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# Do children still pick and choose? The relationship between phonological knowledge and lexical acquisition beyond 50 words

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Abstract

Previous studies document an influence of phonological knowledge on word learning that differs across development. Specifically, children with expressive lexicons of fewer than 50 words learn words composed of IN sounds more rapidly than those composed of OUT sounds (Leonard, Schwartz, Morris, and Chapman, 1981; Schwartz and Leonard, 1982). In contrast, preschool children with larger expressive lexicons show the reverse effect (Storkel, in press). The goal of the current study was to provide a re-analysis of existing data to determine if this discrepancy across studies may be related to how phonological knowledge has been defined. This study defines knowledge on a continuum from most to more to less. Results showed a continuous inverse relationship between phonological knowledge and word learning by preschool children. Specifically, most phonological knowledge was associated with poorest word learning, more knowledge with intermediate word learning, and less knowledge with best word learning. Theoretical implications are discussed.

Keywords: Phonology, word learning, language development

## Introduction

Phonological knowledge is often defined in terms of phonotactic constraints. Phonotactic constraints determine which sounds and sound sequences occur in production and can be divided into three types of constraints: inventory constraints, positional constraints, and sequence constraints (Dinnsen, 1984; Elbert and Gierut, 1986). Inventory constraints define the set of sounds that occur in production. Positional constraints refer to context conditioned limitations in sound occurrence. Sequence constraints restrict the co-occurrence of sounds.

Past research provides evidence that phonological knowledge influences word learning. In many cases, phonological knowledge has been viewed as a binary distinction between the sounds that are produced, IN sounds, and the sounds that are not produced, OUT sounds. These studies have shown that many children at the earliest stages of word learning tend to learn words that are consistent with the phonotactic constraints observed in their babbling or the phonological preferences observed in their first words (e.g. Ferguson and Farwell, 1975; Stoel-Gammon and Cooper, 1984; Vihman, Macken, Miller, Simmons, and Miller, 1985; Vihman, Ferguson, and Elbert, 1986; Velleman and Vihman, 2002). Likewise, when exposed equally to novel words composed of IN sounds and novel words composed of OUT sounds, children at this early stage of word learning tend to learn the words composed of IN sounds more rapidly than those composed of OUT sounds (Leonard, et al., 1981; Schwartz and Leonard, 1982; Schwartz, Leonard, Loeb, and Swanson, 1987). Taken together, phonotactic constraints appear to act as a filter for lexical acquisition by children with productive vocabularies of fewer than 50 words (Vihman, 1993).

Recently, we explored the role of phonological knowledge in word learning by children well beyond the 50 word stage, namely 3- to 5-year-old children (Storkel, in press). This study involved 20 children with delayed phonological development and 24 younger phonology-matched typically developing children. Children with phonological delays and younger phonology-matched children were exposed to eight nonsense words composed of IN sounds (/m g/) in the onset position and eight nonsense words composed of OUT sounds (/r θ/) in the onset position. Exposure occurred through a story narrative with supporting pictures of characters interacting with novel objects. Learning was measured in a picture naming task at varying intervals of exposure with scoring corrected for phonological knowledge (i.e. a child's typical substitutes for a given target were scored as correct). Results showed that both groups of children were more accurate responding to words composed of OUT sounds than words composed of IN sounds. This pattern is opposite of that reported for younger children.

There are two possible accounts of this discrepant finding across development. One possible account relates to the changing salience of IN versus OUT sounds. In particular, it is possible that IN sounds may be more salient than OUT sounds early in development because few sounds are classified as IN and many sounds are classified as OUT. In this way, the ratio of IN to OUT sounds may make IN sounds more unique or salient than OUT sounds. In contrast, later in development as phonology is acquired many sounds are likely to be classified as IN and few sounds are likely to be classified as OUT. Now the ratio of IN to OUT sounds indicates that OUT sounds may be more unique or salient than IN sounds. In support of this hypothesis, Vihman and Nakai (2003, August) reported that production preferences are negatively correlated with perceptual

preferences. That is, infants listened longer to sounds they produced infrequently, OUT sounds, than sounds they produced frequently, IN sounds. It could be that this preference emerges early in listening tasks but only later in word learning tasks.

A second possibility is that methodological differences across studies in the definition of IN versus OUT sounds could account for the discrepancy. Specifically, the criterion for IN sounds is fairly similar across studies, but the criterion for OUT sounds differs. Studies of younger children generally require that OUT sounds not be produced by the child and not be characteristic of the words attempted by the child (Leonard, et al., 1981; Schwartz and Leonard, 1982). Studies of older children used an accuracy criterion (Storkel, in press). This allows for the possibility that younger children may have had less knowledge of OUT sounds than older children because of the sound selection criterion used. This hypothesis predicts a U-shaped influence of phonological knowledge on word learning such that most phonological knowledge (i.e. IN sounds) would be associated with intermediate word learning, more phonological knowledge (i.e. OUT sounds in studies of older children) would be associated with best word learning, and less phonological knowledge (i.e. OUT sounds in studies of younger children) would be associated with poorest word learning. Studies of younger children may have sampled most and less knowledge, whereas, the study of older children may have sampled most and more knowledge.

The current study attempts to differentiate these two hypotheses by examining the influence of degrees of phonological knowledge (most vs. more vs. less) on word learning by children who are the same age. A subset of data are taken from Storkel (in press) and re-analyzed. Phonological knowledge is operationalized in a manner similar

to Gierut, Elbert, and Dinnsen (1987) who proposed a continuum of knowledge with no constraints being characterized as most knowledge, positional constraints being characterized as more knowledge, and inventory constraints being characterized as less knowledge. If a linear relationship between phonological knowledge and word learning is obtained, then this would favor the salience account and disfavor the methodological difference account of the discrepancy across studies. Alternatively, if a U-shaped relationship between phonological knowledge and word learning is obtained, then this would support the methodological difference account but not the salience account of the differing findings across studies.

## Methods

### Participants

Data from 18 children from Storkel (in press) were re-analyzed. Knowledge of the target sounds /m ɡ r θ/ was determined based on spontaneous productions in a comprehensive picture naming probe (Gierut, 1985). For all 18 children, no constraints were observed for target /m/, meaning that all children had most knowledge of the IN sound /m/. In contrast, children differed in their knowledge of the OUT sound /r/, dividing the children into two groups: one with more knowledge of the OUT sound /r/ and one with less knowledge of the OUT sound /r/. The nine children in the more knowledge group evidenced positional constraints for target /r/. These were the only children in the original study that evidenced positional constraints for target /r/. Of these children, five had phonological delays and four were typically developing. The less knowledge group was randomly selected from the remaining children in Storkel (in press) with the criterion that children in this group had to evidence inventory constraints for

target /r/. In addition, these children had to match those in the more knowledge group on presence/absence of a phonological delay, chronological age, vocabulary development, and phonological development. Table 1 shows performance by each group for each of these areas.

Insert table 1 about here

A t test analysis showed that the more knowledge group was significantly more accurate producing /r/ in the coda than the less knowledge group, $t(16) = -7.15$, $p < 0.001$, confirming the intended group difference in knowledge of /r/. In contrast, both groups were equally inaccurate producing /r/ in the onset, $t(16) < 0.02$, $p \geq 0.90$, and equally accurate producing the IN sound /m/ in either syllable position, both $t(16) \leq 1.00$, $p \geq 0.35$. Likewise, there were no significant differences between the more knowledge and less knowledge groups on chronological age, standard scores on the Peabody Picture Vocabulary Test - 3 (Dunn and Dunn, 1997), standard scores on the Expressive Vocabulary Test (Williams, 1997), or percentile ranks on the Goldman-Fristoe Test of Articulation-2 (Goldman and Fristoe, 2000), all $t(16) < 0.98$, $p > 0.30$.

Word learning task

Details of the word learning task can be found in Storkel (in press). The current analysis focuses on only a subset of the novel words used in that study, namely the words with /m/ or /r/ in the onset. This subset of novel words was chosen based on variation in knowledge of the OUT sounds and the matching of IN to OUT sounds. Specifically, there was greater variation in knowledge of the OUT sound /r/ than the OUT sound /θ/, yielding a slightly larger group of more knowledge participants. The IN sound /m/ was selected because the /m/ novel words were matched in phonotactic probability to the /r/

novel words. This sound selection yielded a total of eight novel consonant-vowel-consonant words, four with an /m/ onset and four with an /r/ onset. The coda in each novel word was accurately produced by all participants.

Children were exposed to the novel words in a story accompanied by pictures. Learning was tracked across exposures in a picture naming task. In this task, children were shown one of the objects from the story and asked to name it. Responses were audio recorded, phonetically transcribed, and scored using a lenient scoring criteria (i.e. 2 of 3 phonemes correct scored as correct) with correction for misarticulation (i.e. child's typical substitute for a more or less knowledge target counted as correct). Data were analyzed from the post-test that occurred one-week after exposure to the novel words. This test point was chosen because it yielded the highest accuracy.

## Results

Figure 1 shows the mean proportion correct in the picture naming task for novel words with IN sounds in the onset (/m/) versus those with OUT sounds in the onset (/r/) for both groups (more knowledge vs. less knowledge). Performance for novel words containing IN sounds was compared to performance for novel words containing OUT sounds for each group using a t test. For the more knowledge group, there was no significant difference between learning words composed of IN sounds versus OUT sounds, $t(8) = 1.00$, $p = 0.35$. The trend was for slightly better performance for words composed of OUT sounds than words composed of IN sounds. In contrast, for the less knowledge group there was a significant effect of knowledge with novel words composed of OUT sounds being responded to more accurately than those composed of IN sounds, $t(8) = 2.31$, $p = 0.05$.

Insert figure 1 about here

Discussion

These results suggest a continuous inverse relationship between phonological knowledge and word learning by preschool children. In particular, poorest accuracy in word learning was seen for words composed of most knowledge sounds (i.e. no constraints); intermediate accuracy in word learning was observed for words composed of more knowledge sounds (i.e. positional constraints); greatest accuracy in word learning was shown for words composed of less knowledge sounds (i.e. inventory constraints). It is important to note that the difference in learning of words composed of most knowledge sounds and those composed of more knowledge sounds was not statistically significant. It could be argued that the influence of phonological knowledge on word learning is dichotomous with a distinction between most/more knowledge and less knowledge; however, the sample size for the current study raising the possibility of lack of power. This issue warrants further investigation from studies with more participants.

The findings from this study failed to provide evidence of a U-shaped relationship between phonological knowledge and word learning by preschool children. Therefore, the discrepancy between results from studies of younger children and studies of older children may relate to the changing salience of IN versus OUT sounds across development. That is, the salience of IN versus OUT sounds may vary over time, leading to changes in the relationship between phonological knowledge and word learning. Early in development, words composed of OUT sounds may be avoided; whereas later in development, words composed of OUT sounds may facilitate word learning.

One limitation of the current study is its focus on production evidence to infer phonological knowledge. Based on this evidence, it was assumed that younger children from previous studies had similar knowledge of OUT sounds as the less knowledge group in this study; however, there still may have been differences in phonological knowledge between the younger and older children, and this difference may have been revealed by appealing to conceptual evidence (cf. Gierut, 1996; Gierut, 1998). Specifically, the conceptual structure of the phonological categories for the OUT sounds may have been less developed in the younger children in previous studies than the older children in this study. On the surface, the productions may have been the same but underlyingly the phonological representations may have been different.

This conceptual knowledge hypothesis may provide an integration of the salience account and the methodological account of the discrepant results across studies. For example, the emergence of accurate production may indicate a stable adult-like conceptual structure, as in the more knowledge group and the IN sounds. This stable phonological structure may be associated with a neutral effect on word learning such that novel words containing these sounds are not avoided or collected. This condition would serve as a baseline condition. In contrast, the children in the less knowledge group in this study may have had an emerging adult-like conceptual structure for OUT sounds, even though these sounds were not produced. This emerging conceptual structure may have served to highlight these sounds in the environment, facilitating acquisition of novel words containing these sounds. Finally, the younger children may have had an impoverished or holistic conceptual structure for OUT sounds, and this may have lead to avoidance of novel words containing OUT sounds. Thus, this integrated account assumes

that stable conceptual structure in phonology is associated with a neutral effect on word learning, emerging conceptual structure in phonology is associated with facilitation of word learning, and impoverished conceptual structure in phonology is associated with avoidance in word learning. This hypothesis highlights a potentially interesting relationship between phonological and lexical development that might be revealed by considering evaluating phonological knowledge based on conceptual evidence.

## Conclusion

This study provides evidence of an inverse relationship between phonological knowledge and word learning by preschool children. Specifically, most phonological knowledge was associated with poorest word learning, more phonological knowledge was associated with intermediate word learning, and less phonological knowledge was associated with best word learning. This finding is counter to those of previous studies with younger children at the earliest stage of word learning. It is suggested that this apparent discrepancy may be reconciled by examining conceptual evidence to differentiate different types of phonological knowledge. The hypothesis put forth was that stable conceptual structure in phonology may have a neutral effect on word learning, emerging conceptual structure in phonology may facilitate word learning, and impoverished conceptual structure may inhibit word learning.

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Table 1. Means and standard deviations (in parenthesis) for measures of phonological development, age, and vocabulary development.

| | More knowledge | Less knowledge |
|---|---|---|
| Diagnosis | n = 5 phonological delay<br>n = 4 typically developing | n = 5 phonological delay<br>n = 4 typically developing |
| OUT sound /r/ [a] | | |
| **coda accuracy | 79% | 6% |
| | (27) | (14) |
| onset accuracy | 6% | 6% |
| | (13) | (14) |
| IN sound /m/ [a] | | |
| coda accuracy | 98% | 99% |
| | (7) | (1) |
| onset accuracy | 100% | 100% |
| | (0) | (0) |
| Chronological age | 4; 2 | 4; 5 |
| | (9) | (10) |
| Standard score PPVT-3[b] | 108 | 109 |
| | (9) | (9) |
| Standard score EVT[c] | 111 | 107 |
| | (10) | (9) |
| Percentile rank GFTA-2[d] | 28 | 23 |
| | (25) | (17) |

Note: ** indicates a significant difference between the groups.

[a]Accuracy for target items on the Phonological Knowledge Protocol (Gierut, 1985)

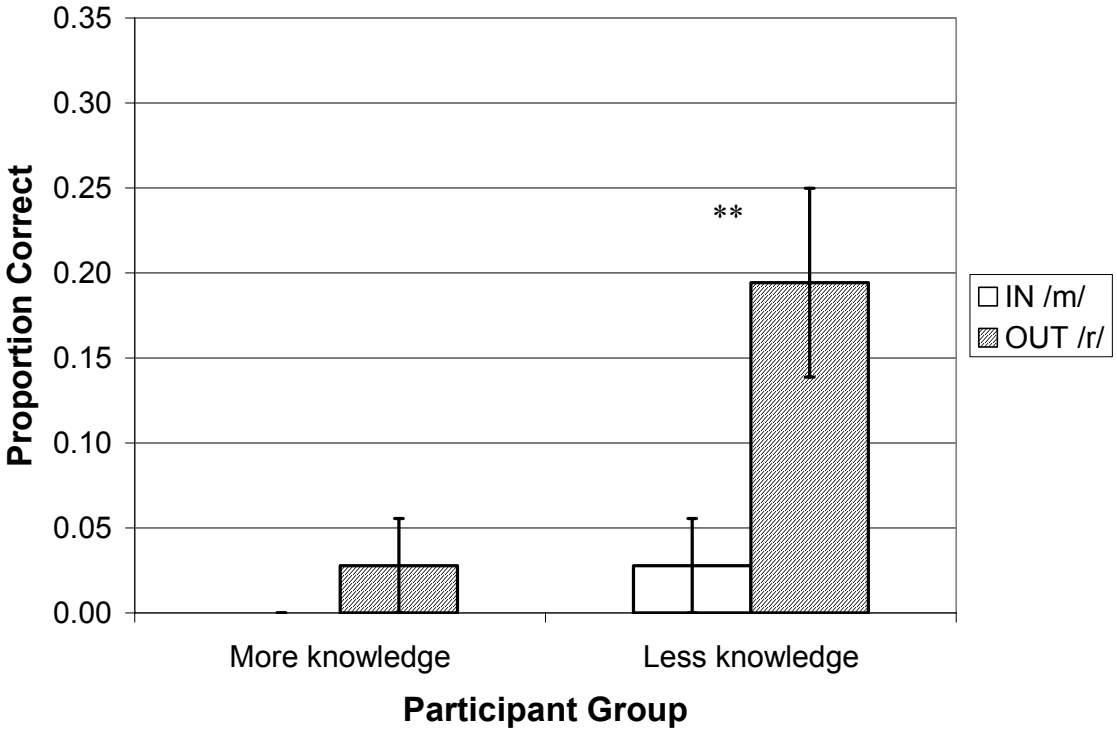
[b]Peabody Picture Vocabulary Test-3 (Dunn and Dunn, 1997)

[c]Expressive Vocabulary Test (Williams, 1997)

[d]Goldman-Fristoe Test of Articulation-2 (Goldman and Fristoe, 2000)

# Figure Captions

Figure 1. Mean proportion of correct responses in the picture naming task by children in the more knowledge and less knowledge groups for novel words composed of IN sounds (open bar) versus those composed of OUT sounds (filled bar). Error bars indicate the standard error.


0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Proportion Correct
**
IN /m/
OUT /r/
More knowledge
Less knowledge
Participant Group