers, were studied to see if differences exist between the two groups. Since there was so much variability among the late talkers in Experiment 1, this prompted the question for Experiment 2, which was whether persistent and non-persistent late talkers have vocabularies that are structured differently. This question was addressed by longitudinally examining the vocabularies of
toddlers who were late talkers at 18 months of age and comparing the vocabulary structures of participants were remained late talkers at 26 months and those who did not. The results were that all the non-persistent late talkers had vocabularies that were structured similarly but the persistent late talkers had more variability in the structures of their vocabularies. It is possible that the wide variability in the vocabulary structures of the persistent late talkers reveals that these toddlers are late talkers because they are not attending to the correct characteristics when categorizing objects. For example, ltp117 had a large proportion of solid-both and non-solid-both words. Since this participant had so many words that were categorized by both shape and material it is possible that she (and other individuals who have similarly structured vocabularies) is too rigid in her object categorization, which may hinder her ability to learn new words.

Measures

Although the MCDI has been shown to be a reliable tool, it also has its critiques (Feldman et al, 2000). One criticism is that the MCDI is based on percentile scores and not based on standard deviations so it does not reflect how much difference exist between a child who, for example, is in the 5th percentile and a child who is in the 95th percentile (Anastasi & Urbino, 1997). One counterargument for this criticism is that early word acquisition is to variable among different children and that the percentiles used in the MCDI reflect this variability more accurately than standard deviations. Another criticism is that, because the MCDI is a parent report checklist, it is possible that the parents may not accurately report all of the words their child can produce. However, one rebuttal to this criticism is that parents have been shown to accurately report the number of words their child can produce but their reports become less accurate when the parents report the use of irregular nouns, verb forms, and
overregularized forms (Feldman et al., 2000). Since the parents in the present study only reported the productive vocabularies of their children, the data should have been accurate.

Furthermore, due to the nature of the MCDI, vocabulary structures can be imposed onto the participants. That is, since there are a specific number of words for each noun category in the MCDI, the average child would have a vocabulary that is structured similarly to the structure on the MCDI. Figure 7 shows the proportion of each noun type of a prototypical child who knows all the words on the MCDI. These proportions are similar to the proportions of the non-persistent late talkers, some of the persistent late talker, and the bilingual participant. Since the MCDI does have an imposed structure, it makes it all the more unusual that the persistent late talkers had vocabularies that deviated from this structure.

![Figure 7. Proportion of each noun type in the MCDI](image)

**Limitations of the Current Study**

The current study would have been improved by using a sample of participants that is more representative of the general population. All of the participants came from middleclass
families and all of the participants also came from families where at least one parent had a college degree. This sample is not representative of the actual population of children in this country. However, for the purposes of the current study, one advantage of using a homogenous sample is that the differences between the children was due mostly to individual differences in word learning and not due to external factors such as socioeconomic status.

Also, the participants in Experiment 2 took part in a larger study. Since Experiment 2 had a longitudinal design, the participation in the larger study may have affected the vocabularies of the participants. In the larger study, the participants performed a novel noun generalization task for solid objects and non-solid substances. This may have changed the underlying biases that the participants already had, which may have affected the types of words that they learned. For instance, it may have strengthened a shape bias and therefore caused the participants to know more solid shape words than they normally would have. However, it is also possible that the participation in the novel noun generalization task only strengthened the underlying biases that the participants already had. Also, the participation in a language study may have caused the parents of the participants to become more involved in their child’s language development than they would have been otherwise. This more active involvement may have caused the participants’ vocabularies to become larger than they normally would have become in the time frame. Because participation in the larger longitudinal study may have affected the participants’ vocabularies, for future studies it would be beneficial to also have a cross-sectional condition as a control in order to determine if participation in the longitudinal study did affect the participants’ vocabularies.

_Future Studies_
As an extension of the current study, the participants from Experiment 2 will be contacted again in one year, when they are 3 years of age. The parents of the participants will be asked to fill out the MCDI Vocabulary Checklist: Level II, which is intended for toddlers. This form contains a 100-word productive vocabulary checklist and contains a question about combining words (Fenson, et al, 2000). The purpose of administrating this checklist in a year is to see if the participants’ previous vocabulary structures will be related to their productive vocabularies and word combinations when they are 3 years of age. This would be especially important for ltp117, ltp158, and ltp166 because they had vocabularies that deviated from their peers; ltp117 and ltp166 had different proportions of words than their peers and ltp117 and ltp158 did not have a pro-material bias ratio. It would also be interesting to see if ltp131 and ltp195, who had vocabularies that were structured similarly to the non-persistent late talkers, would be caught up to their peers by this time.

Late talking toddlers can have a disadvantage to their typically developing peers so it is important to provide early interventions for toddlers who are likely to have persistent language delays in the future. The MCDI can be a helpful screening tool because if the pro-shape and pro-material bias ratios of nouns in the MCDI reflect a child’s actual shape and material biases, than the ratios in the MCDI can be a simpler tool to examine biases than a laboratory task. Unlike a laboratory task, such as the novel noun generalization task, the MCDI can be administered by anyone and can be administered in person, through the mail, or online. The current study used the MCDI to examine vocabulary structures in toddlers and found that persistent late talkers had a wide variability in the structures of their vocabularies. Specifically, two of the late talkers with deviating scores had vocabularies that were skewed towards one direction (i.e. more solid both and non-solid both nouns) and had a pro-material bias ratio of
zero. Future research needs to use a larger sample size and follow the participants for a longer period of time to see if these factors have predictive power.
References


Appendix A

**Persistent late talkers at 18-months**

- Solid shape
- Solid material
- Solid both
- NS shape
- NS material
- NS both

**Non-persistent late talkers at 18-months**

- Solid shape
- Solid material
- Solid both
- NS shape
- NS material
- NS both

**Bilingual at 18-months**

- Solid shape
- Solid material
- Solid both
- NS shape
- NS material
- NS both
Persistent late talkers at 22-months

Non-persistent late talkers at 22-months

Bilingual at 22-months
Persistent late talkers at 26-months

Non-persistent late talkers at 26-months

Bilingual at 26-months