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An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
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Abstract

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Beginning readers decode words through pronunciation of the individual sounds represented by each letter in succession. This method requires not only the mapping of speech sounds onto their graphic representations, but also the more basic knowledge that words have the potential to be broken up into their component sounds, a skill called phonological awareness. Competency in phonological awareness is strongly associated with concurrent and later reading ability in young children, although the current literature posits that this knowledge only emerges at around 4 years of age. The accepted model of development postulates that phonological awareness is refined with increasing sensitivity to smaller intraword units. I proposed to test a different model that suggests phonological awareness undergoes a process of explicitization, such that early implicit and receptive knowledge later becomes accessible to explicit verbal report regardless of the size of the intraword unit. In this study, I aimed to determine whether 3.5- and 2.5-year-old children have receptive knowledge of phonological awareness that has been overlooked by the existing measures of this skill by implementing a novel measure with lower task demands. The results indicated that children at both 3.5 and 2.5 years old do possess receptive phonological awareness competency, and that variance in these abilities is predictive of improvement over a 6-month period. These findings challenge the accepted models of early phonological awareness development and urge further research into these abilities in very young children.

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Emergence and Development of Phonological Awareness in 2.5- and 3.5-Year-Old Children

The ability to read is a vital skill demanded by our streamlined, industrialized society. Children only learn to master this skill through overt instruction, and failure to learn early on in development severely hinders their ability to learn at all later in life (Moats, 1999). It is no wonder then, that there has been ample research into the most effective methods of teaching reading and of intervening to assist children with reading difficulties. Although children of socioeconomically disadvantaged home environments tend to have more trouble initially learning to read, successful teaching strategies can be employed in the classroom to overcome these obstacles and master the skill of reading (Moats, 1999; Moats & Foorman, 2003). From this perspective, much of the responsibility rests on the formal education system that typically begins with kindergarten at around five years of age. This study aims to determine whether children possess some of the basic language abilities that underlie reading skills before they receive any formal instruction. Competency in these skills would challenge not only the notion that preschool-age children do not yet have access to such knowledge but also the theoretical framework outlining the development of such abilities. This knowledge can aid in the detection of children at risk for reading delay and inform the creation of interventions to be employed early in development.

There is ample evidence that certain language competencies, which are refined over the course of development, are also highly associated with reading proficiency. Further evidence has demonstrated the particularly robust predictive value of a subset of these language competencies, so the current study used measures of this skill to determine how such abilities progress, within the model outlined by a theoretical framework of development.

Although most children are proficient language users before they begin to learn to read, subtle aspects of children's sensitivity to the structure of language are intrinsically related to later reading proficiency. For example, beginning readers will sound out words by identifying each sound in isolation, pursuant to the typical sound associated with each letter in succession. The successful identification of written language requires connecting individual sounds to form recognizable words. This process demonstrates understanding of the mapping of speech sounds (phonemes) onto written symbols (graphemes), which Juel, Griffith, and Gough (1986) term the “orthographic cypher.” In fact, early elementary school curricula involve teaching children to consciously deconstruct words in this way (Moats, 1999). The foundation for understanding that such mechanisms can be employed to read print symbols lies in phonological awareness, which is essentially the ability to divide words into smaller sound units. With this understanding comes the concept then that words share certain sounds, and one’s native language consists of a discrete set of phonemes, which when arranged in different permutations, create significant morphological (semantically meaningful) units.

In order for a native speaker to use language, she must have some implicit knowledge of phonemes, and this is why she would choose to articulate /k/ /a/ /t/ to refer to the small, furry animal instead of /b/ /a/ /t/. A fluent child using English would necessarily have to possess at least this level of knowledge of phonemes. It must either be the case then that children are innately equipped with higher order understanding of phonological awareness, or that phonological awareness skills become refined with experience over the course of development. In the latter case, there would be evidence of the progression of phonological awareness, beginning with knowledge that is incomplete in some systematic way and ending with adult-like proficiency.

The research in this field points to the latter explanation that children's phonological awareness competency increases over the course of early development, but the exact trajectory of this development remains unknown. A study of preschool-age children found a significant correlation of .6 between phonological awareness abilities and age, indicating that such abilities improve over development (Lonigan, Burgess, Anthony, & Baker, 1998). The older children demonstrated proficiency in all tasks, but the two-year-old subjects demonstrated little sensitivity to phonological awareness, only performing the blending tasks at the word level (*cow* + *boy* = *cowboy*), but not with intrasyllabic units, nonword syllables, or phonemes (mom + i = *mommy*; bro + ther = *brother*; /h/ + /a/ +/t/ = hat) (Lonigan, Burgess, Anthony, & Baker, 1998). Another cross-sectional study found that in typically developing children, phonological awareness abilities at the phoneme, onset/rime, and syllable level all increase fairly linearly from about 4.5 years old until about 7 years old, or from preschool to first grade (Thatcher, 2010). It is clear that phonological awareness competency increases over the course of development.

While cross-sectional studies demonstrate an overall increasing proficiency in phonological awareness, they fail to account for the developmental process within an individual. A longitudinal study of young and older preschool-age children found notable development in phonological awareness abilities between 3 and 4 year olds and between 5 and 6 year olds (Lonigan, Burgess, & Anthony, 2000). Overall, the results indicated robust stability in phonological awareness from late preschool and beyond, but that younger children showed less stability in their abilities, so that measures of phonological sensitivity at 3 years old did not reliably predict performance at 4 years old. The researchers posited that the lack of correlations could have been a result of the measures actually capturing letter knowledge and not phonological sensitivity. However, the researchers concluded that any intervention measures would only be helpful for older preschool-age children because it would be impossible to reliably separate out phonological awareness for the younger children (Lonigan, Burgess, & Anthony, 2000). They also concluded that word and syllable blending were superior to phoneme blending as predictors of reading ability (Lonigan, Burgess, & Anthony, 2000).

Another longitudinal study measured five different levels of phonological processing beginning in kindergarten and found that while individual differences across abilities were generally stable, each ability followed a predictable developmental trajectory over the two years of testing (Wagner, Torgesen, & Rashotte, 1994). This indicates that competency in phonological awareness at five years old is predictive of competency at least two years into the future. Significantly, this study did use several measures of phoneme-level discrimination in deletion, oddity, segmentation, and blending tasks, and only one measure of onset-rime level sensitivity. Therefore, it appears that phonological awareness abilities emerge relatively early in development, with some consistency at around 4 years old, and are then refined with age and experience over the early developmental years.

There are common established measures of phonological awareness that have been used throughout the literature. One such measure, the rhyming task, presents the subject with a stimulus and three options at test, one of which is the rhyming target. This task only measures syllable- and rime-level phonological awareness and is often regarded as a more superficial measure since rhyming capabilities account for no unique variance in language or reading skills and therefore may reflect a different underlying ability (Muter, Hulme, Snowling, & Taylor, 1998). Blending tasks present a set of stimuli and ask the subject to combine them together. Such tasks can be done at the word level (e.g. combine *cow* and *boy*), syllable level (e.g. combine *mo* and *ther*), the onset-rime level (e.g. combine /k/ and /at/), or the phoneme level (e.g.

combine /k/ /a/ /t/). Segmenting tasks are the reverse of blending, such that a whole word is presented, and the subjects are asked to parse it into a certain level of intraword units. Deletion, or elision, tasks require that children say a word but leave off one sound, typically at the beginning or end of the word. These tasks can also be accomplished at different intraword unit levels (e.g. say *cowboy* without *boy* at the end, or say *stop* without /s/ in the beginning). Oddity tasks present a stimulus and an array of test items, one of which is different from the others in the list based on a particular sub-word unit (e.g. initial or final phoneme, rime, or syllable). Sound matching/detection tasks use a similar format to the oddity task, but the target word now shares a particular sub-word unit with the stimulus. Each of these tasks has been used to measure performance at different levels of phonological awareness, and competency in each one has been shown to predict current and future reading ability.

There is overwhelming agreement in the field that phonological awareness, as measured by any of these tasks, is both highly correlated with and extremely predictive of both current and future reading ability (Bryant, MacLean, Bradley, & Crossland, 1990; Goodman, Libenson, & Wade-Woolley, 2010; Hulme, Hatcher, Nation, Brown, Adams, & Stuart, 2002; Lonigan, Burgess, Anthony, & Barker, 1998; Lonigan, Burgess, & Anthony, 2000; Snowling & Hulme, 1994; Juel, Griffith, & Gough, 1986). One longitudinal study of children ages 4 years 7 months to 6 years 7 months found that rhyme and alliteration both directly and indirectly, by improving sensitivity to phonemes, contributed to later reading ability (Bryant, MacLean, Bradley, & Crossland, 1990). The researchers used these results to propose a combined model of the influence of rhyme and alliteration on reading development. Another study found significant correlations between phonological awareness and reading ability for 5.5 year olds (Goodman, Libenson, & Wade-Woolley, 2010). Three separate measures of phonological awareness produced significant correlations: phoneme deletion (.61), blending (.69), sound matching (.80), and a significant composite score correlation was also calculated (.84) (Goodman, Libenson, & Wade-Woolley, 2010). Furthermore, a study of children in preschool found correlations between rhyme and alliteration tasks and reading measures in older preschool-age children (Lonigan, Burgess, Anthony, & Barker, 1998). Each of these studies suggests a strong relationship between phonological awareness abilities of varying levels of discrimination and both current and future reading abilities.

The predictive value of phonological awareness on reading ability has also been tested longitudinally. In one such study, the researchers were interested in the predictive value of several measures of individual differences on reading ability after one year and again after two years. The researchers used a verbal phoneme segmentation task as an index of phonological awareness skills at the start of the academic year in kindergarten, and also measured 38 other indicators of reading-related skills at that time, including letter names, vocabulary, sentence memory, word recognition, and spelling (Share, Jorm, Maclean, & Matthews, 1984). The results of this study demonstrated that phoneme segmentation had the single highest correlation with reading performance after both one and two years had elapsed since initial testing (.66 and .62, respectively), and that phoneme segmentation alone accounted for 39% of the unique variance in later reading achievement (Share, Jorm, Maclean, & Matthews, 1984). These data exhibited that of the 39 different measures of individual differences theorized or known to predict later reading ability, phonological awareness, as measured by oral phoneme segmentation, was the single strongest predictor. This provides powerful evidence for the relationship between phonological awareness and reading achievement.

All of these studies identified significant positive correlations between diverse measures of phonological awareness and reading ability. The size of the intraword unit studied, however, was quite varied across these studies. One model posits that reading necessitates understanding of the phoneme-grapheme mapping, the so-called "orthographic cypher," so it follows that children must first be able to identify individual phonemes in spoken language in order to piece together individual letters into whole words (Juel, Griffith, & Gough, 1986). In fact, the researchers indicated that without phonological awareness at the phoneme level, a child would not have sufficient knowledge to acquire reading proficiency (Juel, Griffith, & Gough, 1986). These researchers used several indices of phonological awareness at the phoneme level (segmentation, blending, deletion, and substitution) to measure this skill at the beginning of first grade, and they found that these skills were predictive of measures of reading performance, including word recognition, spelling, reading comprehension, and writing, both one and two years later (Juel, Griffith, & Gough, 1986). Therefore, at least for 6-year-old children, phonological awareness is a robust predictor of later reading achievement.

Juel, Griffith, and Gough (1986) simply theorized the overarching salience of phoneme-level awareness, as compared to larger intraword distinctions, in the prediction of reading ability, but other researchers have explored this possibility empirically. A longitudinal study measured reading ability and three separate measures of phonological awareness (detection, oddity, and deletion tasks), each at the onset, rime, initial phoneme, and final phoneme levels (Hulme, Hatcher, Nation, Brown, Adams, & Stuart, 2002). The results of this study indicated that for all three tasks, discrimination at the phoneme level was a stronger predictor of reading ability 7-14 months after the initial assessment, as compared to the predictive power of onset- and rime-level phonological awareness. Even after controlling for reading ability at the first test point, performance on tasks involving the manipulation of final phoneme stimuli still accounted for unique variance in time 2 reading level. So, while phonological awareness as a composite measure of differing levels of sensitivity is an accurate predictor of reading ability, awareness at the smallest, individual sound level is the single most powerful predictor.

Although there has been some debate over whether there is truly a difference in the predictive power of these abilities (Bryant, 2002), follow-up studies on these and other data have supported the fact that although rime awareness predicts future phonological awareness ability to some degree, phoneme-level awareness is a stronger predictor of these later abilities (Bowey, 2002; Hulme, 2002). Even though Lonigan, Burgess, and Anthony (2000) suggested that word- and syllable-level manipulations were better predictors of reading ability than phoneme-level discrimination, these conclusions were based on overwhelming floor effects on the phoneme-level tasks for the younger participants. When full variability in phoneme-level awareness is captured, it appears that this measure is the single most reliable predictor of concurrent and future reading abilities.

A separate study of older children clearly demonstrated how when full variability is indexed in phoneme-level sensitivity, this measure of phonological awareness is superior to others. The researchers performed a cross sectional study on 6-9 year old children to determine the predictive value of different levels of phonological awareness on both reading and spelling abilities. The children were given a phoneme segmentation task, an onset-rime segmentation task, a rhyme oddity task, and an initial phoneme oddity task (Nation & Hulme, 1997). In this study, while phoneme segmentation significantly predicted both spelling and reading performance, rhyming and onset/rime segmentation predicted no unique variance for either task, and alliteration categorization only significantly predicted reading ability (Nation & Hulme, 1997). Since the children in this age range were able to demonstrate their abilities in all levels of verbal phonological awareness tasks, the measures successfully reflected individual differences in competence. These accurate indices of phonological awareness skill at different intraword subunits then demonstrated the varying levels of predictive power granted by proficiency at each subunit on reading ability. Based on the evidence from such studies, it can be concluded that phonological awareness at the level of the phoneme is the strongest predictor of reading ability.

Theoretically, it should be the case that proficiency at phoneme-level discrimination translates to reading proficiency, since reading typically involves the mapping of those individual phonemes onto their graphical representations. Single letters, or sometimes groups of letters, represent distinct phonemes. Once a child understands that the word *cat* can be segmented into the phonemes /k/ /a/ /t/, then it is a logical progression to learn that the letters *c*, *a*, *t* map onto these sounds in the graphical representation.

In terms of the trajectory of phonological awareness competency, the current body of literature favors a developmental process of increasingly deeper level refinement. The existing evidence seems to indicate that children become sensitive to increasingly smaller intraword units, so that they first can only differentiate word-level differences (e.g. *doll – house*), then syllables (e.g. *bro – ther*), then onset-rime units (e.g. /b/ – *at*), and finally phoneme distinctions (e.g. /b/ /a/ /t/) (Lonigan, Burgess, Anthony, & Baker, 1998; Snowling & Hulme, 1994). This theory indicates that the improvement in phonological awareness abilities over time is due to an increasingly refined sensitivity to sub-word linguistic units, which supports the previously recorded evidence that very young children, at two and three years old, demonstrate no competency to small unit level phonological distinctions (Lonigan, Burgess, Anthony, & Baker, 1998).

In her book on cognitive development, Karmiloff-Smith (1994) proposes a developmental framework, which can also be applied to the emerging phonological awareness abilities observed in young children. According to her theory, such knowledge begins as implicit and then is "explicitized" such that it is available to conscious access and verbal report (Karmiloff-Smith, 1994). Early implicit and procedural knowledge can be used only in responding to the environment but cannot be analyzed or manipulated. Children understand they must use specific constructions to convey intended meanings (e.g. saying *cat* instead of *bat*), but they do not consciously understand the links between these constructions and the individual phonemes that comprise them (e.g. that *cat* and *bat* differ only in the first phoneme and that switching these phonemes changes the meaning of the word). Through "representational redescription" children may begin to understand these links but initially may not be able to verbally parse words; only later can children consciously access and verbally report such knowledge (Karmiloff-Smith, 1994).

Using the example of the words *cat* and *bat* then, we can understand the stages of this theory more clearly. In the early implicit stage, the child recognizes that *cat* and *bat* are different words referring to different concepts; such knowledge is available upon reaching fluency in a language. With later stages, links become available, and the child implicitly understands that *cat* and *bat* share some common sounds, or phonemes, but she cannot yet make any conscious use of this knowledge. Further development makes these links explicit but nonverbal, so the child will receptively understand that /k/ /a/ /t/ sounds more like *cat* than like *bat*, but she will be unable to consciously segment the word herself to identify the precise unit that distinguishes the two words. Finally, in the explicit verbal report stage, the child can verbally produce the segments /k/ /a/ /t/ in pronouncing the individual sounds that comprise the word *cat*. As Karmiloff-Smith emphasizes, however, the stages are not absolute for any given child, as she may have only procedural knowledge for some words or phonemes but consciously accessible knowledge for others.

This representational redescription model has several implications for the development of phonological awareness. First, the theory suggests that there is a developmental trajectory to the mastery of phonological awareness abilities such that the knowledge becomes more consciously accessible and more manipulable over time. This would indicate then that a child might have some knowledge of phonological awareness at any intraword unit level that is not yet available to conscious manipulation. In other words, a child may possess phoneme-level sensitivity but be unable to express such knowledge verbally. Furthermore, this model predicts different levels of phonological awareness such that tasks requiring verbal report may involve performance demands that are simply too difficult for young children to overcome. Most of the literature on phonological awareness and reading ability has employed verbal report as the response method to record performance, especially those studies that concluded the increasingly smaller intraword unit sensitivity theory of phonological awareness (Lonigan, Burgess, Anthony, & Baker, 1998; Snowling & Hulme, 1994). If it is the case that children have access to phonological awareness knowledge before they have access to verbal report of this knowledge, then it would seem that the current body of literature has overlooked the possibility that an emerging ability to gain explicit access to phonological structure may be evident earlier than previously believed. By requiring verbal report, established tasks measuring phonological awareness may be masking the critical components of the developmental process that inform how phonological awareness abilities emerge and grow.

While the previous research has been successful in heavily supporting the correlation between phonological awareness, especially at the phoneme level, and reading ability, and the existence of a developmental trajectory of phonological awareness capabilities, there are some notable problems with the previous research that this study aims to resolve. In many of these studies, the children being tested were already receiving formal reading instruction (Goodman, Libenson, & Wade-Woolley, 2010; Hulme, Hatcher, Nation, Brown, Adams, & Stuart, 2002; Share, Jorm, Maclean, & Matthews, 1984), which creates a significant confound in any of the interpretations of the results: while the researchers concluded that phonological awareness predicted the observed reading ability, perhaps it was the reading instruction that afforded the subjects with phonological awareness capabilities (Castles, & Coltheart, 2004). In fact, several studies have specifically noted the bidirectional causality between phonological awareness performance and reading achievement; while phonological awareness strongly predicted reading competency, letter identification more modestly had an impact on phonological processing (Wagner, Torgesen, & Rashotte, 1994; Snowling & Hulme, 1994). Additionally, in one particular instance, the researchers based their conclusion that earlier phonological awareness predicted later reading ability on a procedure that used different measures at the two time points; the "predictive" measures were rhyme, alliteration, phoneme deletion, and phoneme tapping for younger children and the "outcome" measures included reading, spelling, and arithmetic for the older preschool children (Bryant, MacLean, Bradley, & Crossland, 1990). This presents another problematic factor in the interpretation of any results.

Most significantly to the purpose of this study, Lonigan, Burgess, Anthony, and Baker (1998) concluded that 2 and 3 year olds do not yet have phonological awareness knowledge, since children this young performed at chance levels on their phonological awareness measures.

However, these measures required verbal responses, so they did not tap at receptive and not yet verbal understanding that these children may have possessed, as is predicted by the representational redescription model. Equally problematic were the stimuli themselves. Specifically, their blending task stimuli consisted of mostly compound words for syllable blending (presumably because the researchers believed younger children would not be able to blend non-words or phonemes), some smaller syllabic units, and only a few phonemes, of which there was only one minimal pair set. As pairs of words differing only in a single phoneme in the same location (e.g. *cat* and *bat*), minimal pairs are ideal for investigating phoneme-level sensitivity because differentiation between the two words requires discrimination at the level of the individual phoneme. Lonigan, Burgess, Anthony, and Baker (1998), however, used few measures of phonemic sensitivity, although it has been proven to be the most robust predictor of reading ability. Furthermore, there were severe floor effects for the 2 and 3 year olds, underscoring the problem that the measures used did not assess non-verbally accessible abilities.

In this study, I addressed these gaps by using age-appropriate measures with low performance demands so as to capture any available phonological awareness knowledge in young preschool-age children. I used only phoneme-level discrimination for three reasons. First, phonemic sensitivity is the single best predictor of future reading ability, so if these measures are to be used as reading difficulty assessments for young children, they should be accurate predictors of such reading ability. Second, affirmative evidence that young preschool-age children do possess phoneme-level awareness would seriously challenge the generally accepted model of increasingly refined intraword unit sensitivity. This would be strong support for the representational redescription model of developmental abilities and offer a new perspective on early childhood language development. Lastly, there is no evidence in the literature that children this young should have any explicit phonological awareness whatsoever. Therefore, evidence that they do in fact possess phoneme-level awareness will be all the more compelling and hopefully spur more research into the development of early pre-reading language skills.

More specifically, I addressed the gaps in the research by using a measure not requiring verbal report to test phoneme-level phonological awareness. Since no such measure existed previously, I created a forced-choice selection task. Due to the low task demands and motivated by the notion of explicit but verbally inaccessible phonological awareness knowledge, I predicted that there would be evidence of phonological awareness abilities in children younger than is predicted by the existing research. Since there is evidence of phonological awareness in 4-year-old children, I first investigated 3.5 year olds to explore early receptivity and validate the forced-choice task. Based on my findings with 3.5 year olds, I subsequently investigated receptive ability to exhibit phonological awareness in 2.5 year olds. Finally, I conducted an exploratory longitudinal investigation of the development of phonological awareness abilities by following up with a subset of the 3.5 year olds from the first experiment 6 months later.

Experiment 1

In Experiment 1, I sought to determine whether children at 3.5 years of age possessed some level of phonological awareness understanding that has been overlooked by established measures of this construct. I hypothesized that the reduced task demands of testing receptive phonological awareness would enable 3.5 year olds to demonstrate their competency with this language skill. Measures of general intelligence, verbal short-term memory, and productive phonological awareness were also included in order to account for any contribution of these extraneous abilities to performance on the receptive phonological awareness task.

Method

Participants

The study participants were 20 3.5 year olds (65% female) recruited from the Emory Child Study Center database, which is a list of families in the Atlanta metropolitan area who have expressed interest in having their children participate in developmental studies. The participants ranged in age from 3.39 years to 3.70 years (M = 3.51 years, SD = 0.083). The sample was comprised of 20% African American, 70% Caucasian, 5% American Indian, and 5% mixed ethnicity participants. Additionally, 5% of participants were Hispanic/Latino.

Materials

Two levels of phonological awareness were measured: receptive and productive abilities, including blending and segmenting tasks. In addition, measures of vocabulary level and verbal short-term memory were administered.

The receptive phonological awareness tasks involved 32 laminated picture cards, comprising 16 sets of minimal pair words and 4 additional cards with 2 sets of non-minimal pair words for training (see Appendix A for full list of stimuli). Each word contained three phonemes in consonant-vowel-consonant (CVC) structure. Eight of these minimal pairs had initial phoneme contrasts (e.g. cat/bat), and eight had final phoneme contrasts (e.g. bus/bug). The order of minimal pairs was randomized, and assignment of pairs to the blending and segmenting tasks was counterbalanced across participants. In total, there were 2 training pairs (repeated for training in both tasks) and 8 test pairs (unique sets of 8 for the two tasks) for each of the blending and segmenting tasks, totaling 30 pictures per participant. Two versions (1 and 2) of the task were created so that each of the 16 minimal pairs was used for blending in one version and segmenting in the other. The order of the stimuli was randomized, and the words were counterbalanced for right and left side in a third and fourth version.

In addition to the pictures, audio recordings of individual phonemes were created by a middle aged Caucasian female speaker who grew up in the south central United States and currently resides in the southeastern United States. The volume of each recording was equalized so that no one sound would be louder than any others when played. Individual recordings were then combined in order to form each three-phoneme word, and the duration of each clip was edited to span 2.0 seconds. All recordings were played on a laptop computer.

For the productive phonological awareness measure, a standardized measure, the Phonemic Segmentation Fluency (PSF) measure of the Dynamic Indicator of Basic Early Literacy Skills (DIBELS) was administered. The task involved one training item and 20 test items. Each test item contained three to five phonemes that comprise a familiar word. None of the words in the productive measure appeared in the receptive measure. The 20 different versions were randomly assigned to participants. This measure has a reliability of .88 for kindergarteners and a criterion validity of .43 to .65 (Good & Kaminsky, 1996).

The Peabody Picture Vocabulary Test 4th Edition (PPVT-IV) was used to measure vocabulary level of the participants. The PPVT is a well-established and commonly used measure of vocabulary and indirect index of general intelligence for children ages 2.5 years and older. The participant was presented with four pictures per page and asked to point to the picture showing a particular word (e.g. “Show me baby”). The task involved two training items and began on a page appropriate for the participant’s age group. The pages were grouped into sets of twelve items of similar vocabulary level, and each new set became progressively more difficult.

To measure verbal short-term memory load, I administered a task using small picture cards from a children's memory game in which children were given a list of items to locate from a set and had to remember the items long enough to locate the cards depicting those items. The cards depicted familiar items including animals, foods, and toys. Three progressively more difficult phases of this task, each involving three trials, were administered. The first phase used a 2x2 matrix in which the child was asked to find two pictures, the second phase employed a 3x3 matrix in which the child was asked to find three pictures, and the third phase comprised a 4x4 matrix, and the child was asked to find four pictures. Pictures were repeated across trials, but no two trials used the same combination of pictures.

Procedure

Each participant completed the four tasks. Because receptive phonological awareness in preschool-age children was the main skill of interest, the receptive measures of phonological awareness were administered first to each participant. This procedure ensured that the receptive measure was completed for each participant without the influence of fatigue from other tasks. After that, participants took a short play break to minimize fatigue. Then the other three measures (DIBELS, PPVT, and memory game) were administered in a random order.

Receptive phonological awareness was divided into two separate forced-choice tasks: blending and segmenting. The blending task measured children's ability to combine individual phonemes to form whole words without requiring them to produce an oral response. Subjects were told that they would look at two pictures and hear some funny sounds and then have to choose which picture best matched those sounds. For example, the child would be presented with two pictures: a cat and a bat. The experimenter named each picture and then said, "Now let's listen to the funny sounds." The child would then hear the recording of /k/ /a/ /t/, for example, and be asked to point to the picture for the word she heard.

The segmenting task measured children's ability to parse words into individual phonemes. The experimenter introduced the children to two puppets, LouLou the Ladybug and Christy the Cricket, instructing the children that they would see one picture this time, and that LouLou would label it one way, Christy would label it another way, and the child had to decide who said it right. For example, the experimenter revealed and named a picture of a cat, then said "LouLou says [and played the audio recording of /b/ /a/ /t/] and Christy says [audio recording of /k/ /a/ /t/], who said it right?" The child was asked to point to or name the puppet that "said" the word the right way.

For the DIBELS, the children were instructed that they would "say the sounds in words." The experimenter then demonstrated how to parse two words ("Listen to all the sounds in the word fan, /f/ /a/ /n/") and asked the child to try a third ("Now it's your turn. Can you say all the sounds in the word *soap*?"). They received corrective feedback, and repetition of the correct response was encouraged. Then testing would begin, and the experimenter would ask the child to say the sounds in each of 20 words on the list, and testing was stopped after the time reached one minute, pursuant to standard DIBELS administration. As the child responded, the experimenter underlined the segments produced for each word. The total score was the number of segments produced, summed across trials.

In the PPVT-IV task, children first completed a training page where the experimenter instructed them to touch their finger to the picture that showed a specific word and then asked them to locate two of the four pictures depicted on the page. If the first two items were correctly identified, the children moved on to test items. If the child did not correctly identify the first two, the third and fourth items were tested. If the child got all training items wrong, testing was discontinued. The test was divided into blocks of 12 words each of a similar vocabulary level, which got progressively more difficult as the task went on. The test was continued until the child responded incorrectly on 8 trials in any given block.

The memory task was designed to measure verbal short-term memory capacity. The first phase involved the experimenter placing 4 cards facedown on the table and asking the child to find 2 objects in particular (e.g. "We're going to find the ball and the shoe"). The experimenter then flipped over the pictures and asked, "Which ones did I say to find?" The first two choices were recorded. Two more trials of the same difficulty were administered. Then three trials were administered in which children had to remember which 3 pictures the experimenter wanted from a set of 6, and then 3 trials in which children located 4 pictures out of a set of 8. A total score was computed by adding up trials of 100% accuracy. In order to account for the increasing difficulty of the successive levels, the number of accurate trials was then multiplied by a weight of 1 for the first level, 2 for the second, and 3 for the third level.

Results

I hypothesized that 3.5 year olds would succeed on the forced-choice versions of both the blending and segmenting tasks. To first analyze these data, I compared 3.5 year olds' performance on this task to chance levels (a correct response rate of .50). I calculated accuracy scores separately for the blending and segmenting tasks and also averaged them to generate a composite score. I also investigated whether performance differed for word-initial (e.g. *cat* vs. *bat*) and word-final (e.g. *bug* vs. *bus*) phoneme contrasts in each of the forced-choice tasks.

3.5 year olds' performance was compared to chance on the forced-choice task using one-sample t-tests (see Table 1 for means and standard deviations). The results of the t-tests indicated that the composite forced-choice score was significantly above chance performance, $t(19) = 3.188$, $p = .005$. Analyzed separately, blending and segmenting were both significantly above chance, $t(19) = 3.473$ and 2.163, *p's* = .003 and .044, respectively. Within the blending skill, both initial phoneme contrasts and final phoneme contrasts were also significantly above chance performance $t(19) = 2.602$ and 3.138, *p's* = .018 and.005, respectively. Within the segmenting task, neither initial nor final phoneme contrasts examined independently exceeded chance responding.

I also investigated whether performance differed for the different skills (blending and segmenting) and whether this varied as a function of the different contrast positions (initial and final phoneme) in 3.5 year olds' performance on the forced-choice task. To test this, I performed a 2x2 repeated measures ANOVA (skill: blending v. segmenting x contrast: initial v. final). This revealed no significant main effects or interaction effects. Performance did not differ reliably across tasks.

Finally, I wanted to test the hypothesis that measures of individual differences across children, including the PPVT, DIBELS, and memory task, would predict performance on the forced-choice task. To do this, I first calculated Pearson correlation coefficients among the composite score, total blending, total segmenting, PPVT score, and DIBELS. I used a Spearman correlation to calculate correlations with the memory scores because these were based on an ordinal scale of measurement (see Table 2 for correlations matrix). Aside from the three measures of receptive phonological awareness, the only other significant correlation was between memory and PPVT scores ($\rho = .608$, $p < .01$).

I then performed a multiple regression analysis in which I regressed PPVT, DIBELS, and memory scores on the composite receptive phonological awareness score. This analysis yielded a marginally significant regression equation, $F(3, 16) = 2.432$, $p = .103$, in which both PPVT and memory scores reliably predicted performance on the forced-choice task ($\beta = -.582$, $p = .058$; $\beta = .725$, $p = .019$, respectively) (Table 3). This suggests that performance on the forced-choice task was, at least in part, attributable to overall cognitive ability. The lack of predictive relationship between the receptive measure of phonological awareness and the productive measure (as assessed by DIBELS score) was likely due to a floor effect on DIBELS performance.

Discussion

The results of this experiment revealed that 3.5 year olds performed better than chance on receptive versions of both blending and segmenting tasks. At the same time, these children demonstrated overwhelming floor effects on their performance on the productive measure of phonological awareness. This indicates that 3.5 year olds have some consciously accessible receptive phonological awareness prior to their ability to exhibit this knowledge using a productive measure. These results challenge the accepted knowledge in the field that children younger than about 4 years old do not have any phonological awareness competency at the phoneme level.

The analysis of different levels of skill (blending vs. segmenting) and contrast location (word-initial vs. word-final) showed no significant main effects or interactions, suggesting that 3.5 year olds did not perform significantly differently as a function of the particular level of each variable, even though performance was slightly better overall on the blending tasks.

The results indicated that performance on the receptive measures was predicted, at least in part, by individual differences in vocabulary and memory. There was no significant correlation between the forced-choice task and the DIBELS, but this was likely due to the large floor effect performance on the DIBELS task. Most of the 3.5 year olds refused to produce a response or simply did not know how to respond when being asked to segment words orally. This underscores the problem with existing measures of phonological awareness in that the DIBELS missed much of the variation captured by the forced-choice task.

Experiment 2

The results of the first experiment indicated that despite accepted findings in the field, 3.5 year olds do possess some phonological awareness competency at the phoneme-level and that this knowledge is receptive in nature. This discovery motivated the exploration of these receptive abilities in even younger children at just 2.5 years of age. In Experiment 2, I replicated the forced-choice procedure used in Experiment 1. I also attempted to collect the additional measures (DIBELS, PPVT, and memory task) with this age group, but the younger children tended to become fatigued and even when they did attempt these tasks, their performance often showed overwhelming floor effects. Therefore, although I collected data on all measures when possible with this age group, I only reported analyses on the forced-choice data for the 2.5 year olds.

Method

Participants

The study participants were 20 2.5 year olds (45% female,) recruited from the same Emory Child Study Center database as used in Experiment 1. The children were 2.41 years to 2.67 years old (M = 2.51 years, SD = 0.070). The sample was comprised of 20% African American, 55% Caucasian, 10% Asian, and 15% mixed race participants. There were also 10% Hispanic/Latino participants.

Materials

The same materials were used as in Experiment 1.

Procedure

The procedure was the same as that described in Experiment 1. Because these younger children had considerably more limited attention spans than the 3.5 year olds, many of the participants were unable to complete all four tasks. All completed the receptive phonological awareness tasks, which were administered first each time. Due to revisions in the procedure and fussing out of several participants, 13 participants completed only the receptive measure and 7 completed all 4 tasks, but I only conducted analyses on the receptive measure.

Results

As in Experiment 1, I compared 2.5 year olds' performance on the forced-choice versions of the composite, segmenting, and blending tasks to chance performance (.50). These one-sample t-tests revealed that 2.5 year olds performed significantly above chance on the composite measure, $t(19) = 2.792$, $p = .012$ and on the total blending task, $t(19) = 3.107$, $p = .006$ (see Table 1 for means and standard deviations). Performance on the segmenting task did not differ significantly from chance levels. Within the blending skill, 2.5 year olds performed better than chance on final phoneme contrasts, $t(19) = 3.577$, $p = .002$ but not on the initial phoneme contrast subset.

Next, I conducted a 2x2 repeated measures ANOVA with skill and contrast location as the two within-subject factors. This test revealed a significant main effect of skill on performance, $F(1, 18)= 5.153$, $p = .035$, with significantly better performance on the blending task than on the segmenting task (Table 1). There was neither a main effect of phoneme contrast location nor an interaction effect.

I then conducted a cross-experiment analysis to compare performance on the forced-choice task at the different age levels. I conducted a 2x2x2 mixed-model ANOVA with skill and contrast location as within-subject factors and age as a between-subjects factor (Figure 1). The results of the ANOVA indicated a significant main effect of skill, $F(1, 38)= 5.540$, $p = .024$ indicating better performance on the blending than the segmenting task, echoing this finding among the 2.5 year olds' performance. There was also a marginally significant main effect of age with 3.5 year olds exhibiting higher accuracy overall, $F(1, 38)= 3.587$, $p = .066$. There were no other significant effects.

Discussion

After I discovered that 3.5 year olds were consistently performing better than chance on various subsets of the receptive phonological awareness measure, I wondered whether children one year younger would possess the initial phases of these abilities. The data showed that 2.5 year olds performed above chance on overall blending, final phoneme blending, and the composite score. This finding is even more surprising than that in Experiment 1 because it appears that children demonstrate some degree of competence in phoneme-level phonological awareness tasks a full year and a half before the literature posits they should be capable of doing this.

Interestingly, the pattern of above-chance performance differed by age. While the 3.5 and 2.5 year olds performed above chance on several of the same individual tasks, there were two tasks on which only the older children demonstrated consistent competence. The 3.5 year olds performed significantly above chance on initial phoneme contrast blending and overall segmenting, whereas the 2.5 year olds did not. These results indicated developmental improvement in phonological awareness skills in the year between these two groups as indexed by these forced-choice measures. It seems that initial phoneme contrasts and segmenting tasks may be more difficult for the younger children, but achievement in these tasks improves over just one year. There is no existing account in the literature for such differences in performance due in part to the overwhelming underperformance of children in this age range in previous studies (Lonigan, Burgess, Anthony, & Baker, 1998; Lonigan, Burgess, & Anthony, 2000). These results suggest there are emerging phonological awareness skills even at this early stage in development and that there is significant change in the year between 2.5 and 3.5 years of age.

Experiment 3

In Experiments 1 and 2, 3.5 and 2.5 year olds exhibited competency on the novel measures of receptive phonological awareness used in this study. Their performance provided evidence of some understanding of phonological awareness at earlier stages in development than is supported by existing literature. As predicted by the literature, neither of these groups of young children performed well on the DIBELS task, the standard measure of productive phonological awareness ability. The questions remained of whether the abilities captured by the receptive phonological awareness task are stable over development and whether they are actually the same skills measured by the DIBELS at later stages in development.

In order to test this hypothesis, I did an exploratory investigation by completing a follow-up session with 6 of the 3.5-year-old children who participated in Experiment 1. By measuring the same children's performance on all tasks at a later time point, I was able to determine both if there was stability in performance on the receptive measures of phonological awareness within the individual (i.e., if there were significant correlations between time 1 performance and time 2 performance on the forced-choice task), and if these novel receptive measures of phonological awareness at time 1 shared significant correlations with the valid and accepted measure of productive phonological awareness (i.e., DIBELS) as measured at time 2.

Method

Participants

The study participants were 6 of the 3.5 year olds who participated in Experiment 1 (50% female). The families were contacted about 5 months after their first visit and asked to participate in a follow-up study at the 6-month mark from their first visit. At the second visit, the children were 3.9 years to 4.2 years old (*M* = 4.03. years, *SD* = 0.100). This small sample was comprised of 1 African American, 4 Caucasian, and 1 mixed race participants, none of whom were Hispanic/Latino.

Materials

The same materials were used as in Experiment 1.

Procedure

The procedure was the same as that described in Experiment 1 with all four tasks administered again at the second visit. In order to control for the possible effects of learning, the children received a different version of each task from the one they used in the first visit (i.e., the counter-balanced version of the receptive measure, a different version of DIBELS, and different words to find in the memory task). The same PPVT-IV was administered.

Results

In Experiment 3, I conducted a six-month follow-up visit with six of the 3.5 year olds who originally participated in Experiment 1 (see Table 4 for means and standard deviations of this subsample at each time point). In order to explore the hypothesis that performance at 3.5 years old would predict performance at 4 years old across measures, I performed a series of Pearson correlations on the longitudinal mini sample. Although such a small sample size requires cautious interpretation, I believed that this exploratory analysis would be suggestive.

The test revealed eight significant correlations between the two time points involving the receptive measures of phonological awareness, of which seven involved blending scores either at the earlier or the later testing point (Table 5). Even of the correlations involving the receptive measures of phonological awareness that were not significant, ten had very high values of over .6, and an additional seven had correlations of over .5. With a larger sample size and more power, many more correlations would probably reach levels of significance.

This indicates that there was stability in receptive measures of phonological awareness in that there was consistency between performance on certain tasks at 3.5 years old and performance on other tasks 6 months later. Most importantly, the composite and blending phonological awareness scores at Time 1 showed a significant correlation with DIBELS performance at Time 2. Although the sample size was small, this provides compelling evidence of the validity of the novel receptive measure of phonological awareness as an index of emerging ability related to subsequent productive ability.

Discussion

In the third experiment, I explored the developmental trajectory over a 6-month period to determine both whether receptive phonological awareness abilities early on are predictive of these corresponding abilities 6 months later and whether the novel measure of receptive phonological awareness created for these experiments was a valid index of this construct.

I found several significant correlations between performance at 3.5 years old and performance 6 months later in the small longitudinal group. Notably, performance on initial phoneme blending at the first time point rendered strong correlations with final phoneme blending, overall blending, and the composite score at the second testing session; overall blending at time 1 had a significant correlation with total blending at time 2. Of the eight significant correlations then, four of them involved blending in some capacity at time 1, and an additional 3 significant correlations involved blending at time 2. It seems then that blending is a robust predictor of later phonological awareness abilities. This may reflect the fact that blending scores were more variable across the 3.5-year-old participants whereas segmenting had a truncated range of scores. However, all results should be interpreted cautiously, as these analyses are merely exploratory and based on a small sample size. Also, the Pearson correlation coefficient is very susceptible to the influence of outliers.

The exploratory longitudinal follow-up provided an opportunity to attempt to validate the novel forced-choice task as a measure of receptive phonological awareness. There was a significant correlation between the composite receptive phonological awareness score at the first testing session and the DIBELS performance at the second testing session. This is only based on 6 participants, 2 of whom received scores of 0 on the DIBELS at the second testing session, but even so, three of the forced-choice task components at time 1 were significantly correlated with DIBELS scores at time 2, and the non-significant correlations all had values greater than .55. This suggests substantial validity for the forced-choice task as a measure of some construct (what I have deemed receptive phonological awareness) that accurately predicts future performance on an already valid task measuring a related construct (in this case, productive phonological awareness). Future research should continue to use and refine this measure.

General Discussion

For both 3.5 and 2.5 year olds, overall receptive phonological awareness at the phoneme level was significantly better than chance. This alone necessitates reexamination of the established model of the developmental progression of phonological awareness in the literature. Experts currently espouse the model that phonological awareness abilities are refined linearly along the dimension of increasingly smaller intraword units, so that children are first only sensitive to word-level units, then syllable level, then onset-rime, and finally individual phonemes (Lonigan, Burgess, Anthony, & Baker, 1998; Snowling & Hulme, 1994). This theory has been supported by evidence that while children at 5 years old can reliably manipulate phonemes, younger children only perform consistently well when target units are larger (Lonigan, Burgess, Anthony, & Baker, 1998; Snowling & Hulme, 1994; Lonigan, Burgess, & Anthony, 2000; Wagner, Torgesen, & Rashotte, 1994).

This study provided evidence that the existing literature does not tell the whole story. Existing measures often require verbal report in order to capture phonological awareness abilities. However, the representational redescription model posits that instead of following a developmental refinement based on increasingly smaller levels of intraword units, phonological awareness may actually undergo a process of explicitization, such that children start out with implicit knowledge of all intraword unit manipulations, regardless of size, and this knowledge becomes more readily cognitively accessible over the course of development. Before the knowledge is explicitized then, it is inaccessible to verbal report and would be overlooked by measures requiring such a response. Our study captured this receptive ability through a novel forced-choice task requiring simple selection between two pictures or two puppets.

Significantly, of the two receptive measures, the blending scores for both age groups were the abilities that surpassed chance accuracy to a greater extent for the 3.5 year olds, and singularly for the 2.5 year olds. Overall, the participants demonstrated less competence on the segmenting tasks. I posit two possible explanations for this phenomenon. First, perhaps segmenting is simply a more difficult task requiring more explicit manipulation of the phonemes. While blending requires the combining of provided phonemes (e.g. blend /k/ /a/ /t/ into *cat*), segmenting requires the parsing of a whole word into its individual phonemes (e.g. *cat* is comprised of /k/ /a/ /t/). In the former, the individual receives the phonemic information and is tasked with linking this clearly incomplete data together into a more cohesive and readily available whole; this whole unit is more readily available because it is the more familiar format in which individuals typically experience word forms. This is similar to the way in which beginning readers are instructed to sound out the words on the page because individual sounds lend themselves to combination into word forms that match meaningful units in the mental lexicon. The case of segmenting provides the individual with the readily identifiable and meaningful whole word information, which therefore requires moving from a more to a less familiar representational format, requiring decomposition into individual phonemes that have no semantic meaning.

The possibility cannot be ruled out, however, that the task demands for the segmenting measure were simply too high for such young children. Perhaps these young children are able to segment words receptively, but the memory load of this task precluded them from demonstrating this ability. The blending task required manipulation of only three phonemes in working memory in order to compare them with two presented pictures. The segmenting task, however, required the children to manipulate two three-phoneme sets in working memory, as “produced” by the two puppets, in order to compare each set to the presented picture. In the regression analysis of the 3.5 year olds’ performance on the individual differences measures as predictors of receptive phonological awareness performance, the equation reached a level of marginal significance, and the beta weight of the memory task was significant, indicating that perhaps memory was a contributor to performance on the forced-choice task.

Furthermore, although both 3.5 and 2.5 year olds exhibited above chance performance on several receptive phonological awareness tasks, the patterns of performance differed by age. 3.5 year olds performed marginally better overall than their 2.5-year-old counterparts. However, 2.5 year olds' performance on the final phoneme blending task was almost at 3.5-year-old levels. There seems to be a developmental trajectory in which not only does the blending skill develop earlier, but final phoneme contrasts are also slightly more identifiable.

The trend towards developmental change between 2.5 and 3.5 years of age should be interpreted with caution given that the effect of age was marginally significant. Perhaps with more power and a larger number of trials to increase the variance, there would emerge a significant and clearer main effect of age, providing stronger support for the trend of developmental improvement at this young age, whereas the current literature posits no such improvement should occur this early in development.

The longitudinal follow-up with the subsample of 3.5 year olds revealed that there were strong correlations between a child's receptive phonological awareness at 3.5 years of age and her corresponding abilities 6 months later. This indicates that receptive phonological awareness develops predictably over these 6 months, even though the current literature espouses the idea that phonological awareness abilities, at least as measured by available tools, are not stable until about 5 years of age.

Additionally, the exploratory longitudinal study helped to validate the forced-choice task as a measure of receptive phonological awareness ability. Significant correlations between time 1 receptive phonological awareness scores and time 2 DIBELS scores demonstrated the predictive and construct validity of the forced-choice measure. The non-significant correlations were still quite high in value, suggesting that perhaps there was simply not enough power or variability in scores to reach levels of significance. Future researchers should take this into account and administer more test trials to more subjects.

Limitations

One of the main limitations of this study was the novelty of the measure used to index receptive phonological awareness, which was the main variable of interest. Because this task was an invention, it had no established validity as a measure of the very skill it purported to measure. I addressed this limitation by finding a significant correlation between this novel measure, which captures more variance at younger ages, and an established measure indexing a parallel ability when it emerges at older ages. However, the significant correlation does not inform the direction of the relationship, so it remains unclear whether the forced-choice task performance is predictive of or predicted by the DIBELS scores. Further research with larger sample sizes should be used to illuminate this relationship and ultimately determine the validity of the forced-choice task as a measure of receptive phonological awareness ability.

Additionally, since individual difference factors were intentionally controlled for in this study, the number of forced-choice trials was limited by factors such as fatigue and boredom. Only 16 forced-choice trials, 8 blending and 8 segmenting, were administered to each participant, so the amount of variability across subjects was somewhat limited. Future studies should employ more trials of each task in order to increase variability among the scores, which could potentially reveal more significance in the existing findings or provide additional findings.

Overall, the children performed worse on the segmenting task, and this could be attributed to the level of explicit phonological awareness demanded by this skill or potentially to the task demands. Perhaps the 2.5 year olds did not understand what was being asked of them, or that the two puppets were producing sounds related to the picture presented to them. It is worth mentioning that the sounds “said” by each puppet were the voice recordings of the same woman. It may have been the case that the 2.5 year olds did not realize these identical voices were supposed to represent the two different puppets’ articulations. These issues could be reconciled by first determining whether 2.5 year olds understand their role in the segmenting task by lowering task demands perhaps by making the stimuli whole words instead of segmented words. Second, having two different people record the phonemes so that the two puppets actually have discriminable voices could also lower task demands by making the presentation less representational in nature.

Finally, there were certain minimal pair stimuli on which the participants performed worse overall (See Appendix A). It seems that these performance issues were not related to the types of phoneme contrasts, since performance was not consistent along this dimension, but perhaps reflected other factors, such as familiarity with or affinity for the pictured object. The particular word stimuli were chosen because they were thought to be common and recognizable items for these children. Future research should validate these stimuli by testing their salience among 3.5- and 2.5-year-old children to determine whether that is the case.

Implications and Future Directions

Many of the findings in this study are extraordinarily novel contributions and can greatly inform our understanding of the development of phonological awareness in young children. Based on the overall above chance performance of both the 3.5 and 2.5 year olds, it seems that even before formal instruction, children possess at least some of the language abilities required for learning how to read. This knowledge is receptive in nature, so it may not yet be available to explicit and verbal manipulation by these children, but it can be tested through receptive measures. This study demonstrated the validity of the forced-choice task in capturing receptive phonological awareness knowledge.

Further investigation should be conducted into the power of this measure and these particular stimuli. Future studies with more trials of each level of skill (blending and segmenting) and contrast location (initial and final) could potentially reveal even more significant differences or correlations.

Furthermore, the non-significant correlation between the forced-choice task and the concurrent DIBELS segmentation task could be explained by the representational redescription theory. While the forced-choice task measured receptive phonological awareness, the DIBELS required explicit verbal report, which according to this model, is a higher level of phonological awareness ability. If these children do in fact possess receptive knowledge of phoneme-level distinctions, this does not imply that they are yet able to consciously verbally report this knowledge. Among the 3.5 year olds that achieved any score greater than zero on the DIBELS segmentation task, the variability was quite high, coinciding with the predictions made by the model that explicit knowledge does not emerge all at once, but becomes more accessible over time.

The investigative longitudinal follow-up study revealed surprisingly significant correlations with a very small sample size. This suggests a challenge to the proposition adopted by Lonigan, Burgess, and Anthony (2000) that phonological awareness abilities are too unstable before preschool to predict future performance, so any early reading interventions should not be implemented until school age. In fact, future longitudinal studies could potentially uncover more significant correlations than were captured here with the limited sample size. It seems that early intervention to prevent reading difficulties could be implemented earlier than commonly believed, which would greatly enhance the effectiveness of these therapies.

Conclusion

This study demonstrated that children as young as 2.5 years old possess emerging knowledge of phonological awareness that could be contributing to pre-reading skills well before standard measures have been able to detect such language capabilities. There seems to be a systematic developmental emergence beginning with language use very early on, when children implicitly distinguish between phonemes to glean meaning from their infinite combinations. Over the course of development, this knowledge becomes more explicit and consciously available to manipulation, ultimately facilitating learning to read.

Contrary to the existing body of literature in this area, children have receptive access to phonological awareness skills well before formal instruction. This knowledge can be used to create benchmark measures indexing this ability in normally developing children in order to facilitate early detection of children at risk for reading difficulty. Because these abilities are stable, at least in children as young as 3.5 as discovered in this study, early interventions could then be employed even at this young age.

The developmental trajectory of phonological awareness is also brought into question by these experiments. Existing research has rarely examined children as young as 3.5 or 2.5 years old, claiming instead that children at these ages do not yet exhibit any of the skills that could be characterized as phonological awareness. Not only does it seem that these young children do possess such skills, but it also appears that they only have receptive abilities, which are not yet accessible to verbal report. Whereas the currently accepted model holds that phonological awareness skills develop through increasing sensitivity to smaller subword units, this evidence suggests that in fact the progression starts with receptive knowledge and develops into explicit and expressive knowledge at even the finest-grain level of analysis, the individual phoneme.

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Tables and Figures

Table 1. Means and Standard Deviations of All 3.5 and 2.5 Year Olds in Experiments 1 and 2

	3.5 Year Olds		**2.5 Year Olds**	
Task	**Mean**	**SD**	**Mean**	**SD**
Blending	.6667	.215	.6000	.144
Initial Phoneme	.6417	.243	.5375	.219
Final Phoneme	.6917	.273	.6625	.203
Segmenting	.6125	.233	.5000	.107
Initial Phoneme	.6250	.287	.5125	.309
Final Phoneme	.6000	.338	.4875	.286
Composite	.6396	.196	.5500	.080
PPVT	115.70	10.1		
DIBELS	4.50	7.1		
Memory	6.15	3.2		

Table 2. Simple Correlations between Measures of Individual Differences and Receptive Phonological Awareness in 3.5 Year Olds

	Blending	Segmenting	Composite	PPVT	DIBELS	Memory
Blending	_____	.533*	.864**	-.005	.159	.274
Segmenting		_____	.886**	-.152	.044	.223
Composite			_____	-.093	.113	.303
PPVT				_____	-.044	.608**
DIBELS					_____	.230
Memory						_____

*Correlation is significant at the 0.05 level.
**Correlation is significant at the 0.01 level.

Table 3. Multiple Regression with Memory, PPVT, and DIBELS Predicting Composite Receptive Phonological Awareness Scores in 3.5 Year Olds

	B	**SE *B***	***t***	***p***
Memory	.045	.017	2.611	.019
PPVT	-.011	.005	-2.040	.058
DIBELS	.000	.006	-.027	.979

R^2 = .313

Table 4. Means and Standard Deviations of the Subsample of 3.5 Year Olds in the 6-month Follow-up in Experiment 3

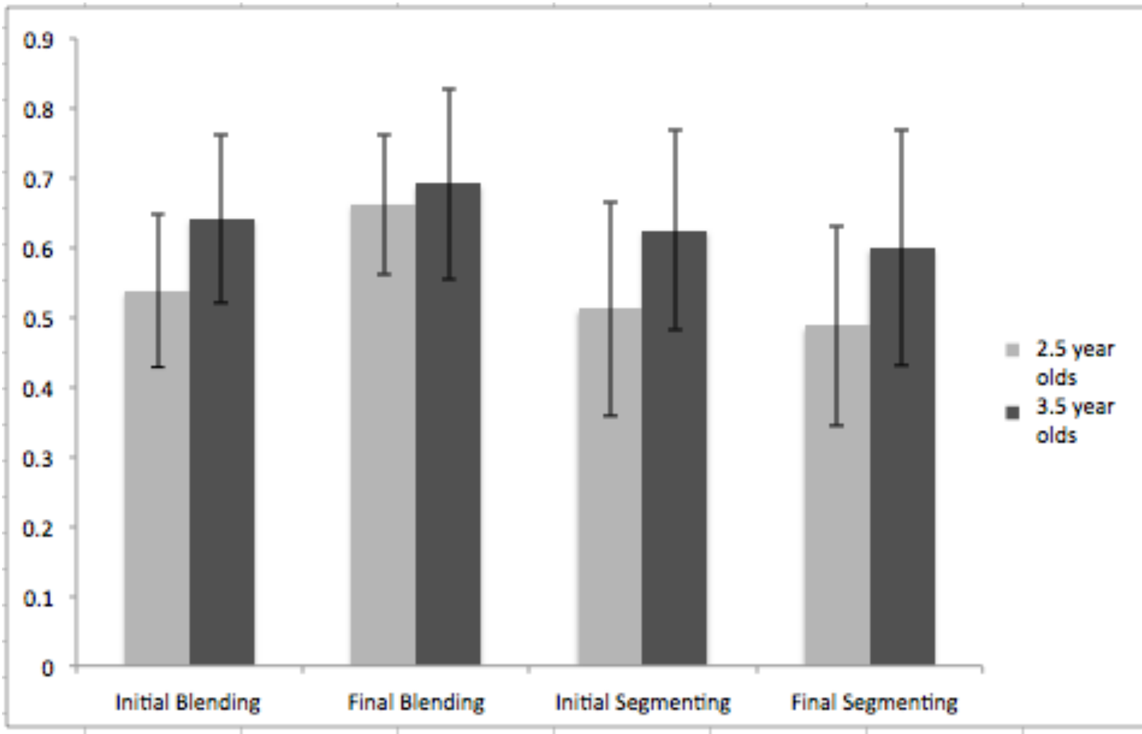
	3.5 Year Olds		**4.0 Year Olds**	
Task	**Mean**	**SD**	**Mean**	**SD**
Blending	.7153	.235	.7708	.200
Segmenting	.5833	.332	.7292	.166
Composite	.6495	.262	.7502	.163
PPVT	120.67	12.8	123.00	14.0
DIBELS	2.67	6.5	8.5	8.5
Memory	6.67	4.4	7.00	1.2

Table 5. Correlations Matrix between All Time 1 Measures and All Time 2 Measures for Longitudinal Subsample

		Time 2									
		Initial blend	**Final blend**	**Total blend**	**Initial seg**	**Final seg**	**Total seg**	**Comp**	**PPVT**	**DIBELS**	**Memory**
Time 1	**Initial blend**	.594	.884*	.977**	.548	.297	.505	.857*	.414	.554	.354
	Final blend	.675	.286	.543	.591	-.355	.162	.416	-.173	.863*	.000
	Total blend	.746	.617	.838*	.666	-.102	.352	.694	.078	.856*	.168
	Initial seg	.788	.104	.453	.485	-.438	.050	.303	-.179	.754	.000
	Final seg	.872*	-.107	.325	.721	.150	.528	.469	.523	.569	.645
	Total seg	.933**	.000	.438	.676	-.167	.321	.433	.188	.745	.357
	Comp	.926**	.277	.653	.727	-.151	.361	.585	.154	.856*	.302
	PPVT	.194	.037	.120	.140	.443	.337	.246	.866*	-.345	.445
	DIBELS	.542	.387	.561	.800	.542	.799	.751	.279	.838*	.775
	Memory	.743	.502	.745	.7966	.562	.807	.869*	.889*	.492	.788

* Correlation is significant at the 0.05 level.
**Correlation is significant at the 0.01 level.

Figure 1. Mean scores and standard deviations on receptive phonological awareness for 2.5 and 3.5 year olds.



Appendix A

Minimal Pair Stimuli Used in the Forced-Choice Task

Training Items	Initial Phoneme Contrasts	Final Phoneme Contrasts
Watch – gum	Cat – bat	Cake – cage
Pot - door	Goose – juice	Beak – beach
	Dish – fish	Bug – bus
	Can – fan	Dog – doll
	Sock – lock	Boat – bowl
	Hose – nose	Coat – comb
	Sun – one	Couch – cows
	Seal – wheel	Mail – man

Average Performance on the Forced-Choice Task by Phoneme Contrast Categories

Phoneme Contrast Categories	**Mean**	**SD**
Stop – nasal	.750	.44
Stop - fricative	.700	.46
Fricative – glide	.675	.47
Stop – stop	.650	.49
Fricative – liquid	.650	.49
Stop – liquid	.625	.49
Stop – affricate	.617	.49
Affricate – fricative	.600	.50
Liquid – nasal	.550	.51