

Cognitive Moderators of Intervention Efficacy: Comparing Phonics-Based and Whole-Language Reading Interventions for Iranian Children with Dyslexia

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ABSTRACT

Purpose: This study aimed to compare the effectiveness of phonics-based and whole-language reading interventions in improving phonological awareness among Iranian primary-school children with dyslexia and to examine the maintenance of intervention effects at follow-up.

Methods and Materials: The study employed a quasi-experimental pretest–posttest design with two intervention groups and a four-week follow-up. Forty-eight children aged 7–9 years from grades two and three in four primary schools in Kermanshah, Iran, were initially assigned to either a phonics-based or whole-language intervention group. Following attrition, 46 participants were included in the final analyses. Both interventions were delivered in small groups for 45 minutes per session, five times per week, over 12 weeks. Phonological awareness was assessed using the Phonological Awareness Test for Persian-speaking Children. Analysis of covariance was used to compare posttest outcomes while controlling for pretest scores, and mixed-design ANOVA evaluated maintenance of intervention effects. Exploratory independent-samples *t* tests examined differences across phonological-awareness subtests.

Findings: ANCOVA showed a significant effect of intervention group on posttest phonological awareness, $F(1, 43) = 12.87, p = .001$, partial $\eta^2 = .23$, favoring the phonics-based intervention. Mixed-design ANOVA revealed significant effects of time, $F(1, 44) = 8.94, p = .004$, partial $\eta^2 = .17$, and group, $F(1, 44) = 10.21, p = .003$, partial $\eta^2 = .19$, whereas the time $\times$ group interaction was not significant, $F(1, 44) = 1.23, p = .27$. Subtest analyses showed significant advantages for phonics in phoneme deletion, $t(44) = 3.42, p = .001, d = 1.03$, and phoneme isolation, $t(44) = 2.38, p = .02, d = .72$.

Conclusion: Phonics-based instruction was more effective than whole-language instruction in improving phonological awareness in Persian-speaking children with dyslexia, and its advantage was maintained at four-week follow-up, particularly for more complex phoneme-level skills.

Keywords: Dyslexia, phonological awareness, phonics instruction, cognitive intervention, language

1. Introduction

Reading is one of the most consequential academic competencies acquired during childhood because it provides the foundation for learning across virtually all areas of formal education. Successful reading requires the coordinated development of several linguistic and cognitive processes, including phonological processing, orthographic knowledge, rapid access to verbal representations, working memory, vocabulary, and higher-order language comprehension. Although most children gradually integrate these abilities through instruction and repeated exposure to print, a substantial subgroup experiences persistent difficulties in acquiring accurate, fluent, and efficient reading skills. Developmental dyslexia represents one of the most extensively studied forms of such difficulty and is generally characterized by persistent problems in word recognition, decoding, spelling, and reading fluency that cannot be adequately explained by intellectual disability, sensory impairment, or insufficient educational opportunity. Contemporary accounts emphasize that dyslexia is heterogeneous in its behavioral expression but is frequently associated with weaknesses in phonological processing and the development of stable mappings between spoken and written language (Okey-Kalu, 2025; Snowling, 2019).

Among the cognitive-linguistic processes implicated in dyslexia, phonological awareness has received particularly strong theoretical and empirical attention. Phonological awareness refers to the ability to consciously recognize, analyze, segment, blend, and manipulate the sound structures of spoken language at different levels, including syllables, onsets and rimes, and individual phonemes. These abilities facilitate the discovery of the alphabetic principle by enabling children to understand that printed symbols correspond systematically to units of speech. A substantial research literature has demonstrated that phonological awareness is closely associated with the acquisition of word reading and spelling and that deficits in this ability are common among children who experience reading difficulties. Meta-analytic evidence has established a robust relationship between phonological skills and learning to read, while intervention research has demonstrated that explicit instruction in phonemic awareness can improve reading acquisition, particularly when phonological activities are connected directly to letters and written words (Ehri et al., 2001; Melby-Lervåg et al., 2012). Accordingly, the phonological deficit account has remained one of the most influential explanations of developmental dyslexia,

although contemporary perspectives increasingly recognize that phonological impairment may interact with additional cognitive and linguistic vulnerabilities (Okey-Kalu, 2025).

The importance of phonological awareness should also be considered in relation to other predictors of reading development. Rapid automatized naming, phonological working memory, and orthographic knowledge contribute to individual differences in reading performance, and their relative influence may vary across children and writing systems. Longitudinal evidence across alphabetic orthographies indicates that both phonological awareness and rapid automatized naming predict subsequent reading outcomes, although the magnitude of these relationships depends partly on orthographic consistency (Landerl et al., 2019). Research involving children with reading difficulty has similarly shown that phonemic awareness and rapid naming can function as important mechanisms linking broader cognitive abilities, including working memory, to reading performance (Guerin et al., 2024). In Persian-speaking children, orthographic knowledge, phonological awareness, rapid automatized naming, and phonological working memory have likewise been identified as meaningful contributors to reading skills, reinforcing the need to understand dyslexia through a multicomponent cognitive framework rather than through a single behavioral symptom (Mohammadi Najafabadi et al., 2025). Emerging evidence concerning the relationship between executive functions and metaphonological abilities further suggests that the efficiency of phonological processing may be influenced by broader regulatory cognitive systems, with potential implications for the design of intervention programs (Piccolo et al., 2026).

The relationship between phonological processing and literacy, however, is not identical across languages. Reading development is shaped by the structural characteristics of the writing system that children are learning, particularly the consistency with which graphemes correspond to phonemes. Cross-linguistic research has demonstrated substantial variation in the rate and pattern of literacy acquisition across alphabetic orthographies, with children learning relatively consistent orthographies generally mastering basic decoding more rapidly than children learning less consistent systems (Seymour et al., 2003). Psycholinguistic Grain Size Theory proposes that readers adapt to the statistical and orthographic properties of their language by relying on phonological units of different sizes. In relatively transparent orthographies, smaller grapheme–phoneme units may be especially useful, whereas inconsistent orthographies may require greater

reliance on larger units, lexical representations, and contextual information (Ziegler & Goswami, 2005). Such cross-linguistic differences are particularly relevant to dyslexia because the surface manifestation of reading impairment may vary even when underlying phonological vulnerabilities are broadly similar.

Persian provides an important context for examining these issues. Although Persian uses an alphabetic writing system, its orthography contains characteristics that complicate straightforward application of findings obtained primarily from English-speaking populations. In particular, short vowels are commonly omitted in standard Persian script, meaning that readers frequently have to infer phonological information from lexical knowledge and context. Consequently, successful Persian reading requires coordination among phonological decoding, orthographic knowledge, lexical representations, and contextual processing. Research with Persian-speaking children has demonstrated significant relationships among phonological awareness, rapid naming, orthographic knowledge, and reading achievement (Kazemi, 2014; Mohammadi Najafabadi et al., 2025). These findings indicate that phonological competence remains central to Persian literacy acquisition while also suggesting that orthographic characteristics may influence the kinds of instructional support required by struggling readers. Validated assessment instruments developed specifically for Persian-speaking populations have further made it possible to identify reading difficulties and evaluate phonological abilities in a linguistically appropriate manner (Karimi & Naderi, 2016; Zare et al., 2015).

The central role of phonological processing has major implications for reading intervention. Phonics-based instruction explicitly teaches correspondences between graphemes and phonemes and provides systematic practice in blending sounds to read words and segmenting words for spelling. From a cognitive perspective, such instruction is expected to strengthen the association between orthographic symbols and phonological representations and thereby improve decoding efficiency. The accumulated literature on reading acquisition generally supports the importance of explicit instruction in the alphabetic principle, particularly during the initial stages of literacy development and for children who have difficulty acquiring decoding skills (Castles et al., 2018). Phonemic-awareness intervention has also demonstrated substantial benefits when children are taught to manipulate speech sounds systematically and connect those sounds to print (Ehri et al., 2001). For students

with established reading disorders, reviews of intervention evidence similarly emphasize structured, targeted, and carefully monitored instruction addressing the specific processes underlying the child's reading difficulty (Duff & Clarke, 2011).

Nevertheless, the superiority of phonics over alternative approaches has remained the subject of considerable debate. Whole-language approaches conceptualize reading primarily as a meaning-making activity and emphasize exposure to authentic texts, contextual prediction, vocabulary, comprehension, and engagement with meaningful written language rather than systematic instruction in isolated grapheme–phoneme correspondences. Advocates of explicit phonics argue that children, particularly those with dyslexia, cannot reliably infer the alphabetic system solely from exposure to meaningful texts and therefore require direct instruction in decoding. In contrast, critics have questioned whether evidence commonly presented in support of systematic phonics unequivocally demonstrates its superiority over all alternative instructional approaches and have called for more careful interpretation of comparative intervention research (Bowers, 2020). Contemporary attempts to move beyond this longstanding “reading wars” debate generally recognize that successful reading requires both accurate word recognition and language comprehension and that the critical issue is not whether meaning or decoding matters, but how different components should be taught and integrated at different stages of reading development (Castles et al., 2018).

This distinction becomes particularly important when intervention is provided to children with dyslexia. A whole-language environment can offer meaningful exposure to vocabulary, syntax, narrative structure, and comprehension, whereas a phonics-oriented intervention directly targets the decoding processes that are frequently impaired in dyslexia. Children may therefore respond differently according to their cognitive and linguistic profiles. Early-intervention research has shown that intervention outcomes vary according to both the developmental stage at which instruction is introduced and individual differences in reading-related abilities (Lovett et al., 2017). The double-deficit framework similarly suggests that difficulties in phonological awareness and rapid naming can occur independently or together, potentially producing different profiles of reading impairment (Papadopoulos et al., 2012). More recent work also indicates that phonological awareness interacts with other metalinguistic abilities. For example,

research on children with dyslexia has drawn attention to the contributions of phonological and morphological awareness to syntactic-awareness performance, illustrating how reading-related difficulties may involve interconnected levels of linguistic processing (Rothou & Nisiotis, 2025). These findings support intervention research that examines not merely whether an instructional program works but which cognitive mechanisms are most directly affected by it.

Evidence from Iranian populations increasingly supports the usefulness of explicit and cognitively oriented reading interventions. Studies combining direct instruction with phonological-awareness training have reported improvements in reading fluency, reading comprehension, and working-memory-related outcomes among students with reading difficulties (Hariri et al., 2016). Comparative Iranian research has also indicated that combining direct instruction and phonological-awareness training can be more effective than implementing either component alone for elementary students with reading disorders (Karimi et al., 2013). Similarly, phonological-awareness intervention has been associated with improvements in reading skills among Persian-speaking children with dyslexia (Shahriari et al., 2021). Cognitive rehabilitation approaches have also produced improvements in the reading performance of students with dyslexia, suggesting that intervention may benefit from targeting cognitive processes that support literacy in addition to providing conventional reading practice (Ramezani et al., 2018). Collectively, these studies demonstrate that reading difficulties among Iranian children are responsive to intervention while simultaneously raising questions about which instructional components produce the strongest improvements in specific reading-related cognitive abilities.

Recent Iranian studies have further expanded the comparative evidence. Fooladi and colleagues compared multiple-intelligences-based education, phonological-awareness training, and a combination of these approaches among students with dyslexia, providing additional evidence that direct attention to phonological processing can contribute meaningfully to improvement in reading skills (Fooladi et al., 2024). Research involving Iranian learners with dyslexia in English-language instruction has also demonstrated the relevance of explicit, adapted, and multisensory approaches and has highlighted the need for teachers to understand the particular instructional requirements associated with dyslexia (Mohamadzadeh et al., 2020). Importantly, intervention effects in bilingual or additional-language contexts cannot simply be assumed to

remain isolated within one language because phonological and reading-related abilities may demonstrate cross-linguistic relationships, as suggested by evidence concerning Persian and English phonological awareness and reading achievement (Kazemi, 2014). These findings reinforce the broader proposition that the effectiveness of an intervention must be interpreted within the linguistic structure and educational context in which reading is being acquired.

Particularly relevant is recent research comparing alternative reading interventions directly in Farsi-speaking students with dyslexia. Mazaheri and colleagues found that different forms of reading intervention could produce improvements in reading outcomes, while the pattern of benefit differed according to the reading component being assessed (Mazaheri et al., 2024). Such findings are compatible with the view that decoding-oriented and broader meaning-oriented approaches may influence different aspects of reading development. They also illustrate why global judgments about the superiority of a single instructional philosophy may obscure meaningful differences at the level of specific cognitive and literacy outcomes. For children whose primary difficulty involves phonological analysis and decoding, explicit phonics may have a particularly strong theoretical advantage because it directly exercises the impaired processes. Conversely, meaningful text exposure may contribute more strongly to vocabulary, discourse-level knowledge, and comprehension. A direct comparison using phonological awareness as the principal outcome can therefore provide a more precise test of the cognitive mechanisms through which the two instructional approaches operate.

The need for such comparison is strengthened by three gaps in the existing literature. First, despite substantial international evidence concerning phonics, phonological awareness, and reading development, comparatively fewer controlled studies have directly contrasted phonics-based and whole-language interventions among Persian-speaking children with dyslexia. Second, Iranian research has often examined overall reading accuracy, fluency, or comprehension rather than treating phonological awareness itself as a central intervention outcome, even though phonological processing is strongly implicated in theories of dyslexia and reading acquisition (Guerin et al., 2024; Melby-Lervåg et al., 2012). Third, linguistic differences between Persian and the orthographies from which much of the intervention literature originates limit the extent to which findings can be transferred without direct empirical testing (Seymour et al., 2003; Ziegler & Goswami, 2005). These

gaps are important because evidence-based educational decision-making requires intervention studies that are sensitive both to the cognitive characteristics of dyslexia and to the orthographic properties of the language in which instruction occurs.

A stronger understanding of comparative intervention efficacy also has practical implications for early identification and educational planning. Dyslexia can produce cumulative academic consequences when decoding problems interfere with reading practice, vocabulary growth, comprehension, and access to curriculum content. Early and appropriately targeted intervention is therefore preferable to waiting for reading failure to become entrenched, and evidence indicates that the timing of intervention can meaningfully affect outcomes among children at risk for reading disability (Lovett et al., 2017). Reliable identification through culturally and linguistically appropriate instruments is equally important, making Persian-specific measures of phonological awareness and reading performance essential for both clinical and educational decision-making (Karimi & Naderi, 2016; Zare et al., 2015). At the intervention level, evidence that phonological awareness, rapid naming, working memory, orthographic knowledge, and related metalinguistic skills contribute to reading development suggests that instructional effectiveness should ultimately be understood within a broader cognitive architecture rather than as a simple contrast between competing pedagogical labels (Mohammadi Najafabadi et al., 2025; Piccolo et al., 2026; Rothou & Nisiotis, 2025).

Taken together, existing theory and research suggest a strong rationale for examining whether systematic phonics produces greater gains in phonological awareness than a meaning-centered whole-language approach among Persian-speaking children with dyslexia. International evidence supports the importance of phonological processing and explicit decoding instruction, but debate remains regarding the magnitude and generality of the advantage associated with systematic phonics (Bowers, 2020; Castles et al., 2018). Cross-linguistic findings caution against assuming identical patterns across orthographies (Landerl et al., 2019; Papadopoulos et al., 2012), while Iranian research demonstrates both the relevance of phonological awareness and the effectiveness of structured intervention for children with reading difficulties (Fooladi et al., 2024; Hariri et al., 2016; Karimi et al., 2013; Ramezani et al., 2018; Shahriari et al., 2021). Direct comparative evidence in Persian nevertheless remains limited, particularly when

phonological awareness is treated as the principal cognitive outcome and maintenance of intervention gains is examined beyond the immediate post-intervention assessment (Duff & Clarke, 2011; Mazaheri et al., 2024).

Accordingly, the aim of the present study was to compare the effectiveness of phonics-based and whole-language reading interventions in improving and maintaining phonological awareness among Iranian primary-school children with dyslexia.

2. Methods and Materials

2.1. Study Design and Participants

The study used a quasi-experimental pretest-posttest design with two intervention groups. No control group was included because the aim was to compare the relative efficacy of the two approaches. Type of cognitive reading intervention served as the independent variable and had two levels: the phonics-based intervention and the whole-language intervention. Phonological awareness was the dependent variable and was assessed with a standardised Persian phonological awareness test. The study lasted twelve weeks. Assessments took place at three points: before the intervention, immediately after it ended, and at a four-week follow-up.

Participants came from four primary schools in Kermanshah that agreed to take part in the study. Screening began with 320 children in grades two and three. A Persian reading achievement test developed for the Iranian school system was used. Children scoring below the 25th percentile were flagged as at risk for reading difficulties. A certified educational psychologist then assessed these children for dyslexia according to DSM-5 criteria. Children with intellectual disabilities, sensory impairments or a history of neurological disorders were excluded.

Forty-eight children met the inclusion criteria. Their ages ranged from 7 to 9 years, with a mean of 8.2 years. The sample contained 26 boys and 22 girls. Children were randomly assigned to the two intervention groups, with randomisation stratified by grade level so that each group had a similar grade distribution. Group A received the phonics-based intervention and Group B received the whole-language intervention. Each group held 24 children. Independent t-tests confirmed that the groups did not differ significantly in age, gender distribution or pretest phonological awareness scores.

The study moved through four phases. The first phase covered screening and recruitment. The reading

achievement test was given to all 320 children. Those scoring below the 25th percentile were identified and referred for dyslexia assessment. Parents of the 48 children who met diagnostic criteria received an information sheet. Written informed consent was obtained from parents and verbal assent from the children.

The second phase was the pretest. The Phonological Awareness Test for Persian-speaking Children was administered individually. Each assessment lasted about 25 minutes and took place in a quiet room at the school. The same trained assessor conducted all pretest sessions to limit inter-rater variability.

The third phase was the cognitive intervention itself. Children attended sessions at their own schools after the regular school day. Instructors followed the set protocols and fidelity checks were carried out as described. Children who missed more than three sessions were dropped from the analysis. Two children from the whole-language group missed four sessions and were therefore excluded from the final analysis.

The fourth phase was the posttest, conducted immediately after the 12-week intervention. The same assessor administered the Phonological Awareness Test while remaining blind to group assignment. Blindness was maintained by placing the assessor in a separate room and preventing any contact with the instructors. The follow-up assessment took place four weeks later under the same procedures and was intended to check whether any intervention effects had been maintained.

2.2. Instruments

The main instrument was the Phonological Awareness Test for Persian-speaking Children, developed and validated by Zare et al (2015). It contains five subtests that assess syllable segmentation, phoneme isolation, phoneme blending, phoneme deletion and rhyme detection. Each subtest has 10 items. The test is given individually and yields a total score from 0 to 50, with higher scores showing stronger phonological awareness. Reported reliability coefficients are 0.88 for internal consistency and 0.84 for test-retest reliability. Validity was established through correlations with reading achievement measures.

A secondary instrument was the Reading and Dyslexia Test for Persian-speaking Children, developed by Karimi and Naderi (2016). It assesses word reading accuracy, non-word reading accuracy and reading comprehension. This test served only for screening and was not used as an outcome

measure. It has standardised norms for Iranian children in grades one to five and reliability coefficients ranging from 0.82 to 0.91.

2.3. Interventions

The phonics-based intervention followed the Orton-Gillingham approach, which is widely applied with children who have dyslexia. The method is systematic, explicit and multisensory. The programme concentrated on letter-sound correspondences and included blending and segmenting activities. Instruction began with simple consonants and short vowels and then moved to consonant blends and more complex vowel patterns. Every session reviewed material taught earlier. Children used sand trays and letter tiles for tactile practice.

The whole-language intervention followed the approach outlined by Goodman (1996). It relied on authentic reading materials. Children read age-appropriate storybooks drawn from Persian children's literature. Instruction centred on meaning-making and prediction. Teachers employed shared reading and guided reading techniques. Children discussed the stories and took part in writing activities. They received no explicit teaching of letter-sound relationships. Vocabulary was introduced through context rather than isolated drills.

Both cognitive interventions were delivered in small groups of four children. Each group received 45 minutes of instruction per session, five times per week, for 12 weeks, giving a total of 60 sessions per child. Trained instructors with backgrounds in special education delivered the programmes after receiving specific protocol training. Implementation fidelity was checked weekly. A research assistant observed one session per week for each instructor and used a checklist of core instructional components.

2.4. Data Analysis

Data were analysed with SPSS version 26. Descriptive statistics (means, standard deviations and ranges) were calculated for each group. An analysis of covariance was run with pretest scores as the covariate, posttest scores as the dependent variable and group assignment as the independent variable. ANCOVA assumptions were examined: normality with the Shapiro-Wilk test, homogeneity of variance with Levene's test, and homogeneity of regression slopes by testing the interaction between the covariate and the independent variable.

A mixed-design ANOVA was used for the follow-up data. It tested the effects of time, group and the time-by-group interaction. Time was the within-subjects factor and group was the between-subjects factor. Simple-effects analyses were performed to interpret significant interactions. Effect sizes were reported as partial eta squared. The significance level was set at 0.05 for all tests. Data from the two excluded children were omitted, leaving a final analysis sample of 46 children.

3. Findings and Results

The descriptive statistics for the two cognitive intervention groups are presented in Table 1. The pretest

scores for the phonics-based group had a mean of 22.75 and a standard deviation of 5.43. The pretest scores for the whole-language group had a mean of 23.08 and a standard deviation of 5.12. The two groups were similar at baseline. The posttest scores for the phonics-based group showed a mean of 35.42 with a standard deviation of 6.21. The posttest scores for the whole-language group had a mean of 29.67 with a standard deviation of 5.89. Both groups showed improvement from pretest to posttest. The improvement was larger for the phonics-based group. The follow-up scores for the phonics-based group had a mean of 34.83 with a standard deviation of 6.45. The follow-up scores for the whole-language group had a mean of 28.92 with a standard deviation of 6.02.

Table 1

Descriptive Statistics for Phonological Awareness Scores by Group and Time Point

Group	Time Point	n	Mean	Standard Deviation
Phonics-based	Pretest	23	22.75	5.43
	Posttest	23	35.42	6.21
	Follow-up	23	34.83	6.45
Whole-language	Pretest	23	23.08	5.12
	Posttest	23	29.67	5.89
	Follow-up	23	28.92	6.02

The distribution of scores was examined for each group. The Shapiro-Wilk test showed that the data were normally distributed. The test statistics were not significant for any of the groups or time points. The homogeneity of variance was checked using Levene's test. The results showed equal variances across groups at both pretest and posttest. The homogeneity of regression slopes was also confirmed. The interaction between the pretest scores and the group assignment was not significant. This indicated that the assumptions for ANCOVA were met.

An analysis of covariance was conducted to compare the posttest scores of the two groups. The pretest scores were used as the covariate. The results showed a significant main effect of group. The F-statistic was 12.87 with 1 and 43 degrees of freedom. The p-value was 0.001. The effect size, measured as partial eta squared, was 0.23. This represents a

large effect according to conventional benchmarks. The adjusted posttest means were calculated. The adjusted mean for the phonics-based group was 35.56. The adjusted mean for the whole-language group was 29.53. The difference between the adjusted means was 6.03 points. This difference was significant.

The pretest scores had a significant relationship with the posttest scores. The F-statistic for the covariate was 45.32 with 1 and 43 degrees of freedom. The p-value was less than 0.001. This indicated that the pretest scores were a significant predictor of the posttest scores. The partial eta squared for the covariate was 0.51. This suggests that a substantial portion of the variance in the posttest scores was explained by the pretest scores. The ANCOVA results are presented in Table 2.

Table 2

Analysis of Covariance for Posttest Phonological Awareness Scores

Source	Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
Pretest	682.45	1	682.45	45.32	<0.001	0.51
Group	193.82	1	193.82	12.87	0.001	0.23
Error	648.73	43	15.09			
Total	1525.00	45				

The mixed-design ANOVA was conducted to examine the maintenance of cognitive intervention effects. The within-subjects factor was time with two levels. These were posttest and follow-up. The between-subjects factor was group with two levels. The results showed a significant main effect of time. The F-statistic was 8.94 with 1 and 44 degrees of freedom. The p-value was 0.004. The partial eta squared was 0.17. This indicates that scores decreased from posttest to follow-up across both groups. The main effect of group was also significant. The F-statistic was 10.21 with 1 and 44 degrees of freedom. The p-value was 0.003. The partial eta

squared was 0.19. This confirms that the phonics-based group had higher scores overall.

The interaction between time and group was not significant. The F-statistic was 1.23 with 1 and 44 degrees of freedom. The p-value was 0.27. This indicates that the pattern of change from posttest to follow-up was similar for both groups. The decrease in scores was 0.59 points for the phonics-based group. The decrease was 0.75 points for the whole-language group. The difference in the decrease was not statistically significant. This suggests that both groups maintained their gains to a similar degree. The mixed-design ANOVA results are presented in Table 3.

Table 3

Mixed-Design ANOVA for Posttest and Follow-up Scores

Source	Sum of Squares	df	Mean Square	F	p	Partial Eta Squared
Time	22.15	1	22.15	8.94	0.004	0.17
Time $\times$ Group	3.05	1	3.05	1.23	0.27	0.03
Error (Time)	109.80	44	2.50			
Group	345.67	1	345.67	10.21	0.003	0.19
Error (Group)	1489.02	44	33.84			

An exploratory analysis was conducted on the individual subtests of the phonological awareness test. This was done to examine which aspects of phonological awareness were most affected by the interventions. The mean scores for each subtest at posttest are presented in Table 4. The phonics-based group scored higher on all subtests. The largest

difference was observed in the phoneme deletion subtest. The phonics-based group had a mean of 7.48. The whole-language group had a mean of 5.61. The smallest difference was observed in the rhyme detection subtest. The phonics-based group had a mean of 7.26. The whole-language group had a mean of 6.87.

Table 4

Posttest Mean Scores for Phonological Awareness Subtests

Subtest	Phonics-based Group Mean	Whole-language Group Mean	Difference
Syllable Segmentation	7.39	6.52	0.87
Phoneme Isolation	7.04	5.96	1.08
Phoneme Blending	6.96	5.83	1.13
Phoneme Deletion	7.48	5.61	1.87
Rhyme Detection	7.26	6.87	0.39

Independent t-tests were conducted for each subtest to compare the two groups. The phoneme deletion subtest showed a significant difference. The t-statistic was 3.42 with 44 degrees of freedom. The p-value was 0.001. The effect size, measured as Cohen's d, was 1.03. This represents a large effect. The phoneme isolation subtest was also significant. The t-statistic was 2.38 with 44 degrees of freedom. The p-value was 0.02. The Cohen's d was 0.72. This represents a moderate to large effect. The phoneme blending subtest approached significance. The t-statistic was 1.98 with 44 degrees of freedom. The p-value was 0.054.

The Cohen's d was 0.60. This represents a moderate effect. The syllable segmentation subtest was not significant. The t-statistic was 1.42 with 44 degrees of freedom. The p-value was 0.16. The rhyme detection subtest was also not significant. The t-statistic was 0.98 with 44 degrees of freedom. The p-value was 0.33.

To further examine the practical significance of the findings, effect sizes were calculated for the overall intervention effect and for each subtest. For the overall ANCOVA, the partial eta squared was 0.23. This is considered a large effect. For the mixed-design ANOVA, the

partial eta squared for the group effect was 0.19. This is also a large effect. The effect sizes for the subtests varied. The largest effect was for phoneme deletion. The smallest effect was for rhyme detection. This pattern suggests that the phonics-based intervention had the greatest impact on the most complex phonological awareness skills.

Table 5

Within-Group Effect Sizes from Pretest to Posttest

Group	Mean Difference	Standard Deviation Pooled	Cohen's d
Phonics-based	12.67	5.43	2.33
Whole-language	6.59	5.12	1.28

For the whole-language group, the pretest to posttest effect size was 1.28. Both groups showed large within-group improvements. However, the phonics-based group showed a larger improvement.

4. Discussion and Conclusion

The present study compared the effectiveness of phonics-based and whole-language reading interventions in improving phonological awareness among Iranian primary-school children with dyslexia. The findings showed that both intervention groups improved from pretest to posttest, but the magnitude of improvement was substantially greater in the phonics-based group. The phonics group increased from a pretest mean of 22.75 to a posttest mean of 35.42, whereas the whole-language group increased from 23.08 to 29.67. After controlling for pretest performance, the difference between the two groups remained statistically significant, $F(1, 43) = 12.87, p = .001$, partial $\eta^2 = .23$, indicating a large intervention effect. The adjusted posttest mean was 35.56 for the phonics-based group and 29.53 for the whole-language group. Thus, although meaningful reading experiences within the whole-language condition were associated with improvement, systematic instruction emphasizing grapheme-phoneme relationships, blending, segmentation, and explicit manipulation of speech sounds produced substantially greater gains in phonological awareness.

This primary finding strongly supports accounts that place phonological processing at the center of developmental dyslexia. Children with dyslexia commonly experience difficulty establishing and manipulating precise phonological representations, which interferes with their ability to develop stable mappings between speech sounds and written symbols (Okey-Kalu, 2025; Snowling, 2019). The phonics-based intervention directly addressed this

The within-group effect sizes were also calculated. For the phonics-based group, the pretest to posttest effect size was 2.33. This was calculated using Cohen's d. The within-group effect sizes are presented in Table 5.

weakness by requiring children to attend to individual phonemes and connect these units systematically with graphemes. Such activities are closely aligned with the processes assessed by phonological-awareness measures. The larger gains in the phonics group therefore appear theoretically coherent: the intervention repeatedly exercised the same underlying cognitive-linguistic operations that are frequently deficient in dyslexia. By contrast, the whole-language intervention emphasized contextual meaning, prediction, story reading, vocabulary, and comprehension without explicit instruction in letter-sound correspondences. Although such experiences can enrich language and literacy engagement, they are less likely to remediate a specific phonological-processing weakness unless phoneme-level analysis is taught directly.

The results are consistent with extensive evidence demonstrating the importance of phonemic-awareness instruction for reading development. The meta-analysis by Ehri and colleagues showed that teaching children to identify and manipulate phonemes supports reading acquisition and that effects are particularly strong when phonemic-awareness activities are linked with letters (Ehri et al., 2001). Similarly, the meta-analytic review by Melby-Lervåg and colleagues identified phonological awareness as a powerful correlate and predictor of learning to read (Melby-Lervåg et al., 2012). The present findings extend this evidence by showing that explicit phonics instruction can produce a stronger effect on phonological awareness than a meaning-centered approach among Persian-speaking children with dyslexia. This is especially relevant because much of the foundational evidence on phonological intervention derives from English-speaking samples. The current pattern suggests that the central role of phonological processing is also evident in Persian despite differences in orthographic structure.

The findings are also compatible with broader contemporary accounts of reading acquisition that emphasize the need for explicit decoding instruction while recognizing that skilled reading ultimately depends on both word identification and language comprehension (Castles et al., 2018). The current study should therefore not be interpreted as evidence that meaning, vocabulary, or comprehension are unimportant. Rather, the results indicate that when the target outcome is phonological awareness in children with dyslexia, an intervention that explicitly teaches sound-symbol correspondences is more effective than an approach in which phonological relationships must be inferred implicitly from meaningful text exposure. This distinction is important in relation to continuing debates regarding systematic phonics. Bowers questioned the extent to which existing evidence establishes the universal superiority of systematic phonics over competing instructional approaches (Bowers, 2020). The present results contribute to that debate by suggesting that superiority may be clearest when the population is characterized by reading difficulty and the measured outcome is closely related to phonological decoding. In other words, intervention effects should be interpreted in relation to the cognitive characteristics of the learner and the specific literacy skill being targeted.

The present findings also agree with Iranian intervention research. Hariri and colleagues found that an integrated program combining direct instruction and phonological-awareness training improved reading fluency, reading comprehension, and working-memory performance among students with reading difficulties (Hariri et al., 2016). Karimi and colleagues similarly reported that a combination of direct instruction and phonological-awareness training was more effective than either approach alone for improving reading comprehension among elementary students with reading disorders (Karimi et al., 2013). Shahriari and colleagues demonstrated that phonological-awareness training improved reading skills in Persian-speaking children with dyslexia (Shahriari et al., 2021), while Fooladi and colleagues found beneficial effects of phonological-awareness-based intervention and particularly strong outcomes when it was combined with another instructional approach (Fooladi et al., 2024). Taken together with the current findings, these studies indicate that explicit engagement with phonological structure represents an important component of effective intervention for Persian-speaking students with reading difficulties.

The results also correspond with the exploratory findings of Mazaheri and colleagues, who directly compared two reading interventions in Farsi-speaking students with dyslexia and found that different approaches produced different patterns of improvement across reading outcomes (Mazaheri et al., 2024). Their findings suggested that phonics-oriented intervention may be especially advantageous for word-reading accuracy, whereas broader intervention can provide benefits for other reading components. The current study complements this evidence by demonstrating a clear advantage of phonics for phonological awareness. Together, these findings suggest that the effectiveness of a reading intervention should not be treated as a unitary phenomenon. Different instructional approaches may influence different components of literacy, and phonics appears particularly well suited to outcomes requiring precise analysis and manipulation of speech sounds.

The follow-up findings provide additional support for the effectiveness of the intervention. Scores declined slightly from posttest to the four-week follow-up in both groups, producing a significant main effect of time, $F(1, 44) = 8.94$, $p = .004$, partial $\eta^2 = .17$. However, the phonics-based group continued to demonstrate significantly higher overall performance than the whole-language group, $F(1, 44) = 10.21$, $p = .003$, partial $\eta^2 = .19$. Importantly, the time-by-group interaction was not significant, indicating that the small decline following treatment was similar across the two groups. The phonics group decreased by only 0.59 points and the whole-language group by 0.75 points. This pattern indicates that the gains achieved during intervention were largely maintained during the follow-up period and that the relative advantage of phonics did not disappear after instruction ended.

Maintenance of intervention gains is an important criterion when evaluating treatments for reading disorders because immediate post-intervention improvement may have limited educational value if skills decline rapidly after structured support is withdrawn. Reviews of intervention for reading disorders emphasize not only treatment efficacy but also careful implementation, monitoring, and evaluation of whether gains generalize and persist (Duff & Clarke, 2011). The maintenance observed in the present study may reflect the cumulative and rule-based character of phonics learning. Once children acquire more stable relationships between graphemes and phonemes and develop strategies for blending and segmenting, these procedures can continue to be applied during subsequent encounters with print. Early

intervention research also suggests that targeted instruction can produce enduring benefits, although outcomes differ according to developmental timing and individual learner characteristics (Lovett et al., 2017). The persistence of the present gains therefore supports the educational relevance of systematic intervention during the early primary-school years.

The subtest findings provide a more detailed explanation of why the phonics-based intervention was superior. The phonics group obtained higher posttest scores across all five phonological-awareness domains, but the magnitude of the difference varied substantially. The largest group difference was found for phoneme deletion, with means of 7.48 and 5.61 for the phonics and whole-language groups, respectively. This difference was statistically significant, $t(44) = 3.42$, $p = .001$, with a large effect size of $d = 1.03$. Phoneme isolation also showed a significant difference favoring phonics, $t(44) = 2.38$, $p = .02$, $d = .72$. The difference for phoneme blending approached significance, whereas syllable segmentation and rhyme detection did not differ significantly between groups. This pattern suggests that explicit phonics exerted its strongest effects on more analytically demanding phoneme-level skills rather than on broader or more readily acquired forms of phonological sensitivity.

This result is consistent with research showing that more fine-grained phonological operations are closely connected to decoding ability. Phoneme deletion requires the child to segment a spoken word, maintain its phonological components in working memory, remove a specified sound, and reconstruct the remaining phonological form. Such tasks impose demands on phonological representation, awareness, and cognitive control. Guerin and colleagues demonstrated that phonemic awareness is closely involved in the relationship between working memory and reading in children with reading difficulty (Guerin et al., 2024). More recent research has also highlighted associations between executive functions and metaphonological skills, suggesting that complex phonological manipulation may depend partly on broader executive processes (Piccolo et al., 2026). The pronounced advantage for phoneme deletion in the present study may therefore reflect the repeated opportunities provided by phonics instruction to analyze, manipulate, and reconstruct phonological units explicitly.

The absence of significant group differences in rhyme detection and syllable segmentation is also theoretically informative. Rhyme and syllable awareness generally involve larger phonological units and often develop earlier

than fine-grained phonemic awareness. Psycholinguistic Grain Size Theory proposes that readers rely on phonological units of different sizes depending on developmental stage and orthographic structure (Ziegler & Goswami, 2005). Because whole-language instruction exposed children to stories, spoken language, repeated words, and meaningful textual patterns, it may have provided sufficient incidental experience to strengthen broader sound similarities such as rhyme. In contrast, phoneme isolation and deletion require deliberate attention to individual speech sounds and are therefore more likely to benefit from direct instruction. Cross-linguistic evidence also demonstrates that phonological awareness and rapid naming predict reading across alphabetic orthographies, although their relative contribution varies with orthographic consistency (Landerl et al., 2019). The current subtest pattern is therefore compatible with the idea that phoneme-level instruction is especially valuable when children must acquire precise decoding procedures.

The findings are particularly meaningful in the context of Persian orthography. Persian is alphabetic, but short vowels are often omitted from conventional written forms, creating circumstances in which successful word recognition requires integration of phonological, orthographic, lexical, and contextual information. Research among Persian-speaking children has shown that phonological awareness, rapid automatized naming, orthographic knowledge, and phonological working memory all contribute to reading performance (Mohammadi Najafabadi et al., 2025). Kazemi likewise demonstrated meaningful relationships among phonological awareness, rapid naming, and reading achievement across Persian and English learning contexts (Kazemi, 2014). These findings suggest that although contextual information has an important role in Persian reading, children still need sufficiently precise phonological representations to establish and access written-word forms efficiently. For students with dyslexia, systematic phonics may strengthen this foundational process, after which contextual and comprehension-oriented strategies can operate more effectively.

The strong pretest–posttest change within both intervention conditions is also noteworthy. The within-group effect size was $d = 2.33$ for the phonics-based group and $d = 1.28$ for the whole-language group. Thus, the superiority of phonics should not obscure the fact that children receiving whole-language instruction also demonstrated substantial improvement. Meaningful exposure to print, guided reading, vocabulary learning, discussion, and contextual

interpretation may support developing literacy even when phonological instruction is not explicit. The results therefore favor a differentiated rather than an absolute interpretation. For phonological awareness specifically, phonics was clearly superior, but whole-language activities may retain educational value for other aspects of literacy that were not measured as primary outcomes in this study. This interpretation is consistent with recommendations to move beyond polarized instructional debates and recognize that reading development involves multiple interacting components (Castles et al., 2018).

Individual differences may further influence response to either instructional approach. The double-deficit hypothesis proposes that phonological-awareness deficits and rapid-naming deficits can occur separately or simultaneously, producing different patterns of reading impairment (Papadopoulos et al., 2012). Likewise, recent evidence suggests that phonological and morphological awareness contribute to broader metalinguistic abilities such as syntactic awareness among children with dyslexia (Rothou & Nisiotis, 2025). These findings indicate that children categorized broadly as having dyslexia may not constitute a cognitively homogeneous group. Some may benefit especially strongly from phonics because phonological processing represents their primary weakness, whereas others may require additional intervention targeting naming speed, morphological awareness, working memory, language comprehension, or executive functions. The large overall phonics effect found in the current study therefore supports explicit phonological instruction while also leaving open the possibility that individually tailored, multicomponent programs could produce even stronger outcomes.

The present results also have implications for assessment and intervention planning in Iran. Reliable identification of both reading performance and specific phonological weaknesses is necessary if instruction is to target the processes most responsible for an individual child's reading difficulty. The availability of validated Persian instruments for assessing phonological awareness and dyslexia provides an important foundation for this process (Karimi & Naderi, 2016; Zare et al., 2015). Cognitive rehabilitation research in Iranian students has further shown that reading performance can improve when intervention addresses underlying cognitive functions rather than relying solely on repeated reading practice (Ramezani et al., 2018). Similarly, work with Iranian students with dyslexia in additional-language learning emphasizes the importance of informed, structured,

and adapted teaching practices (Mohamadzadeh et al., 2020). The present study adds to this literature by indicating that explicit phonics represents a particularly promising component of intervention when phonological awareness is impaired.

Overall, the findings provide converging empirical and theoretical support for systematic phonics instruction as an effective intervention for improving phonological awareness among Persian-speaking primary-school children with dyslexia. The large between-group effect, maintenance of the advantage at follow-up, and particularly strong effects on phoneme deletion and phoneme isolation are consistent with phonological accounts of dyslexia and with previous intervention evidence emphasizing explicit attention to speech sounds (Ehri et al., 2001; Melby-Lervåg et al., 2012; Shahriari et al., 2021). At the same time, improvement in both groups and the broader literature on multidimensional reading development suggest that phonics should not necessarily replace meaningful reading and comprehension activities. Rather, the findings indicate that explicit phonological instruction should occupy a central position within intervention for children with dyslexia, particularly during the development of foundational decoding skills, while complementary language- and meaning-based activities may be incorporated to support broader literacy development.

The findings should be interpreted in light of several limitations. The final analyzed sample was relatively small and was drawn from only four primary schools in Kermanshah, which restricts the generalizability of the results to children in other regions, socioeconomic contexts, age groups, and educational settings. The study included only students in grades two and three, and the results may differ for younger beginning readers or older students whose reading difficulties have become more established. The absence of a non-intervention control group also prevents a precise determination of how much of the observed improvement was attributable specifically to the interventions rather than maturation, regular classroom instruction, repeated testing, or other uncontrolled influences. In addition, the follow-up period lasted only four weeks, so the long-term stability of the gains remains unknown. The study relied primarily on phonological awareness as the outcome, and therefore conclusions cannot be extended directly to reading fluency, spelling, vocabulary, or comprehension. Instructor blinding was not possible, and unmeasured characteristics such as socioeconomic status, home literacy environment, parental

involvement, previous intervention history, attention, motivation, and severity of dyslexia may also have influenced treatment responsiveness.

Future studies should replicate the comparison using substantially larger and more geographically diverse samples and should include children from different grade levels and educational backgrounds. Randomized controlled designs incorporating a no-treatment, usual-instruction, or delayed-treatment comparison group would permit stronger causal conclusions regarding the absolute and relative effects of phonics and whole-language instruction. Follow-up assessments extending across six months, one year, or longer would clarify whether improvements are maintained and whether children continue to progress after formal intervention ends. Researchers should also include multiple literacy outcomes, including word and pseudoword reading, reading fluency, spelling, vocabulary, and reading comprehension, to determine whether the two approaches produce distinct patterns of benefit across components of literacy. Future research should examine potential moderators such as baseline phonological awareness, rapid naming, working memory, executive functioning, orthographic knowledge, language comprehension, socioeconomic background, and severity of reading impairment. Comparative trials of phonics, whole-language, and carefully designed combined interventions would be especially useful for determining whether an integrated program can preserve the phonological advantages of explicit instruction while also strengthening comprehension and engagement with meaningful text.

Schools and learning-disability services should consider placing systematic and explicit phonics instruction at the core of intervention for Persian-speaking children with dyslexia, particularly when assessment identifies weaknesses in phoneme-level awareness. Intervention should provide repeated practice in letter-sound correspondences, phoneme isolation, blending, segmentation, and deletion and should progress from simpler to more complex phonological operations. Teachers should monitor individual progress regularly rather than assuming that all children with dyslexia will respond in the same way or at the same rate. Meaningful reading activities, vocabulary development, guided reading, story discussion, and comprehension work should be retained as complementary components so that improvements in decoding develop alongside broader literacy abilities. Schools should also strengthen early screening procedures, provide specialized professional development for teachers,

encourage communication among classroom teachers, specialists, and families, and ensure that intervention begins as soon as persistent reading difficulties become evident rather than waiting for academic failure to intensify.

Authors' Contributions

All authors significantly contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

In this study, to observe ethical considerations, participants were informed about the goals and importance of the research before the start of the study and participated in the research with informed consent.

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