NORTHERN ILLINOIS UNIVERSITY

Speech Measures as Early Indicators of Kindergarten Speech and Language Skills

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By

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ABSTRACT:

**Purpose:** The purpose of this study is to formulate early indicators for children at high risk for speech and language disorders. Indicators are important for acquisition of language from birth to age five.

**Method:** Five children were assessed twice. The first assessment occurred when children were between 18 and 22 months of age. Articulation rate, syllable structure level, and phonetic inventory were calculated based on a twenty-minute speech sample collected while the child played with mother. The second assessment occurred when children were five years old. A standardized articulation test, the Goldman Fristoe Test of Articulation-2, and a phonological awareness test, the Comprehensive Test of Phonological Processing were administered. Additionally, percent consonants correct was determined from 20 minute language samples obtained while the child played with mother.
**Results:** Although all children were developing as expected for the first assessment, two children scored below the expected level on Percent Consonants Correct. Retrospective evaluation of their conversational speech between 18-22 months of age found that one of the children had a lower syllable structure level than the other four children.

**Conclusion:** A syllable structure level of under 2.0 at 22 months may be predictive of speech impairment at age 5 years.
The most critical time period for language acquisition in children is from birth to five years of age (Hoff, 2005). In this development time frame, children are gaining control of their phonetic capabilities as well as developing sentence complexity and grammatical competence. Additionally, this time frame marks an important language word burst that builds and strengthens a child's vocabulary. (Hoff, 2005) However, language deficits are often not obvious to parents or teachers until a child is in preschool or kindergarten. This is because children's language skills are challenged in a school environment that requires more strenuous social and educational language tasks. Many of these skills were unforeseen in the home environment, such as interaction with age-appropriate peers or following directions instructed to a group. An unseen language deficit can negatively affect a child's social life as he or she struggles to communicate with peers. In addition, evidence shows that children with language impairment are at a much higher risk to struggle with important educational milestones, such as learning to read and write (Catts, 1993). By not being identified with language disorders until school, children lacking the language skills equivalent to their normally developing peers are already behind in their language learning development. (Hoff, 2005)

With earlier diagnosis of a language disorder followed by proper intervention and therapy, children can receive accommodations earlier in life and develop age appropriate language skills (Hoff 2005). It is both unpractical and financially unrealistic to expect every child to receive therapy at a young age to prevent language deficits when school-age; therefore, a type of screening or preliminary test is needed to diagnose young children at high risk to developing language impairments later. While an obvious conclusion in theory, the obstacle in practice has been the development of a speech or language measurement that predicts with accuracy the high probability of a language deficit at a later time. This study aims to obtain.
possible language indicators of children at 18-22 months that may predict language abilities when five years old.

The language measurements examined includes independent measures as well as relational measures. Relational measures are aimed to compare the child's production with expected targeted productions that would be used by an adult. Independent measures, however, have less of an emphasis on production errors compared to the target and are more focused on a child's ability to produce phonemes. These independent measures are especially important when measuring children ages 18-22 months because they are not expected to have complete competence of the English language or perfect articulation. With independent measurements, one can obtain a larger speech sample because he or she does not necessarily have to eliminate unintelligible or nonsense speech. (Bleile, 2004)

Method

Subjects

Five subjects volunteered their time in a response to flyers placed in various child-friendly places throughout the DeKalb community (Morris, 2009). Parents who responded to the flyers were mailed the Language Development Survey (Achenbach & Rescorla, 2000). The surveys were returned and calculated; children who scored above the 16th percentile (within one standard deviation of the mean) were asked to meet play sessions with his or her parent or guardian for further analysis (Morris, 2009). All five subjects were English-speaking, monolingual, and residing in the northern Illinois area (Morris, 2009). According to the Hollingshead SES scale, all children were profiled as middle class (Hollingshead, 1975). Parents
who brought children in for this study were compensated in the amount of twenty dollars (Morris, 2009).

*Speech Samples*

When the subjects were 18 to 22 months old, researchers recorded twenty minutes of speech. Each subject was recorded while playing with various toy sets with his or her caretaker or guardian. The toys included a farm set with animals, Lincoln Logs®, and a tea set. The subjects returned at age five to produce another speech sample. This sample was also taken as the child played with the aforementioned toys with his or her caretaker or guardian. (Morris, 2009)

Each speech sample was transcribed orthographically. Orthographical transcription is the process of listening to the speech samples and producing a written account, much like a script, of everything said by the subjects in the speech sample. An orthographical transcription is important for researchers to analyze syllable structure level, articulation rate, and many more speech-language related measurements.

In addition to orthographical transcription, phonetic transcription was also used. This differs from orthographic transcription because, instead of writing the intended word target of the conversation, one uses a special International Phonetic Alphabet (IPA) to write the specific sounds made to produce speech. This gives researchers more information about the subject’s production abilities instead of the intended speech. From this information, calculations such as phonetic inventory and percentage of consonants correct (PCC) were derived.

*Speech Sample Measurements*
Using the phonetic and orthographic transcriptions created from the speech samples, three measurements were calculated at 18 to 22 months: phonetic inventory, syllable structure level, and articulation rate. In addition, another type of speech measurement was taken from the five-year old speech samples.

Phonetic inventory lists the sounds made by the subject in the speech sample. To formulate this independent measure, one must examine the phonetic transcriptions and categorize the information according to manner of production and the position of the sound within the syllable. It is used as a measurement to show the extent to which the subject understands phonemic processes. (Stoel-Gammon, 1985)

Syllable structure level is the analysis of language complexity (Paul & Jennings, 1992). This is an independent speech measure that records syllable shapes, which are different consonant-vowel combinations, as well as information about phonetic inventory to rate the subject's syllabic complexity. To do this, each speech production is analyzed and given a hierarchical point value, which is then added all together and divided by the total number of words.

Articulation rate measures the speed of the subject's speech. The process of measuring articulation rate involves the careful dissection of a speech sample. By an acoustical analysis computer program called Speech Filing System (SFSWin), one can visually analyze the data to make careful and calculated temporal measurements such as length of utterance, pausing time, number of syllables in the utterance. Articulation rate is determined by counting the number of syllables produced and dividing that quantity by the amount of time taken to produce the
syllables. Because this measure is so precise with measures in the hundredths of a second, this was conducted by two trained researchers and their results were averaged together.

Using the five-year old speech sample, researchers also determined a percentage of consonants correct for each child. To calculate percentage of consonants correct, a relational phonological measure, one must first phonetically transcribe each word of speech from the speech sample. Then, these phonetic interpretations of each word are compared to the target word intended by the speaker. The number of consonants produced correctly and incorrectly is recorded and the number of correct consonants is divided by the total number of consonants to create a percentage. It is recommended to have a minimum of 180 words (words that are repeated may only be used once) in order to produce an accurate percentage.

Standardized Measurements

In addition to the speech sample analyses, each child was administered standardized tests at five years of age. The two tests given were the Goldman Fristoe Test of Articulation (Goldman & Fristoe, 2000) and the Comprehensive Test of Phonological Processing (C-TOPP) (Wagner, Torgesen, & Rashotte, 1999).

The Goldman Fristoe Test of Articulation is norm-referenced and criterion-referenced test to measure phonology and articulation. This is done by showing the subject pictures in order to elicit single-word production and narrative production for analysis. (McCauley, 2001)

The Comprehensive Test of Phonological Processing (C-TOPP) also measures phonological capabilities formally. A unique concept of this test is that it includes non-word repetition tasks in order to help in the assessment of phonetic ability. (Reed, 2005)
Results

First Assessment: Ages 18 months to 22 months

<table>
<thead>
<tr>
<th>Child Description</th>
<th>Syllable Structure Level</th>
<th>Phonetic Inventory (Initial, Final)</th>
<th>Articulation Rate (averaged)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1. Male at 18 mo. old</td>
<td>2.076</td>
<td>4,4</td>
<td>1.983</td>
</tr>
<tr>
<td>#2. Male at 18 mo. Old</td>
<td>2.222</td>
<td>7,4</td>
<td>2.036</td>
</tr>
<tr>
<td>#3. Female at 18 mo. old</td>
<td>2.330</td>
<td>6,4</td>
<td>1.76</td>
</tr>
<tr>
<td>#4. Male at 22 mo. old</td>
<td>1.936</td>
<td>12,3</td>
<td>2.629</td>
</tr>
<tr>
<td>#5. Male at 22 mo. old</td>
<td>2.370</td>
<td>6,4</td>
<td>2.26</td>
</tr>
</tbody>
</table>

Second Assessment: Ages 5 years, 0 months to 5 years, 2 months

<table>
<thead>
<tr>
<th>Child Description</th>
<th>Goldman-Fristoe Test of Articulation- 2</th>
<th>Comprehensive Test of Phonological Processing</th>
<th>Percentage of Consonants Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1. Male</td>
<td>110</td>
<td>132</td>
<td>91.9%</td>
</tr>
<tr>
<td>#2. Male</td>
<td>110</td>
<td>104</td>
<td>90.84%</td>
</tr>
<tr>
<td>#3. Female</td>
<td>102</td>
<td>100</td>
<td>84.8%</td>
</tr>
<tr>
<td>#4. Male</td>
<td>91</td>
<td>98</td>
<td>83.7%</td>
</tr>
<tr>
<td>#5. Male</td>
<td>95</td>
<td>115</td>
<td>81.25%</td>
</tr>
</tbody>
</table>

The tables pictured above display results from the tests and measurements at both the 18-22 month age range and at five years of age. As one can see, there are a wide variety and range of results according to the measurement administered.

At age five, most of the children are within normal ranges of both the Goldman-Fristoe Test of Articulation and the Comprehensive Test of Phonological Processing. Showing a below average score on the PCC were Child #4 and Child #5. Both of these children utilized phonological processes in their speech. There are patterns of errors that affect multiple sounds.
Scores under 85% indicate a severity range of mild to moderate disorder (Watson et al., 2003). Child #4 is now receiving speech-language therapy to improve his abilities.

Because Child #4 scored lower than the other four children in all five-year-old measures, his measurements at 18 to 22 months were compared to the other children in order to find variation that may be indicators of the later language deficits. Firstly, it must be noted that Child #4 was the only subject to score under 2.0 on the syllable structure level measurement. The predictability of SSL is not evident for Child #5 who also had a low score on the PCC at age five. However, he had the highest score on the syllable structure level measurement. Both phonetic inventory and articulation rate did not seem to be reliable indicators at this age to predict later speech problems. In fact, Child #4 had the highest number of initial phonemes compared to the rest of the children, as well as the fastest articulation rate. Child #5’s results were rather average among the others.

**Syllable Structure Level**

Syllable structure level measurements showed that Child #4 was the only subject to fall below 2.0 with a score of 1.936. However, he is still very close in measurement to Child #1, who scored 2.076. This is odd because Child #1 had very competent scores on the Goldman-Fristoe and CTOPP tests at age 5. The difference between these two children is that Child #1 was 18 months at the initial session while Child #4 was 22 months. The large amount of development that occurs within this four month period likely indicates that an SSL under 2.0 at 22 months is much more predictive of later problems than an SSL under 2.0 at 18 months.
Additional research with a large number of children at the age of 20 months may clarify the predictability of SSL.

**Phonetic Inventory**

Phonetic inventory at a younger age was not representative of a child's language ability when age five. The number of final phonemes used was very similar across the board and did not show any significant distinctions. In regards to initial phoneme, the child who had the highest number (and therefore, presumably the best language ability) was Child #4, the child who had the most language deficit at age five. Therefore, this measurement is not representative of later language capabilities. Child #5 had very average phonemic counts in both initial and final positions when compared to the other children, which also supports the evidence that phonetic inventory is not a reliable indicator.

**Articulation Rate**

This measure was also not a reliable indicator of future skills. Children #4 and #5 showed the highest levels of articulation rate. One may be tempted to draw conclusions from this, suggesting that these children were talking too fast, which is causing errors in speech or language. However, one can see that these two children were not faster by a significant margin in articulation rate than the other three children.

**Discussion**

From these conclusions, one can see that it is very difficult to pinpoint one exact test that will predict later language deficits with 100% accuracy. However, several of these tests, if
measured together, can collaborate evidence supporting that a child is at a high risk of having speech-language impairments at a later time. From this research, evidence points to syllable structure level at 22 months, may predict future speech skills at 5 years of age.

There are several concerns that must be considered and remembered with caution when deciding to use these measurements as indicators of later speech problems. One such concern is that syllable structure level is not a standardized measurement; the only age-appropriate data I had to compare Child #4 to for syllable structure level was the other four children, which is obviously an small sample. Therefore, it is inaccurate to draw vast conclusions from only five subjects. Future research should focus on repeating this study with a larger subject group and/or delving into research regarding normative syllable structure level scores for different age groups, particularly the age group of 18-22 months.

The percentage of consonants correct is a measurement that already has normative data and, therefore, different ranges of percentages to decipher the presence or severity of a disorder have been established. While this makes the measurement more reliable, I feel that it is important to note that one must acquire the minimum required total consonants of 180. Because of this requirement, a clinician may have to obtain more than twenty minutes of a speech sample, depending on the frequency of a child’s spontaneous speech.

Articulation rate and phonetic inventory were unreliable and unremarkable. In particular, researchers found articulation rate to be the most tedious, as well as debatable, measurement to calculate. This measurement was found using a special computer program, SFSWin, to examine each production. However, there were different opinions about when a phrase begins and ends between clinicians, as well as opposing views for phrases that occurred with loud background
noise or within the presence of another speaker. These speech samples were difficult to distinguish and caused variation between clinicians that could cause results to be unreliable.

This study provides preliminary insight into two measurements, syllable structure level and percentage of consonants correct, which when used together, may provide early indicators of speech-language deficits at age five. Further longitudinal research with more subjects must be conducted to repeat this study and find more correlation between early measurements and later language ability.
References


Hollingshead, A. A. (1975). Four-factor index of social status. Unpublished manuscript, Yale University, New Haven, CT.


