



Double-Deficit Hypothesis and Reading Difficulties: A Longitudinal Analysis of Reading and Reading Comprehension Performance of Groups Formed According to This Hypothesis

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Abstract

In this study, we aimed to determine the validity of the double-deficit hypothesis, which argues that reading difficulties arise due to inadequacies in phonological awareness and rapid naming, in relation to reading difficulties in a transparent language such as Turkish. Accordingly, children attending a kindergarten were assigned to four groups: a double-deficit group (n = 23), phonological awareness deficit group (n = 35), rapid naming deficit group (n = 29) or control group (n = 48) according to the scores they received on measures of phonological awareness and rapid naming. The performance of the groups in reading and reading comprehension was followed longitudinally from the first grade to the end of the second grade and were compared at four time points. On the basis of multivariate analysis of variance (MANOVA), it was determined that the double-deficit group performed worst in reading and reading comprehension tasks, and the control group performed best. While the reading and reading comprehension achievements of all groups increased over time, the findings suggest that the performance of groups with phonological awareness and rapid naming deficits differed significantly from the double-deficit group and the control group. This study, which examined the effects of the double-deficit hypothesis for Turkish-speaking children, offers a new approach to identifying children at risk of reading difficulties in early years and to planning appropriate interventions.

Keywords

Reading difficulties
Double-deficit hypothesis
Reading
Reading comprehension
Longitudinal analysis

Article Info

Received: 06.12.2021
Accepted: 04.05.2022
Online Published: 12.09.2022

DOI: 10.15390/EB.2022.11002

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Introduction

Reading is a skill that forms the basis of independent learning and academic success. Children's success in learning to read significantly affects their academic performance in upper classes (Cunningham & Stanovich, 1997). Of children who have problems learning to read and who perform less well than their peers, 65–75% will continue to have difficulty reading and will lag behind their peers in subsequent years (Scarborough, 2002). Difficulty with reading is also key to diagnosis of learning disability (Stanford & Oakland, 2000). Observable difficulties in decoding, accuracy, fluency and reading comprehension skills usually follow an increasing course if appropriate interventions are not put into effect.

Although the underlying causes of reading difficulties are still not fully known (Norton et al., 2014), it is thought that the difficulties experienced are closely related to deficiencies in phonological awareness (Wagner & Torgesen, 1987). Phonological awareness, which is critical for decoding skills, is defined as the ability to recognize key sounds (units of language) and manipulate these in words (Whitehurst & Lonigan, 2001). Numerous studies have shown that phonological awareness is one of the strongest early predictors of reading success in both transparent orthographies with high phoneme-grammatical consistency and opaque orthographies (Kirby, Parrila, & Pfeiffer, 2003; Lepola, Poskiparta, Laakkonen, & Niemi, 2005; Wimmer, Mayringer, & Landerl, 2000). Cross-sectional and longitudinal studies show that phonological awareness has a high correlation with reading and strongly predicts word-reading success (Georgiou, Parrila, & Kirby, 2006; Kirby et al., 2003). It has been stated that phonological awareness is predictive, especially in the process of learning to read (Kirby et al., 2003; Norton & Wolf, 2010), and explains individual differences in reading from kindergarten to fourth grade (Wagner et al., 1997). In this context, it is possible to say that children with a phonological awareness deficit most commonly experience difficulties in the process of learning to read and in the acquisition of decoding skills (Papadopoulos, Georgiou, & Kendeou, 2009).

Difficulties in reading are primarily explained by the phonological core deficit hypothesis (Nelson, 2015). According to this hypothesis, children with reading difficulties cannot learn letter-sound relationships due to deficiencies in their phonological awareness skills, and they experience problems in learning to read and with reading accuracy (e.g., Caravolas, Vólin, & Hulme, 2005). On the other hand, the phonological core deficit hypothesis has been criticized for not being able to explain the diversity of reading difficulties observed in children and adults with dyslexia (Torppa, Georgiou, Salmi, Eklund, & Lyytinen, 2012). In relation to these criticisms, it has been suggested that phonological awareness is not the only factor in reading difficulties and that deficiencies in rapid naming skills also cause reading difficulties, leading to proposal of other approaches, emphasizing that reading difficulties are largely due to deficiencies in rapid naming and/or phonological awareness (Wolf & Bowers, 1999).

Rapid naming is defined as an indicator skill, focused on how long it takes to identify the name or sound of visually presented stimuli (Georgiou, Parrila, Cui, & Papadopoulos, 2013). It has been argued that rapid naming, assessed by a task based on naming items with which children are sufficiently familiar (objects, colors, letters and numbers, presented repetitively and sequentially), as quickly as possible, is one of the most important current and longitudinal predictors of reading success in transparent (Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, 2010), opaque (Kirby et al., 2003, 2010) and non-alphabetic orthographies (Georgiou, Aro, Liao, & Parrila, 2016; Georgiou, Parrila, & Liao, 2008). Studies also show that rapid naming success in preschool is a strong predictor of reading success and reading difficulties in primary school (Kirby et al., 2003; Lepola et al., 2005). It has been found that rapid naming is highly correlated with decoding (Papadopoulos et al., 2009) and reading comprehension skills (Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004; Wolf & Bowers, 1999), especially with reading fluency at first (Nelson, 2015; Papadopoulos et al., 2009; Torppa et al., 2012; Wimmer et al., 2000). Studies show that these relationships are valid even after controlling for socioeconomic level, intelligence and phonological awareness (e.g., Kirby et al., 2010) and that children with poor reading

skills perform less well on rapid naming tasks than good readers (Bowers, 1995). However, there are many research results showing that children who have difficulty with rapid naming also perform less well than their peers in terms of reading skills (e.g., Araujo & Faisca, 2019).

An approach widely accepted in the literature, based on the premise that reading difficulties arise as a result of a deficit in either phonological awareness or rapid naming skills (or both of these), is the double-deficit hypothesis (Wolf & Bowers, 1999). According to this hypothesis, deficits in rapid naming and phonological awareness affect the ability to read in different dimensions (Wolf & Bowers, 1999). Accordingly, phonological awareness is related to the decoding dimension of reading, and in the case of some level of inadequacy, it affects the process of learning to read and manifests as misreading. Rapid naming, on the other hand, is related to the speed and fluency dimensions of reading and affects the acquisition of reading fluency skills in the case of inadequacy, manifesting as slow reading (Araujo, Pacheco, Faisca, Petersson, & Reis, 2010; Furnes & Samuelsson, 2011; Kirby et al., 2003; Wimmer et al., 2000; Ziegler et al., 2010). In the case of inadequacy in relation to both of these skills, difficulties will arise with both decoding and fluency dimensions and will be evident at a more severe level (Araujo et al., 2010; Schatschneider, Carlson, Francis, Foorman, & Fletcher, 2002; Wolf & Bowers, 1999).

With the double-deficit hypothesis, it is assumed that the effects of deficiencies in phonological awareness and rapid naming on the development of reading skills are independent of each other, and individuals with reading difficulties are classified into three groups: those who have deficits in rapid naming, those who have deficits in phonological awareness, and those who have deficits in both skills (Wolf & Bowers, 1999). In this classification, which is important in diagnosis and intervention processes, individuals are considered to have a phonological awareness deficit if they have a significant deficit in both phonological awareness and rapid naming ability in terms of what is appropriate for their age. Individuals are considered to have a rapid naming deficit if they have a significant deficit in rapid naming but have phonological awareness skills appropriate for their age. Those who have a deficit in both skills – in other words, those with a double deficit – are those who have a deficit in both phonological awareness and rapid naming. The double-deficit hypothesis also predicts some differences between the reading performances of the three subgroups. Accordingly, it is expected that readers with a phonological awareness deficit will have lower reading accuracy measurements than readers with a rapid naming deficit, and readers with a rapid naming deficit are to be expected to have lower reading fluency/speed measurements than those with a phonological awareness deficit. It is assumed that readers with a double deficit will perform significantly less well in terms of both reading accuracy and reading fluency than readers with a single deficit (Wolf & Bowers, 1999).

This grouping and its effects on reading performance, as proposed in the double-deficit hypothesis, have been supported by the findings of many studies (Cronin, 2013; Heikkilä, Torppa, Aro, Närhi, & Ahonen, 2016; Kirby et al., 2010; Lovett, Steinbach, & Frijters, 2000; Norton et al., 2014; Papadopoulos et al., 2009; Steacy, Kirby, Parrila, & Compton, 2014; Torppa et al., 2013; Wimmer et al., 2000). For example, Lovett et al. (2000) found that 84% of students with reading difficulties could be grouped according to the double-deficit hypothesis and that children with a rapid naming deficit only performed best in terms of reading accuracy, while children with a phonological awareness deficit performed less well than this group. The researchers determined that children with a double deficit were the ones with the poorest performance in reading. In a study of children with reading difficulties, Katzir, Kim, Wolf, Morris, and Lovett (2008) found that children in the double-deficit group performed significantly less well in terms of reading accuracy and reading speed measurements than both single-deficit groups; and in reading fluency measurements, children with a phonological awareness deficit were more successful than the group with a rapid naming deficit. In addition, Vukovic and Siegel (2006) found that most children with dyslexia have deficits in both phonological awareness and rapid naming.

On the other hand, some findings inconsistent with the double-deficit hypothesis have been reported in the literature (Kirby et al., 2010; Vukovic & Siegel, 2006). For example, some studies have found that children with a deficit in one area do not have significant differences from their peers in reading skills (Cronin, 2013; Norton et al., 2014; Torppa et al., 2012), and some studies have found that children with a double deficit do not have significant differences from children with just one deficit (Nelson, 2015; Moura, Pereira, Morena, & Simoes, 2020; Vaessen, Gerretsen, & Blomert, 2009; Wimmer et al., 2000) or from children without any deficit (Ackerman, Holloway, Youngdahl, & Dykman, 2001; Pennington, Cardoso-Martins, Green, & Lefly, 2001; Schatschneider et al., 2002).

The grouping proposed in the double-deficit hypothesis and its effects on reading performance have also been used in studies of the orthographies of different transparency levels (e.g., English, Finnish, Greek and German) (Cronin, 2013; Heikkilä et al., 2016; Kirby et al., 2010; Lovett et al., 2000; Norton et al., 2014; Steacy et al., 2014; Papadopoulos et al., 2009; Torppa et al., 2013; Wimmer et al., 2000). In one study conducted on an orthography with a low level of transparency such as English, Kirby et al. (2003) followed children from kindergarten to the end of the fifth grade and compared the performance of three groups formed according to the double-deficit hypothesis, exploring meaningful and pseudoword reading and reading comprehension tests, with a control group. In the study, it was determined that children in the control group consistently outperformed the other groups, and children in the double-deficit group were consistently the poorest performing group. Underperformance of children with a phonological awareness deficit in early years tended to increase in subsequent years and approached that of the control group. In contrast, those with a rapid naming deficit performed nearly as poorly as their peers with a double deficit by the end of the fifth grade. Finally, it was emphasized that children with a double deficit fell behind by about two years, compared to the control group, and had a high risk of reading difficulties. In a study conducted in Greek, which is a more transparent orthography, Papadopoulos et al. (2009) followed children from kindergarten to the second grade and compared the reading accuracy, reading fluency, orthographic processing and reading comprehension performances of groups formed in the first grade according to the double-deficit hypothesis with a control group. In the study, it was determined that in the first grade, the double-deficit group performed significantly less well than the other groups for all measures, while groups with a single deficit performed less well than the control group in reading accuracy and reading fluency tasks. In the second grade, it was observed that performance of the group with a phonological awareness deficit improved in terms of reading accuracy, but the poor performance of groups with a rapid naming deficit and double deficit in reading fluency continued. In a German study, another orthography with high transparency (Wimmer et al., 2000), it was determined that all three deficit groups, followed from kindergarten to the fourth grade, did not differ from the control group in reading accuracy performance. Finally, in other studies conducted in German (Vaessen et al., 2009) and Finnish (Torppa et al., 2012), it was found that among the groups formed according to this hypothesis, those with a double deficit showed the poorest performance, while the performance of those with only one deficit did not show within-group differences. Within the framework of these findings, it is noteworthy that there are differences as well as similarities in the effects of the double-deficit hypothesis on the acquisition and development of reading skills in different orthographies.

Although there have been studies showing the effects of phonological awareness and rapid naming on reading success in Turkish, which has a high level of transparency in its orthography (Babayiğit & Stainthorp, 2007; Erdoğan, 2012; Ergül et al., 2020; Öney & Durgunoğlu, 1997), there has been no comprehensive study examining the double-deficit hypothesis and the reading performance of groups formed according to this hypothesis. However, it is thought that examining the effects of the hypothesis on Turkish-speaking children will provide a different and effective perspective both for early identification of children in the risk group, in terms of reading difficulties, and for making appropriate intervention plans for their needs. It is clear that determining the level of development of groups formed according to the double-deficit hypothesis in all dimensions of reading, especially within the scope of this longitudinal study, will contribute to increasing understanding of the importance of phonological awareness and rapid naming deficits in terms of reading success. In addition, considering

the importance of children's reading accuracy and reading fluency performance in terms of reading comprehension success, it is thought that understanding the direct or indirect consequences of phonological awareness and rapid naming deficits for reading comprehension will be effective in determining intervention needs.

In this context, we aimed to examine the reading and reading comprehension performance of groups formed according to the double-deficit hypothesis in a longitudinal way for a transparent orthography like Turkish. For this purpose, we investigated whether there were significant differences between the reading and reading comprehension performance of groups formed in kindergarten, compared to the control group, from the first grade to the end of the second grade.

Method

A longitudinal comparative research design was used in this study. In the study, carried out within the scope of a project supported by TÜBİTAK, children were followed from kindergarten to the end of the second grade, and both phonological awareness and rapid naming skills were evaluated in different dimensions of reading. The data obtained were analyzed within the framework of the research purpose.

Participants

A total of 540 children, of different socioeconomic status (SES), attending kindergarten in 45 different schools in the central districts of Ankara, participated in this longitudinal study. In this process, kindergarten teachers were interviewed, and participants were selected whose first language was Turkish, who did not have a diagnosis of special educational needs and showed typical development. The children were divided into four groups according to their phonological awareness and rapid naming performance, measured in the spring semester of kindergarten. While three of these were deficit groups, created according to the double-deficit hypothesis, one was the control group. As defined in previous studies, in identifying disability groups (e.g., Jimenez et al., 2008; Heikkilä et al., 2016; Spector, 2005; Wimmer et al., 2000) based on phonological awareness and rapid naming measurements, one standard deviation below the group mean was taken as a criterion. Accordingly, 35 children (16 girls and 19 boys) who performed at least one standard deviation below the mean in phonological awareness, despite average or above average performance in rapid naming, were assigned to the group with a phonological awareness deficit; while 29 children (20 girls and 9 boys) who performed at least one standard deviation below the mean in rapid naming, despite average or above average performance in phonological awareness, were assigned to the group with a rapid naming deficit; 23 children (9 girls and 14 boys) who performed more than one standard deviation from the mean in both phonological awareness and rapid naming were assigned to the double-deficit group. Finally, the control group consisted of 48 children (27 girls and 21 boys), randomly selected from among the children, with average and above average performance for both skills. The mean age of the children in the kindergarten spring term was 77.09 (SD = 8.18) months. According to the information determined by the SES Index Form (Ergül & Demir, 2017), 34 of the participants came from families of a low socioeconomic level; 51 were at a medium level; and 35 were at a high socioeconomic level. SES information for 15 children could not be ascertained.

Data Collection Tools

The SES Index Form (Ergül & Demir, 2017) was used to determine the socioeconomic status of the children. In this longitudinal study, while children were evaluated in terms of rapid naming and phonological awareness skills in the spring semester of kindergarten, they were evaluated in terms of reading and reading comprehension skills at four different times, from the fall semester of the first grade to the spring semester of the second grade. Children's phonological awareness skills were evaluated using the Test of Early Literacy (TEL; Kargın, Ergül, & Güldenöğlü, 2018), and rapid naming skills were evaluated using the Rapid Naming Test (RNT; Ergül & Demir, 2018). Reading and reading comprehension achievement was also measured using the Literacy Assessment Battery (LAB; Ergül, Ökcün Akçamuş, Akoğlu, Kılıç-Tülü, & Demir, 2018). Information about the data collection tools is given below.

SES Index Parent Information Form (Ergül & Demir, 2017): The tool used to determine the SES of the children participating in the study was filled in by the parents. The form includes variables such as mother and father's education level, occupation, home ownership, the number of books in their homes and participation in cultural activities. As a result of the information obtained from the form, five SES levels were defined: low, medium-low, middle, middle-upper and upper. Following analysis of data collected from the parents of a total of 2411 children from kindergarten to the fourth grade, a five-factor structure explaining 57% of the variance for the SES index was defined and confirmed.

Test of Early Literacy (TEL; Kargın vd., 2018): The test used in this study to evaluate phonological awareness skills is an assessment tool developed to identify children at risk in terms of early literacy skills at an early stage. The TEL includes a total of 102 items in seven dimensions (receptive language vocabulary, expressive vocabulary, general naming, functional knowledge, letter knowledge, phonological awareness and listening comprehension), which can be applied to children attending kindergarten. In the phonological awareness dimension of the TEL, there are eight subtests for rhyme awareness, matching initial word-sound, matching ending word-sound, sentence segmentation, syllable segmentation, syllable blending, initial word-sound deletion and final word-sound deletion skills. Each of these subtests includes two sample items and four question items. The validity-reliability study for the TEL was conducted with 403 children aged 5–6 years, and cut-off scores were determined for each subtest. The internal consistency coefficient was found to be .94 for the whole test and between .65 and .90 for the subtests; the test-retest consistency coefficient was found to be between .56 and .89 (Kargın, Ergül, Büyüköztürk, & Güldenöğlü, 2015).

Rapid Naming Test (RNT; Ergül & Demir, 2018): The RNT, which was developed to assess levels from kindergarten to the fourth grade, is an assessment tool for determining how long it takes children to retrieve name information from their memory for visual stimuli related to objects, colors, letters and numbers that they know very well. The RNT consists of four subtests: object naming, color naming, letter naming and number naming. In each subtest, there are five items (color, object, letter or number), presented in a mixed and repetitive manner. The selected items are placed in five rows, one after the other, with 10 items in each row. The total naming time for each subtest is determined as the measurement result. If children make more than six naming errors in any subtest, it is terminated, and the measurement results are not taken into account. In this study, the object naming subtest of the Rapid Naming Test was used. The validity and reliability studies of the Rapid Naming Test were carried out, and cut-off intervals and evaluation criteria were established for grade levels from kindergarten to the fourth grade. For the content validity of the RNT, the evaluations of different field experts were taken into account, and it was determined that the test had content validity. Exploratory and confirmatory factor analysis was performed for construct validity, and the variance explained by the subtests together and for a single factor was found to be 67.53%. The discriminant validity of the test according to grade levels was also determined by hypothesis tests. Test-retest coefficients were between .83 and .95.

Literacy Assessment Battery (LAB; Ergül et al., 2018): The LAB is a tool developed to assess the reading, reading comprehension and writing performance of children from the first grade to the fourth grade. It consists of a total of 10 tests (four reading, three comprehension and three writing), aiming to examine different aspects of these skills. All tests have A and B forms. LAB tests are administered individually, and the number of words or items that the child can read, write or answer correctly within a certain time (e.g., one minute, 90 seconds, etc.) is determined. Within the scope of this study, reading and reading comprehension LAB tests (form A) were used. Information about the tests used is presented below.

Reading Tests

Word Recognition Test: In this test, which is used to determine the reading accuracy and fluency of children, there are 100 meaningful 1–6-syllable words of increasing difficulty and printed in an 18-pt font in a two-column format. The number of words that children read correctly in one minute is determined.

Word Decoding Test: This test, which is used to assess the fluency of phonological decoding, consists of 60 non-words with 1–6 syllables (of increasing difficulty), which are formed according to the syllabic structure of Turkish, printed in an 18-pt font in a two-column format. The number of non-words that children read correctly in one minute is determined.

Phonetic Analysis Test: In this test, which aims to assess the ability to establish a sound-letter relationship by distinguishing the phonemes of spoken words, children are required to distinguish the beginning sound of the words told to them and to indicate the letter corresponding to that sound from among the three letters shown. The test consists of 53 words with one and two syllables. In the test, the number of letters that children identify correctly in one minute is determined.

Passage Reading Fluency Test: In this test, which is used to evaluate text-reading fluency, the number of words that children read correctly in one minute in narrative and informative texts is determined, and the average is calculated. While the narrative texts in the test consist of 36–37 sentences and 145–148 words, the informative texts consist of 25–29 sentences and 115–116 words.

Reading Comprehension Tests

Cloze Test: This test, which measures reading comprehension skills, comprises 32 items consisting of two sentences and ordered from easy to difficult in terms of syntactic complexity. Children are expected to choose the appropriate word from three options given under the item, based on semantic clues, to fit the spaces left blank in sentences. The number of items that the child completes correctly in two minutes is recorded as the performance score.

Semantic Processing: In this test, which was developed to assess reading comprehension skills, there are 45 sentences that are semantically correct or incorrect. It is expected that children will evaluate the sentences they read in terms of semantics, determine whether the sentence is correct or not and indicate the appropriate one by choosing from two facial expressions (happy and sad) next to the sentences. The number of items correctly identified by the child in 90 seconds is recorded as the performance score.

Passage Comprehension Test: In this test, which aims to assess reading comprehension skills with texts, the narrative and informative texts used in the passage reading fluency test are used. Children are expected to read the text in the passage reading fluency test silently a second time, and then verbally answer six information and three inference questions about the text. In the test, which does not have a time criterion, the average of the number of questions answered correctly for the narrative and informative texts is recorded as the performance score.

In studies conducted to determine the validity and reliability of the LAB, the construct validity findings showed that the battery consists of three sub-dimensions, namely reading, comprehension and writing, at all grade levels. All tests in the battery and the paths between these sub-dimensions are significant, and the model's goodness-of-fit indexes are high. It was determined that the discriminant validity of the tests was high, and there were significant differences at the level of .001 between the upper and lower groups (27%) in all tests (the eta square values determined for the effect sizes were .56 and .71). It was found that the equivalence coefficients for the A and B forms of all tests were between .82 and .96; the Cronbach alpha internal consistency coefficients were between .73 and .85; and the correlation coefficients for the test-retest reliability were between .86 and .96. Cut-off points and intervals were also calculated in order to make a five-level evaluation of the battery's performance at all class levels ("very low, low, medium, high, very high") (Ergül, Ökcün-Akçamuş, Akoğlu, Kılıç-Tülü, & Demir, 2021).

Data Collection

During the research process, the approval of Ankara University Ethics Committee (decision number 1110) and official permissions from the Ministry of National Education were obtained. Participation in the study was based on voluntariness, and studies were conducted with children whose families gave written consent for their participation in the study. Assessments were carried out by eight

research fellows who have continued their graduate and doctorate education and who completed application training for the measurement tools used. Application training was carried out by the researchers who developed the tests, and sample application videos were shown. After the sample applications, feedback was given by enabling the practitioners to apply the measurement tools to one another. After the training, all practitioners were asked to assess and record the performance of at least five children using the tools. The records were monitored by the researchers who developed the test and feedback given, and the training process was completed when the practitioners reached the desired competency.

The children in the study were followed from kindergarten until the end of the second grade and were evaluated at five points during this time. Children's phonological awareness and rapid naming skills were assessed between April and May in the spring semester of kindergarten. Assessment of children's phonological awareness skills took an average of 15 minutes, and rapid naming skills took an average of 10 minutes. Reading and reading comprehension skills were assessed in the fall (November–December) and spring terms (April–May) of the first and second grades. Although the application time for LAB tests varies for each child, they were completed in individual sessions lasting approximately 20–30 minutes. Most assessments were completed in the same session, with a 2–5-minute break, and if a child could not continue the assessment, it was resumed during a second session within the next seven days. All assessments were carried out individually in a quiet environment free from distracting stimuli, in the children's school. During the assessment process, class teachers were contacted, and the children were taken from the classroom. The sessions were conducted in schools at times when the teacher indicated that it was appropriate. Before starting the application, practitioners introduced themselves and asked the children questions about their names, favorite things or games. In cases where it was observed that child's attention was distracted during the assessment sessions, small breaks were given, and finger games were played or riddles asked. At the end of the completed assessment process, small gifts (stickers, puzzles or toys) were presented to the children to reward them for their participation. In terms of the implementation reliability of the study, 20% of the evaluation sessions were observed by the researchers and evaluated according to the implementation reliability form. Observed applications were scored, and reliability between raters was also examined. Accordingly, it was determined that the coefficients of implementation reliability and inter-rater reliability were above .95.

Data Analysis

In the analysis of the data, descriptive statistics were examined first. Predictive variables and predicted variables were handled as separate groups, and univariate and multivariate outliers were examined. Outliers determined according to standard Z scores in univariate outliers and Mahalanobis distances in multivariate outliers were excluded from the data set. Multivariate Analysis of Variance (MANOVA) was used to evaluate whether there was a significant difference between the reading and reading comprehension performances of the groups formed according to phonological awareness and rapid naming deficit, while the Tukey HSD test was used to examine which reading skills the groups differed significantly in. Analyses were made using the SPSS 22.0 package program.

Results

In this study, it was aimed to examine the double-deficit hypothesis for Turkish-speaking children. In this context, the reading and reading comprehension skills of the three groups, formed according to phonological awareness and rapid naming skills measured in kindergarten, were compared for each term (fall and spring semester of the first grade; fall and spring semester of the second grade).

Performance Differences Among Groups in the Fall Semester of the First Grade

First of all, descriptive statistics of scores obtained by the groups from reading and reading comprehension measurements in the fall of the first grade were examined. It was determined that the mean and median values for the groups in terms of reading and reading comprehension skills were close. The skewness-kurtosis coefficients were in the range of ± 1.5 , and the data showed a normal distribution. The homogeneity of the covariance matrices was evaluated with Box's M statistics. With the Box M value (95.567) not being significant ($p = .048 > .001$), the assumption of homogeneity of the covariance matrices was met ($p > .001$). Since the assumptions were met, MANOVA was used to examine whether there were significant differences in the reading and reading comprehension skills of children in different groups. Descriptive statistics for group scores for reading and reading comprehension skills, along with F values and post-hoc analysis results regarding differences between the groups, are given in Table 1.

Table 1. Descriptive Statistics and F Values of Fall Semester of First Grade Reading and Reading Comprehension Scores

Variable	DD		PD		RD		CG		F	Post-Hoc
	M	SD	M	SD	M	SD	M	SD		
Word Recognition	9.14	7.59	11.00	7.55	13.28	5.66	16.50	12.05	1.15	-
Word Decoding	8.14	6.41	7.08	4.69	9.60	4.49	11.76	7.35	1.51	-
Phonetic Analysis	13.14	3.52	13.75	3.99	14.56	3.53	17.61	4.43	4.80**	DD<CG PD<CG RD<CG
Passage Reading	8.92	7.62	9.52	6.55	12.48	5.62	16.90	12.35	4.56**	DD<CG PD<CG
Composite Reading	39.35	20.89	41.50	19.72	49.92	16.46	62.78	32.36	4.79**	DD<CG PD<CG
Cloze	1.78	2.01	1.25	1.39	2.44	1.66	3.11	2.49	2.85*	PD<CG
Semantic Processing	3.28	3.19	3.66	2.64	5.12	2.78	6.90	4.44	3.76*	DD<CG PD<CG
Passage Comprehension	1.28	2.43	1.68	2.26	2.44	2.90	3.45	2.98	3.34*	DD<CG PD<CG
Composite Reading Comprehension	6.35	6.76	6.66	5.26	10.00	6.53	13.47	9.02	3.29*	DD<CG PD<CG

*** $p < .001$, ** $p < .01$, * $p < .05$

DD: Double Deficit, PD: Phonological Awareness Deficit, RD: Rapid Naming Deficit, CG: Control group

As can be seen in Table 1, according to the results of the analysis, significant differences were found between the groups' reading and reading comprehension skills ($\lambda = .847$, $F(6, 200) = 2.892$, $p = .01$, $\eta^2 = .080$). When the results were examined separately for the dependent variables, a significant difference was found between groups for the following: word recognition ($F(3, 101) = 1.152$, $p = .335$, $\eta^2 = .052$); word decoding ($F(3, 101) = 1.511$, $p = .220$, $\eta^2 = .067$), phonetic analysis ($F(3, 101) = 4.809$, $p = .004$, $\eta^2 = .186$), passage reading ($F(3, 102) = 4.563$, $p = .005$, $\eta^2 = .118$), composite reading ($F(3, 101) = 4.792$, $p = .004$, $\eta^2 = .004$), cloze ($F(3, 101) = 2.851$, $p = .044$, $\eta^2 = .120$), semantic processing ($F(3, 101) = 3.768$, $p = .015$, $\eta^2 = .152$), passage comprehension ($F(3, 102) = 3.344$, $p = .022$, $\eta^2 = .090$) and composite reading comprehension ($F(3, 101) = 3.288$, $p = .024$, $\eta^2 = .024$). When the Tukey HSD test results for pairwise comparisons between the groups were examined, significant differences were determined in favor of the control group in the reading composite score between the double deficit group and the control group, and between the group with phonological awareness deficit and the control group. It was determined that children with double deficit and those with only phonological awareness deficit scored significantly lower than the

control group. When the differences between the groups were examined for the reading subtests, it was seen that while there was no significant difference between the groups in the Word Recognition and Word Decoding subtests, in the Phonetic Analysis subtest, all deficit groups scored significantly lower than the control group, and the scores were listed as DD<PD<RD<CG. On the other hand, in the Passage Reading subtest, in which the number of correct words read per minute is measured, it was determined that the scores of the double deficit and phonological awareness deficit groups were significantly lower than the control group, and the double deficit group received the lowest score.

Similarly, in the reading comprehension composite score, Semantic Processing, and Text Comprehension subtest scores, the double deficit and phonological awareness deficit groups were found to have significantly lower scores than the control group. In the Cloze subtest, although all deficit groups scored lower than the control group, it was determined that only the group with phonological awareness deficit differed significantly.

Performance Differences of the Groups in the Spring Semester of First Grade

The descriptive statistics of the scores obtained from the reading and reading comprehension measurements in the spring of first grade were examined and it was determined that the data showed a normal distribution. When the homogeneity of the covariance matrices was evaluated with Box's M statistics, it was seen that the Box M value (122.380) was not significant ($p=.063>.001$) and the homogeneity assumption of the covariance matrices was met ($p>.001$). Since the assumptions were met, MANOVA was used to examine whether there were significant differences in reading and reading comprehension skills of children in different groups. The descriptive statistics and F values of the groups' scores on reading and reading comprehension skills in the spring of first grade are given in Table 2.

Table 2. Descriptive Statistics and F Values of Spring Semester of First Grade Reading and Reading Comprehension Scores

Variable	DD		PD		RD		CG		F	Post-Hoc
	M	SD	M	SD	M	SD	M	SD		
Word Recognition	31.33	10.93	37.57	9.62	31.36	8.86	38.52	10.78	3.83*	DD<CG RD<CG
Word Decoding	16.26	5.07	21.42	5.33	18.76	5.53	23.05	6.54	6.12**	DD<PD DD<CG RD<CG
Phonetic Analysis	16.26	3.03	19.10	4.10	19.48	4.24	21.90	4.18	7.74***	DD<CG PD<CG
Passage Reading	31.36	12.33	42.80	14.53	36.00	17.34	49.23	19.92	5.34**	DD<CG RD<CG
Composite Reading	95.23	28.88	123.55	30.97	105.60	32.22	135.66	38.21	7.24***	DD<CG DD<PD RD<CG
Cloze	5.73	2.18	6.35	2.61	6.52	2.64	8.00	2.64	4.04**	DD<CG
Semantic Processing	10.26	4.46	12.10	3.87	11.16	4.18	14.25	3.43	5.45**	DD<CG RD<CG
Passage Comprehension	3.13	1.42	4.30	1.75	3.94	1.61	5.43	1.33	10.27***	DD<CG PD<CG RD<CG
Composite Reading Comprehension	19.13	7.29	22.86	7.06	21.62	7.54	28.00	6.36	8.32***	DD<CG PD<CG RD<CG

*** $p<.001$, ** $p<.01$, * $p<.05$

DD: Double Deficit, PD: Phonological Awareness Deficit, RD: Rapid Naming Deficit, CG: Control group

When Table 2 is examined, it is seen that there are significant differences between the groups' reading and reading comprehension skills ($\lambda=.759$, $F(6, 210)=5.212$, $p=.000$, $\eta^2=.087$). When the results were examined separately for the dependent variables, a significant difference was found between the groups for word recognition ($F(3, 104)=3.839$, $p=.012$, $\eta^2=.100$), word decoding ($F(3, 104)=6.124$, $p=.001$, $\eta^2=.150$), phonetic analysis ($F(3, 104)=7.742$, $p=.000$, $\eta^2=.183$), passage reading ($F(3, 104)=5.345$, $p=.002$, $\eta^2=.134$), composite reading ($F(3, 107)=7.244$, $p=.000$, $\eta^2=.169$), cloze ($F(3, 104)=4.042$, $p=.009$, $\eta^2=.104$); semantic processing ($F(3, 104)=5.450$, $p=.002$, $\eta^2=.136$); passage comprehension ($F(3, 104)=10.270$, $p=.000$, $\eta^2=.229$); and composite reading comprehension ($F(3, 107)=8.320$, $p=.000$, $\eta^2=.189$).

When the results of the Tukey HSD test for pairwise comparisons between the groups were examined, it was observed that for the reading composite score and word decoding test, the double-deficit and rapid naming deficit groups had significantly lower scores than the control group, and it was determined that the double-deficit group had significantly lower scores than the group with a phonological awareness deficit. In the word recognition and passage reading subtests, the double-deficit and rapid naming deficit groups had significantly lower scores than the control group, while in the phonetic analysis test, the double-deficit and phonological awareness deficit groups had significantly lower scores than the control group. It was found that all deficit groups achieved significantly lower scores than the control group in terms of reading comprehension composite scores and passage comprehension subtest scores. In the cloze subtest, the double-deficit group had significantly lower scores than the control group, and in the semantic processing subtest, the double-deficit and rapid naming deficit groups had significantly lower scores than the control group.

Performance Differences Among Groups in the Fall Semester of the Second Grade

The descriptive statistics for scores obtained by the groups for reading and reading comprehension measurements in the fall of the second grade were examined, and it was determined that the data showed a normal distribution. When the homogeneity of the covariance matrices was evaluated with Box's M statistics, it was seen that the Box M value (125.524) was not significant ($p=.051 > .001$), and the homogeneity assumption of the covariance matrices was met ($p > .001$). Since the assumptions were met, MANOVA was used to examine whether there were significant differences in the reading and reading comprehension skills of children in different groups. The descriptive statistics and F values for group reading and reading comprehension scores in the fall semester of the second grade are given in Table 3.

Table 3. Descriptive Statistics and F Values of Fall Semester of Second Grade Reading and Reading Comprehension Scores

Variable	DD		PD		RD		CG		F	Post-Hoc
	M	SD	M	SD	M	SD	M	SD		
Word Recognition	36.06	13.80	44.80	11.85	39.85	10.96	48.51	12.50	4.79**	DD<CG RD<CG
Word Decoding	19.80	8.66	26.15	6.15	22.90	6.88	25.92	5.94	4.08**	DD<PD DD<CG
Phonetic Analysis	17.73	4.81	22.73	3.77	22.80	3.94	25.53	5.19	10.83***	DD<PD DD<RD DD<CG
Passage Reading	43.50	21.74	59.30	20.53	54.00	19.14	65.68	20.47	4.74**	DD<CG
Composite Reading	121.57	44.37	155.88	40.00	139.57	36.53	168.27	41.1	5.69**	DD<CG RD<CG
Cloze	7.46	2.92	9.00	2.22	8.52	2.82	11.39	3.35	9.02***	DD<CG PD<CG RD<CG
Semantic Processing	11.93	1.32	14.80	3.11	14.52	4.67	17.78	4.86	7.21***	DD<CG PD<CG RD<CG
Passage Comprehension	4.20	1.49	5.98	1.33	6.00	1.93	6.86	1.40	11.31***	DD<PD DD<RD DD<CG
Composite Reading Comprehension	24.89	7.51	29.94	5.23	29.04	7.94	36.17	8.38	10.35***	DD<CG PD<CG RD<CG

*** $p < .001$, ** $p < .01$, * $p < .05$

DD: Double Deficit, PD: Phonological Awareness Deficit, RD: Rapid Naming Deficit, CG: Control group

As can be seen from the above table, there were significant differences between the groups' reading and reading comprehension skills ($\lambda = .716$, $F(6, 200) = 6.055$, $p = .000$, $\eta^2 = .154$). When the results were examined separately for the dependent variables, a significant difference was found between the groups for the following: word recognition ($F(3, 103) = 4.794$, $p = .004$, $\eta^2 = .127$); word decoding ($F(3, 103) = 4.083$, $p = .009$, $\eta^2 = .110$); phonetic analysis ($F(3, 103) = 10.832$, $p = .000$, $\eta^2 = .247$); passage reading ($F(3, 103) = 4.744$, $p = .004$, $\eta^2 = .126$); composite reading ($F(3, 101) = 5.693$, $p = .001$, $\eta^2 = .145$); cloze ($F(3, 103) = 9.027$, $p = .000$, $\eta^2 = .215$); semantic processing ($F(3, 103) = 7.219$, $p = .000$, $\eta^2 = .179$); passage comprehension ($F(3, 103) = 11.313$, $p = .000$, $\eta^2 = .255$); and composite reading comprehension ($F(3, 101) = 10.353$, $p = .000$, $\eta^2 = .235$).

When the Tukey HSD test results for pairwise comparisons between the groups were examined, it was seen that the double-deficit and rapid naming deficit groups had significantly lower scores than the control group in the reading composite score and the word recognition test. While the double-deficit group achieved significantly lower scores than the other three groups, in the phonetic analysis subtest, it scored significantly less well than the phonological awareness deficit group and control group in the word decoding test, and scored significantly less well than the control group only in the passage reading test. When the reading comprehension composite score, cloze and semantic processing subtest scores were examined, it was found that all deficit groups scored significantly less well than the control group, and the double-deficit group had significantly lower scores than the other groups in the passage comprehension subtest.

Performance Differences Among Groups in the Spring Semester of the Second Grade

The descriptive statistics for scores obtained by groups for reading and reading comprehension measurements in the spring of the second grade were examined, and it was determined that the data showed a normal distribution. When the homogeneity of the covariance matrices was evaluated with Box's M statistics, it was seen that the Box M value (111.197) was not significant ($p = .200 > .001$), and the homogeneity assumption of the covariance matrices was met ($p > .001$). Since the assumptions were met, MANOVA was used to examine whether there were significant differences in the reading and reading comprehension skills of the children in different groups. The descriptive statistics and F values for groups' reading and reading comprehension scores in the spring semester of the second grade are given in Table 4.

Table 4. Descriptive Statistics and F Values of Spring Semester of Second Grade Reading and Reading Comprehension Scores

Variable	DD		PD		RD		CG		F	Post-Hoc
	M	SD	M	SD	M	SD	M	SD		
Word Recognition	41.40	14.80	51.69	10.67	48.54	11.80	54.43	15.73	3.55*	DD<CG
Word Decoding	21.93	7.26	28.26	7.21	25.95	5.76	28.07	6.93	3.53*	DD<PD DD<CG
Phonetic Analysis	20.40	6.55	25.15	4.05	25.66	3.35	26.33	5.41	5.56**	DD<PD DD<RD DD<CG
Passage Reading	58.23	25.06	70.21	17.86	68.02	19.71	79.08	26.34	3.33*	DD<CG
Composite Reading	141.96	48.48	177.38	36.15	168.18	36.03	190.30	50.28	4.72**	DD<CG
Cloze	8.60	3.31	10.03	2.58	10.50	3.24	12.17	3.88	4.80**	DD<CG
Semantic Processing	14.86	6.34	17.53	3.07	17.66	4.96	20.28	5.64	4.57**	DD<CG
Passage Comprehension	4.50	1.65	5.57	1.54	6.50	1.82	6.29	1.62	5.68**	DD<RD DD<CG
Composite Reading Comprehension	27.96	10.64	33.18	4.74	34.66	8.48	39.30	10.07	6.92***	DD<CG PD<CG

*** $p < .001$, ** $p < .01$, * $p < .05$

DD: Double Deficit, PD: Phonological Awareness Deficit, RD: Rapid Naming Deficit, CG: Control group

According to the results of the analysis, there were significant differences between the reading and reading comprehension skills of the groups ($\lambda = .787$, $F(6, 204) = 4.317$, $p = .000$, $\eta^2 = .113$). When the results were examined separately for the dependent variables, a significant difference was found between the groups for the following: word recognition ($F(3, 103) = 3.553$, $p = .017$, $\eta^2 = .096$); word decoding ($F(3, 103) = 3.536$, $p = .017$, $\eta^2 = .096$); phonetic analysis ($F(3, 103) = 5.562$, $p = .001$, $\eta^2 = .143$); passage reading ($F(3, 103) = 3.338$, $p = .022$, $\eta^2 = .091$); composite reading ($F(3, 103) = 4.724$, $p = .004$, $\eta^2 = .121$); cloze ($F(3, 103) = 4.802$, $p = .004$, $\eta^2 = .126$); semantic processing ($F(3, 103) = 4.574$, $p = .005$, $\eta^2 = .121$); passage comprehension ($F(3, 103) = 5.683$, $p = .001$, $\eta^2 = .146$); and composite reading comprehension ($F(3, 103) = 6.923$, $p = .000$, $\eta^2 = .168$).

When the Tukey HSD test results for pairwise comparisons between the groups were analyzed, it was seen that the reading composite score, word recognition and passage reading subtest scores of the double-deficit group were significantly lower than those of the control group. The double-deficit group also had significantly lower scores than the other three groups in the phonetic analysis subtest, and significantly lower scores than the phonological awareness deficit group and control group in the word decoding test. When the reading comprehension scores were examined, it was determined that there was a significant difference between the double-deficit group and the control group in the composite score, cloze and semantic processing subtests, and the double-deficit group differed significantly from the rapid naming deficit group and the control group in the passage comprehension

subtest. In addition, a significant difference was found between the phonological awareness deficit group and the control group in the reading composite score.

Visual Analysis of the Progress of the Groups Over the Four Periods

In addition to the comparisons between groups, a visual analysis of development of the groups' reading and reading comprehension skills over the four periods was also made. For this purpose, the average performance scores of the groups in reading and reading comprehension for each period were graphed and are presented in Figure 1 and Figure 2.

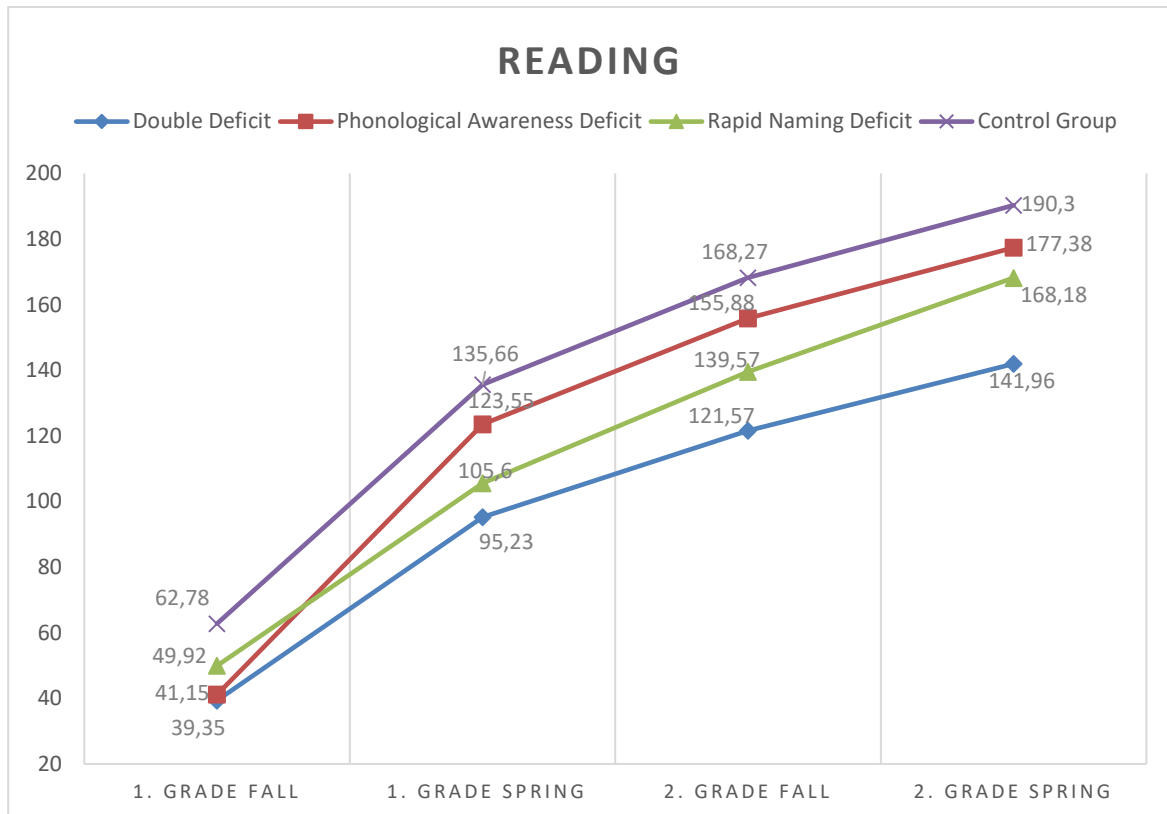


Figure 1. Development of Reading Performances of the Groups During the Four Periods

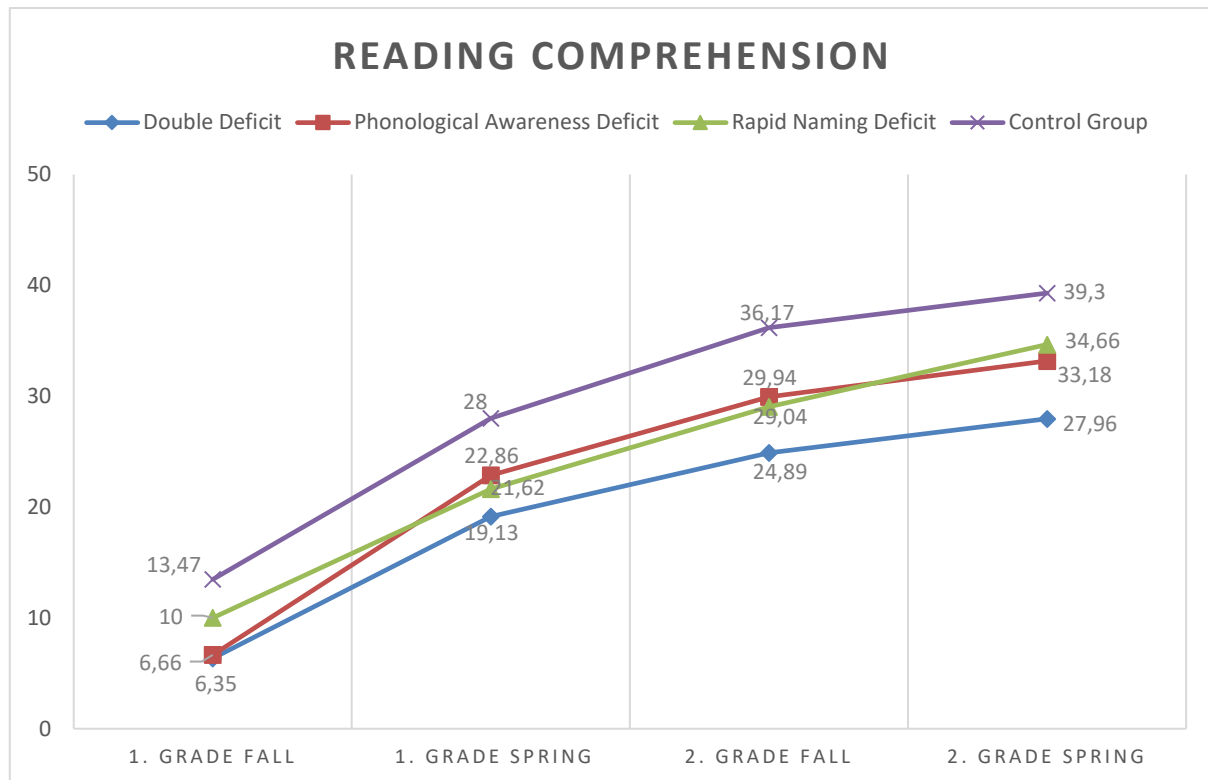


Figure 2. Development of Reading Comprehension Performances of the Groups During the Four Periods

As can be seen in Figures 1 and 2, the reading and reading comprehension scores of all groups increased over time, and the group with a double deficit displayed the poorest performance in all periods. While the reading performance of children with a phonological awareness deficit in the process of learning to read (fall of the first grade) was poorer than that of the rapid naming deficit group and control group, it started to improve after the spring semester, and it was observed that this group performed better than the rapid naming deficit group. While the reading scores for the spring of the second grade were $DD < RD < PD < CG$, the reading comprehension scores became $DD < PD < RD < CG$.

Discussion

In this study, the performance of the groups (formed according to phonological awareness and rapid naming skills, measured in kindergarten on the basis of the double-deficit hypothesis, in Turkish, which has a transparent orthography) was compared for reading and reading comprehension skills from the first grade to the end of the second grade. The results showed that, in general, the reading and reading comprehension performance of all groups improved over time. The control group (children without any deficit) had the highest scores in all periods, while the double-deficit group had the lowest scores. Although the performance of groups with a phonological awareness deficit and rapid naming deficit differed according to the period, it was observed that they got higher scores than the double-deficit group and lower scores than the control group.

In the first stage of the study, the reading and reading comprehension performance of the groups formed according to the hypothesis was compared, in the fall of the first grade. The results indicated no difference between the groups for the word recognition and word decoding tests, while there were significant differences between the groups in phonetic analysis and passage reading tests. It was determined that the double-deficit group had the lowest scores for these measurements. In addition to the group with a double deficit in tests with significant differences, it was determined that the group with a phonological awareness deficit had significantly lower scores than the control group, and in the phonetic analysis test, all deficit groups differed from the control group and had significantly lower scores.

The fall of the first grade is a period when reading instruction is most intense and children learn to decode. Phonological awareness skills are therefore particularly important. The fact that the groups that showed the poorest performance in this period (compared to the others) were the double-deficit group (which included a deficit in phonological awareness) and the phonological awareness deficit group was evaluated as a finding consistent with the double-deficit hypothesis. Studies conducted with transparent (Papadopoulos et al., 2009; Torppa et al., 2013) and non-transparent (Steady et al., 2014) orthographies found that these two deficit groups performed less well than other groups in the periods involving the learning-to-read process, and were less successful in reading and reading comprehension measurements. Therefore, it seems understandable that these two groups performed poorly in the phonetic analysis test of our study, which measures high-level skills associated with phonological awareness, and the passage reading test, which requires phonological analysis. The lower success rate of the group with a rapid naming deficit in the phonetic analysis test, compared to the control group, is thought to be related to the fact that the task in this test also requires rapid naming. After distinguishing the sounds in spoken words in the phonetic analysis test, children need to identify the letter name related to the sound, drawing from their long-term memory (Ergül et al., 2021). Since the test is time-based, performance of the rapid naming skill becomes an important determinant, and children who have difficulties in rapid naming experience failure in this task in the phonetic analysis test. On the other hand, it is thought that the reason why the deficit groups did not differ significantly from the control group in word recognition and word decoding tests may be related to the marked individual differences in the performance of groups. As is already known, the fall of the first grade is a period in which intense and rapid developments are experienced in terms of learning to read, especially in transparent orthographies such as Turkish. Therefore, developmental and learning characteristics and some environmental factors can have strong effects on children's performance in this period and cause significant differences in performance. For this reason, it is thought that individual differences within the group, manifested in a high standard deviation in the word-reading performance of the groups, may be one of the main reasons why differences in the mean scores did not reach a significant level, and this situation is thought to be normal in the first period of reading instruction.

Significant differences between the groups were observed for all measures of reading comprehension in the fall of the first grade. As with the results for reading measurements, the group with a phonological awareness deficit and the group with a double deficit had significantly lower scores for reading comprehension than the control group. The only group that differed significantly from the control group only in the cloze test was the group with a phonological awareness deficit. The double-deficit group did not differ significantly from the control group, despite low scores for this measure. Since the fall semester of the first grade is a period in which children acquire decoding skills, it is to be expected that children who have difficulties in acquiring decoding skills (related to their deficit in phonological awareness) and who cannot read at the level of their peers will also experience failure in terms of reading comprehension (Papadopoulos et al., 2009; Torppa et al., 2012). In this context, it is to be expected that children with a deficit in rapid naming will perform better than children with a deficit in phonological awareness and will not differ significantly from the control group (Steady et al., 2014).

These findings, obtained in the first semester of the first grade, largely support the double-deficit hypothesis. The fact that the groups with deficiencies in phonological awareness (which is important for successful decoding in the learning-to-read process) generally showed poorer performance in reading and reading comprehension confirms that inadequate phonological awareness manifests itself in difficulties arising during the decoding phase, as the hypothesis claims. The obtained findings partially support the other assumption of the hypothesis. According to the hypothesis, it is to be expected that the double-deficit group will perform less well than single-deficit groups (Wolf & Bowers, 1999). In this study, however, the double-deficit group did not differ significantly from the groups with a deficit in phonological awareness or rapid naming. On the other hand, we believe that the relevant assumption of the hypothesis was partially met, since these children had lower scores in almost all tests. In addition, it should be noted that this finding is consistent with the results of some studies conducted in relation to the hypothesis, which found that children with a double deficit did not

differ significantly from those with a single deficit (Ackerman et al., 2001; Nelson, 2015; Moura et al., 2020; Vaessen et al., 2009; Wimmer et al., 2000). It is possible to say that these results are very similar to the findings of studies conducted in all languages, regardless of the transparency level of orthography.

Analyses made in the spring of the first grade showed that, unlike the results for the fall semester, performance of the group with a phonological awareness deficit improved slightly more than that of the other disability groups. On the other hand, the results in which the poor performance of the group with a rapid naming deficit came to the fore were remarkable. The group with a rapid naming deficit performed significantly less well than the control group on all measures except phonetic analysis and the cloze test. The double-deficit group, on the other hand, had lower scores than the control group on all reading and reading comprehension measures. The double-deficit group also had significantly lower scores in terms of word decoding and the reading composite score than the group with a phonological awareness deficit. The group with a phonological awareness deficit did not differ significantly from the control group in the majority of the tests in the spring semester, but these children continued to achieve significantly lower scores than those of the control group for the reading comprehension composite score and in the phonetic analysis and passage comprehension tests.

These findings, obtained in the spring of the first grade, are also largely consistent with the double-deficit hypothesis and the results of previous studies. The fact that the double-deficit group showed the poorest performance, and the other deficit groups were less successful in some reading and/or reading comprehension measures than the control group (although not in every test), shows a significant similarity with the effects described by the hypothesis. In addition, these findings are broadly similar to the results of previous studies on all transparent and non-transparent orthographs. In many studies, groups with a phonological awareness deficit have shown an improvement after learning to read and have reached a level close to that of their peers (e.g., Landerl & Wimmer, 2008; Papadopoulos et al., 2009; Torppa et al., 2012; Wimmer et al., 2000). On the other hand, a deficit in rapid naming becomes more evident and begins to have a more detrimental effect on reading success. In addition, the double-deficit group will be the group that exhibits the poorest performance throughout the entire process. Similarly, in Turkish, which has a very transparent orthography, it can be seen that a deficit in rapid naming will begin to have a marked effect on reading success, since children will have largely completed the decoding stage in the spring semester of the first grade (Kirby et al., 2003; Papadopoulos et al., 2009; Torppa et al., 2012; Vaessen et al., 2009; Wimmer et al., 2000). As reading success was evaluated based on speed in this study, this may have helped render the deficit in rapid naming more evident. Finally, since phonological awareness affects reading comprehension through decoding and rapid naming affects fluency, the finding that both deficit groups fared less well than the control group in comprehension tests is to be expected (Solari, Grimm, McIntyre, & Denton, 2018).

When it comes to the fall semester of the second grade, the performance of deficit groups creates a slightly different picture in some respects. According to this picture, performance of the double-deficit group differed significantly from the other deficit groups, thus widening the differences between them, and this finding, together with the fact that the single-deficit groups showed slightly improved performance in reading tests but exhibited increasingly poor performance in reading comprehension tests, is remarkable. In this context, it is possible to say that the risk level of the double-deficit group increased in terms of reading, reading comprehension and related general academic failure. It can be said that single-deficit groups are also at risk due to their poor performance in reading comprehension, even in the event of an improvement in reading. These findings are also consistent with the double-deficit hypothesis and previous study results (Jimenez et al., 2008; Norton et al., 2014; Steacy et al., 2014; Wolf & Bowers, 1999). The continued poor performance of children with a double deficit in the second grade is a strong finding, supporting the hypothesis. In this study, the poor performance of deficit groups in terms of reading comprehension, in addition to their reading skills, is considered to be an important finding in terms of the field and practice. It is noteworthy that although the group with a phonological awareness deficit did make some progress in terms of reading, the same level of improvement in reading comprehension was not observed. The fact that poor performance of the group

with a rapid naming deficit observed in the spring of the first grade in reading tests disappeared to a large extent is compatible with some studies. For example, in studies conducted in Finnish (Torppa et al., 2013) and Greek (Papadopoulos et al., 2009), the reading success of groups with a single deficit was found to approach that of the control group.

Finally, in the spring of the second grade, performance of the double-deficit group, which was significantly poorer than that of the other groups, was clearly maintained in all reading and comprehension tests, and performance of the single-deficit groups, which did not differ significantly from the control group, despite being low, improved notably in this sense. The fact that the double-deficit group continued to experience such failure in terms of both reading and reading comprehension during all periods within the scope of the study is considered to be an important indication that their failure will most likely continue in the years that follow. The results of studies examining the effects of the hypothesis over a longer time period emphasize that the problems experienced by the double-deficit group are likely to continue to a large extent in subsequent years (Katzir et al., 2008; Kirby et al., 2003; Papadopoulos et al., 2009; Steacy et al., 2014; Torppa et al., 2012, 2013; Wimmer et al., 2000) and that the prevalence and severity of reading difficulties will be highest in this group (Heikkilä et al., 2016; Lovett et al., 2000). This finding in our study strongly supports the double-deficit hypothesis. Wolf and Bowers (1999), who put forward the hypothesis, have also stated that children in the double-deficit group will have more severe difficulties in reading, compared to other deficit groups.

Although, in our study, the expected reading problems in the single-deficit groups were specific to the first grade and largely disappeared in the second grade, the consistently poor performance of the double-deficit group throughout the four semesters is thought to be an important finding, which should guide practice. Today, an approach that focuses on early diagnosis and intervention is generally adopted in order to increase the effectiveness of practices relating to reading and learning difficulties all over the world, and it is foreseen that such practices will be shaped accordingly. Therefore, the findings of this study provide important information about the indicative skills on which early diagnosis or risk-group identification studies should be based. Accordingly, assessing both phonological awareness and rapid naming in preschool screening and identifying children with a performance measure in excess of one standard deviation below the average in both areas (addressing these in the intervention process) would seem to be a suitable way to increase the effectiveness of such practices. It is thought that in these practices, considering the poor performance of children who have a single deficit in the first grade and poor performance in reading comprehension in the second grade, and determining risk groups, will be an important factor that will increase the effectiveness of early diagnosis and intervention practices.

In conclusion, it is possible to say that the results of this study provide significant experimental support for the double-deficit hypothesis. It is clear that the double-deficit hypothesis can be used to explain reading difficulties in Turkish-speaking children, especially within the framework of its assumptions for children with a double deficit. On the other hand, the results of this study do not fully support the hypothesis's assumptions about single-deficit groups. The results of the study for single-deficit groups are not fully consistent with the results of previous studies reported in the literature relating to this hypothesis. However, this inconsistency can also be found among all studies based on this hypothesis in the literature. It is thought that factors such as participant characteristics, the tasks used to measure relevant skills, the criteria for determining deficit groups, and whether the grouping is done before or after formal reading instruction may be possible reasons for inconsistent results. In addition, Wolf and Bowers (1999) have stated that although the double-deficit hypothesis can provide an important indication of reading difficulties, it does not fully explain reading difficulties, and researchers and practitioners should consider the heterogeneity of groups of children who have reading difficulties.

Limitations and Recommendations

Although this study obtained important results for explaining reading difficulties, there are some limitations that should be considered when evaluating the results. The first of these is that the study was carried out with a small sample. Small sample groups are a factor that significantly reduces the statistical power of the analyses (Pallant, 2010). This may be one of the reasons why not all of the expected (significant) differences between the single-deficit groups and the control group could be obtained in accordance with the hypothesis. For this reason, it is important that the investigation be repeated with a larger sample in further studies, to obtain more explanatory information about the double-deficit hypothesis. Secondly, this study was conducted only until the end of the second grade. During this period, it was determined that the performance of children in terms of reading and reading comprehension varied significantly. Accordingly, it is likely that children will show different characteristics in subsequent grades. For this reason, it is important that the effects of the double-deficit hypothesis on children's performance be monitored in future studies, including in subsequent years, in order to examine more closely the assumptions of the hypothesis regarding reading difficulties. Thirdly, in this study, the reading performance of children in the first and second grades, grouped according to phonological awareness and rapid naming skills assessed in kindergarten, was examined. We did not examine whether children's deficit in phonological awareness and rapid naming continued after reading instruction began. Therefore, it is thought that measuring phonological awareness and rapid naming skills simultaneously, along with children's reading performance, in further studies will facilitate better explanation of group differences. Finally, in this study, performance comparisons of children in different deficit groups were made on the basis of group averages. However, examining individual differences within groups may provide important information to help determine which characteristics in children are effective in changing reading skills. Thus, it will be possible to plan the content of intervention programs more effectively.

References

- Ackerman, P. T., Holloway, C., Youngdahl, P., & Dykman, R. A. (2001). The double-deficit theory of reading disability does not fit all. *Learning Disabilities Research and Practice, 16*(3), 152-160. doi:10.1111/0938-8982.00016
- Araujo, S., & Faisca, L. (2019). A meta-analytic review of naming-speed deficits in developmental dyslexia. *Scientific Studies of Reading, 23*(5), 349-368. doi:10.1080/10888438.2019.1572758
- Araujo, S., Pacheco, A., Faisca, L., Petersson, K. M., & Reis, A. (2010). Visual rapid naming and phonological abilities: Different subtypes in dyslexic children. *International Journal of Psychology, 45*(6), 443-452. doi:10.1080/00207594.2010.499949
- Babayiğit, S., & Stainthorp, R. (2007). Preliterate phonological awareness and early literacy skills in Turkish. *Journal of Research in Reading, 30*(4), 394-413. doi:10.1111/j.1467-9817.2007.00350.x
- Bowers, P. G. (1995). Tracing symbol naming speed's unique contributions to reading disabilities over time. *Reading and Writing, 7*, 189-216.
- Caravolas, M., Volin, J., & Hulme, C. (2005). Phoneme awareness is a key component of alphabetic literacy skills in consistent and inconsistent orthographies: Evidence from Czech and English children. *Journal of Experimental Child Psychology, 92*(2), 107-139. doi:10.1016/j.jecp.2005.04.003
- Cronin, V. S. (2013). RAN and Double-Deficit Theory. *Journal of Learning Disabilities, 46*(2), 182-190. doi:10.1177/0022219411413544
- Cunningham, A. E., & Stanovich, K. E. (1997). Early reading acquisition and its relation to reading experience and ability 10 years later. *Developmental Psychology, 33*(6), 934-945. doi:10.1037/0012-1649.33.6.934
- Erdoğan, Ö. (2012). İlköğretim birinci sınıf öğrencilerinin fonolojik farkındalık becerileri ile okuma becerileri arasındaki ilişki. *Eğitim ve Bilim, 37*(166), 41-51.
- Ergül, C., & Demir, E. (2017). *SED İndeks Ebeveyn Bilgi Formu*. Unpublished project report.
- Ergül, C., & Demir, E. (2018). *Hızlı Isimlendirme Testi Uygulayıcı Kılavuzu*. Ankara: Ankara Üniversitesi Yayınları.
- Ergül, C., Akoğlu, G., Ökcün Akçamuş, M. Ç., Demir, E., Kılıç Tülü, B., & Bahap Kudret, Z. (2020). Longitudinal results on phonological awareness and reading performance of Turkish-speaking children by socioeconomic status. *Education and Science, 46*(205), 49-68. doi:10.15390/EB.2020.8991
- Ergül, C., Ökcün-Akçamuş, M. Ç., Akoğlu, G., Kılıç Tülü, B., & Demir, E. (2018). *Okuma Yazma Değerlendirme Bataryası*. Ankara.
- Ergül, C., Ökcün-Akçamuş, M. Ç., Akoğlu, G., Kılıç Tülü, B., & Demir, E. (2021). İlkokul çocuklarına yönelik geliştirilmiş Okuma Yazma Değerlendirme Bataryasının (OYAB) geçerlik ve güvenilirlik çalışması. *Ana Dili Eğitimi Dergisi, 9*(3), 740-770. doi:10.16916/aded.874262
- Furnes, B., & Samuelsson, S. (2011). Phonological awareness and rapid automatized naming predicting early development in reading and spelling: Results from a cross-linguistic longitudinal study. *Learning and Individual Differences, 21*(1), 85-95. doi:10.1016/j.lindif.2010.10.005
- Georgiou, G. K., Aro, M., Liao, C. H., & Parrila, R. (2016). Modeling the relationship between rapid automatized naming and literacy skills across languages varying in orthographic consistency. *Journal of Experimental Child Psychology, 143*, 48-64. doi:10.1016/j.jecp.2015.10.017
- Georgiou, G. K., Parrila, R., & Kirby, J. R. (2006). Rapid naming speed components and early reading acquisition. *Scientific Studies of Reading, 10*(2), 199-220. doi:10.1207/s1532799xssr1002_4
- Georgiou, G. K., Parrila, R., & Liao, C. (2008a). Rapid naming speed and reading across languages that vary in orthographic consistency. *Reading & Writing, 21*, 885-903. doi:10.1007/s11145-007-9096-4
- Georgiou, G. K., Parrila, R., Cui, Y., & Papadopoulos, T. C. (2013). Why is rapid automatized naming related to reading?. *Journal of Experimental Child Psychology, 115*(1), 218-225. doi:10.1016/j.jecp.2012.10.015

- Heikkilä, R., Torppa, M., Aro, M., Närhi, V., & Ahonen, T. (2016). Double-deficit hypothesis in a clinical sample: Extension beyond reading. *Journal of Learning Disabilities, 49*(5), 546-560. doi:10.1177/0022219415572895
- Jimenez, J. E., Hernandez-Valle, I., Rodrigez, C., Guzman, R., Diaz, A., & Ortiz, R. (2008). The double-deficit hypothesis in Spanish developmental dyslexia. *Topics in Language Disorders, 28*(1), 46-60. doi:10.1097/01.adt.0000311415.69966.76
- Kargın, T., Ergül, C., & Güldenoğlu, İ. B. (2018). *Erken Okuryazarlık Testi*. Ankara: Ankara Üniversitesi Yayınları.
- Kargın, T., Ergül, C., Büyüköztürk, Ş., & Güldenoğlu, B. (2015). Anasınıfı çocuklarına yönelik Erken Okuryazarlık Testi (EROT) geliştirme çalışması. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Özel Eğitim Dergisi, 16*(3), 237-268. doi:10.1501/Ozlegt_0000000231
- Katzir, T., Kim, Y. S., Wolf, M., Morris, R., & Lovett, M. W. (2008). The varieties of pathways to dysfluent reading. *Journal of Learning Disabilities, 41*(1), 47-56.
- Kirby, J., Georgiou, G., Martinussen, R., Parrila, R., Bowers, P., & Landerl, K. (2010). Review of research: Naming speed and reading: From prediction to instruction. *Reading Research Quarterly, 45*(3), 341-362. doi:10.1598/RRQ.45.3.4
- Kirby, J. R., Parrila, R. K., & Pfeiffer, S. L. (2003). Naming speed and phonological awareness as predictors of reading development. *Journal of Educational Psychology, 95*(3), 453-464. doi:10.1037/0022-0663.95.3.452
- Landerl, K., & Wimmer, H. (2008). Development of word reading fluency and spelling in a consistent orthography: An 8-year follow-up. *Journal of Educational Psychology, 100*(1), 150-161. doi:10.1037/0022-0663.100.1.150
- Lepola, J., Poskiparta, E., Laakkonen, E., & Niemi, P. (2005). Development of and relationship between phonological and motivational processes and naming speed in predicting word recognition in Grade 1. *Scientific Studies of Reading, 9*(4), 367-399.
- Lovett, M., Steinbach, K. A., & Frijters, J. C. (2000). Remediating the core deficits of developmental reading disability: A double-deficit perspective. *Journal of Learning Disabilities, 33*(4), 334-358. doi:10.1177/002221940003300406
- Moura, O., Pereira, M., Morena, J., & Simoes, M. R. (2020). Investigating the double-deficit hypothesis of developmental dyslexia in an orthography of intermediate depth. *Annals of Dyslexia, 70*(1), 43-61. doi:10.1007/s11881-020-00190-1
- Nelson, J. M. (2015). Examination of the double-deficit hypothesis with adolescents and young adults with dyslexia. *Annals of Dyslexia, 65*(3), 159-177. doi:10.1007/s11881-015-0105-z
- Norton, E. S., & Wolf, M. (2010). Rapid automatized naming (RAN) and reading fluency: Implications for understanding and treatment of reading disabilities. *Annual Review of Psychology, 63*(1), 427-457. doi:10.1146/annurev-psych-120710-100431
- Norton, E. S., Black, J. M., Stanley, L. M., Tanaka, H., Gabrieli, J. D. E., Sawyer, C., & Hoefft, F. (2014). Functional neuroanatomical evidence for the double-deficit hypothesis of developmental dyslexia. *Neuropsychologia, 61*(1), 235-246. doi:10.1016/j.neuropsychologia.2014.06.015
- Öney, B., & Durgunoğlu, A. Y. (1997). Beginning to read in Turkish: A phonologically transparent orthography. *Applied Psycholinguistics, 18*(1), 1-15. doi:10.1017/S014271640000984X
- Pallant, J. (2010). *SPSS survival manual - A step by step guide to data analysis using SPSS* (4th ed.). New York: Open University Press/McGraw-Hill.
- Papadopoulous, T. C., Georgiou, G. K., & Kendeou, P. (2009). Investigating the double-deficit hypothesis in Greek: Findings from a longitudinal study. *Journal of Learning Disabilities, 42*(6), 528-547. doi:10.1177/0022219409338745

- Pennington, B., Cardoso-Martins, C., Green, P. A., & Lefly, D. L. (2001). Comparing the phonological and double-deficit hypotheses of developmental dyslexia. *Reading and Writing: An Interdisciplinary Journal*, 14, 707-755. doi:10.1023/A:1012239018038
- Scarborough, H. S. (2002). Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice. In S. B. Neuman & D. K. Dickinson (Eds.), *Handbook of early literacy research* (pp. 97-110). New York, NY: Guilford Press.
- Schatschneider, C., Carlson, C. D., Francis, D. J., Foorman, B. R., & Fletcher, J. M. (2002). Relationship of rapid automatized naming and phonological awareness in early reading development: Implications for the double deficit hypothesis. *Journal of Learning Disabilities*, 35(3), 245-256. doi:10.1177/002221940203500306
- Schatschneider, C., Fletcher, J. M., Francis, D. J., Carlson, C. D., & Foorman, B. R. (2004). Kindergarten prediction of reading skills: A longitudinal comparative analysis. *Journal of Educational Psychology*, 96(2), 265-282. doi:10.1037/0022-0663.96.2.265
- Solari, E. J., Grimm, R. P., McIntyre, N. S., & Denton, C. A. (2018). Reading comprehension development in at-risk vs. not at-risk first grade readers: The differential roles of listening comprehension, decoding, and fluency. *Learning and Individual Differences*, 65, 195-206.
- Spector, J. E. (2005). The instability of double-deficit subtypes among at-risk first grade readers. *Reading Psychology*, 26(3), 285-312. doi:10.1080/02702710590967834
- Steady, L. M., Kirby, J. R., Parrila, R., & Compton, D. L. (2014). Classification of double deficit groups across time: An analysis of group stability from kindergarten to second grade. *Scientific Studies of Reading*, 18(4), 255-273. doi:10.1080/10888438.2013.873936
- Stanford, G., & Oakland, T. (2000). Cognitive deficits underlying learning disabilities: Research perspectives from the United States. *School Psychology International*, 21(3), 306-321. doi:10.1177/0143034300213007
- Torppa, M., Georgiou, G. K., Salmi, P., Eklund, K., & Lyytinen, H. (2012). Examining the double-deficit hypothesis in an orthographically consistent language. *Scientific Studies of Reading*, 16(4), 287-315. doi:10.1080/10888438.2011.554470
- Torppa, M., Lyytinen, P., Erskine, J., Eklund, K., & Lyytinen, H. (2010). Language development, literacy skills, and predictive connections to reading in Finnish children with and without familial risk for dyslexia. *Journal of Learning Disabilities*, 43(4), 308-321. doi:10.1177/0022219410369096
- Torppa, M., Parrila, R., Niemi, P., Lerkkanen, M. K., Poikkeus, A. M., & Nurmi, J. E. (2013). The double-deficit hypothesis in the transparent Finnish orthography: A longitudinal study from kindergarten to Grade 2. *Reading and Writing*, 26(8), 1353-1380. doi:10.1007/s11145-012-9423-2
- Vaessen, A., Gerretsen, P., & Blomert, L. (2009). Naming problems do not reflect a second independent core deficit in dyslexia: Double deficits explored. *Journal of Experimental Child Psychology*, 103(2), 202-221.
- Vukovic, R. K., & Siegel, L. S. (2006). The double-deficit hypothesis: A comprehensive analysis of the evidence. *Journal of Learning Disabilities*, 39(1), 25-47. doi:10.1177/00222194060390010401
- Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin*, 101(2), 192-212. doi:10.1037/0033-2909.101.2.192
- Wagner, R. K., Torgesen, J. K., Rashotte, C. A., Hecht, S. A., Barker, T. A., Burgess, S. R., ... Garon, T. (1997). Changing relations between phonological processing abilities and word-level reading as children develop from beginning to skilled readers: A 5-year longitudinal study. *Developmental Psychology*, 33(3), 468-479. doi:10.1037//0012-1649.33.3.468
- Whitehurst, G. J., & Lonigan, C. J. (2001). Development from prereaders to readers. In S. B. Neumann & D. K. Dickinson (Eds.), *Handbook of early literacy research* (pp. 11-29). New York: The Guilford Press.

- Wimmer, H., Mayringer, H., & Landerl, K. (2000). The double-deficit hypothesis and difficulties in learning to read a regular orthography. *Journal of Educational Psychology, 92*(4), 668-680. doi:10.1037/0022-0663.92.4.668
- Wolf, M., & Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology, 91*(3), 415-438. doi:10.1037/0022-0663.91.3.415
- Ziegler, J. C., Bertrand, D., Toth, D., Csepe, V., Reis, A., Faisca, L., ... Blomert, L. (2010). Orthographic depth and its impact on universal predictors of reading: A cross-language investigation. *Psychological Science, 21*(4), 551-559. doi:10.1177/0956797610363406