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Learning New Words Affects Nonword Pronunciation in Children

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In two experiments we examined how children's nonword pronunciations are influenced by learning words. In Experiment 1, children pronounced nonwords before and after learning words sharing orthographic rimes with the nonwords. These rimes varied in spelling-to-sound consistency and regularity. Children's nonword pronunciations were more sensitive to consistency and regularity after instruction than before. Experiment 2 expanded upon Experiment 1 by modifying the instruction to highlight regularity and consistency in rime unit neighborhoods and by including both younger (*M* age = 7.6) and older (*M* age = 9.92) participants. After instruction, Experiment 2 participants demonstrated greater sensitivity to rime unit consistency and regularity than Experiment 1 participants. In both experiments, the children, especially the younger participants, made more adultlike pronunciations after instruction than before. We conclude that learning words varying in consistency and regularity increased the children's sensitivity to these properties.

In English, the relationship between orthography and phonology is quasi-regular (Seidenberg & McClelland, 1989). That is, although many words contain orthographic segments that are pronounced consistently, some pronunciations do not follow simple letter-to-sound rules (i.e., grapheme-to-phoneme correspondence

[GPC] rules). To deal with quasi-regularity and the processing of novel forms (i.e., nonwords, e.g., *jint*), different types of English word recognition models have been proposed (e.g., Coltheart, Curtis, Atkins, & Haller, 1993; Plaut, McClelland, Seidenberg, & Patterson, 1996; Perry, Ziegler, & Zorzi, 2007). Each of these models provides a useful framework to interpret how people process words and nonwords. However, these models differ in the degree to which word knowledge influences nonword pronunciation in developing readers. For example, the Dual Route Cascaded (DRC) model of Coltheart and colleagues (1993) proposes relatively little influence of word knowledge on nonword pronunciation, whereas the Parallel Distributed Processing (PDP) model of Plaut and colleagues (1996) indicates a relatively large influence of word knowledge on nonword pronunciation. Thus, the main goal of the current study is to examine the extent to which word knowledge influences nonword pronunciation in developing readers.

One way to accomplish this goal is to measure the extent to which readers pronounce novel letter strings via irregular analogies or GPC rules.[1] In fact, this approach has been employed by many studies over the past 20 years (e.g., Andrews & Scarratt, 1998; Brown & Deavers, 1999, Coltheart & Leahy, 1992; Goswami, 1986, 1993; Treiman, 1985). Furthermore, some studies have examined if the selection of pronunciation strategy changes with reading experience (e.g., young readers more often use the GPC rule strategy first and later may use the analogy strategy, cf. Coltheart & Leahy, 1992).

The current work extends this research in two ways. First, in two experiments, we used reading aloud instruction programs with children and monitored the influence of these programs on nonword pronunciation strategies. These programs focused on teaching children neighborhoods of words varying in spelling-to-sound consistency. We hypothesized that the children's pronunciations of nonwords derived from these neighborhoods would change as a result of learning. In addition, we wanted to see if the children's reading aloud strategies (GPC based or word analogy based) were flexible and depended on the spelling-to-sound consistency of the nonword's rime unit. Brown and Deavers's (1999) results indicate that children's reading aloud strategy selection is flexible and depends on task characteristics (e.g., reading nonwords in isolation vs. with a clue word in sight). Second, we compared the strategies used by adults to the developing strategies of children on a common set of nonwords containing rimes that varied in spelling-to-sound consistency and regularity. Children's pronunciations were assessed both before and after instruction to see if they became more (or less) adultlike after instruction.

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[1]By the term "analogy," we are referring to a pronunciation that is based on lexical knowledge about rime units. However, the psychological mechanisms involved may or may not employ localist lexical representations. Similarly, pronunciations that are based on GPCs may or may not involve rules. Instead of rules, grapheme-to-phoneme-based pronunciations may also be based on probabilistic properties about the relationship between graphemes and phonemes.

CONSISTENCY AND REGULARITY

Consistency refers to how often a letter string maps onto a particular phonemic string (see, e.g., Andrews, 1982; Balota, Cortese, Sergent-Marshall, Spieler, & Yap, 2004; Cortese & Simpson, 2000; Glushko, 1979; Jared, 1997, 2002; Treiman, Mullennix, Bijeljac-Babic, & Richmond-Welty, 1995). Although consistency can be applied to various units, much research has focused on the rime. In a monosyllabic word, the rime is the vowel and subsequent consonants. In the literature, consistency is defined in terms of the ratio of "friends" (i.e., words sharing both the orthographic and phonological rime) to "enemies" (i.e., words sharing the orthographic rime but having a different pronunciation; see, e.g., Jared, McRae, & Seidenberg, 1990). For example, *pint* is inconsistent because it has many more enemies (e.g., *mint, tint, lint*, etc.) than friends. In contrast, *punt* is consistent as it has many more friends (e.g., *hunt, bunt, runt*, etc.) than enemies.

Regularity indicates whether a letter string is pronounced via GPC rules. These rules are categorical and determined by frequency of occurrence in the language: A particular grapheme (e.g., *ch*) may be associated with various phonemes (e.g., /tʃ/, /k/, and /ʃ/), but the GPC rule corresponds to the one most frequently used (e.g., /tʃ/). Although most regular words are consistent (e.g., *punt*) and most irregular words are inconsistent (e.g., *pint*), regularity and consistency are separable dimensions (cf., Cortese & Simpson, 2000; Jared, 2002).

NONWORD PRONUNCIATION STRATEGIES

Previous studies have distinguished between pronunciations produced by analogies and those produced by GPC rules. When reading by analogy, one pronounces a nonword like a similarly spelled word. For example, the nonword *jind* would be pronounced to rhyme with *bind* because most *ind* words are pronounced with a long *i*. In contrast, if GPC rules are used, then *jind* will be pronounced with a short *i* because the reader will access four GPC rules: (a) *j*= /j/, (b) *i* = /ɪ/, (c) *n* = /n/, and (d) *d* = /d/. In most cases, both strategies will produce the same pronunciation because most words are regular and consistent. However, in some cases (e.g., *jind*), the two strategies[2] lead to different pronunciations. In addition, strategy-use may be flexible and may change with reading experience.

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[2]Note, that in some cases, a reader could apply an analogy strategy that produces a pronunciation that appears to be based on GPC rules. For example, if *jind* were pronounced with a short /I/, it is possible that an analogy to *wind* = /wInd/ produced that pronunciation. In other words, when a "regular" pronunciation is given for a nonword, and if at least one regular word occurs in the nonword's neighborhood, an analogy strategy cannot be ruled out. However, if an "irregular" pronunciation is provided, an analogy strategy can be confirmed.

DO CHILDREN READ BY ANALOGY OR GPC RULES?

According to Goswami's (1993) interactive analogy model, children read new words by forming analogies to known words. In fact, Goswami's (1986) results indicated that beginning readers form analogies between a known clue word and test items, especially when the test items share either the onset (e.g., *bean* or *beal*) or rime (e.g., *peak* or *neak*) with the clue word (e.g., *beak*; also see Treiman, 1985). However, Goswami's (1986) technique has been criticized for creating a response bias because the clue word remained in view (and the pronunciation in memory) while children pronounced the test items (Brown & Deavers, 1999; Muter, Snowling, & Taylor, 1994; Savage, 1997). In addition, several studies suggest that the clue word analogical transfer is phonological in nature. For example, Savage and Stuart (1998) found audio recordings led to similar rates of analogies as did text presentation. Thus, Goswami's children may have been experiencing phonological priming from the clue word rather than making bona fide analogies.

Furthermore, because most of the stimuli employed by Goswami (1986) were regular and consistent, the GPC and analogy strategies would produce the same pronunciation. To get a clearer picture of which pronunciation strategy children use, Coltheart and Leahy (1992) used three types of nonwords: (a) regular consistent nonwords that contained rimes consistently pronounced according to GPC rules (e.g., *-ell* to rhyme with *fell*), (b) irregular consistent nonwords that contained rimes that are consistently irregular (e.g., *-ook*, which is usually pronounced as in *book*), and (c) ambiguous inconsistent nonwords that contained rimes that are pronounced regularly at times and irregularly at others (e.g., *-one*, which can be pronounced as in *phone, gone,* or *done*). Coltheart and Leahy found that children produced more GPC-based pronunciations than irregular analogies. However, they also found that these participants were sensitive to rime consistency. Specifically, fewer GPC-based pronunciations were given to nonwords derived from inconsistent rime units, and this sensitivity increased with age. Thus, Coltheart and Leahy's results suggest that children may use a GPC-based or analogy-based strategy for pronouncing new words depending on rime unit regularity and consistency.

Brown and Deavers (1999) hypothesized a flexible-unit-size model in which children's use of strategies (e.g., GPC rules vs. rime analogies) to pronounce unfamiliar letter strings depends on reader skill and task demands. For example, in a nonword list reading task with no clue word present, the more skilled child readers used analogy-based pronunciations for nonwords with irregular consistent rimes 63% of the time, whereas less-skilled child readers used an analogy-based strategy only 41% of the time. Brown and Deavers also found that when children were presented with an irregular consistent clue word (e.g., *talk*) before each to-be-pronounced nonword (e.g., *dalk*) they usually produced an analogy to the clue word. However, the proportion of analogies dropped substantially when participants received one clue word before reading aloud four target nonwords. These results suggest that the ability of a reader to engage in a GPC-based strategy or an analogy-based strategy is flexible.

ADULT STUDIES OF NONWORD PRONUNCIATIONS

Numerous studies have examined adults' pronunciation strategies (e.g., Andrews & Scarratt, 1998; Seidenberg, Plaut, Petersen, McClelland, & McRae, 1994) to contrast theoretical models (e.g., the DRC model of Coltheart et al., 1993, and the connectionist PDP model of Plaut et al., 1996; see also Zevin & Seidenberg, 2004) that differ in the degree to which rime-unit consistency and regularity influence the pronunciation of words and nonwords.

In the DRC model, pronunciations for words and nonwords are achieved via two mechanisms. The lexical route contains phonological codes for known words, and the sublexical route contains GPC rules. It has been hypothesized that nonword pronunciation should be influenced more by the sublexical route than the lexical route because no lexical entry exists for a nonword. This would result in the assignment of a regular pronunciation for most nonwords, even for those containing irregular rime units (e.g., *moup*). In fact, Andrews and Scarratt (1998) found that the DRC model never generated a pronunciation that deviated from GPC rules.

In contrast, PDP models generate both word and nonword pronunciations via a network of simple processing units that learns associations between orthographic inputs and phonological outputs. Via experience, connections linking coactivated units become strengthened. In terms of reading aloud, the consistency of spelling–sound pairings determines the strength of connections. Furthermore, knowledge of orthographic-to-phonological relationships reflects the statistical properties of the environment. The model's sensitivity to the environment leads to excellent accounting for consistency effects in word naming (cf. Cortese & Simpson, 2000; Jared, 2002).

To differentiate these models, Andrews and Scarratt (1998) examined adults' nonword pronunciations for four groups of nonwords varying on rime-unit regularity and consistency: (a) regular consistent rimes (e.g., *doke*), (b) inconsistent rimes (e.g., *pome*), (c) no-regular analogy rimes with many neighbors, (e.g., *feigh*), and (d) no-regular analogy rimes with one unique neighbor (e.g., *linth*). Andrews and Scarratt's participants produced the highest proportion of irregular analogies for nonwords with no regular neighbors (.65 when they had many irregular neighbors and .42 when they had one irregular neighbor). Inconsistent nonwords had an analogy rate of .09, and regular consistent nonwords produced no irregular analogies.

The results of the Andrews and Scarratt (1998) study are problematic for both of the theoretical models under consideration. Although participants preferred GPC-based pronunciations over analogy-based pronunciations, the DRC overestimated the proportion of GPC-based pronunciations in all conditions, and the PDP model overestimated the proportion of GPC-based pronunciations in the no-regular analogy conditions.

More recently, Perry et al. (2007) proposed a connectionist dual-process (CDP+) model that combines properties of the DRC and PDP models. The CDP+ model, similarly to the DRC model, contains lexical and sublexical routes. The lexical route is very similar to that of the DRC model. The sublexical route is a two-layer network that learns through weight adjustment like the PDP model. Initial simulations have been promising. It produces consistency effects for both words and nonwords similar to those observed in adults because the sublexical route learns via weight adjustment. Specifically, the proportion of GPC-based pronunciations assigned to Andrews and Scarratt's (1998) no regular analogy words approaches that of human participants.

The current study was designed to examine changes in children's nonword reading aloud strategies and how children's nonword reading aloud strategies relate to adult strategies and those predicted by theoretical models of word recognition. In particular, we examined if children, like adults, are sensitive to rime unit spelling-to-sound consistency. In addition, we examined if sensitivity to rime-unit consistency increases after the children are taught words from four rime-unit categories varying in orthographic consistency and regularity[3]: (a) regular consistent, (b) ambiguous, (c) irregular, and (d) no regular analogy (NRA). In Experiment 1, children were taught 101 words from these four categories with no mention of how the words' rime units varied in spelling-to-sound consistency and regularity. In Experiment 2, the instruction explicitly focused on these properties of spelling-to-sound consistency and regularity. We predicted that learning these new words leads children to pronounce the nonwords more similarly to how adults would pronounce them. Specifically, we expected that instruction leads to (a) higher proportions of GPC-based pronunciations for regular and consistent nonwords, (b) increases in both GPC-based and irregular-analogy-based pronunciations for ambiguous nonwords, and (c) increases in irregular-analogy-based pronunciations for irregular nonwords and NRA nonwords. This pattern of pro-

[3]Regular consistent nonwords contained orthographic rimes always pronounced according to GPC rules (e.g., *ract*). Ambiguous nonwords (e.g., *roul*) contained rimes associated equally with irregular and regular mappings (e.g., *foul, soul*). Irregular nonwords (e.g., *choll*) contained rimes that are usually (but not always) irregular. Finally, NRA nonwords (e.g., *moup*) had rimes associated exclusively with irregular words. We should make it clear that when we refer to regular or irregular nonwords, we are referring to the regularity in the pronunciation pattern of the rime unit when it appears in words. We acknowledge that because we are using nonwords, there are no defined pronunciation patterns for these letter strings and, thus, a nonword cannot be regular or irregular per se.

nunciation changes would also coincide with the predictions of word recognition models such as the PDP model (Plaut et al., 1996) and the CDP+ model (Perry et al., 2007) that are sensitive to the orthographic neighborhood consistency. Finally, we predicted that sensitivity to neighborhood characteristics acquired during learning is more prominent in Experiment 2 than Experiment 1 because the Experiment 2 instruction emphasized these neighborhood characteristics more than that of Experiment 1 and because Experiment 2 instruction consisted of more active student engagement than did Experiment 1 instruction.

EXPERIMENT 1

Method

Participants

Experiment 1 included 63 participants: 20 child participants ranging in age from 6.83 to 10.67 years ($M = 8.62$) and 43 adult participants. Children were recruited from academic after-school and summer programs from a midsized southeastern U.S. metropolitan area. This sample of students was both ethnically and financially diverse with students attending school in a largely lower middle-class to middle-class neighborhood. In this sample, half of the children were from ethnic minority groups (e.g., African American, Latino/a, or multiracial) and half were Caucasian. Before working with the participants, we obtained permission from the local school district, the coordinators of the after-school and summer programs, and each participant's parent(s)/guardian(s). We also obtained informed assent from each participant. The teachers reported using primarily phonics-based instruction, indicating that their reading curriculum focused on learning spelling to sound correspondences and in coaching the children to use "sounding out" strategies for reading aloud.

The adult participants were recruited from introductory psychology courses at a midsized university in the southeastern United States. Participants received course credit in exchange for their participation.

Materials

Nonwords

There were 26 nonwords: 6 nonwords each from the regular consistent, ambiguous, and irregular categories, and 8 nonwords from the NRA category. These nonwords can be found in Table A1 of the Appendix, along with pretest and posttest item means and standard deviations for each sample on the proportion of implausible responses, GPC-based responses, and irregular analogies.

Real Words

We also tested the children on their knowledge and pronunciation of 101 words. These words were in the orthographic neighborhoods of the nonwords just described. The neighborhood characteristics of these words can be found in Table 1, whereas a list of these words with each one's HAL log frequency (Lund & Burgess, 1996), length and orthographic neighborhood size is included in Table B1 of the appendix. The participants' knowledge of the meanings of these words was measured via a simple vocabulary test in which the children responded yes/no to questions designed to gauge their understanding of the meanings of these words (e.g., *Can you have a tract of land?*). For each of the 101 words, two questions were created, one which would result in a correct response of "yes" and one with a correct response of "no." These questions were counterbalanced across two lists so that if the affirmative question for a specific word was included in one list the negative question was included in the other list. The lists were counterbalanced across participants and across testing sessions. All questions were presented in text on the computer monitor at the same time that the child heard an audio recording of the question. We used both auditory and visual presentation for these questions for three reasons. First, we wanted to ensure that presentation rate of the questions was the same for each child (this could not be verified if the children read the sentences aloud). Second, we wanted to gauge the children's understanding of the word meanings independent of whether the child knew the appropriate pronunciation of the words. Third, we used the visual presentation of the questions to be consistent with the visual presentation used in the nonword and the real word pronunciations tasks. The audio recordings of the questions were recorded by a female speaker using Goldwave Software (Goldwave Inc., St. John's NL, Canada).

Preinstruction Phase

In the preinstruction phase, each child worked with an experimenter in a quiet room provided by his or her school. In this session, the participants performed the

TABLE 1
Neighborhood Characteristics by Nonword Type

Nonword Type	*M Regular Neighbors*	*M Irregular Neighbors*	*M Frequency of Regular Neighbors Per Item*	*M Frequency of Irregular Neighbors Per Item*
Regular	3.2	0.0	8.3	0.0
Ambiguous	1.8	1.5	4.6	4.8
Irregular	1.7	6.7	1.3	7.6
NRA	0.0	1.5	0.0	7.0

Note. Frequency statistics were accessed from the English Lexicon Project website (http://elexicon.wustl.edu/) and are based on HAL log frequency. NRA = no regular analogy.

nonword pronunciation task, the real word reading task, and the word knowledge task in fixed order. The completion of these tasks took between 20 and 40 min. All tasks were conducted on an IBM compatible laptop computer with a standard 15.4-in. monitor using E-Prime software (Psychology Software Tools, Pittsburgh, Pennsylvania). This computer interfaced with a serial response box, a standard desktop microphone, and standard headphones.

Nonword pronunciation task. Participants were instructed that they would be shown a series of made-up or "fake" words on the computer screen one at a time. They were asked to read aloud each of these fake words in the way that they thought it should sound. They were also told that these fake words were not real words, so there were no right answers. This task included the 26 critical nonwords trials as well as 4 practice trials. On each trial, the nonword was presented in black type on a white background. Participants read aloud each nonword into the microphone, and the experimenter transcribed the pronunciation. The nonword remained on the screen until the experimenter pressed a key to advance to the next trial.

Real word pronunciation task. Child participants were told that they would read real words one at a time into the microphone. It was emphasized that these were real words, so there was a right way to say each word. There were 101 experimental trials that were preceded by 4 practice trials. On each trial, first, a fixation cross appeared for 1 sec. Next, the word was presented, and the participant read aloud the word into the microphone. Then, the experimenter coded (via the mouse) the pronunciation as correct or incorrect. Finally, there was a 2-sec intertrial interval before the beginning of the next trial.

Real word knowledge task. In this task, child participants were tested on their understanding of the real word meanings of the 101 words that were to be the focus of the instruction phase. Participants were told that they would be presented with a series of questions to which they were to respond "yes" or "no." Each trial began with the presentation of a fixation sign (+) for 1 sec. Next was the presentation of one question. Each question was presented both visually (via text on the screen) and auditorily via headphones. Upon hearing and seeing each question, the participant was to respond "yes" or "no." The experimenter entered the participant's response via the keyboard. This trial sequence repeated for all 101 real words plus four practice trials which preceded the experimental trials.

Instruction Phase

At least 1 day after and no more than 1 week after the preinstruction testing session, child participants began the instruction phase of the experiment. These instructions sessions occurred on 5 consecutive days. Each session lasted between 30 and 45 min and was conducted in a classroom provided by the participants' school. The 20 participants were divided into two groups, one for the 10 younger students and another for the 10 older students. The experimenter presented information to the participants using the blackboard and chalk. In each of the five sessions, the experimenter read aloud half of the words (except on the last day of instruction, when all 101 words were reviewed), spelled each word on the chalkboard, used each word in a sentence, and invited the students to make up a sentence using each word. This style of instruction was repeated across all days of the instruction phase and resulted in each child being exposed to the pronunciation, spelling, and meaning of each of the 101 words three times.

Postinstruction Phase

At least 1 day but not more than 1 week after the last day of instruction, each participant completed the nonword pronunciation, real word pronunciation, and real word knowledge tasks again. The procedure for these tasks was identical to the procedures of the preinstruction phase. The only difference was that the real word knowledge lists used for each participant in the postinstruction phase was the list not given to that participant in the preinstruction phase.

Procedure

Each child participant engaged in preinstruction, instruction, and postinstruction phases. However, the adults did not complete the instruction phase of the experiment. Instead, they completed the nonword pronunciation task only once.

Results

For each child participant, three measures were recorded during the preinstruction and postinstruction phases: the pronunciations for each of the nonwords, the pronunciation accuracy for each of the real words, and the accuracy of responses to the real word knowledge questions. In the analyses that follow, subject and item means were treated as random factors. Subject analyses are indicated with an *s* subscript, and item analyses are indicated with an *i* subscript.

Real Word Instruction

The mean pronunciation accuracy rates and standard deviations as well as the mean definition accuracy rates and standard deviations by time (preinstruction and postinstruction) are provided in Table 2. Word instruction increased word pronunciation accuracy (.63 at Time 1, and .76 at Time 2), $t_s(19) = 7.38$, $p < .0001$, $\eta^2 =$

TABLE 2
Pronunciation Accuracy and Definition Accuracy as a Function of Experiment, Level of Reader, and Time of Test

Vocabulary Measure	Experiment 1		Experiment 2			
	Grades 1–5		Grades 1–2		Grades 3–5	
	T1	*T2*	*T1*	*T2*	*T1*	*T2*
Pronunciation accuracy	.63 (.17)	.76 (.15)	.53 (.23)	.75 (.18)	.69 (.23)	.85 (.13)
Definition accuracy	.73 (.09)	.82 (.12)	.71 (.13)	.82 (.06)	.70 (.16)	.84 (.11)

Note. Standard deviations appear in parentheses.

.74; $t_i(97) = 10.66$, $p < .0001$, $\eta^2 = .54$, and word knowledge (.73 at Time 1 and .82 at Time 2), $t_s(19) = 4.51$, $p < .0001$, $\eta^2 = .52$; $t_i(100) = 4.37$, $p < .0001$, $\eta^2 = .16$.

Nonword Pronunciation

For each of the nonword pronunciations, we noted the type of pronunciation that the child or adult participant used. We coded each pronunciation as a GPC-based pronunciation, an irregular-analogy-based pronunciation, or an implausible pronunciation (i.e., it did not coincide with either GPC rules or an irregular neighbor analogy). A pronunciation was coded as GPC based if it followed the dominant grapheme-to-phoneme mapping (e.g., pronouncing *choll* as /tʃɒl/ to rhyme with *doll*; cf., Berndt, Reggia, & Mitchum, 1987). Finally, a pronunciation was coded as an irregular-analogy-based pronunciation if the nonword was pronounced in a way to rhyme with an irregular real word neighbor (e.g., pronouncing *choll* as /tʃoʊ/ to rhyme with *roll*). We should note that because nonwords from the regular consistent neighborhood did not have any irregular neighbors, it was impossible for any irregular-analogy-based pronunciations to occur in this category. Therefore, this condition was eliminated in all analyses where the proportion of irregular-analogy-based pronunciations served as the dependent variable.

The mean proportion and standard deviation of (a) GPC-based pronunciations, (b) irregular-analogy-based pronunciations, and (c) implausible pronunciations by rime condition and by time of test are presented in Tables 3, 4, and 5, respectively. For clarity, we report our analyses on the children's pronunciations, and then we present our comparisons between the adults and the children before and after instruction. For the child participant analyses, we performed separate two-factor within-subjects (F_s) and mixed-design items (F_i) analyses of variance (ANOVAs) on each of these dependent measures. Rime condition (regular–consistent, ambiguous, irregular, and NRA) was a within-subjects factor and a between-items factor,

TABLE 3
The Mean Proportion and Standard Deviation of Grapheme-to-Phoneme Correspondence–Based Pronunciations as a Function of Experiment, Level of Reader, and Time of Test

	Experiment 1				*Experiment 2*		
	Grades 1-5		*Grades 1-2*		*Grades 3-5*		*Undergraduates*
Rime Type	*T1*	*T2*	*T1*	*T2*	*T1*	*T2*	*T1*
Regular	.45 (.29)	.65 (.27)	.40 (.31)	.72 (.23)	.50 (.38)	.89 (.17)	.89 (.11)
Ambiguous	.40 (.24)	.51 (.23)	43 (.34)	.56 (.27)	.39 (.31)	.48 (.25)	.62 (.20)
Irregular	.36 (.20)	.40 (.21)	.44 (.30)	.52 (.25)	.35 (.29)	.37 (.20)	.53 (.20)
NRA	.24 (.20)	.23 (.15)	.16 (.14)	.28 (.17)	.24 (.23)	.20 (.14)	.42 (.12)

Note. NRA = no regular analogy.

TABLE 4
The Mean Proportion and Standard Deviation of Irregular Analogies as a Function of Experiment, Level of Reader, and Time of Test

	Experiment 1				*Experiment 2*		
	Grades 1–5		*Grades 1–2*		*Grades 3–5*		*Undergraduates*
Rime Type	*T1*	*T2*	*T1*	*T2*	*T1*	*T2*	*T1*
Ambiguous	.16 (.16)	.23 (.19)	.11 (.12)	.21 (.20)	.17 (.18)	.40 (.24)	.31 (.22)
Irregular	.30 (.15)	.34 (.23)	.12 (.13)	.36 (.19)	.25 (.20)	.52 (.19)	.45 (.21)
NRA	.24 (.20)	.30 (.17)	.17 (.20)	.39 (.22)	.18 (.13)	.49 (.26)	.47 (.17)

Note. NRA = no regular analogy.

TABLE 5
The Mean Proportion and Standard Deviation of Implausible Pronunciations as a Function of Experiment, Level of Reader, and Time of Test

	Experiment 1				*Experiment 2*		
	Grades 1–5		*Grades 1–2*		*Grades 3–5*		*Undergraduates*
Rime Type	*T1*	*T2*	*T1*	*T2*	*T1*	*T2*	*T1*
Regular	.55 (.29)	.35 (.27)	.59 (.31)	.28 (.24)	.50 (.38)	.11 (.17)	.11 (.11)
Ambiguous	.44 (.29)	.26 (.20)	.45 (.33)	.22 (.18)	.45 (.28)	.11 (.12)	.07 (.08)
Irregular	.34 (.26)	.27 (.27)	.45 (.35)	.12 (.20)	.40 (.33)	.11 (.19)	.02 (.05)
NRA	.52 (.29)	.47 (.22)	.67 (.30)	.33 (.21)	.58 (.26)	.32 (.24)	.11 (.12)

Note. NRA = no regular analogy.

and time of test (preinstruction, postinstruction) was a within-subjects factor and a within-items factor.

Children's GPC-Based Pronunciations

The proportion of GPC-based pronunciations produced by the children before and after instruction is displayed in Table 3. GPC-based pronunciations increased from preinstruction (.36) to postinstruction (.45), $F_s(1, 19) = 9.19$, $p < .01$, $\eta^2_p = .33$; $F_i(1, 22) = 11.37$, $p < .01$, $\eta^2_p = .34$. GPC-based pronunciations varied by rime condition, $F_s(3, 57) = 15.17$, $p < .001$, $\eta^2_p = .44$; $F_i(3, 22) = 2.99$, $p = .053$, $\eta^2_p = .29$. Individual *t* tests conducted by subjects indicated that there were significant differences in the mean proportion of GPC-based pronunciations by rime condition for the following comparisons: (a) irregular versus regular, $t_s(19) = 3.76$, $p < .001$, $\eta^2 = .43$; (b) irregular versus NRA, $t_s(19) = 3.33$, $p < .01$, $\eta^2 = 0.37$; (c) regular versus ambiguous, $t_s(19) = 2.31$, $p < .05$, $\eta^2 = .22$; (d) ambiguous versus NRA, $t_s(19) = 4.28$, $p < .001$, $\eta^2 = .49$; and (e) regular versus NRA, $t_s(19) = 6.19$, $p < .001$, $\eta^2 = .67$. In the analyses by items, only the comparison involving the regular consistent condition and the NRA condition was significant, $t_i(12) = 3.08$, $p < .01$, $\eta^2 = .44$ (all other *p*s > .08). The Rime Type × Time of Test interaction was significant by subjects, $F_s(3, 57) = 4.01$, , $p < .05$, $\eta^2_p = .17$, and approached significance by items, $F_i(3, 22) = 2.93$, $p = .056$, $\eta^2_p = .29$ The interaction was due to there being increases in GPC-based pronunciations over time for the regular consistent condition, $t_s(19) = 3.27$, $p < .01$, $\eta^2 = .36$; $t_i(5) = 3.16$, $p < .05$, $\eta^2 = .67$, and the ambiguous condition, $t_s(19) = 3.32$, $p < .01$, $\eta^2 = .37$; $t_i(5) = 2.29$, $p = .071$, $\eta^2 = .51$, but not for the irregular or the NRA conditions, both $|ts| > 1$.

Children's Irregular Analogy Pronunciations

As can be seen in Table 4, the proportion of irregular analogy pronunciations increased from pretest (.29) to posttest (.38), but the effect was only significant by items, $F_i(1, 17) = 6.80$, $p < .05$, $\eta^2_p = .29$, and approached significance by subjects, $F_s(1, 19) = 3.30$, $p = .085$, $\eta^2_p = .15$. In addition, irregular analogy pronunciations varied by rime condition with the proportion of irregular analogy pronunciations as .20, .32, and, .27 for the ambiguous, irregular, and NRA conditions, respectively. The effect of rime on proportion of irregular-analogy-based pronunciations was significant by subjects only, $F_s(2, 38) = 4.17$, $p < .05$, $\eta^2_p = .18$, $F_i < 1$. Individual *t* tests conducted by subjects indicated that children produced more irregular analogies in the irregular condition than in the ambiguous condition, $t_s(19) = 2.43$, $p < .05$, $\eta^2 = .24$. The proportion of analogies produced in the NRA condition was higher than the proportion of analogies produced in the ambiguous condition, but this effect only approached significance, $t_s(19) = 1.96$, $p = .064$, $\eta^2 = .17$. The difference in the proportion of irregular analogies produced by the irregular condition and the NRA condition was not significant ($p > .24$). The Rime Type × Time of Test interaction was not significant (both Fs < 1).

Children's Implausible Pronunciations

The proportions of implausible pronunciations that the children produced both before and after instruction are displayed in Table 5. The proportion of implausible pronunciations decreased from preinstruction to postinstruction (.46 vs. .34), $F_s(1, 19) = 10.67$, $p < .005$, $\eta^2_p = .36$; $F_i(1, 22) = 20.12$, $p < .001$, $\eta^2_p = .48$. The proportion of implausible pronunciations varied across rime conditions, but the effect of rime condition was significant only by subjects, $F_s(3, 57) = 8.34$, $p < .001$, $\eta^2_p = .31$; $F_i(3, 22) = 2.16$, $p = .122$, $\eta^2_p = 0.23$. The proportion of implausible pronunciations was smallest for nonwords derived from irregular neighborhoods (.31), was slightly higher (.35) for nonwords from the ambiguous condition, higher again (.45) for nonwords in the regular condition, and the highest (.50) for nonwords in the NRA condition. Individual paired-samples t tests conducted by subjects indicated that there were significant differences in the mean proportion of implausible pronunciations by rime condition for the following comparisons: (a) irregular versus regular, $t_s(19) = 3.42$, $p < .005$, $\eta^2 = .38$; (b) irregular versus NRA, $t_s(19) = 5.67$, $p < .001$, $\eta^2 = .63$; (c) regular versus ambiguous, $t_s(19) = 2.42$, $p < .05$, $\eta^2 = .24$; and (d) ambiguous versus NRA, $t_s(19) = 3.73$, $p < .001$ $\eta^2 = .42$. In the analyses by items, the comparison between the regular consistent condition and the irregular condition approached significance, $t_i(10) = 1.90$, $p = .09$, $\eta^2 = .27$, as did the comparison between the irregular and NRA conditions, $t_i(12) = 1.94$, $p = .08$, $\eta^2 = .24$ (all other ps > .14). The Rime × Time of Test interaction approached significance by subjects, $F_s(3, 57) = 2.47$, $p = .071$, $\eta^2_p = .12$, and was not significant by items, $F_i(3, 22) = 1.85$, $p = .168$, $\eta^2_p = .20$. The marginally significant interaction was due to there being significant reductions in implausible pronunciations from preinstruction to postinstruction only for the regular consistent condition, $t_s(19) = 3.27$, $p < .005$, $\eta^2 = .36$, and the ambiguous condition, $t_s(19) = 3.69$, $p < .005$, $\eta^2 = .42$ (both other ps > .20).

Comparisons Between Children and Adults

To compare the pronunciation patterns of children and adults, correlation coefficients were calculated between the children and adults' item means for the proportion of implausible pronunciations, GPC-based pronunciations, and irregular-analogy-based pronunciations. The correlation matrix is presented in Table 6. We expected that, after instruction, the pronunciation patterns of children would become closer to the adults' pronunciation patterns. As can be seen from Table 6, after instruction, the children from Experiment 1 looked more like adult readers than they did before instruction on all dependent measures. Also, the mean proportion of responses by condition presented in Tables 2, 3, and 4 shows that the chil-

TABLE 6
Item-Level Correlations Between Adults and Children for the Proportion of Implausible Pronunciations, GPC-Based Pronunciations, and Irregular Analogies

	All Children T1	*All Children T2*	*Experiment 1 (Grades 1-5) T1*	*Experiment 1 (Grades 1-5) T2*	*Experiment 2 (Grades 1-2) T1*	*Experiment 2 (Grades 1-2) T2*	*Experiment 2 (Grades 3-5) T1*	*Experiment 2 (Grades 3-5) T2*
Young Adults–Implausible	.52	.59	.46	.60	.49	.43	.44	.58
Young Adults–GPC	.78	.81	.68	.77	.70	.76	.82	.76
Young Adults–Irregular Analogies	.68	.76	.67	.75	.62	.80	.60	.58

Note. All *p*s < .05. GPC = grapheme-to-phoneme correspondence.

dren became more adultlike in their performance after instruction in that the proportion of implausible pronunciations decreased and the proportion of GPC-based and irregular-analogy-based pronunciations that corresponded with the spelling-to-sound consistency of the nonword rime units increased.

Discussion

Exposure to words and their meanings increased word knowledge in terms of both pronunciation accuracy and meaning accuracy. In addition, learning words increased the use of GPC-based pronunciations for nonwords from regular and ambiguous neighborhoods, increased the use of irregular analogies for nonwords in neighborhoods containing consistently irregular words, and decreased implausible pronunciations of nonwords. Furthermore, the child participants' pronunciation patterns resembled those of adults more after instruction than before. However, some of the instruction effects reported only approached significance. Thus, these results seemed to provide some support for the idea that simple exposure to words and their pronunciations can lead to the development of pronunciation rules that will be applied to novel letters strings (Coltheart et al., 1993).

It is possible that children would produce pronunciation patterns even more sensitive to rime-level constraints if the properties of consistency and regularity at the rime-level were made more explicit. Thus, in Experiment 2, we modified the instruction program to include a more explicit and active emphasis on rime unit neighborhoods and their properties of spelling-to-sound regularity and consistency. In fact, a recent rational analysis of the frequency of spelling-to-sound mappings of whole words and sublexical units such as graphemes and rimes, suggested that reading instruction that includes rime mappings should be beneficial above and beyond instruction exclusively based on whole words or GPC rules (Vousden, 2008). Furthermore, Vousden (2008) suggested that instruction that includes an emphasis on rimes will help children learn to read words that are inconsistent and/or irregular. In addition to emphasizing rime-unit properties, we also wanted our instruction in Experiment 2 to be more engaging than that of Experiment 1, so, we included more activities in order to be more student centered and more similar to the type of instruction found in a typical classroom setting.

EXPERIMENT 2

In Experiment 2, the child participants engaged in a more active learning procedure that could be easily administered in a classroom. The first modification was that the to-be-learned words were grouped by rime type during instruction. In other words, regular consistent neighborhoods, ambiguous neighborhoods, irregular neighborhoods, and NRA neighborhoods were taught as groups during instruction. Second, participants were given materials (see next) from which they wrote a series of stories and illustrations involving all of the to-be-learned words. We expected that these changes would better stimulate the learning of the words and would have a more dramatic impact on nonword pronunciation than Experiment 1. Finally, we included more child participants so that we could divide the sample into two age groups. The younger age group consisted of first and second graders, and the older age group consisted of third, fourth, and fifth graders.

Method

Participants

Forty participants ranging in age from 6.5 to 10.92 (M = 8.72) participated in this experiment. There were 21 participants from Grades 1 and 2 (M age = 7.64) and 19 participants from Grades 3 to 5 (M age = 9.9). Participants were recruited from academic after-school and summer programs from a midsized Midwestern metropolitan area of the United States. This sample of students was both ethnically and financially diverse with students attending schools in largely lower middle-class to middle-class neighborhoods. As with Experiment 1, approximately half of the participants were from ethnic minority groups (e.g., African American, Latina/o, or multiracial), and the other half were of Caucasian descent. Before working with any of the minor participants, we obtained permission from the school principals, the coordinators of the after-school and summer programs, and each participant's parent(s)/guardian(s). Upon receiving permission to work with a child, we also obtained informed assent from each participant. The students' school-based reading instruction focused on spelling-to-sound correspondences and in helping the students learn how to "sound out" unfamiliar words.

Materials

The nonword lists, real word lists, and real word knowledge lists used in this experiment were identical to those used in Experiment 1. In an effort to make the instruction phase of Experiment 2 more engaging and more realistic for the participants, we decided to ask the participants to create booklets that depicted stories and illustrations of the 101 real words drawn from the same 26 neighborhoods as the target nonwords (no direct mention of the similarity in spelling between the words being taught and the nonwords was made). To create these booklets, each student received a reference glossary of all of the words divided into the four neighborhood types (regular, ambiguous, irregular, and NRA), with each word presented within its neighborhood (i.e., all the words from the *–all* neighborhood were presented together). This glossary also contained the definition of each word and a sentence in which the word was used. Each student also received construction paper, crayons, markers, pencils, and string (for booklet binding).

Procedure

The materials, tasks, and procedures that were completed in the pre-instruction and post-instruction phases of Experiment 1 were also used in Experiment 2.

Instruction Phase

Participants engaged in five sessions of instruction. Each instruction session lasted for approximately 45 min. Students were instructed in groups of approximately 10 students. We divided students into four groups—two groups of younger students (Grades 1–2) and two groups of older students (Grades 3–5). The instruction was the same for all students, but we decided to divide them into age groups to more closely resemble classroom groupings.

Each instruction session was divided into two sections: a guided instruction section and an independent practice section. In the guided instruction section, the experimenter stood at the front of a classroom and used a chalkboard to aid in instruction. She introduced the participants to one or two neighborhoods of words from each of the four categories of neighborhoods (regular, ambiguous, irregular, NRA). For example, the experimenter told the participants that a specific neighborhood of words (e.g., the *–eap* neighborhood) was a regular neighborhood of words in which all of the words were pronounced the same way and according to the GPC rules (which the students were told were similar to phonics rules). For ambiguous neighborhoods (e.g., the *–eaf* neighborhood), the experimenter told participants that words in this type of neighborhood would follow GPC rules in their pronunciations about half of the time (e.g., *leaf*) and the other half of the time they would be pronounced in a way that did not coincide with GPC rules (e.g., *deaf*). Participants were told that the words in the irregular neighborhoods (e.g., the *–oll* neighborhood) rarely were pronounced according to the GPC rules (but sometimes were, e.g., *doll*) but that most words in irregular neighborhoods were pronounced in a similar way across words (e.g., *poll, stroll, troll,* etc.). For the No Regular Analogy neighborhoods (e.g., *-oup*), the participants were told that words in these neighborhoods were never pronounced in a way that obeyed GPC rules and that the way the words were pronounced was not necessarily similar across words. For example, in the *–oup* neighborhood, the words *group* and *soup* sound the same, but *coup* does not. For each of the neighborhoods introduced, the participants and the experimenter listed all of the words from the neighborhood on the board, discussed the meanings of each, and suggested sentences that appropriately used the words. Each day the experimenter introduced and discussed five or six rime-unit neighborhoods. This guided practice section of the instruction took about 15 min. It is important to note that the experimenter never used terms like “strategy” and never told students that knowing the pronunciation characteristics of neighborhoods could help the children pronounce new words with similar spellings. We did not include these features in the instruction because we wanted to see if the students would extend what they learned about words to novel letter strings (i.e, the nonwords).

In the remaining 30 min of each instruction session, the participants generated a brief story and a picture that illustrated all of the members of a neighborhood for each of the five to six neighborhoods learned in that day. For example, for the *–eap* neighborhood, one child drew a picture of a person jumping over a pile of wheat with a store in the background. For this picture, he included the brief story that "the farmer will reap the wheat from his field. He will pile it in a big heap that he will leap over and then sell it to a store for really cheap." Of course, the quality of stories and illustrations varied considerably among children. In addition, 4 to 6 children sat at round or hexagonal tables and shared booklet construction materials (construction paper, crayons, markers, pencils, etc.). Although each child created his or her own illustrations and stories, we did allow the children to help one another and to receive help from the experimenter. This help usually came in the form of the other students or the experimenter clarifying the meaning of a word. We felt that this open type of communication and helpful environment resembled the type of instruction that children may receive in a classroom setting. Finally, we should note that the participants were not assessed formally on the accuracy of their stories or their illustrations. We felt that this possibly would appear punitive to the children, and we felt it was important that they enjoyed their participation in the instruction phase of the experiment.

In each of the five instruction sessions, five or six new neighborhoods were introduced, and the guided practice and independent practice sections of the session focused on these neighborhoods. Thus, by the end of the instruction phase, each child had been introduced to all of the 101 words in the 26 rime neighborhoods. At the end of the final instruction session, the children were asked to bind their complete booklets together. They were then given the option to take the booklets home, which most of the participants did.

Results

Real Word Knowledge

The mean pronunciation accuracy rates and mean definition accuracy rates for the real words for each grade level are provided in Table 2. An initial 2 (time) × 2 (age group) repeated measures ANOVA indicated no interaction between time and age group for either the real word pronunciation accuracy or for the word knowledge tasks. However, there were main effects of time for both tasks, indicating that instruction increased word pronunciation accuracy, $F_s(1, 38) = 96.54$, $p < .001$, $\eta^2_p = .72$, and real word knowledge, $F_s(1, 38) = 20.28$, $p < .001$, $\eta^2_p = .35$. In addition, when collapsed across time, the children in the older age group pronounced words more accurately (.77) than children in the younger group (.64), $F_s(1, 38) = 4.35$, $p < .05$, $\eta^2_p = .10$. No other effects were significant (all ps > .11).

Nonword Pronunciation

The mean proportion of (a) GPC-based pronunciations, (b) irregular-analogy-based pronunciations, and (c) implausible pronunciations, by rime condition and age group, are presented in Tables 3, 4, and 5, respectively. We performed separate mixed-factor subjects (F_s) and items (F_i) ANOVAs on each of these dependent measures. Rime condition (regular, ambiguous, irregular, and NRA) was a within-subjects factor and a between-items factor, time of test (preinstruction, postinstruction) was a within-subjects factor and a within-items factor, and age group (younger or older) was a between subjects factor and a within-items factor. Note that in the analyses conducted on the proportion of irregular analogies, the regular rime condition was excluded due to the absence of irregular words in that neighborhood.

GPC-Based Pronunciations

The initial omnibus mixed-factors ANOVAs comparing rime type, time of test, and age groups did not indicate a three-way interaction in the production of GPC-based pronunciations (Fs < 2.3, p >.11). However, there was a main effect of time in the proportion of GPC-based pronunciations such that they increased from pretest (.34) to posttest (.50), $F_s(1, 38) = 18.74$, $p < .001$, $\eta^2_p = .33$; $F_i(1, 22) = 46.65$, $p < .001$, $\eta^2_p = .68$. The proportion of GPC-based pronunciations varied across rime conditions (with proportions of GPC-based pronunciations of .62 for regular, .47 for ambiguous, .42 for irregular, and .22 for NRA rimes), $F_s(3, 114) = 55.42$, $p < .001$, $\eta^2_p = .59$; $F_i(3, 22) = 6.52$, $p < .005$, $\eta^2_p = .47$. Individual paired-samples t tests conducted by subjects and independent samples t test conducted by items tested for significant differences between conditions in the mean proportion of GPC-based pronunciations. The following rime condition comparisons indicated differences in proportions of GPC-based pronunciations: (a) irregular versus regular, $t_s(39) = 4.95$, $p < .001$, $\eta^2 = .39$; $t_i(10) = 2.51$, $p < .05$, $\eta^2 = .39$; (b) irregular versus NRA, $t_s(39) = 6.85$, $p < .001$, $\eta^2 = .55$; $t_i(12) = 1.88$, $p = .085$, $\eta^2 = .23$; (c) regular versus ambiguous, $t_s(39) = 4.89$, $p < .001$, $\eta^2 = .38$; $t_i(10) = 1.98$, $p = .076$, $\eta^2 = .28$; (d) regular versus NRA, $t_s(39) = 12.40$, $p < .001$, $\eta^2 = .80$; $t_i(12) = 4.37$, $p < .001$, $\eta^2 = .61$; (e) ambiguous versus NRA, $t_s(39) = 7.76$, $p < .001$, $\eta^2 = .61$; $t_i(12) = 2.29$, $p < .05$, $\eta^2 = .30$, but no difference for (f) irregular versus ambiguous, $t_s(39) = 1.29$, $p = .204$, $\eta^2 = .04$ $|t_i| < 1$. It is important to note that there was a significant interaction between time of test and rime condition, $F_s(3, 38) = 17.76$, $p < .001$, $\eta^2_p = .32$; $F_i(3, 22) = 12.63$, $p < .001$, $\eta^2_p = .63$. GPC-based pronunciations clearly increased in the regular consistent condition after training (.45 for pretraining and .80 for posttraining), $t_s(39) = 8.48$, $p < .001$, $\eta^2 = .65$; $t_i(5) = 13.15$, $p < .001$, $\eta^2 = .97$. There was an increase in GPC-based pronunciations observed in the ambiguous condition (.41 for pretraining and .52 for posttraining) by subjects, $t_s(39) = 2.42$, $p < .05$, $\eta^2 = .13$, and by items, $t_i(5) = 2.70$ $p < .05$, $\eta^2 = .59$, $p = .041$. The increase observed in the irregular condition (.40 for pretraining and .45 for posttraining) was not significant by subjects, $t_s(39) = 1.19$, $p = .241$, $\eta^2 = .04$, or by items, $t_i(5) = 1.63$, $p = .163$, $\eta^2 = .35$. The increase in GPC-based pronunciations observed in the NRA condition was slight (.20 for pretraining and .24 for posttraining) and nonsignificant (both $|ts| < 1$). In addition, there was a significant interaction between age group and rime condition, $F_s(3, 114) = 5.66$, $p < .001$, $\eta^2_p = .13$; $F_i(3, 22) = 6.80$, $p < .005$, $\eta^2_p = .48$. *T* tests indicated that although the older students produced more GPC-based pronunciations than the younger students in the regular consistent condition, this difference was not significant by subjects, $t_s(38) = 1.61$, $p = .116$, $\eta^2 = .06$, but was significant by items, $t_i(5) = 2.70$, $p < .05$, $\eta^2 = .59$. In contrast, the older students produced fewer GPC-based pronunciations in the irregular condition, but this effect was not significant by subjects, $t_s(38) = 1.73$, $p = .093$, $\eta^2 = .07$, and was significant by items, $t_i(5) = 3.17$, $p < .05$, $\eta^2 = .67$. No other differences observed between the grade levels were significant (all *p*s > .25).

Irregular Analogy Pronunciations

The initial omnibus mixed factors ANOVAs comparing rime type, time of test, and age group did not indicate a three-way interaction in the production of irregular analogy-based pronunciations across the three rime types (ambiguous, irregular, and NRA; F_s and $F_i < 1.54$). Most important, the proportion of irregular analogies increased between pretest (.16) and posttest (.39), $F_s(1, 38) = 81.77$, $p < .001$, $\eta^2_p = .68$; $F_i(1, 17) = 79.28$, $p < .001$, $\eta^2_p = .82$. Older children produced more irregular analogies than younger children (.33 and .23, respectively), $F_s(1, 38) = 10.11$, $p < .001$, $\eta^2_p = .88$; $F_i(1, 17) = 34.31$, $p < .001$, $\eta^2_p = .67$. Irregular analogies varied by rime condition (.22, .31, .30, respectively for the ambiguous, irregular, and NRA conditions), $F_s(2, 76) = 5.26$, $p < .01$, $\eta^2_p = .12$, but the effect of rime type was not significant by items ($F_i < 1$). There was a trend toward an interaction between rime condition and time in the subject analyses, $F_s(2, 76) = 2.45$, $p = .09$, $\eta^2_p = .06$; however, this same trend was not found in the items analyses ($F_i < 1.55$). *T* tests conducted by subjects indicated that participants produced more irregular analogies in the irregular condition than in the ambiguous condition, $t_s(39) = 3.01$, $p < .005$, $\eta^2 = .19$, and more irregular analogies were produced in the NRA condition than in ambiguous condition, $t_s(39) = 2.51$, $p < .05$, $\eta^2 = .14$. The proportion of irregular analogies produced in the irregular condition and the NRA condition did not differ ($|t| < 1$). None of the by items comparisons indicated reliable differences in the use of the irregular analogy strategy across rime conditions (all $t_i < 1.03$).

Implausible Pronunciations

Initial omnibus mixed-factors ANOVA comparing rime type, time of test, and age groups did not indicate a three-way interaction, $F_s(3, 114) = 1.87$, $p = .138$, $\eta^2_p = .05$; $F_i(3, 22) = 1.61$, $p = .22$, $\eta^2_p = .18$. However, there was a substantial decrease in the proportion of implausible pronunciations from pretest to posttest (.51 vs. .20), $F_s(1, 38) = 100.99$, $p < .001$, $\eta^2_p = .73$; $F_i(1, 22) = 291.20$, $p < .001$, $\eta^2_p = .93$. The proportion of implausible pronunciations varied across rime conditions, $F_s(3, 114) = 22.31$, $p < .001$, $\eta^2_p = .73$; $F_i(3, 22) = 3.88$, $p < .05$, $\eta^2_p = .35$. The proportion of implausible pronunciations was smallest for nonwords derived from irregular neighborhoods (.27) and increased to .31 in the ambiguous condition, .37 in the regular condition, and .48 in the NRA condition respectively. Individual paired-samples *t* tests conducted by subjects indicated that there were significant differences in the mean proportion of implausible pronunciations by rime condition for the following comparisons: (a) irregular versus regular, $t_s(39) = 3.36$, $p < .005$, $\eta^2 = .22$; (b) irregular versus NRA, $t_s(39) = 8.05$, $p < .001$, $\eta^2 =. 62$; (c) regular versus ambiguous, $t_s(39) = 3.20$, $p < .005$, $\eta^2 = .21$, (d) regular versus NRA, $t_s(39) = 3.46$, $p < .005$, $\eta^2 = .23$; and (e) ambiguous versus NRA, $t_s(39) = 6.48$, $p < .005$, $\eta^2 = .52$. In the analyses by items, the comparisons involving the ambiguous condition versus the NRA condition, $t_i(12) = 2.14$, $p = .054$, $\eta^2 = .28$, and the regular condition versus the irregular condition, $t_i(10) = 2.13$, $p = .059$, $\eta^2 = .31$, approached significance, and the comparison involving the irregular condition versus the NRA condition was significant, $t_i(12) = 2.76$, $p < .05$, $\eta^2 = .39$. Also, the older children (.36) tended to make fewer implausible pronunciations than the younger children (.39), but this effect was only significant by items, $F_s(1, 38) = 1.02$, $p =.32$, $\eta^2_p = .03$; $F_i(1, 22) = 9.86$, $p < .005$, $\eta^2_p = .31$. No other effects were significant (all *p*s > .13).

Comparisons With Adults of Experiment 1

As in Experiment 1, we examined whether the participants of Experiment 2 participants produced pronunciations that resembled adults more after instruction than before. The correlation matrix provided in Table 6 shows that the younger readers from Experiment 2 generally looked more like the adult readers, but the Grade 3 to 5 readers' similarity to the young adults did not increase to the same extent as that of the younger children. However, there are several things to note. First, the proportion of implausible pronunciations was reduced dramatically with word exposure and instruction. In addition, the adults were clearly sensitive to the statistical properties of the rimes tested in our experiment (also see Andrews & Scarratt, 1998, Zevin & Seidenberg, 2006). Based on the preinstruction data and the correlations between pronunciation patterns of adults and preinstruction children, it is also clear the child readers had prior knowledge about many of the 101 words. Thus, even though we would expect learning these words to reduce the proportion of implausible pronunciations in children, a dramatic change in the pattern of responses might not be expected. In other words, items that produced a relatively high or low proportion of a particular type of response at pretest would still be expected to produce a relatively high or low proportion of that type of response at posttest. For example, *taugh* produced a high proportion of implausible pronunciations at both pretest and posttest, even though the proportion of implausible pronunciations generally decreased.

Discussion

Similar to Experiment 1, exposure to words and active engagement in learning their pronunciations and meanings produced reliable increases in vocabulary measures. Of importance, learning these words also produced reliable increases in GPC-based pronunciations and irregular analogies, as well as a reliable reduction in implausible pronunciations. It is interesting to note that the gain over time in the proportion of GPC-based pronunciations was largest for nonwords from regular-consistent neighborhoods and decreased as the frequency of regular pronunciations in the neighborhood decreased. In addition, the proportion of irregular analogies increased with word learning similarly across conditions. Although there was a tendency for larger increases in irregular analogies over time for nonwords from irregular-word dominated neighborhoods, these larger increases were not statistically significant.

Results from Experiment 2 also suggest some age group differences in pronunciation strategies. Specifically, via the items analyses, the older children appeared to be more sensitive to the rime unit characteristics of regularity and consistency. Compared to younger children, older children produced higher proportions of GPC-based pronunciations for nonwords with regular rime units, lower proportions of GPC-based pronunciations for the nonwords with irregular rime units, and higher proportion of irregular analogy-based pronunciations. These age differences suggest that sensitivity to rime unit characteristics increases with age-related increases in reading experience.

Comparison With Experiment 1

We hypothesized that compared to Experiment 1, the method employed in Experiment 2 would lead to children producing pronunciations more sensitive to rime unit regularity and consistency for at least three reasons. First, twice as many children participated in Experiment 2 than Experiment 1. This modification increased the statistical power for the subjects' analyses and produced more reliable estimates of item means. Second, by categorizing the words into rime-unit neighborhoods, the consistency of spelling-to-sound relationships was emphasized. Third, the participants engaged in more active word learning in constructing stories and illustrations about the rime neighborhoods of words. The memory literature suggests that an explicit memory boost occurs for words that have been actively processed versus those that have been processed more passively (see, e.g., Jacoby, 1983).

To examine between-experiment differences, we conducted another set of analyses in which experiment was included as a between-subjects factor. One modification that we made was to collapse across the grade level of the participants in Experiment 2. There was no significant difference in age between the participants from Experiment 1 (M age = 8.62) and Experiment 2 (M age = 8.71; $|t| < 1$). In the following analyses, all lower order effects that were observed in Experiments 1 and 2 were maintained in these analyses and we report here only the effects involving experiment.

Results and Discussion

The word pronunciation accuracy increase resulting from instruction was more pronounced in Experiment 2 than in Experiment 1, as exhibited by the marginally significant experiment by time of test interaction, $F_s(1, 58) = 3.59$, $p = .063$. In terms of real word knowledge, time of test did not interact with experiment ($F_s < 1$).

In the analyses of strategies used before and after instruction, there was a greater increase after instruction in the proportion of GPC-based pronunciations in Experiment 2 than in Experiment 1. The interaction between experiment and time of test was not significant by subjects, $F_s(1, 58) = 1.24$, $p = .271$, $\eta^2_p = .02$, but was significant by items, $F_i(1, 22) = 5.40$, $p < .05$, $\eta^2_p = .20$.. In addition, Experiment 2 participants increased their use of the irregular-analogy strategy more than Experiment 1 participants, as exhibited by the significant interaction between experiment and time of test, $F_s(1, 58) = 15.39$, $p < .001$, $\eta^2_p = .21$; $F_i(1, 17) = 38.86$, $p < .001$, $\eta^2_p = .70$. Finally, the decrease in implausible pronunciations that occurred with instruction was more pronounced for Experiment 2 than Experiment 1 participants, $F_s(1, 58) = 13.17$, $p < .001$, $\eta^2_p = .19$; $F_i(1, 22) = 46.41$, $p < .001$, $\eta^2_p = .68$.

These results confirmed the prediction that the method employed in Experiment 2 in which rime units were introduced was more powerful than that employed in Experiment 1, as would be supported by Vousden (2008). Of interest, there were no significant interactions involving experiment and rime condition. Thus, although the effects observed tended to be stronger in Experiment 2 than Experiment 1, the pattern of results was quite consistent across experiments.

GENERAL DISCUSSION

The results of these experiments allow us to make four conclusions about nonword reading aloud strategies. First, the orthographic-to-phonological consistency of neighborhoods from which nonwords are derived influences children's pronunciations of nonwords. Second, sensitivity to rime unit regularity and consistency increases with instruction that focuses on words varying in these neighborhood characteristics. Third, the type of instruction utilized in Experiment 2 (i.e., concentrating on a variety of words from various rime-unit neighborhoods that vary in rime-unit consistency and regularity) leads children to pronounce nonwords more similarly to adult pronunciations. Fourth, children are able to generalize pronunciation patterns from learned words that to new words, even when the new and already learned words are encountered at different times.

Our results suggest that even before instruction, the children in both experiments assigned more GPC-based pronunciations to nonwords with regular rime units than to nonwords with irregular rime units. If the children were not sensitive to these rime-unit pronunciation patterns they would have employed a GPC-rule strategy consistently across conditions. We also found that sensitivity to rime-unit regularity and consistency increased as children learned words that varied in these pronunciation features. This conclusion is based on the relatively large increase in GPC-based pronunciations for the nonwords in regular and ambiguous rime-unit neighborhoods but relatively little increase in the use of the GPC-based strategy for nonwords in the irregular and NRA neighborhoods. The children, however, did increase their use of the irregular-based analogy strategy from preinstruction to postinstruction for the irregular and NRA nonwords. These pronunciation changes were seen in both the passive instruction of Experiment 1 and the more student-centered and overt instruction of Experiment 2.

The interpretation of the results from Experiments 1 and 2 is limited by the absence of a control group that was not exposed to the specific words in our training set. It is possible that the performance changes from pretest and posttest could be due to (a) the specific instruction administered, (b) exposure to any set of words and reading instruction, (c) the passage of time, or (d) some combination of these. However, the observed changes in nonword pronunciations depended on the specific neighborhood tested: nonwords derived from neighborhoods containing entirely regular words showed the biggest increase in GPC-based pronunciations, whereas those derived from neighborhoods containing mostly irregular words showed the smallest increase in GPC-based pronunciations. This finding indicates that participants extracted (i.e., learned) the statistical properties of the neighborhoods to which they were exposed and used this information to guide their subsequent pronunciations. It is unlikely that this systematic change in performance could be due to the passage of time, especially because the amount of time between tests was less than 2 weeks. It also seems unlikely that exposure to a random set of 101 words would produce such systematic changes. Exposure to any set of words might lead to a decrease in implausible pronunciations, and one could argue that it might lead to an increase in the use of the GPC-based pronunciation strategy equally across conditions. However, the idea that exposure to a random set of words would produce systematic changes in performance like those observed in our experiments is not plausible.

In addition, the results from these experiments suggest that children are able to generalize pronunciation patterns from words that they are learning to new words. That is, new word or nonword pronunciations were clearly influenced by the pronunciation patterns of rime-unit neighbors. This provides evidence for children's ability to use an analogy-based strategy when pronouncing new words. Thus, our findings further support the view that children can use analogy to aid in reading new words. Unlike previous work suggesting that children are able to use an analogy strategy (cf. Goswami, 1986), we did not use only regular words and regular rime units. Instead, we used nonwords with rime units that varied in regularity and consistency. By using irregular rime units we could accurately determine if the child was using an analogy or a GPC-based strategy. In nonwords such as *moup*, the two strategies would lead to distinctly different pronunciations (the GPC-based strategy would lead to a pronunciation of /maʊp/ whereas an analogy-based strategy would lead to a pronunciation of /mup/).

Another interesting difference between current experiments and previous examinations of children's reading aloud strategies is in the amount of time separating the study sessions and the testing sessions. Previous experiments asked children to read aloud a new word or a nonword, whereas a similarly spelled word was in full-view (e.g., Brown & Deavers, 1999, Experiment 2; Goswami, 1986), or the nonword was embedded in a list of real words that resembled the nonword in terms of spelling (e.g., Brown & Deavers, 1999, Experiment 3). We conducted the testing sessions at least 1 full day after the last study session, and we made no suggestion to children to think about the previously learned words when reading the nonwords. Thus, we can argue that children using an analogy-based strategy were accessing the pronunciation pattern of a given rime unit from memory and were not immediately primed to use the analogy strategy. These results provide strong support for the notion that children can and do use an analogy-based strategy for pronouncing unfamiliar words.

It is clear from these data that nonword pronunciation is influenced by lexical knowledge and the statistical properties of orthographic-to-phonological neighborhoods. Therefore, models that are sensitive to neighborhood consistency, such PDP models and the CDP+ model, are best suited to explain these results. Localist lexical representations per se are not necessary to produce irregular analogies. For example, in a PDP model that does not contain localist lexical representations, nonword pronunciation is a function of knowledge acquired during learning. This knowledge is represented in connection weights that reflect the statistical relationships between orthography and phonology that is present in the reader's environment. When a nonword is derived from a neighborhood that contains more irregular words than regular words, the connections weights between the orthographic input and phonological output may encourage an irregular pronunciation of the nonword.

We would like to argue that our results also are consistent with the flexible-unit size hypothesis put forth by Brown and Deavers (1999). This hypothesis is based on the principle that the strategy a reader uses to pronounce a new word depends on the information provided and the context in which the new word is read. That is, in some contexts (e.g., in a list of all nonwords, cf. Brown & Deavers, 1999, Experiment 1) a reader will rely on small units (e.g., GPC units) to guide pronunciations, whereas at other times (e.g., when irregular rime units are present) a reader will use an analogy strategy. Our participants showed flexibility in their use of the GPC-based and rime-unit analogy strategies. After being exposed to real word neighbors that shared their rime units with the nonwords, the children were more likely to use the rime-unit analogy strategy than they were before instruction when they relied more on GPC rules to guide pronunciations. Thus, it appears that readers are not only flexible in the unit size of pronunciation based on the context and the task at hand, but also based on their exposure to similarly spelled words. This conclusion is also supported by age group differences in Experiment 2. As readers are exposed to more and more words over time, they will rely increasingly on the analogy-based strategy for pronouncing new words. In other words, children will behave more like adult readers as they learn new words and are exposed to more irregular words. This is not surprising given that an analogy-based strategy will lead to a successful pronunciation of more words (i.e., for both regular and irregular words) than a GPC-rule based strategy that is only successful for regular words.

Most important, these experiments illustrate the utility of designing reading curricula that emphasize the pronunciation properties of rime-unit neighborhood regularity and consistency. In addition, these experiments support the suggestion that irregular words and a focus on various levels of spelling-to-sound mapping should be incorporated into reading instruction, even at an early age (Vousden, 2008). Our results also emphasize the importance of active learning, even when the goal simply is to teach children a series of words. Perhaps not surprisingly, we found that children in Experiment 2 (who received direct and active instruction about neighborhood's rime-unit regularity and consistency) appeared to be more sensitive to consistency and regularity than children in Experiment 1. This is even more interesting when we consider that Experiment 2 employed a realistic classroom lesson plan consisting of direct instruction, guided practice, and individual work. Compared to Experiment 1 in which instruction was more passive, children in Experiment 2 showed greater increases in rime-type relevant pronunciations (i.e., nonword pronunciations that were similar to the pronunciations of words sharing the rime with the nonword).

We should also note that Experiment 2 instruction seemed to focus the children's attention on orthography and phonology more than Experiment 1 instruction, but the focus on semantic information remained relatively constant across techniques. Evidence for this assertion comes from the fact that the change in pronunciation accuracy was greater in Experiment 2 than Experiment 1, but the change in meaning accuracy remained constant across experiments.

Finally, the results from the adult readers are similar to those reported by Andrews and Scarratt (1998). Specifically, adult readers displayed sensitivity to the neighborhood consistency of nonwords. We found that the proportion of GPC-based pronunciations decreased systematically such that nonwords derived from entirely regular neighborhoods were more likely to be given a GPC-based pronunciation than nonwords from neighborhoods associated with many irregular words. Also, nonwords were more likely to be given an irregular-analogy-based pronunciation when they were associated with neighborhoods populated largely by irregular words. As we previously noted, children also show this sensitivity to neighborhood characteristics, especially after learning new words from orthographic neighborhoods varying in spelling-to-sound consistency. Furthermore, postinstruction children and adult readers are similarly sensitive to the statistical properties of orthographic neighborhoods based on the evidence of moderate to high correlations between children's and adults pronunciations patterns (see Table 6).

In sum, our results indicate that children are flexible and sensitive in their use of nonword pronunciation strategies. Their sensitivity appears to depend on not only the consistency of the rime units in the to-be-named letter strings but also the consistency and regularity of the words that they already know. In general, as children learn words that vary in their rime-unit consistency and regularity they use pronunciation strategies that are more adultlike. Thus, early reading instruction programs should introduce children to words that vary in rime-unit regularity and consistency.

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APPENDIX

TABLE A1
Nonword Items and the Proportion of GPC-Based Pronunciations, and the Proportion of Irregular Analogies for the Various Participant Groups at Pretest and Posttest

		Experiment 1:			Experiment 2						Experiment 3:
		Grades 1–5			Grades 1–2			Grades 3–5			Undergraduates
Nonword		T1	T2	Change	T1	T2	Change	T1	T2	Change	Adults
Regular											
pern	GPC	.65	.75	.10	.29	.62	.33	.47	.95	.48	.95
pount	GPC	.40	.65	.25	.29	.52	.23	.53	.84	.31	.86
ract	GPC	.35	.75	.40	.33	.86	.53	.53	.89	.36	.95
sobe	GPC	.25	.60	.35	.33	.67	.34	.42	.79	.37	.84
teap	GPC	.60	.65	.05	.62	.81	.19	.53	.95	.42	.93
yeech	GPC	.45	.50	.05	.57	.86	.29	.53	.89	.36	.81
Ambiguous											
feath	GPC	.25	.45	.20	.48	.86	.38	.47	.53	.06	.74
	Analogy	.05	.30	.25	.14	.10	–.04	.16	.32	.16	.26
heaf	GPC	.50	.70	.20	.57	.67	.10	.37	.47	.10	.63
	Analogy	.20	.20	.00	.05	.33	.28	.16	.53	.37	.37
peard	GPC	.25	.40	.15	.43	.33	–.10	.21	.32	.11	.53
	Analogy	.30	.45	.05	.10	.29	.19	.11	.58	.47	.44
pome	GPC	.75	.80	.05	.62	.76	.14	.63	.74	.11	.74
	Analogy	.00	.00	.00	.05	.14	.09	.05	.16	.11	.23
roul	GPC	.35	.50	.15	.29	.57	.28	.42	.63	.21	.30
	Analogy	.10	.05	–.05	.00	.05	.05	.11	.11	.00	.37
pouth	GPC	.30	.20	–.10	.19	.19	.00	.21	.21	.00	.74
	Analogy	.30	.40	.10	.38	.38	.00	.42	.74	.32	.21
Irregular											
choll	GPC	.20	.05	–.15	.24	.24	.00	.11	.16	.05	.21
	Analogy	.65	.65	.00	.38	.71	.33	.63	.79	.16	.77
gomb	GPC	.20	.15	–.05	.29	.62	.33	.37	.26	–.11	.47
	Analogy	.15	.30	.15	.05	.33	.28	.05	.53	.48	.51
grall	GPC	.20	.35	.15	.24	.24	.00	.16	.42	.26	.19
	Analogy	.45	.50	.05	.19	.62	.43	.42	.58	.16	.74
hild	GPC	.60	.70	.10	.71	.76	.05	.63	.53	–.10	.81
	Analogy	.10	.15	.05	.05	.14	.09	.05	.42	.37	.19
jind	GPC	.70	.65	–.05	.62	.62	.00	.53	.42	–.11	.72
	Analogy	.15	.20	.05	.00	.29	.29	.11	.47	.36	.28
smead	GPC	.25	.50	.25	.52	.67	.15	.32	.42	.10	.79
	Analogy	.30	.25	–.05	.05	.10	.05	.21	.32	.11	.21
NRA											
dinth	GPC	.65	.85	.20	.52	.86	.34	.53	.74	.21	.88
	Analogy	.05	.05	.00	.00	.14	.14	.05	.21	.16	.09
hourt	GPC	.15	.15	.00	.00	.19	.19	.16	.11	–.05	.19

(continued)

TABLE A1 (*Continued*)

Nonword		Experiment 1: Grades 1–5 T1	T2	Change	Experiment 2: Grades 1–2 T1	T2	Change	Grades 3–5 T1	T2	Change	Experiment 3: Undergraduates Adults
	Analogy	.30	.40	.10	.29	.52	.23	.26	.63	.37	.70
kearn	GPC	.15	.15	.00	.10	.24	.14	.16	.05	–.11	.21
	Analogy	.40	.65	.25	.19	.52	.33	.42	.79	.37	.79
moup	GPC	.20	.10	–.10	.14	.24	.10	.16	.21	.05	.33
	Analogy	.10	.20	.10	.14	.33	.19	.11	.32	.21	.37
poung	GPC	.20	.30	.10	.14	.38	.24	.16	.11	–.05	.44
	Analogy	.35	.25	–.10	.19	.38	.19	.26	.37	.11	.28
taugh	GPC	.00	.00	.00	.00	.00	.00	.05	.05	.00	.33
	Analogy	.20	.20	.00	.14	.33	.19	.00	.26	.26	.56
vonth	GPC	.40	.30	–.10	.38	.33	–.05	.63	.26	–.37	.88
	Analogy	.20	.20	.00	.00	.33	.33	.00	.58	.58	.12
vourn	GPC	.15	.05	–.10	.00	.00	.00	.11	.05	–.06	.09
	Analogy	.35	.45	.10	.38	.57	.19	.32	.74	.42	.84

Note. The proportion of implausible pronunciations can be derived by adding the proportion of grapheme-to-phoneme correspondence (GPC)-based pronunciations and the proportion of irregular analogies and subtracting that total from 1.0. NRA = no regular analogy.

TABLE B1
Experimental Training Corpus and Item Characteristics

Neighborhood	*Item*	*HAL Log Frequency*	*Length*	*Orthographic Neighborhood Size*
Regular				
	act	11.2	3	5
	fact	12.1	4	5
	pact	7.2	4	7
	tact	6.6	4	6
	tract	7.4	5	3
	breech	6.2	6	1
	screech	5.9	7	0
	cheap	10.4	5	2
	heap	8.4	4	8
	leap	8.7	4	6
	reap	7.3	4	6
	count	10.4	5	2
	mount	9.8	5	2
	fern	6.3	4	1
	stern	8.5	5	1

(continued)

TABLE B1 (*Continued*)

Neighborhood	*Item*	*HAL Log Frequency*	*Length*	*Orthographic Neighborhood Size*
	globe	8.6	5	1
	lobe	6.1	4	7
	probe	8.7	5	3
	robe	7.4	4	9
Ambiguous				
	breath	9.6	6	2
	death	11.3	5	1
	sheath	6.8	6	0
	wreath	5.7	6	1
	leaf	8.9	4	6
	deaf	8.7	4	5
	sheaf	4.4	5	2
	beard	8.1	5	3
	heard	11.8	5	4
	chrome	7.9	6	0
	come	12.4	4	15
	dome	7.7	4	13
	home	12.2	4	9
	some	13.9	4	9
	foul	8.3	4	6
	ghoul	8.8	5	0
	soul	10.4	4	5
	mouth	10.4	5	4
	south	11.1	5	3
	youth	9.6	5	3
Irregular				
	doll	8.6	4	11
	knoll	6.3	5	0
	poll	9.0	4	12
	roll	10.0	4	7
	toll	8.9	4	12
	bomb	9.6	4	4
	comb	7.4	4	5
	tomb	8.7	4	4
	womb	7.8	4	3
	all	14.3	3	5
	ball	10.6	4	19
	call	12.4	4	13
	fall	10.7	4	12
	gall	7.1	4	14
	hall	10.4	4	17
	mall	9.0	4	16
	pall	5.1	4	16

(continued)

TABLE B1 (*Continued*)

Neighborhood	*Item*	*HAL Log Frequency*	*Length*	*Orthographic Neighborhood Size*
	shall	11.0	5	6
	small	12.0	5	3
	stall	7.9	5	5
	tall	9.3	4	15
	wall	11.4	4	13
	child	11.1	5	3
	gild	4.3	4	6
	mild	8.6	4	9
	wild	10.1	4	8
	bind	8.8	4	12
	blind	9.5	5	4
	find	12.8	4	13
	grind	8.0	5	2
	hind	9.5	4	8
	kind	11.8	4	8
	mind	11.8	4	13
	wind	10.1	4	12
	bead	7.5	4	13
	bread	9.1	5	5
	dead	11.2	4	10
	dread	7.8	5	4
	head	11.6	4	13
	knead	6.1	5	0
	lead	10.8	4	12
	plead	6.9	5	2
	read	12.6	4	12
	spread	10.0	6	0
	stead	6.5	5	4
	thread	11.0	6	1
	tread	8.1	5	5
NRA				
	ninth	7.6	5	0
	court	11.0	5	1
	earn	9.4	4	6
	learn	11.2	5	1
	yearn	5.9	5	2
	coup	7.7	4	3
	group	12.6	5	1
	soup	8.7	4	4
	young	11.1	5	0
	laugh	9.5	5	0
	month	11.2	5	2
	mourn	6.3	5	0

Note. NRA = no regular analogy.