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Learning Phonologically Specific New Words Fosters Rhyme Awareness in Dutch Preliterate Children

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How do children use phonological knowledge about spoken language in acquiring literacy? Phonological precursors of literacy include phonological awareness, speech decoding skill, and lexical specificity (i.e., the richness of phonological representations in the mental lexicon). An intervention study investigated whether early literacy skills can be enhanced by training lexical specificity. Forty-two prereading 4-year-olds were randomly assigned to either an experimental group that was taught pairs of new words that differed minimally or a control group that received numeracy training. The experimental group gained on a rhyme awareness task, suggesting that learning phonologically specific new words fosters phonological awareness.

Young children are surrounded by mysterious sounds and symbols: phonemes and graphemes. How do they make use of knowledge about spoken language when learning to read an alphabetic orthography? Because learning to read involves mapping graphemes onto phonemes, phonological knowledge (e.g., knowing how different words sound) is essential in becoming literate. In the current intervention study, the causal relations between phonological precursors to literacy are explored, focusing on speech decoding skill, phonological awareness, and lexical specificity, that is, the phonological specificity of words in preliterate children's mental lexicons.[1]

Known precursors to literacy include speech decoding skill and phonological awareness. Speech decoding skill refers to the ability to categorize the acoustic information in the continuous

[1]Note that lexical specificity could also refer to specificity of semantic information in the mental lexicon (Perfetti & Hart, 2002). However, the current study focuses on phonological specificity.

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speech stream into discrete units, such as phonemes or allophones, and hence recognize spoken words. Because of the inter- and intraspeaker variability in speech (McQueen, 2006), it is crucial to be able to decode spoken language in this way in order to learn words and develop a lexicon. Already at a very young age, infants have knowledge about the phonemic categories of their native language (Werker & Tees, 1984). By 10 months of age, infants have become less sensitive to contrasts between phonemic categories that are not relevant for their native language. The native language neural magnet theory states that the amount of sensitivity to irrelevant phonemic categories is negatively correlated with later language success (Kuhl et al., 2008; Kuhl, Conboy, Padden, Nelson, & Pruitt, 2005). In particular, children diagnosed with dyslexia show a higher sensitivity to irrelevant phonemic distinctions (Serniclaes, Van Heghe, Mousty, Carré, & Sprenger-Charolles, 2004). Furthermore, over the past years, many studies have suggested that reading problems, such as dyslexia, may be caused by underlying problems in speech perception (Manis et al., 1997, but see Boets, Wouters, Van Wieringen, Ghesquière, 2006). Thus, speech decoding skill and sensitivity for relevant phonemic categories seem to be correlated with later written language success.

A second precursor to literacy is phonological awareness, that is, the ability to consciously reflect upon and to manipulate speech sounds. Becoming phonologically aware involves focusing attention on the perceptual representations of speech. It develops from larger to smaller sound units, for example, from syllables to rimes to phonemes, as was shown in a study in which a large sample of preschool and kindergarten children were assessed on several phonological awareness skills of different levels of complexity (Anthony, Lonigan, Driscoll, Phillips, & Burgess, 2003; Stanovich, 1992). There is abundant evidence that phonological awareness is a predictor of emergent literacy in several alphabetic orthographies (Bradley & Bryant, 1983; Ehri et al., 2001; Vloedgraven & Verhoeven, 2007; Ziegler & Goswami, 2005) and that training phonological awareness enhances early literacy skills (Bradley & Bryant, 1985).

To become phonologically aware, a child has to be able to decode speech. Thus, speech decoding skill appears to be a precursor for phonological awareness and for print decoding (Chiappe, Glaeser, & Ferko, 2007; Nittrouer, 1996; Studdert-Kennedy, 2002). Furthermore, phonological awareness seems to be a precursor of print decoding in many languages (Bradley & Bryant, 1983; Ehri et al., 2001; Vloedgraven & Verhoeven, 2007; Ziegler & Goswami, 2005). However, speech decoding skill is a perceptual skill, whereas phonological awareness is a metalinguistic skill. Thus, apart from speech decoding skill and phonological awareness, a third phonological precursor to literacy appears to be required, one that mediates between decoding and phonological awareness. Because a crucial aspect of speech decoding (and language comprehension in general) is word recognition (McQueen, 2006), the lexicon or lexical knowledge may play this mediating role. More specifically, the degree of lexical specificity, that is, knowledge about how certain words ought to sound, may be important for phonological awareness. For daily communication purposes, underspecified lexical-phonological representations may sometimes be sufficient, but for detailed phonological manipulations, they may not be sufficient (Elbro, Borstrøm, & Petersen, 1998). In other words, for children to become phonologically aware and hence to be able to manipulate sounds in words, the phonological structure of the representations in their mental lexicons has to be specified to a certain extent.

With respect to the relation between spoken word recognition and emergent literacy, the lexical level appears to be particularly important for several reasons. First, phonological awareness develops from larger to smaller units (Anthony et al., 2003; Stanovich, 1992). Second, a child's vocabulary size predicts print decoding skill and/or phonological awareness (Garlock, Walley, & Metsala, 2001). Third, lexical neighborhood density of items in a phonological awareness task influences performance on that task (De Cara & Goswami, 2003). Accordingly, rimes of words from sparse phonological neighborhoods appear to be less segmentally specified than those of words from dense neighborhoods (Storkel, 2002). Fourth, lexical specificity influences phonological awareness and/or print decoding skill (Elbro et al., 1998; Fowler, 1991; Metsala & Walley, 1998).

In the current study lexical specificity is defined as the richness and specificity of, and distinctness between, phonological representations in the emerging mental lexicon. It evolves over time: Whereas initial lexical representations are holistic, they become more segmental through infancy and early childhood. Hence, lexical specificity is not a skill but rather a characteristic of lexical representations, developing over time from more global to more detailed. According to the lexical restructuring account, this increasing segmentation of phonological representations is driven by vocabulary growth (Metsala & Walley, 1998). With increasing vocabulary size, phonological representations need to become more specific. In a small vocabulary, representations can be holistic, because there is no need to disambiguate lexical items on fine-grained phonological differences (e.g., "bear" can be coarsely distinguished from "dog"). During the vocabulary spurt, however, as vocabulary size expands rapidly, phonological neighborhood density increases and children are more likely to encounter minimal pairs (e.g., "bear" — "pear"). This means that to disambiguate lexical items, representations must become segmentally specified in more detail (e.g., the representation of "bear" should be specific enough to disambiguate it from "pear"; a difference of only one acoustic-phonetic feature). Furthermore, with respect to inter- and intraspeaker variability, this disambiguation should also hold across speakers, speaking rates and phonetic environments, even though these factors can modify the speech sounds in these words extensively.

The lexical restructuring account states that vocabulary growth leads to increasingly segmental representations supporting spoken word recognition, which in turn lead to explicit access to phonemic units (Metsala & Walley, 1998). The lexical restructuring process also entails that what children know about phonemes evolves from implicit to explicit knowledge (Fowler, 1991). Furthermore, individual differences in phonological awareness and success in learning to read can be accounted for by individual differences in lexical growth and in lexical restructuring. Accordingly, Fowler (1991) states that the development of awareness of segments (i.e., syllable, onset/rime, phoneme) has consequences not only for phonological awareness but also for the way phonological representations are stored and structured. The way phonological representations are stored in the lexicon changes significantly. Hence, this restructuring is thought to be related to the development of phoneme awareness. Indeed, by integrating results from correlational, longitudinal, and intervention studies with adults and at-risk children, Elbro et al. (1998) showed that deficits in the quality or distinctness of phonological representations (i.e., lexical specificity) predict phonological awareness and dyslexia in preliterate children. This was also shown in a study by Elbro and Jensen (2005), in which the quality of phonological representations of dyslexic adolescents and reading-age controls (Grade 2 students) was trained. The dyslexic group gained less than the control group in the acquisition of new phonological representations and in a phonological awareness task with the trained words. Furthermore, Goswami (2000) combined several studies in different populations to propose that phonological-processing difficulties in dyslexia are caused by lack of distinctness and/or segmental specificity in phonological representations.

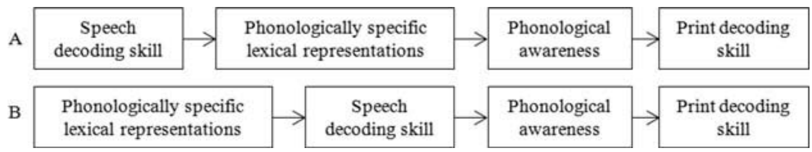

FIGURE 1 Two possible causal chains linking phonological precursors with literacy.

Lexical restructuring theories assume that this restructuring process extends into early childhood and well into elementary school years (Metsala & Walley, 1998). Based on results from studies with young children, however, one could argue that lexical restructuring happens earlier than this. Toddlers are already sensitive to very fine-grained differences in how words are pronounced (Swingley & Aslin, 2000; White & Morgan, 2008) and like adults, their interpretation of phonological detail is flexible (White & Aslin, 2011). Furthermore, McQueen, Tyler, and Cutler (2012) showed that phonological representations in 6-year-olds are abstract and detailed.

Assuming speech decoding skill and phonological awareness influence print decoding skill, the question that then arises is when and how lexical specificity comes into play. Here, two possible causal chains that could account for the apparent missing link between speech decoding, phonological awareness and emergent literacy are proposed (see Figure 1).

In the first account (Figure 1a), lexical specificity functions as a bridge between speech decoding skill and phonological awareness. In this account enhancements in speech decoding skill precede the development of phonologically specific lexical representations, which precedes the emergence of phonological awareness, which in turn precedes the growth of print decoding skill. Another possible causal chain (Figure 1b) puts lexical specificity before speech decoding in development. In this account, phonologically specific lexical representations give rise to enhancements in speech decoding skill, leading to the emergence of phonological awareness and ultimately print decoding skill. The current study explores the role of lexical specificity in these causal chains, by investigating the relation between lexical specificity and the known phonological precursors phonological awareness and speech decoding.

To recapitulate, lexical specificity appears to be an important factor in emergent literacy. However, the evidence is inconclusive concerning the causal relations of phonological precursors to literacy in prereaders. Previous research has mainly led to correlational evidence, either through studying children already receiving formal reading education or through looking into precursors for reading problems (Elbro et al., 1998; Elbro & Jensen, 2005; Goswami, 2000). To investigate the causal role of lexical specificity in normal emergent literacy, the current intervention study was set up. In an attempt to mimic the lexical restructuring process for a limited set of words, a protocol was designed to train prereading children (4-year-olds) to make new lexical representations more specific. The training protocol was presented to the children as a word learning game. In the protocol, children were taught new (i.e., unfamiliar to the children) spoken words, with subtle acoustic-phonetic differences, using pictures. Over the course of the training phase, the difficulty of the phonetic distinctions gradually increased, in two ways. First, there was a gradual decrease in the number of acoustic-phonetic features (i.e., place of articulation, manner of articulation or voicing). Thus, initially, children would encounter differences of two acoustic-phonetic features (e.g., the final consonants of *raap* [turnip] and *raaf* [raven] differ in place of articulation (bilabial vs. labiodental) and in manner of articulation (plosive vs. fricative)) but later would come across differences of only one phonetic feature (e.g., *raap* and *raat* [honeycomb] differ only in place of articulation). Second, initially, the unfamiliar words were paired with familiar words (e.g., *raap* and *raam* [window]), whereas in the latter part of the training protocol, only unfamiliar words were used (e.g., *raap* and *raat*). Thus, children were forced, over the course of training, to attend to increasingly subtle acoustic-phonetic differences, and they could only succeed in the test phase if they had learned the specific one-feature difference between the two words of each pair (e.g., *raap* and *raat*). The phonetic feature contrast type was manipulated, to ask whether children are more sensitive to subtle phonetic differences of a particular contrast type. Hence, the minimal pairs (with a difference of one acoustic-phonetic feature) differed either in manner of articulation, or in place of articulation, or in voicing. In addition to the phonetic feature contrast *type* manipulation, the phonetic feature contrast *position* was manipulated, to ask whether children are more sensitive to subtle phonetic differences at the beginnings of words than at the ends of words. In some trials, the phonetic feature contrast was on the initial phoneme (*lier* [lyre] – *nier* [kidney]), whereas on other trials, the contrast was on the final phoneme (*raap-raat*). It is important to note that the protocol did not train rhyme awareness; the children never heard both members of a minimal pair in the same trial, and successful word learning depended either on an onset discrimination (e.g., *lier-nier*) or discrimination between two different rimes (e.g., *raap-raat*).

To investigate the effect of lexical specificity training and the causal connections to other phonological precursors to literacy, tests of speech decoding skill (i.e., phoneme discrimination) and phonological awareness (i.e., rhyme awareness and phoneme identification) were administered before and after training. Furthermore, to look into the effect of lexical training on top of spontaneous growth in decoding skill and phonological awareness, in addition to the experimental group receiving lexical specificity training, a control group receiving numeracy training was assessed. To control for basic cognitive skills and to assess children's executive functioning, rapid automatized naming, and phonological short-term memory capacity were assessed. Both rapid automatized naming and phonological short-term memory are correlated with (among others) phonological awareness and early literacy at this age. Furthermore, these two measures are also considered to be phonological precursors to literacy (De Jong & Van der Leij, 1999).

In summary, the current study aimed to investigate the causal relations between lexical specificity and two known phonological precursors (i.e., speech decoding, phonological awareness). Specifically, the question was whether lexical specificity training could enhance these early literacy skills. If learning phonologically specified representations of new words gives rise to better speech decoding skill, which in turn leads to phonological awareness (Figure 1b), the training should enhance speech decoding skill and phonological awareness. If, however, a certain degree of speech decoding skill is necessary to develop phonologically specified new lexical representations, which in turn are necessary to become phonologically aware (Figure 1a), the training should not affect speech decoding skill but should affect phonological awareness.

METHOD

Participants

Forty children (20 male, $M_{\text{age}} = 53.43$ months, age range = 48–59 months) were randomly selected from three kindergarten classes of one elementary school in the south of the Netherlands. All children were monolingual, native speakers of Dutch. In the Netherlands, formal reading education starts in first grade, after two years of kindergarten. The children in the current study were in the first year of kindergarten. Teachers indicated that none of the children had developmental or language-related problems.

Materials

Training

Lexical specificity training. A training protocol was designed to train children to make new lexical representations more specific. It was presented as a word learning game. Twenty-four quadruplets of monosyllabic Dutch words were created (see Table 5), containing two unfamiliar target words (e.g., *raap, raat*), a familiar control word (e.g., *raam*), and an unfamiliar control word (e.g., *raaf*). Stimulus words were considered as familiar if they appeared on the Basiswoordenlijst Amsterdamse Kleuters [Basic Vocabulary of Kindergartners in Amsterdam, 2009] and as unfamiliar if they did not appear on this list. The target words were minimal pairs, differing on only one acoustic-phonetic feature (i.e., place of articulation, manner of articulation or voicing). The control words differed with the target words on two phonetic features. The two target words of each quadruplet were recorded by one speaker (a female native speaker of Dutch) and used as target sound files in the training protocol.

The contrast type and position were manipulated. In 13 of the 24 quadruplets, the minimal pairs differed in manner of articulation, in seven quadruplets the pairs differed in place of articulation, and the remaining four pairs differed in voicing. With respect to contrast position: In 16 of the 24 quadruplets, the phonetic feature contrast was on the initial phoneme, and in the remaining 8 quadruplets, the contrast was on the final phoneme. An overview of all quadruplets is given in the appendix.

The training protocol consisted of a practice phase (five trials), a training phase (96 trials), and a test phase (24 trials). Nine filler trials (highly familiar, phonologically unrelated target words) were included to keep the participants motivated. In the practice phase, the children were familiarized with the training protocol and the strategy that could be used (explained next). The training phase consisted of four blocks in which each quadruplet of items appeared once (see Table 1).

TABLE 1
Experimental Design and Examples

Block	*Experimental Condition*	*Example*
1. Training phase	Unfamiliar target word A	*raap* [turnip]
	Familiar control word	*raam* [window]
2. Training phase	Unfamiliar target word B	*raat* [honeycomb]
	Familiar control word	*raam* [window]
3. Training phase	Unfamiliar target word A	*raap* [turnip]
	Unfamiliar control word	*raaf* [raven]
4. Training phase	Unfamiliar target word B	*raat* [honeycomb]
	Unfamiliar control word	*raaf* [raven]
5. Test phase	Unfamiliar target word A	*raap* [turnip]
	Unfamiliar target word B	*raat* [honeycomb]

FIGURE 2 Trial design for the Lexical Specificity training, for a trial in the first block of the training phase.

On each trial, four pictures were shown on a computer monitor—two experimental items and two high-frequency phonologically unrelated fillers (e.g., pictures of a ball and a car; see Figure 2). In the first block, the two experimental items consisted of one of the unfamiliar target words in each quadruplet and its familiar control word. In the second block, the other unfamiliar target word in each quadruplet was paired with its familiar control word. In the third block, the two experimental items consisted of one of the unfamiliar target words in each quadruplet and its unfamiliar control word. In the fourth block, the other unfamiliar target word in each quadruplet was paired with its unfamiliar control word. In the test phase, the unfamiliar target words from each quadruplet were paired. Note that even though the two experimental items were visually presented together, only one of the experimental items was auditorily presented to the children on every trial.

On every trial, the children asked to click on the picture that corresponded to an auditory question, that is, "*Wat is denk je een* [TARGET]?" [What do you think is a [TARGET]?] (see Figure 2). In the first and third block of the training phase, the auditorily presented target word was the first unfamiliar target word of each quadruplet. In the second and fourth training blocks, the auditorily presented target word was the second unfamiliar target word of each quadruplet. In the test phase, on half of the trials the first unfamiliar target word was the auditory target and on the other half of the trials the second unfamiliar target word was the auditory target. In the practice phase, a strategy for the training protocol was explained to the children. They were told that when asked to point out an object based on an unfamiliar word, ruling out all the familiar objects first could help in executing the task.

As can be seen in Figure 2, each trial started with a fixation cross (500 ms), after which the four pictures were shown (1,000 ms). The auditory target sentence was played while the pictures were still on the screen (M duration = 1,379 ms). At word offset, the mouse became active in order to enable responding. Positive feedback on accuracy was provided by means of a picture of a clown (1,000 ms). No feedback was provided on incorrect answers.

The order of the quadruplets within blocks was randomized. Furthermore, the contrast type (manner, place, voice), the contrast position (initial, final), and the position of the target on the screen were pseudo-randomized, allowing a maximum of three trials of the same type in succession. In total, the lexical specificity training protocol consisted of 134 trials and took approximately 15 min on average.

Note that because all target words were unfamiliar to the children, there was no overlap between stimuli in the lexical specificity training protocol and the other measures in this study, as the stimuli in the other measures were all high-frequent and familiar words. Aside from serving as a training protocol, the lexical specificity training protocol was used as a measure of lexical specificity, resulting in an accuracy score for the test phase alone and for the training and test phases combined. Cronbach's alpha on the combined scores was .77, indicating good reliability.

Numeracy training (control). A nonlinguistic control training protocol was designed. It was similar to the lexical specificity training protocol. Thirty pairs (contrasts) of numeracy concepts were used (i.e., "least/most," "lowest/highest," "shortest/longest," "smallest/biggest"). On a computer monitor, two pictures were shown, for example, a picture of one ball ("least") and a picture of three balls ("most"). The child was asked to click on the picture that corresponded to an auditory question (e.g., "*Wat is denk je het minst?*" [What do you think is the least?]). Filler trials, randomization constraints, and feedback procedure were similar to the lexical specificity training protocol. The numeracy training protocol consisted of 120 trials and took 15 min on average.

Basic Cognitive Skills

Rapid naming. The subtest *Woordbenoemen* [Object naming] from the standardized *Screeningstest voor Taal - en Leesproblemen* [Diagnostic Test for Language and Literacy Problems] (Verhoeven, 2005) was used to assess lexical retrieval and expressive vocabulary. A total of 84 pictures of high-frequent, easily identifiable different objects were presented on one five-column card. After one practice item, the children were asked to name as many pictures as possible in 1 min.

Phonological short-term memory: Serial recall. To assess phonological short-term memory, the subtest *Geheugen* [phonological short-term memory] from the standardized *Screeningstest voor Taal- en Leesproblemen* [Diagnostic Test for Language and Literacy Problems] (Verhoeven, 2005) was used. In the first of two subtasks, children were auditorily presented with series of words and were asked to recall all of those words in the same order. In the second subtask, the task was to recall sentences. In both subtasks, the series or sentences increased in length over the course of the test. A subtask was brought to an end when four consecutive items (word series or sentences) were recalled incorrectly.

Phonological awareness. Phonological awareness skills were measured by means of two tasks of the standardized *Screeningsinstrument Beginnende Geletterdheid* [Diagnostic Instrument for Emergent Literacy] (Vloedgraven, Keuning, & Verhoeven, 2009). In each task, three response alternatives were presented auditorily over speakers and visually as pictures on a computer screen. Both tasks contained two practice trials and 15 test trials. All stimuli were high-frequent monosyllabic CVC words. Each task took approximately 5 to 8 min.

Rhyme awareness. Children were asked to select the picture with a name that rhymed with the auditorily presented target stimulus. An example test item was "*Hoed, bal, peer; wat rijmt op beer?*" ["Hat, ball, pear; what rhymes with bear?"].

Phoneme identification. The target consonant and a high-frequent word with the target consonant as the initial phoneme were auditorily presented after the three response alternatives. The task was to select the picture with an initial phoneme that was the target phoneme. An example test item was "*Hoed, bal, peer; de b van beer*" ["Hat, ball, pear; the b of bear"].

Speech Decoding

Phoneme discrimination. To assess speech decoding skills, the subtest *Auditieve discriminatie* [Phoneme discrimination] of the standardized *Screeningstest voor Taal- en Leesproblemen* [Diagnostic Test for Language and Literacy Problems] (Verhoeven, 2005) was used. Children were asked whether pairs of auditory stimuli were the same words. The task contained two practice items and 40 test items, of which 12 pairs were the same (*hak* - *hak*), 11 had a vowel contrast (*boom* - *bom*), 8 had a voice contrast (*beer* - *peer*), and 9 had a place contrast (*tak* - *pak*). All stimuli were monosyllabic CVC words.

Procedure

All participants were tested in a quiet room at their own school by the same experimenter. All tests were administered individually and in a fixed order:

- *Cognitive skills.* First, phonological short-term memory and naming were assessed.
- *Pretest*. The pretest consisted of the rhyme awareness, phoneme identification, and phoneme discrimination tasks.
- *Training*. Children were randomly assigned to the lexical specificity or the (control) numeracy training conditions (20 children in each group).
- *Posttest*. The posttest was the same as the pretest (i.e., rhyme awareness, phoneme identification and phoneme discrimination tasks).

The cognitive skills and pretest measurements were assessed in one session. The training session took place five to six weeks after the pretest session. The posttest session took place one week after the training session.

Analyses

One child (in the control group) was excluded from the analyses because he was unable to concentrate during the tasks. Three children were excluded from the analysis of the Phoneme Discrimination pretest (two in the experimental group, one in the control group) and one child was excluded from the Phoneme Discrimination posttest (in the experimental group) because they did not understand the task (i.e., they gave the same answer on every trial).

To assess possible differences between the experimental and control groups prior to intervention, independent-samples t tests on age, the results of the basic cognitive tests and the pretest results were carried out. Separate Time $\times$ Training repeated-measures analyses of variance for each linguistic variable (rhyme awareness, phoneme identification, phoneme discrimination) were then conducted. For significant interactions, separate t tests were conducted as follow-up analyses, as well as analyses of covariance to control for the influence of rapid naming and phonological short-term memory.

For the experimental group only, performance on the different stimulus characteristics (contrast position and contrast type) in the Lexical Specificity Training Protocol was assessed by means of one-way analyses of variance. Because performance in the entire training session (training and test phases combined) and in the test phase alone correlated highly, analyses were conducted on scores of the entire training session.

RESULTS

Descriptive Statistics and Test Validity

The descriptive statistics and the results of the *t* tests can be found in Table 2. The children in the experimental group and in the control group did not differ significantly in age, on the basic cognitive skills, or on the pretest measurements. Both groups, at both times of testing, scored significantly above chance level on all tasks, except for the Phoneme Identification pretest: experimental group, $t(19) = 1.53$, $p = .14$; control group: $t(18) = 1.66$, $p = .12$.

Correlations

As can be seen in Table 3, both phonological awareness pretest measures correlated significantly with age, the cognitive skills, and each other (except that phoneme identification does not correlate with age). However, they did not correlate with the phoneme discrimination pretest. Moreover, the phoneme discrimination pretest results did not correlate with any other variable, except for age.

Analyses of Variance

Rhyme awareness. The results showed no significant difference in rhyme awareness for the two different training groups, $F(1, 37) = 0.15$, $p = .70$. Furthermore, there was no significant difference in rhyme awareness between the pretest and the posttest, $F(1, 37) = 3.12$, $p = .09$. However, there was a significant interaction effect in rhyme awareness between the pre- and

TABLE 2
Descriptive Statistics for the Experimental and Control Groups

Variable	*Experimental Group* M *(SD)*	*Control Group* M *(SD)*	T
Age[a]	53.15 (3.23)	53.89 (3.54)	−.69
Rapid naming[b]	26.20 (7.04)	27.21 (6.02)	−.48
Short-term memory[c]	14.35 (4.73)	15.63 (5.35)	−.79
Pretest PA: Rhyme awareness[d]	54.67 (16.27)*	63.16 (16.98)*	−1.60
Posttest PA: Rhyme awareness	66.67 (21.08)*	62.11 (20.01)*	.69
Pretest PA: Phoneme identification[d]	38.33 (15.58)	42.11 (23.94)	−.59
Posttest PA: Phoneme identification	45.33 (19.18)*	48.42 (25.42)*	−.43
Pretest phoneme discrimination[e]	65.48 (25.90)*	70.86 (25.98)*	−.63
Posttest phoneme discrimination	67.29 (31.05)*	75.94 (27.71)*	−.91

Note. $n = 39$. PA = phonological awareness.
[a]In months. [b]Number of correctly named pictures per minute. [c]Sum of the number of correctly recalled word series and twice the number of correctly recalled sentences. [d]Percentage correct trails (chance = 33%). [e]Percentage correct trials (chance = 50%).
*Performance significantly above chance level.

TABLE 3
Correlations Between Age, Cognitive Skills, and Linguistic Pretest Measures

Variable	*1*	*2*	*3*	*4*	*5*	*6*
1. Age	—					
2. Rapid naming	.26	—				
3. Phonological short-term memory	.05	.30	—			
4. Pretest PA: RA	.33*	.33*	.34*	—		
5. Pretest PA: PI	.30	.51**	.51**	.50**	—	
6. Pretest PD	.37*	.04	.22	.27	.20	—

Note. PA = phonological awareness; RA = rhyme awareness; PI = phoneme identification; PD = phoneme discrimination.
$^{*}p < .05$. $^{**}p < .01$.

posttest results and the type of training children received, $F(1, 37) = 4.43$, $p = .04$, $\eta_p^2 = 0.11$. Follow-up paired-samples *t* tests indicated that there was a significant increase in rhyme awareness (comparing pre- and posttests) for children in the experimental group, $t(19) = –2.44$, $p = .03$, $\eta^2 = .24$, but not for the children in the control group, $t(18) = .29$, $p = .78$ (see Figure 3). This interaction was also significant when controlling for rapid naming skills and phonological short-term memory in an analysis of covariance, $F(1, 35) = 5.19$, $p = .03$, $\eta_p^2 = 0.13$.

Phoneme identification. There was no significant difference in phoneme identification for the two training groups, $F(1, 37) = 0.30$, $p = .59$. The results showed a significant difference between the phoneme identification pre- and posttest, $F(1, 37) = 6.72$, $p = .01$, $\eta_p^2 = 0.15$. No significant interaction effect in phoneme identification was found between the time of testing and the type of training children received, $F(1, 37) = .02$, $p = .90$.

Phoneme discrimination. The analyses did not reveal any significant main effect for type of training, $F(1, 33) = 1.20$, $p = .28$, or time of testing, $F(1, 33) = 1.25$, $p = .27$. Furthermore, no significant interaction effect was observed, $F(1, 33) = .74$, $p = .40$.

Lexical Specificity Training

The descriptive statistics of the lexical specificity training analysis (training and test phases combined) can be found in Table 4. One-sample *t* tests revealed that children performed significantly above chance on both the initial, $t(79) = 7.55$, $p < .001$, and the final contrast positions, $t(39) = 3.54$, $p = .001$. There was a trend toward a significant difference in performance between the two contrast positions (initial vs. final), $F(1, 119) = 3.73$, $p = .06$. On average, children performed 16.5% better on contrasts in initial than in final position.

Children performed significantly above chance on the manner of articulation, $t(64) = 6.65$, $p < .001$; place of articulation, $t(34) = 4.27$, $p < .001$; and the voicing contrast types, $t(19) = 2.84$, $p = .01$. There were no significant differences in contrast type (manner of articulation versus place of articulation versus voicing), $F(2, 119) = .36$, $p = .70$.

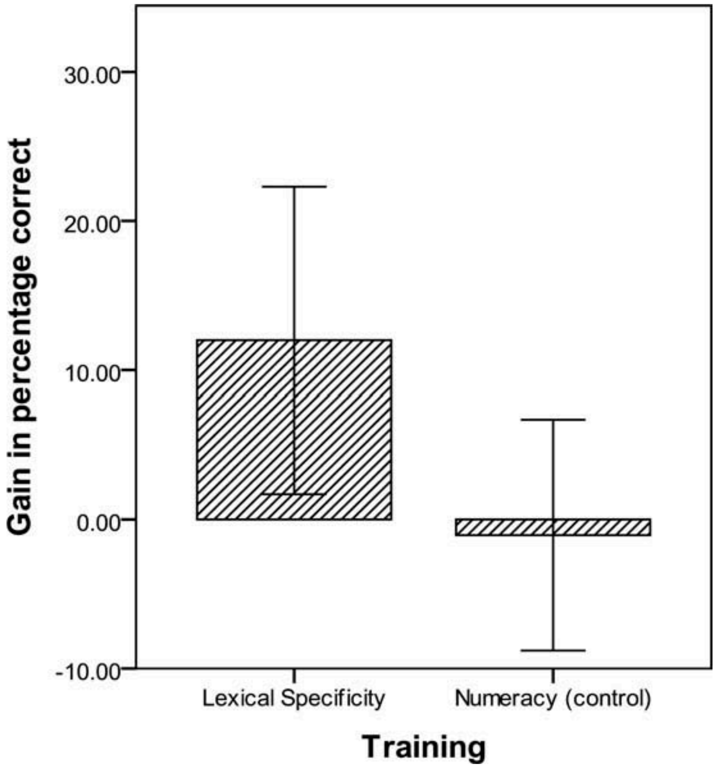

FIGURE 3 Gain on the rhyme awareness pre- and posttests (percentages correct) for the experimental and control groups. *Note.* Error bars show 95% confidence intervals.

DISCUSSION

The current study investigated the links between lexical specificity and two other phonological precursors to literacy (i.e., speech decoding and phonological awareness). In particular, it examined whether training lexical specificity (through learning new words that could only be distinguished from each other if their lexical representations were highly specific) could foster these phonological skills. The results showed that the training had beneficial effects on rhyme awareness, one form of phonological awareness. Children who received a word learning game in which they were forced to learn specific new lexical representations and made significant gains in the specificity of their phonological knowledge about those words, gained in rhyme awareness (comparing posttest and pretest scores). A control group that received numeracy training did not gain in rhyme awareness.[2] Lexical specificity training did not have an effect on phoneme identification skills or on phoneme discrimination skills.

[2]Note, however, that the control group scored numerically, but not significantly, higher than the experimental group at pretest. At posttest, the experimental group reached the scores of the control group.

TABLE 4
Percentage Correct Trials in the Lexical Specificity Training Protocol

		Overall		*Test*	
Category	*Type*	M (SD)	n	M (SD)	n
Contrast position	Initial phoneme	39.85 (17.58)	80	46.13 (19.46)	16
	Final phoneme	33.55 (15.28)	40	29.63 (11.21)	8
Contrast type	Manner of articulation	36.83 (14.34)	65	35.31 (13.56)	13
	Place of articulation	39.80 (20.49)	35	44.00 (24.12)	7
	Voicing	37.15 (19.11)	20	52.00 (21.20)	4
Total experimental items		37.75 (17.05)	120	40.63 (18.66)	24
Filler trials		82.22 (15.43)	9	65.00	1

Note. Chance = 25%.

Note first that even though different results were found for rhyme awareness and phoneme identification, these results do not imply that these skills are entirely independent and/or distinct. Previous research suggests that both measures reflect subskills of one underlying factor, namely, phonological awareness (Vloedgraven & Verhoeven, 2009). Nevertheless, the divergent results for the different phonological awareness measures can be explained. Because phonological awareness evolves from larger to smaller sound units (Anthony et al., 2003; Stanovich, 1992), awareness of the onset-rime structure (e.g., as measured in the rhyme awareness task) is one of the earliest forms of phonological awareness to develop (Vloedgraven & Verhoeven, 2007), whereas phoneme awareness (e.g., as measured in the phoneme identification task) develops only later (Bradley & Bryant, 1983; Goswami & Bryant, 1990). In the literature, phoneme awareness is seen as a precursor (Bradley & Bryant, 1983), corequisite (Perfetti, 2003), or by-product of reading acquisition (Ehri, 2005). Hence, because the participants in the current study were preliterate and had not received any formal reading education, it is possible that phoneme awareness was simply not developed enough and therefore no effect on phoneme identification was found. This suggests that a certain level of phoneme awareness has to be reached in order for a child to be able to benefit from lexical specificity training.

Both groups did not perform significantly above chance on the phoneme identification pretest but did so on the posttest. The significant gain in phoneme identification (over the 6 to 7 weeks between pre- and posttests) could be influenced—to various degrees—by spontaneous growth, test–retest effects, and/or educational reasons (even though children did not receive formal phonological training, they do get acquainted with phonemes and graphemes in a playful way in kindergarten). These results indicate that at this age, children are still developing this specific aspect of phoneme awareness.

Thus, in the current study, children who were trained on making newly learned lexical representations more specific gained on a rhyme awareness task, whereas children who received a control training procedure did not. Increasingly segmental representations, leading to explicit access to the phoneme, give rise to the ability to consciously reflect upon and manipulate phonemes (Fowler, 1991; Metsala & Walley, 1998). Accordingly, Treiman and Zukowski (1996) found that having more specific lexical representations make rhyming easier. Either a global similarity comparison or an analytical approach can be used to make rhyme judgments. Having a lexical representation of a word, even though this representation may not yet be fully specified, makes it easier to compare two items at a global level in a rhyme task (Wagensveld, Van Alphen, Segers, & Verhoeven, 2012). The analytical approach to comparing lexical representations, relying on phoneme awareness, then develops later.

Lexical specificity training had no effect on speech decoding skill, as measured by a phoneme discrimination task. Moreover, for both groups, the phoneme discrimination pretest did not correlate with any other variable, except for age. This result could be task related, even though the task was standardized and children performed above chance at both times of testing. It could also be the case that at this age, in this sample, explicit phoneme discrimination and/or speech decoding skill simply does not correlate with other early literacy skills, even though the literature suggests otherwise. Nevertheless, the correlation with age suggests that phoneme discrimination skill is still in development.

During lexical specificity training, minimal pairs that differed on the initial phoneme were numerically but not significantly better disambiguated than pairs that differed on the final phoneme, suggesting that children were perhaps a little more sensitive to subtle phonetic differences at the onsets of words compared to differences at the offsets of words. These findings can be explained by the incremental nature of speech recognition: Beginnings of words seem to be more important for word recognition, because they appear earlier in time than the ends of words and thus more strongly constrain possible word candidates. The position effect is in accordance with previous research on speech recognition (Allopenna, Magnuson, & Tanenhaus, 1998) and are predicted by models of spoken word recognition (McClelland & Elman, 1986; Norris, 1994; Norris & McQueen, 2008). Alternatively, or additionally, the position effect may occur because children find it easier to divide syllables into onsets and rimes than rimes into vowels and codas. Perception and awareness of the onset/rime division is acquired earlier than that of the vowel/coda division (e.g., Anthony et al., 2003).

To recapitulate, phonological awareness is associated with learning to decode print, and becoming phonologically aware depends on being able to decode speech. Furthermore, the degree of phonological specificity of children's lexical representations plays a role in their emergent literacy. The current study can be seen as a first attempt to unravel the causal relations between phonological precursors to literacy, as it set out to test the relations between the specificity of newly learned words and phonological awareness, and between lexical specificity and speech decoding. The results of the current study (i.e., lexical specificity training had a beneficial effect on rhyme awareness but not on speech decoding skill) seem to support an account in which, during normal development, lexical specificity precedes phonological awareness (Figure 1a).

The intervention led to the development and specification of new lexical representations. Because of the nature of the training and test protocol (they contained only nonfamiliar words), a pretest assessing the specificity of phonological knowledge about these words was impossible. The children in the control group were also not tested on their knowledge about the minimal-pair words. Furthermore, there were no tests within the experimental group of changes in the specificity of other words arising from the training. No claims can therefore be made about whether the intervention had consequences for the phonological specificity of representations across the lexicon. Nevertheless, the children in the experimental group learned, on average, approximately 10 new minimal word-pairs (see Table 4). The control group did not learn anything about these words during the numeracy training. The improvement in detailed phonological knowledge in the experimental group suggests that training in lexical specificity, even if it is limited to a small number of words, can enhance phonological awareness.

The design of the current study does not allow conclusions to be drawn about the entire causal chain involved in acquiring print decoding skill (e.g., the chains depicted in Figure 1). Because the participants in the current study were two years away from formal reading education, print decoding skills could not yet be assessed. Furthermore, no conclusions about the causal link between lexical specificity and speech decoding can be drawn from the null effects on the speech decoding task. Future research could explore the causal relations between the phonological precursors to literacy in more depth, to explain how—at a given stage in development—some children are able to decode speech and discriminate between phonemes but are less able to manipulate individual phonemes. Furthermore, it could offer a description of how differences in speech decoding skill could, through lexical specificity, relate to phonological awareness, and ultimately to literacy. This could, for example, be studied in a longitudinal cohort study, in which children are followed from kindergarten until formal reading education has begun. Because the importance of phonological precursors to literacy and other cognitive skills seem to vary across languages, cross-linguistic studies comparing several orthographic depths could resolve remaining questions about the precursors to literacy in a given orthography. In addition, future research could contrast the current results with the effect of word learning training without minimal phonological differences, to investigate the effect of solely learning new lexical representations (without phonological overlap) on emergent literacy.

Because a significant number of children in elementary school have trouble with learning to read, knowledge about (phonological) precursors to literacy is important. Knowledge about normal language and reading development contributes to understanding problems in language and reading development problems. The present results thus suggest that, in kindergarten, attention should be paid to fine phonetic differences in how (new) words are pronounced. This could enhance the specificity of the children's representations and could thereby help them, through triggering the development of phonological awareness, to learn to read. The 15-min word-learning game used in the present study could be usable in a kindergarten context and has been shown here to be effective. It is reasonable to assume that multiple longer sessions with such a game would have larger benefits.

In summary, the current study explored phonological precursors to literacy, and lexical specificity in particular. Teaching prereaders new words and training them to make the representations of those words phonologically highly specific was found to foster rhyme awareness skill.

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APPENDIX

TABLE A1
Stimulus Quadruplets Used in the Lexical Specificity Training Protocol

Unfamiliar Target A	*Unfamiliar Target B*	*Unfamiliar Control*	*Familiar Control*	*Contrast Type*	*Contrast Position*
aar	*aal*	*aas*	*aap*	Manner	Final
kor	*col*	*kot*	*kom*	Manner	Final
pol	*pon*	*pos*	*pop*	Manner	Final
wal	*war*	*wad*	*was*	Manner	Final
schol	*schor*	*schot*	*schop*	Manner	Final
dom	*don*	*dok*	*dop*	Place	Final
mot	*mok*	*mof*	*mol*	Place	Final
raap	*raat*	*raaf*	*raam*	Place	Final
lak	*rak*	*vak*	*bak*	Manner	Initial
luit	*ruit*	*kuit*	*huid*	Manner	Initial
naad	*raat*	*vaat*	*maat*	Manner	Initial
lier	*nier*	*pier*	*bier*	Manner	Initial
lor	*nor*	*hor*	*tor*	Manner	Initial
dam	*ram*	*ham*	*kam*	Manner	Initial
baal	*maal*	*taal*	*kaal*	Manner	Initial
dis	*lis*	*mis*	*vis*	Manner	Initial
kaak	*taak*	*zaak*	*haak*	Place	Initial
zot	*vod*	*mot*	*bot*	Place	Initial
hiel	*ziel*	*kiel*	*wiel*	Place	Initial
bar	*dar*	*war*	*kar*	Place	Initial
pas	*bas*	*gas*	*jas*	Voice	Initial
peuk	*beuk*	*reuk*	*jeuk*	Voice	Initial
ven	*fan*	*den*	*pen*	Voice	Initial
dip	*tip*	*hip*	*wip*	Voice	Initial