Non-orthographic consonant cluster manipulation by good and poor spellers

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In order to examine the correlations between spelling, reading ability and phoneme awareness (here called analytic awareness), a group of university undergraduate students were tested on measures of reading (Woodcock Reading Mastery Test, Woodcock, 1998), spelling (Test of Written Spelling, Larsen et al., 1999), phonological processing (Comprehensive Test of Phonological Processing, Wagner et al., 1999), and finally on an experimental phoneme awareness task (Squires, 2004). The phoneme awareness task used examines phoneme awareness without the effects of production and orthography, by presenting subjects with auditory stimulus. When good and poor spellers were compared in terms of reaction time and score for the phoneme awareness task, there was no significant difference found. However, there was a significant result observed in confusion of manipulation of an analytic form of phonological unit (phoneme in a complex consonant cluster) and a more holistic form of phonological unit (complex consonant cluster).

1. Introduction

There is a large amount of research identifying the particular abilities that promote, or are promoted by, becoming a good reader or speller. By correlating the ability to read and spell to a set of discrete abilities, it is possible to develop better reading programs. Also, this research makes it possible to demystify the abilities and mechanics behind becoming a skilled reader or speller. Many studies have identified a strong correlation between the ability to read or spell in an alphabetic script, and an ability known as phoneme awareness - the ability to consciously segment and manipulate individual phonemes in words. However, several studies have challenged this idea, suggesting that phoneme awareness does not arise spontaneously, even in the case of good readers. This study will aim in part to confirm or disconfirm whether phoneme awareness is an ability that arises in skilled readers.

2. Phoneme Awareness

The robust correlation of phonological awareness to reading and spelling ability has been well documented in the literature concerning reading and phonological awareness. Phonological awareness is the awareness of, and ability to, manipulate phonological units within words (Blachman, 1991; Goswami and Bryant, 1990: 1-4). There are at least three levels of possible forms of phonological awareness: awareness of phonemes, of intra-syllable
units (onsets and rimes), and of syllables. The unit most cited in research pertaining to reading and spelling ability in alphabetic scripts is that of the phoneme, the ability of which is the basis of this research. Analytic awareness, also known as phoneme awareness, can also be thought of as the ability to consciously manipulate segments in a writing system. This ability involves the comprehension of words as being composed of individual phonemes (Ball, 1993: 141). This type of phonological awareness is in contrast to what can be called holistic awareness, which is comprised of abilities relating to phonological units larger than the phoneme (namely onsets, rimes, syllables, etc.).

3. The relationship between analytic phonological awareness and reading / spelling

The connection between phoneme awareness and reading ability has been assessed through experimental tasks that evaluate phoneme awareness. Tasks that assess phoneme awareness traditionally involve counting, adding, deleting or identifying the position of phonemes in words (Joanisse et al., 1998). The results of phoneme awareness tasks suggest that reading in English correlates with awareness of the phoneme. For example, Bowey and Francis (1991, pg. 114-115) showed that pre-readers (kindergarteners) could not attend to the phonemic structure of words, but performed above chance on tasks evaluating sensitivity to onset and rimes. These pre-readers were able to identify, for example, words with similar rimes in a set like deck, neck, and fit. They were also able to identify words with similar onsets in a set like clue, fray and fry. However, they were unable to identify when words shared a similar phoneme in a set like dog, dip, and dot. This study, and others like it, suggests that the level of phonological awareness is correlated with the level of reading ability. Analytic awareness is assumed to accompany the development of proficiency in reading and spelling.

The incremental pattern of developing phonological awareness in tandem with reading ability and instruction (Bowey and Francis, 1991) seems to indicate that phoneme awareness in particular may be dependent on reading and spelling ability. Good and average spellers at the grade-school level have been shown to have better phonemic segmentation skills than poor readers (in addition to poor readers of a higher grade level) (Rohl and Tunmer, 1988: 336). This study, and others like it, corroborates the idea that phoneme awareness is an ability possessed by good readers. Results like these indicate that the development of phonological awareness starts with more holistic forms in general, and with experience with reading and writing in an alphabetic script, holistic awareness progresses until analytic awareness develops is achieved.

The development of phonological awareness in general is manifested in an incremental pattern, phoneme awareness included (Ball, 1993). Phonological awareness in English begins with the metalinguistic awareness of words, then syllables, then onsets and rimes. Finally, the level of analytic awareness corresponding to that of phonemes or individual sounds develops. Phoneme awareness arises with experience in a language that uses an alphabetic script, in which words can be analyzed through letter-sound correspondences to obtain meaning (Goswami and Bryant, 1990, pg. 271). This type of pattern of development has been shown in the analysis of children's ability to manipulate consonant clusters: before children can parse consonant clusters into separate sounds or phonemes, they treat clusters as a single unit (Barton et al., 1980). For example, children have been shown to judge words as beginning with the same sounds when they begin with a
simpleton consonant cluster onset as opposed to a complex consonant cluster onset (Treiman and Zukowski, 1991, pg. 71). Treiman (1985) showed evidence of this in finding that kindergarten-aged children had more difficulty determining that syllables such as "sna" began with "s" than identifying a syllable such as "san" as beginning with a "s".

However, there are studies that indicate the developmental relationship between analytic awareness and reading and spelling ability is not straightforward. For example, Squires (2004) found that even good readers have a lag in reaction time to the modified "Rosner" task (described next), suggesting that while they are better at phoneme awareness, it is not fully developed. Phoneme awareness was evaluated using the modified phoneme awareness task, which will also be used here. In particular, Squires showed that all groups in her study, even good readers, took a significantly longer time to decide whether words with a whole onset removed were unacceptable answers to the question, "Is the first sound gone?" This is in contrast to, for example, their ability to answer the same question when the second consonant in a cluster was removed. Squires suggests that the representations of the entire consonant cluster and the first phoneme are closely linked, and that the inability to properly analyze CC consonant clusters as two separate units indicates that, even in good readers, phoneme awareness has not fully developed.

Similarly, Penney et al. (in press) report a case study of a backward reader who showed levels of phonetic cue reading in the absence of being able to read and spell. Although the subject was unable to remove individual sounds from words, he could name and identify particular word-initial and word-final letters of the words tested in the phoneme deletion task. The subject displayed an analytic type of phonological awareness, as seen in the ability to connect sounds (phonemes) to their letter counterparts (orthography). These results are also consistent with the less analytic type of onset-rime awareness; however, the results are also compatible with the hypothesis that even poor readers can display analytic phoneme awareness.

In addition to these studies, the success of reading instruction involving onset-rime segmentation also challenges the attested relationship between analytic awareness and reading and spelling ability. Penney (2002) reports the success of teaching reading decoding skills to thirty-three poor high school readers using onset-rime segmentation as opposed to phonics or other "sound-based" methods. It appears, then, teaching analytic awareness is not required in learning to read and spell. All of these findings suggest that the correlation between (a) analytic awareness and (b) reading and spelling ability might not be as clear-cut as has been traditionally suggested.

4. Hypothesis

Based on the discussion here, the results of the testing outlined here are expected to confirm or refute whether phoneme awareness is related to reading and spelling ability. It is still expected that test results on measures of reading and spelling ability will pattern with scores on the task of non-orthographic consonant cluster manipulation. In other words, higher level spellers and readers are expected to outperform lower level readers and spellers on the phoneme deletion detection task.

Secondly, regardless of reading and spelling ability, it is suspected that participants will have difficulty in distinguishing between an analytic awareness task and a more holistic one. Specifically, this difficulty will be observed between consonant cluster onset removal and
initial consonant removal in a complex onset. If there is an effect of deletion type in the task, this hypothesis will be confirmed (similar to Squires (2004)). However, if participants have no difficulty distinguishing between the analytic and holistic task, there will be no observed effect deletion type in the second audio sample in each trial.

The hypotheses proposed here would be disproved if the proficient readers and spellers showed little difficulty in distinguishing between onset removal and single consonant removal. Likewise, if no correlations were found between reading and spelling ability and the analytic awareness task, the hypothesis would be disproved.

5. Methodology

Participants

The participants for this research were recruited from the undergraduate student body of Memorial University of Newfoundland. Participants in this study were used in an independent groups experimental design, where both groups received the same stimuli, training, and procedures. The two groups were chosen post-hoc based on their scores on standardized measures of reading and spelling ability. A median score was picked as the basis for this post-hoc split forming the two separate groups. In the preliminary set of data set of 30 subjects, 16 participants were identified as good spellers and 14 participants were identified as poor spellers. Out of these participants, 17 were female and 13 male with an average age of 19 years, 9 months.

Experimental Tests and Measures

All participants completed a single session where two separate components of the experiment were administered: (1) pretests and measures of reading, and spelling, followed by (2) the main experimental analytic awareness task.

To assess spelling ability, the Test of Written Spelling, (TWS), (Larsen et al., 1999) was administered. The TWS is commonly used as a measure for research efforts designed to investigate spelling, as is the case here. It assesses written spelling ability and will be used to identify students as good or poor spellers. The scores on this test were used primarily to create two post-hoc groups. Where multiple participants score at the median score, the measures of reading ability were used to separate these subjects into the two groups. To assess reading ability, the Woodcock Reading Mastery Test (WRMT), (Woodcock, 1998) was used, specifically the word identification and word attack sub-tests. These tests examine participants' ability to perform a set of tasks that are designed specifically to assess reading ability.

In order to test analytic awareness, the task developed by Squires (Squires, 2004: 42-44) will be used in this experiment. This task evaluates the manipulation of complex consonant clusters in onset position. The ability to parse complex consonant clusters into separate phonemes involves analytic awareness. This type of parsing ability is similar to that of the "Rosner" task (Rosner and Simon, 1971) that asks participants to remove a consonant from a word and produce the result. An example of this task would involve the experimenter asking a participant to say the word "clip". The experimenter would then ask the participant to say it again without the "kuh" sound (Rosner and Simon, 1971, pg. 386). Squires' analytic
awareness task relies on the aid of a computer program that presents a "Rosner" style task involving phoneme segmentation without the influence of orthography. Participants will be presented with sets of words that have been prerecorded through a computer program that presents the auditory stimulus.

Of the two words presented in each trial, the first is a word with an unaltered complex consonant cluster onset, and the second word presented will be altered in some manner. Participants are asked to answer the question "Is the first sound removed?" by pressing a keypad with "yes" and "no" buttons. Examples of stimuli that will be used are shown in Table 1 (Squires, 2004: 41):

<table>
<thead>
<tr>
<th>Stimulus 1</th>
<th>Stimulus 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Word</td>
<td>C1 Deletion</td>
</tr>
<tr>
<td>Blake</td>
<td>lake</td>
</tr>
<tr>
<td>crate</td>
<td>rate</td>
</tr>
<tr>
<td>twin</td>
<td>win</td>
</tr>
</tbody>
</table>

Table 1: Example stimuli

The words given in the C1 deletion column here are the correct answers to the question posed in the experimental task. Columns three and four are incorrect answers to the question. All subjects are asked to complete 554 trials, over two sessions.

6. Preliminary Results

Groups

The preliminary results presented here were taken from the first 30 participants. The group of 30 were split into two groups; 16 good spellers and 14 poor spellers. This division was made through identifying the median (middle score) of the Test of Written Spelling (108.00). The median score presented a problem in terms of grouping this initial data, namely that 5 of the 30 participants scored this median score. In the case of these 5 subjects, there was another factor taken into consideration – their scores on the Woodcock-Johnson Reading Mastery Test batteries for "Word-Identification" and "Word Attack". The post-hoc split made between good and poor spellers was found to be significant (F (1,28) = 51.526, p < .001). The average scores on the standardized measures are presented below in Table 2:

<table>
<thead>
<tr>
<th></th>
<th>TWS scores</th>
<th>WRMT Word Ident. scores</th>
<th>WMRT Word Attack scores</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Good</strong> Mean</td>
<td>116.37</td>
<td>104.06</td>
<td>105.50</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>6.09</td>
<td>5.50</td>
<td>8.32</td>
</tr>
<tr>
<td><strong>Poor</strong> Mean</td>
<td>95.28</td>
<td>91.85</td>
<td>94.35</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>9.79</td>
<td>9.78</td>
<td>9.13</td>
</tr>
<tr>
<td><strong>Total</strong> Mean</td>
<td>106.53</td>
<td>98.36</td>
<td>100.30</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>13.29</td>
<td>9.84</td>
<td>10.25</td>
</tr>
</tbody>
</table>

Table 2: Standardized tests data
Scores on the experimental non-orthographic analytic awareness task were lower for lower level spellers and readers across the board, indicating that this group had more difficulty with this task. Scoring data is shown below in Table 3:

<table>
<thead>
<tr>
<th></th>
<th>SCOREC1</th>
<th>SCOREC2</th>
<th>SCORECC</th>
<th>SCORENO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td></td>
<td>.9429</td>
<td>.0620</td>
<td>.8883</td>
<td>.0493</td>
</tr>
<tr>
<td>Poor</td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td></td>
<td>.8982</td>
<td>.1275</td>
<td>.8035</td>
<td>.0697</td>
</tr>
<tr>
<td>Total</td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td></td>
<td>.9220</td>
<td>.0984</td>
<td>.8487</td>
<td>.0586</td>
</tr>
</tbody>
</table>

Table 3: Analytic awareness scoring data

In order to determine if the observed difference was significant between good and poor spellers’ scores on the analytic awareness task, a repeated measures ANOVA was carried out. There was no significant difference found in scores between good and poor spellers (F (3, 84) = .668, p > .05). This result thus disproves the hypothesis that there would in fact be a significant difference in scores between the good and poor spellers, despite the apparent trend in the data.

In order to test for the second hypothesis made concerning participants’ ability to distinguish CC-deletion from targeted C1-deletion answer, another repeated measures ANOVA was used to determine if condition (C1 deletion, C2 deletion, CC deletion, and no deletion) in the task had any effect on scores. This revealed a significant difference found between condition in experimental task, indicating that the accuracy of response in all subjects was affected by condition (F (3, 84) = 4.666, p = .017). A further repeated measures ANOVA revealed that, as hypothesized, there was a significant difference between scores of CC deletion compared to the other three conditions averaged (F (1, 28) = 5.533, p = .026).

Reaction Time Data

Reaction times recorded for the 30 participants revealed that poor spellers did in fact take longer on average to answer the question, "Is the first sound gone?" In some conditions, the difference is larger than in others. For example, when there was no deletion in the task, participants reaction times were almost identical, compared to other conditions where the time difference is near an entire second. Also interesting is the reaction times observed for good spellers when the initial consonant of a consonant cluster was deleted. This was, in fact, the instance where on average reaction times were highest. Another prominent set of figures from this data set is the much larger standard deviation numbers for poor spellers. This set of numbers indicates that there was a greater amount of variability in reaction times among the poor spelling group, whereas the good spelling group's standard deviation rates indicate that they are more homogenous as a group. Reaction time data is shown below in Table 4:
Table 4: Reaction time data

In order to determine if reaction times were different between good and poor spellers, a repeated measures ANOVA was conducted. Once again, it showed that there was no significant difference between the groupings of good and poor spellers, disproving hypothesis 1 (F (3, 84) = 1.814, p > .05). This finding again disproves the hypothesis that performance on the analytic awareness task would be affected by spelling or reading ability.

Repeated measures ANOVA did indicate that there was an effect of condition on reaction times in the main experimental task (F (3, 84) = 12.869, p < .001), as found above for scores on the task. In order to determine if reaction times were in fact significantly different for the CC-deletion condition, a repeated measures ANOVA was conducted. When CC deletion reaction times were compared to averaged reaction time for the remaining three conditions it was revealed that once again, as hypothesized, there was a significant lag in reaction time for CC deletion condition (F (1, 28) = 8.178, p = .008).

7. Conclusions

The results of this preliminary data showed that, in general, there was not a significant difference between good and poor spellers on an analytic awareness task. This finding was observed in both scoring and reaction times recorded in the analytic task. Thus the initial hypothesis that reading and spelling ability would dictate performance on the analytic awareness task was observed in this study. This hypothesis was made based on the attested correlation between the two abilities. This finding suggests that contrary to the literature, the nature of the relationship between analytic awareness and reading and spelling ability is not straightforward. That is to say, the findings reported here support the notion that analytic awareness (commonly known as phoneme awareness) may not be hinged upon reading or spelling ability as the majority of the research suggests.

Deletion type in the non-orthographic phoneme awareness task significantly affected scores of all subjects. Regardless of spelling or reading ability, participants in this study showed difficulty performing an analytic awareness task when there was an entire onset (a holistic phonological unit) deleted. This result suggests that even good readers and spellers do not possess fully developed analytic awareness, as witnessed in their difficulty to distinguishing initial consonant of an onset cluster removal from entire consonant cluster removal. This may indicate that there are units involved in the process of reading and spelling other than the normally cited phoneme.
In general, it would appear that the results of poor spellers indicate the relationship between reading and spelling ability and the phonological ability here referred to as analytic awareness are not straightforward. If they were, the results here would have found significant differences between groups, as well as more homogenous, categorical results among poor spellers and readers. Instead the results show a greater range and variability among poor spellers, and no differences between the groups. These findings, coupled with the observed effect of deletion type in the non-orthographic analytic awareness task, conspire to provide an effective case against the notion that analytic awareness and the ability to read and spell in an alphabetic script are clearly related.

References


