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Intervention for early literacy success: Phonological awareness and rapid automatized naming

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ABSTRACT

The study aimed to assess the effectiveness of a comprehensive intervention program (including PA and RAN interventions) on improving early literacy skills in preschoolers from low socioeconomic backgrounds while exploring participant perspectives. The experimental group showed significant improvements in PA, RAN-object, and RAN-color performance compared to the control group. These improvements were observed immediately after the intervention and were maintained even after a 16-week follow-up period. The experimental group's scores in PA, RAN-object, and RAN-color increased significantly from pretest to posttest and were further improved at the follow-up. These findings suggest that the interventions effectively enhanced participants' performance in these areas and that the experimental group consistently outperformed the control group. The intervention had a significant positive impact on early literacy performance, with the experimental group outperforming the control group. The findings highlight the effectiveness of the program and its favorable reception among families, teachers, and children.

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Rapid naming; phonological awareness; early literacy; preschool; socioeconomic background

Introduction

In recent years, a growing body of research has shed light on the multifaceted relationship between early literacy development and socioeconomic backgrounds (Aikens & Barbarin, 2008; Bradley & Corwyn, 2002; Chen et al., 2018; Noble et al., 2006). While the importance of phonological awareness (PA) and rapid automatic naming (RAN) in the acquisition of literacy skills has been well-documented (Akgün & Akçamete, 2023; Henning et al., 2010; Hulme et al., 2012; Vander Stappen et al., 2020; Vander Stappen & Van Reybroeck, 2018; Whiteley et al., 2007), understanding the impact of socioeconomic factors on these skills becomes particularly crucial when considering the specific context of Turkish preschoolers. Some researchers have examined the literacy development of young children from low socioeconomic backgrounds, and these studies emphasize the importance of targeted interventions to improve early literacy skills. This study aimed to examine the effectiveness of a comprehensive intervention program targeting both PA and RAN skills. Moreover, it aimed to address the gap in intervention studies involving Turkish preschoolers from low socioeconomic backgrounds.

Importance of rapid automatic naming and phonological awareness

Phonological awareness skills are needed to understand the phonological organization of letter-sound relationships based on the alphabetic principle in word structure (Wright & Jacobs, 2003). PA includes the ability to realize that (a) sentences consist of words, (b) the sounds that make up words differ from each other, (c) the pronunciation of words can be similar, (d) the first sounds of words can start with the same sound, (e) the last sounds of words can end with the same sound, (f) the sounds in the middle of words can be the same, (g) words can be divided into phonemes, (h) words can be produced by combining phonemes, and (i) new words can be formed when some syllables or sounds are removed from words (Bennett-Armistead et al., 2005). PA plays a role in connecting spoken and written language (Ziegler & Goswami, 2005) and predicts aspects of literacy development such as reading accuracy, spelling, and reading rate (Frost et al., 2005; Muter et al., 2004; Smith et al., 2008). PA, especially at the phonemic level, strongly predicts reading accuracy and spelling in languages like English (Frost et al., 2005; Smith et al., 2008). It also contributes to reading comprehension, which is potentially mediated by word decoding skills (Muter et al., 2004).

The relationship between phonological processing skills, such as PA and reading ability is bidirectional (Wagner et al., 1994). Phonemic awareness, a component of PA, seemed to have a moderate impact on reading, spelling, and reading comprehension (Ehri et al., 2001; Pape-Neumann et al., 2015). Early PA education has been found to positively affect children at risk of reading difficulties, improve phonological memory, sensitivity, and metalinguistic abilities, and reduce the risk of dyslexia while enhancing reading and

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spelling performance (Eissa, 2014; Schneider et al., 2000). Interventions that combine PA and letter knowledge positively affect later reading and spelling skills (Schneider et al., 2000).

RAN refers to the speed at which individuals name visual stimuli such as letters or numbers (Araújo et al., 2011). The relationship between RAN and literacy skills is debated, with some proposing a connection based on shared phonological tasks and retrieval of phonological codes, while others suggest that it is related to temporal coordination and high-speed processing in word recognition (Araújo et al., 2011; Catts et al., 2002). RAN has been found to consistently predict reading speed across languages but has limited predictive power for spelling (Babayiğit & Stainthorp, 2010; Caravolas et al., 2012; de Jong & van der Leij, 1999; Georgiou et al., 2008; Holopainen et al., 2001; Landerl & Wimmer, 2008; Savage et al., 2008; Vaessen et al., 2010). Although RAN seems to have a weaker direct contribution to reading accuracy, it appears to be a stronger predictor of reading speed (Kirby et al., 2003; Swanson et al., 2003). Notably, RAN differs from PA and can provide unique insights into prediction studies (Kirby et al., 2010; Manis et al., 2000).

Although some studies have not provided conclusive evidence for enhancing RAN performance (Conrad & Levy, 2011; de Jong & Vrielink, 2004), recent research has shown potential for improvement. For instance, Pecini et al. (2019) found that RAN intervention significantly increased RAN speed, reading performance, and accuracy in Italian-speaking students with dyslexia from the first to fifth grades. Vander Stappen et al. (2020) demonstrated that RAN intervention improved RAN performance and word reading accuracy in French-speaking primary school students with dyslexia, as measured using behavioral and neuroimaging measures.

Vander Stappen & Van Reybroeck (2018) conducted a study on PA and RAN interventions. Both interventions were effective, with the PA intervention showing transfer effects on spelling processes, and the RAN intervention improving word reading speed. Akgün & Akçamete (2023) evaluated the effectiveness of a reading intervention program (OKU-GEL) for primary school students with dyslexia, which improved reading speed and accuracy skills. Vander Stappen et al. (2020) investigated a RAN intervention for children with dyslexia and found significant improvements in RAN performance, and word reading accuracy correlated with brain changes. Whiteley et al. (2007) have identified factors hindering progress in at-risk children despite phonologically based intervention, highlighting the importance of letter knowledge and expressive vocabulary. Hulme et al. (2012) demonstrated that improvements in letter-sound knowledge and phoneme awareness have mediated the development of word-level literacy skills. Henning et al. (2010) reported short-term positive effects but no long-term improvements in language and literacy achievement for socially disadvantaged children. Overall, these studies emphasize the importance of PA and RAN in literacy development and in the effectiveness of targeted interventions (Akgün & Akçamete, 2023; Henning et al., 2010; Hulme et al., 2012; Vander Stappen et al., 2020; Vander Stappen & Van Reybroeck, 2018; Whiteley et al., 2007).

Preschool Education in Turkey: The delivery and importance of early literacy skills

Preschool education programs conducted by the Ministry of National Education (MoNE) in Turkey are implemented for children between the ages of 3-6. In the program, studies related to literacy preparation are specified as verbal language skills, visual perception, general cultural knowledge, writing knowledge, alphabet knowledge, phonological sensitivity, and pre-writing studies (MoNE, 2013). Although the preschool education curriculum includes phonological awareness exercises, such as detecting word beginning and ending sounds and creating rhyming words (MoNE, 2013), most instructors do not perform these exercises (Erdoğan et al., 2013). This situation indicates the difficulties experienced in developing early literacy skills in preschool education.

In recent years, more emphasis has been placed on early literacy skills in preschool education in Turkey. However, there are challenges to the quality and accessibility of preschool education services in Turkey. Although preschool education opportunities in rural areas are often limited, inequalities can also be seen in large cities depending on residential areas and socioeconomic factors. In their study, Ergül et al. (2014) found that teachers with high levels of early literacy knowledge more frequently included in-class practices to develop the skills that constitute early literacy and paid more attention to creating interactions with children during book reading activities. Kargın et al. (2017), in their study evaluating the early literacy skills of preschool children, found that the children included in the study were close to the adequate level only in the field of vocabulary knowledge among the skills addressed within the scope of early literacy skills, but remained below the expected level in all other sub-skill areas. This finding indicates that "reading and writing preparation activities" in the preschool education program did not bring children to the desired level regarding early literacy skills. Therefore, more investment and support are essential to improve the quality of preschool education in Turkey and to strengthen early literacy skills. Qualified training for teachers, more resources for children to develop early literacy skills, and increased accessibility will ensure effective teaching of reading skills in preschool education (Çaliş & Feyman Gök, 2022; Cunningham et al., 2009).

Low socioeconomic backgrounds

Numerous studies have explored the impact of family socioeconomic status (SES) on children's reading skills development (Aikens & Barbarin, 2008; Bradley & Corwyn, 2002; Chen et al., 2018; Noble et al., 2006). However, the mechanisms underlying this effect seem to remain unclear (Liu et al., 2018). A recent meta-analytic structural equation modeling (MASEM) study investigated the mediating role of language skills in the relationship between SES and reading, such as phonological awareness and vocabulary knowledge. This study has also examined variables such as age, country SES, and SES measurement type (Liu et al., 2018). The findings indicate that phonological awareness and vocabulary

knowledge partially mediate the relationship between SES and reading. Age, country SES, and SES measurement type have not directly moderated the relationship but have shown moderation effects through linguistic mediation. The study revealed that older age, higher country SES, and a composite SES index increased the indirect effect of SES on reading ability (Liu et al., 2022). In summary, SES seems to exert both direct and indirect effects on reading through language skills, with the mediation mechanism potentially influenced by age, country SES, and SES measure.

Many studies have shown that SES plays a vital role in early childhood reading development (Chung et al., 2017; Larson et al., 2015; Wang et al., 2017). In these studies, children from low SES backgrounds seem to exhibit lower reading achievement and language skills than those from high SES backgrounds (Chung et al., 2017; Larson et al., 2015; Wang et al., 2017). These reading achievement gaps include reading accuracy, fluency, and comprehension, and these disparities persist from kindergarten to at least age 13 (Chatterji, 2006; Duncan & Magnuson, 2013; Pan et al., 2017; Su et al., 2017). While these differences in reading achievement continue until age 13, studies are generally limited to children in this age group. Despite efforts to reduce these achievement gaps, recent research suggests that inequalities are widening (Bassok & Reardon, 2013).

The Coleman Report showed that the most important determinant of student achievement is the relationship between student and family characteristics and socioeconomic level (Coleman, 1966). In particular, students whose families had higher levels of education and income showed higher academic achievement. These findings seem to mark a potential turning point in educational research, suggesting a potentially strong relationship between student achievement and socioeconomic status. The Coleman Report argues that inequalities in education begin in the preschool period, that the socioeconomic status of families in particular shapes the initial differences between students (school entry level) and that these differences widen over time. Therefore, the persistence of socioeconomic advantages throughout the school years may further widen the gaps.

The "Matthew Effect," as described by Stanovich, children who fail to learn to read for various reasons continue to lag behind their peers in the following years, and the gap between them gradually widens. Given the importance of early literacy skills and early childhood experiences for long-term literacy success, more effective intervention research is needed to ensure equal opportunities for all children (National Early Literacy Panel, 2008). Thus, it seems that early intervention programs may play a essential role in mitigating socioeconomic inequalities in education. Such programs can minimize initial disparities by providing disadvantaged students with equal educational opportunities.

The present study

This research examined the effectiveness of a RAN and PA intervention program tailored for Turkish preschool children aged 60-72 months from lower socioeconomic backgrounds. While previous studies have explored the relationship between PA and RAN in different contexts and populations, more intervention studies focusing on Turkish preschoolers from low socioeconomic backgrounds are needed. This study aims to address this gap by implementing a comprehensive intervention program that combines RAN and PA for this specific group of children. This study seeks to contribute to the existing literature on intervention studies involving PA and RAN in Turkey, as it is the first of its kind to include both PA and RAN components in Turkish preschoolers from low socioeconomic backgrounds.

For this purpose, answers to the following questions were sought:

1. Is there a significant difference between the PA and RAN pretest averages of the experimental group children who participated in the PA and RAN intervention program and the control group children who did not participate in the intervention program?
2. Do the PA pre-, post, and follow-up test scores of preschool children from low socioeconomic backgrounds who received and did not receive PA intervention differ significantly between the groups?
3. Do the RAN object pre-, post, and follow-up test times of preschool children from low socioeconomic backgrounds who received and did not receive RAN object intervention differ significantly between the groups?
4. Do the pre-, post, and follow-up test times of preschool children from low socioeconomic backgrounds who received and did not receive RAN colors intervention differ significantly between groups?
5. Do the early literacy (word knowledge in receptive and expressive language, general naming, functional knowledge, letter knowledge, phonological awareness, listening comprehension) pre-, post, and follow-up test scores of preschool children from low socioeconomic backgrounds who participated and did not participate in intervention programs differ significantly between groups?

Method

Research design

This study used a quasi-experimental research design with a pretest-posttest control group because quantitative data were obtained from existing groups. The dependent variables were students' rapid automatic naming, phonological awareness and early literacy test scores. The independent variables were rapid automatic naming and phonological awareness training.

- Experimental Group: Participants in this group received the rapid automatic naming and phonological awareness training.
- Control Group: Participants in this group did not receive the intervention and served as a comparison group.

Participants

This intervention study was conducted in a public school that served preschool children aged 60-72 months from lower socioeconomic backgrounds in Turkey. A total of 68 students participated in this study: 34 students (17 female, 17 male) in the experimental group and 34 students (17 female, 17 male) in the control group. Measures were taken to ensure that the groups were similar at the beginning of the study. Children were excluded if they had a history of hearing or visual impairment, below-average scores on Raven's Standard Progressive Matrices, or a developmental disorder such as hyperactivity. Independent t-tests were performed before the intervention. Independent t-tests showed no differences between the two groups in age, Raven scores, receptive and expressive language, RAN object, RAN color, PA, The Test of Early Literacy (TEL) (see Table 1). Accordingly, the experimental and control groups showed similar performance before the intervention. After all authors collected the data for the reported study, the first author taught the intervention to the control group.

Procedure

All tests and interventions were conducted during school hours. The school year in Turkey is from September to June. Participants in both intervention groups were assessed by three researchers and trained by the first author. Each child was administered a series of tests before the intervention (September), immediately after the intervention (December), and at follow-up four months later (May). The tests were conducted individually in a 40-minute session in a quiet room close to the children's classrooms. Because fatigue was more critical than order effects, the order of the tasks was kept constant across participants.

The RAVEN and TELD (receptive and expressive language) tests were administered only during the pretest. Score sheets were anonymized before scoring so that a blinded process could be followed. The children in the experimental group were randomly divided into two classes, with 17 students in one class and 17 students in the other, to reduce the negative effects of the crowded classroom during the intervention period. The children received group-based RAN and PA intervention for a period of eight weeks (October-November-December first week). There was a 1-week interruption in November because of the winter break. For PA, 25-35 min lessons were held four days a week. For RAN, 25-minute lessons were delivered twice a week for 8 wk, resulting in 16 lessons. The RAN intervention program was implemented in the first session and the PA intervention program was implemented in the following session.

Table 1. Comparison of the experimental and control groups on pretraining measures.

	Experimental Group ($n=34$)	Control Group ($n=34$)		
Measure	M (SD)	M (SD)	t	p
Age	67.91 (3.94)	67.44 (4.34)	.46	>.05
Raven	17.58 (5.58)	17.32 (5.51)	.19	>.05
RL	9.20 (1.34)	9.73 (1.72)	−1.41	>.05
EL	9.35 (1.77)	9.76 (1.82)	−0.94	>.05
RAN object	75.50 (4.23)	76.85 (3.78)	−1.38	>.05
RAN color	80.55 (3.81)	81.23 (2.75)	−0.83	>.05
PA	22.02 (1.81)	22.73 (2.36)	−1.38	>.05
TEL	40.29 (4.31)	40.05 (5.33)	.20	>.05

Note. RL: receptive language (TELD); EL: expressive language (TELD); PA: phonological awareness; Raven: Raven Standard Progressive Matrices; RAN: rapid automatized naming; TEL: The Test of Early Literacy.

Intervention program

PA Intervention. The TODI Phonological Awareness program prepared by [name deleted to maintain the integrity of the review process] was applied. Sessions were created using the activities in the module according to the developmental order of phonological awareness skills. For eight weeks, 32 lessons were held four days a week in the form of "rhyme-syllable-sound". Each session lasted 25-35 min and included two activities. The types of activities conducted at each stage of the Phonological Awareness Program are listed in Table 2. At the end of each stage, worksheets related to the skill studied at that stage were prepared. These phases were ordered according to their difficulty levels; the other phases were not started until the sessions in one phase were completed.

We developed a meticulously designed program that incorporated comprehensive guidelines to ensure its effectiveness:

a. The exercises were carefully sequenced to gradually increase in difficulty level.
b. The active engagement of all children was emphasized throughout the lessons.
c. Before starting the exercise, multiple examples were provided to the children for better understanding.
d. Immediate feedback was consistently provided for each answer. In the case of an incorrect response, the child was encouraged to self-correct first. Subsequently, other children were invited to assist in finding the correct answer.
e. All activities were enjoyable and engaging, aiming to sustain the children's interest and motivation.

Both interventions were structured identically to mitigate the Hawthorne effect, with equal duration, frequency, and lesson length. This approach ensured that any observed effects could be attributed to the specific interventions rather than external factors.

Table 2. Phonological awareness program.

Rhyme Awareness	1- Rhyme recognition 2- Recognizing rhymes and non-rhymes
Syllable Awareness	1- Spelling / syllable counting 2- Syllable separation 3- Syllable combining 4- Syllable manipulation (substitution)
Sound Awareness	1- Are the words the same or different? 2- First sound - last sound recognition 3- Separating words into sounds 4- Where is the sound in the word (beginning-middle-end) 5- Manipulating sounds (substitution, addition, subtraction)

RAN intervention. The TODI RAN program, developed by [name deleted to maintain the integrity of the review process], was used in this study. The aim of the RAN intervention was to enhance the speed of object and color naming. Two types of RAN matrices were employed: RAN-R matrices contained a small number of items repeated several times (either three items repeated eight times or six items repeated four times). In contrast, the RAN-NR matrices comprised 24 different items. The intervention involved 16 lessons, with the initial eight lessons utilizing RAN-R matrices and the subsequent eight lessons utilizing RAN-NR matrices. Each lesson comprised training with two matrices, resulting in 16 RAN-R matrices and 16 RAN-NR matrices, encompassing 192 items throughout the 16 lessons. The items used were color pictures of familiar objects arranged in a four-line matrix with six items per line. Additionally, the difficulty level gradually increased based on the length and complexity of the syllabic structure of the words.

Each lesson followed a consistent structure, with two RAN matrices practiced using different activities. First, each child took turns naming the objects on a RAN matrix as quickly and accurately as possible while timed by the experimenter. To increase speed, a mechanical ladybird toy was placed on a sloping board, and the children were motivated to finish naming the matrix before the ladybird reached the bottom of the board. Second, the children were encouraged to repeat the task with another RAN matrix to surpass their previous speed record. Third, the same items were practiced in a relay race format to make engaging and enjoyable. Enlarged A4-sized objects from both matrices were placed on the ground with ample spacing arranged in lines or a circle. The children took turns jumping from one item to another and simultaneously naming them. They were motivated to break the collective speed record achieved during the previous week. Finally, the children were asked to draw a matrix from a set containing all the matrices previously practiced during the intervention and quickly name the objects on it. Throughout the 8-week program, a story with a puzzle to solve was narrated to maintain the children's motivation. At the end of each lesson, they received a puzzle piece as a reward.

Treatment fidelity

Several measures were implemented to ensure the faithful execution of the interventions: First, the primary author developed a comprehensive manual outlining the intervention program, including specific materials and exercises. Both experimenters underwent training to ensure their proficiency in implementing the program. Second, a step-by-step checklist was provided for each lesson to guide the experimenters through the process. Analysis of the checklists revealed that 95% of the steps in the PA intervention and 96% of the steps in the RAN intervention were successfully executed. Third, the experimenters maintained records of participant attendance for all lessons. The children actively participated in 94% and 95% of activities in the PA and RAN groups, respectively.

Furthermore, weekly meetings were conducted to discuss the overall progress of the experiment and address any issues encountered. These meetings ensured that the interventions were consistently administered across all subgroups within each intervention. Adjustments to the training program were made based on the children's progress, striking a balance between activities that were neither too easy nor too challenging. These modifications were implemented at the group level to ensure uniformity among all the children in the intervention group. Advancement to the next step occurred once most of the intervention group had successfully acquired the preceding step. Consequently, the manual and checklists were updated weekly to reflect these changes.

Measures

All participants were tested individually. These tests took place after consent was received from parents informed about the general aim of the study, but before participants were trained (or not). Pre-training and post-training comparisons were performed for both groups to check for potential improvement over time. A post-training measurement was applied for both groups within the same periods to evaluate the program's effectiveness.

Demographic information form

The researchers developed demographic information form to collect demographic information about the children and their families. It includes questions about the age and gender of the children and the demographic characteristics of the families (parental education level, income level, etc.).

Raven-color progressive matrices test (CPT; Bildiren et al., 2017)

Raven-Color Progressive Matrices Test was used to assess the cognitive competence of children between the ages of four and six. The first standardization study of this test was conducted by Raven in England in 1949. Bildiren et al. (2017) adapted the test into Turkish and conducted a standardization study. During the application of the test, which consists of a total of 36 items in 3 sets of 12, including A, AB and B forms, the child is asked to show the missing part of the pattern from among the options. The validity and reliability of the test were tested with 640 children aged 4-6 years. Within the scope of validity studies, the criterion validity of the RSM was found to be .70 with the Bender-Gestalt Visual Motor Perception Test, .63 with the Wechsler Intelligence Scale for Children (WISC-R) and .83 with the Test of Nonverbal Intelligence-3 (TONI-3). When the item difficulty levels of the RSM calculated according to age groups were examined, it was found that the item difficulty index ranged between .06 and 1.00 in the A set, .10 and .99 in the AB set, and .03 and 1.00 in the B set. The test-retest reliability coefficient calculated within the scope of reliability studies was found to be .55.

The test of early language development-Turkish (TELD-T)

TELD was usd to assess the oral language abilities of children aged 2 to 7 years (Topbaş & Güven, 2011). This test is an adaptation of the Test of Early Language Development (TELD-3), specifically tailored to Turkish. It comprises 76 items designed to evaluate semantics, morphology, and syntax and consists of two subtests: receptive and expressive language. Reliability analyses for the receptive and expressive language subtests demonstrated strong test-retest reliability, ranging from .96 to .93. The inter-rater reliability was also excellent, with values ranging from .99 to .99. Additionally, the internal consistency coefficient was found to be .94 to .92 for these subtests, indicating high internal reliability. Measures of validity were used to determine the validity of the test. The receptive language subtest displayed a significant correlation of .66 (p = .001) with the WISC-R verbal score and a correlation of .76 (p = .001) with the PPVT. Similarly, the expressive language subtest showed a significant correlation of .53 (p = .001) with the WISC-R verbal score and a correlation of .73 (p = .001) with the PPVT (Topbaş & Güven, 2011). Standard scores for receptive language, expressive language, and general language development are obtained from the TELD-T.

The test of early literacy (TEL)

TEL was employed as an assessment tool to evaluate early literacy skills in children aged 60 to 72 months (Kargın et al., 2015). The fifth question was analyzed separately on the TEL total score and the second question was analyzed separately on the phonological subtest of this test. TEL evaluates early literacy skills in seven dimensions: Word Knowledge in Receptive Language, Word Knowledge in Expressive Language, General Naming, Functional Knowledge, Letter Knowledge, Phonological Awareness, Listening Comprehension. It encompasses 102 items covering vocabulary, letter knowledge, phonological awareness, and listening comprehension. The validity and reliability study of TEL was conducted by Kargın et al. (2015) using Kuder Richardson 20. As a result of the calculation made to determine the internal consistency coefficient of the test, it was determined that the internal consistency coefficient was .94 for the entire test, the highest value belonged to the Letter Knowledge sub-dimension with .90, and the lowest value was .65 in the Function Knowledge sub-dimension. The two-half test correlation with Sperman Brown was .79 for the whole test, the highest value was .80 for the Expressive Language sub-dimension, and the lowest value was .64 for the Listening Comprehension sub-dimension.

For only second in this study, the phonological awareness sub-dimension was used separately in the analysis for the effectiveness of the PA intervention. Rhyme awareness includes eight subtests to evaluate the skills of matching according to the first and last sound, dividing the sentence into words, combining syllables, and discarding the first and last sound. Each subtest includes two sample items and four question items. The phonological awareness dimension, which consists of 32 question items in total, was administered individually and completed in 15-20 min. In the test, 1 point was given for each correct answer and 0 points for each incorrect answer. In the validity studies on the phonological awareness dimension, the item factor loadings of the test items ranged between .43 and .93, correlated with the Turkish Early Language Development Test at the level of .29-. 48 with the Turkish Early Language Development Test, and .27 with children's word reading performance at the end of the first grade, .19 with reading speed, .30 with reading comprehension, and .36 with writing. The internal consistency and half-test reliability of the phonological awareness subtests were found to be .87 and .67, respectively.

Rapid naming test (RNT)

Ergül & Demir (2022) developed the Rapid Naming Test to evaluate the rapid naming performance of children in kindergarten through fourth grade. This test is administered individually and comprises four subtests: Rapid Object Naming, Rapid Color Naming, Rapid Letter Naming, and Rapid Digit Naming. Each subtest presents five items in both a mixed order and repetitive manner, arranged in five rows of 10 items. For instance, the Rapid Object Naming subtest includes pictures of objects such as a clock, cat, table, ball, and apple, displayed in a mixed order across five rows. Children are instructed to quickly and accurately name the objects they see on the page. The same procedure is followed for the other subtests. The total naming time in each subtest is recorded as the measurement outcome. To assess the validity and reliability of the RNT, exploratory and confirmatory factor analyses were conducted. These analyses demonstrated that the subtests together, under a single factor, accounted for 67.53% of the variance. The test also exhibited discriminant validity across different grade levels, and the test-retest coefficients ranged from 0.83 to 0.95, indicating good reliability. This particular study utilized only the Color Naming and Object Naming subtests, as letters and numbers were not systematically taught to the kindergarten children in Turkey. In this study's sample, the Rapid Naming Test demonstrated a Cronbach's α coefficient of 0.70, indicating acceptable internal consistency for rapid naming abilities.

Data analysis

Parametric tests were chosen in the study because the data from the scale that the Kolmogorov-Smirnov test revealed had a normal distribution (p>.05). For the first research question, independent t-tests were conducted to determine whether there were differences between the groups before the intervention. The "ANOVA for Mixed measures" technique was used for the other four research questions to determine whether there was a significant difference between the experimental and control groups according to the pretest, posttest and follow-up test results.

For unbiased effect size calculations, we calculated Hedges'g for each variable (Hedges & Olkin, 1985). Based on Cohen's criteria (Cohen, 1988), an effect size of less than 0.20 means little or no effect; the one between 0.20 and 0.50 is small; 0.50–0.80 is moderate, and more than 0.80 means a strong effect.

Results

Impact of PA intervention

When Table 3 was analyzed, a significant difference was observed between the participants in the experimental and control groups before and after the intervention and in the follow-up study (F= (2, 132) =172.13, $p<.05$, $n^2=.72$). It was evident that the intervention was highly effective. Examining pairwise comparisons revealed that the experimental group's PA scores grew significantly from the pretest to the post-test and from the pretest to follow-up ($p<.05$). In contrast, the scores increased slightly from post-test to follow-up, and this increase was significant ($p<.05$). Figure 1 shows that the mean PA post-test score ($\bar{x}$ =26.64) was significantly higher than the mean pretest score ($\bar{x}$ =22.02). When the mean PA follow-up score ($\bar{x}$ =27.12) was examined, it was found to be significantly higher than the pretest score and increased slightly compared to the post-test score. When the pretest ($\bar{x}$ =22.73), post-test ($\bar{x}$ =23.41) and follow-up mean scores ($\bar{x}$ =23.41) of the control group were analyzed, it was apparent that there was a significant increase in the post-test. In summary, the experimental group exhibited superior performance in PA immediately after the intervention and in the follow-up assessment 16 wk later compared to the control group.

Table 3. PA pretest-posttest-follow up test ANOVA results.

Source of Variance		KT	sd	KO	F	p	n^2
Between the subjects	976.82		67				
Group		245.96	1	245.96	22.21	.000	25
Error		730.86	66	11.07			
Within the subjects	641.32		136				
Measures		336.27	2	168.13	262.50	.000	.80
Group*Measures		220.51	2	110.25	172.13	.000	.72
Error		84.54	132	.64			
Total	1618.14		203				

Impact of RAN-object intervention

When Table 4 was analyzed, a significant difference was observed between the participants in the experimental and control groups before and after the intervention and in the follow-up study (F= (2, 132) =60.75, $p<.05$, $n^2=.48$). The intervention had a high level of effectiveness. Analysis of the pairwise comparisons showed that the RAN object duration decreased significantly ($p<.05$) from pretest to post-test and from pretest to follow-up in the experimental group. The mean RAN object post-test duration ($\bar{x}$ = 75.5) was shown to be significantly lower than the mean pretest score ($\bar{x}$ = 69.73), as shown Figure 1. The mean RAN object follow-up mean score ($\bar{x}$ =69.23) was significantly higher than that of the pretest. When the pretest ($\bar{x}$ =76.85), post-test ($\bar{x}$=76.82) and follow-up mean scores ($\bar{x}$=76.44) of the control group were analyzed, it was observed that they performed at a similar level. In essence, the experimental group demonstrated an accelerated improvement in their RAN object performance.

Impact of RAN-color intervention

As shown in Table 5, a significant difference was observed in the RAN color of the participants in the experimental and control groups before and after the intervention and in the follow-up study (F= (2, 132) =116.44, $p<.05$, $n^2=.63$). The intervention was highly effective. The duration of RAN color dropped significantly ($p<.05$) from pretest to post-test and from pretest to follow-up in the experimental group, according to the pairwise comparisons. As shown in Figure 1, the mean RAN color post-test duration ($\bar{x}$=72.11) was significantly lower than the mean pretest score ($\bar{x}$=80.55). The mean follow-up score of the RAN color ($\bar{x}$=71.7) was significantly lower than that of the pretest. When the pretest ($\bar{x}$=81.23), post-test ($\bar{x}$=80.73), and follow-up mean scores ($\bar{x}$=80.57) of the control group were analyzed, it was clear that they performed at a similar level. Stated differently, the

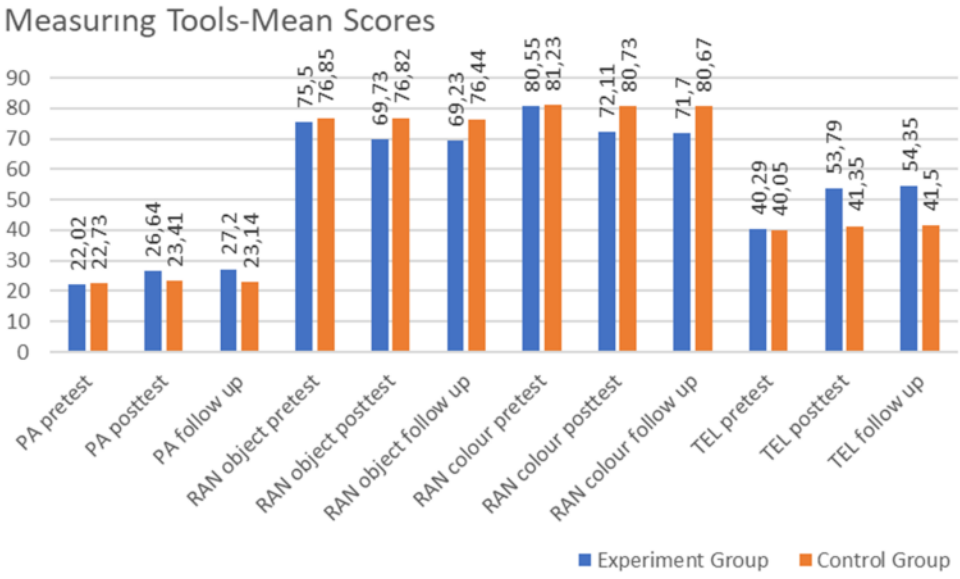

Figure 1. Mean scores.

Table 4. RAN object pretest-posttest-follow-up test ANOVA results.

Source of Variance		KT	sd	KO	F	p	n^2
Between the subjects	4148.70		67				
Group		1387.37	1	1387.37	33.16	.000	.33
Error		2761.33	66	41.83			
Within the subjects	1241.32		136				
Measures		447.24	2	223.62	71.38	.000	.52
Group*Measures		380.59	2	190.29	60.75	.000	.48
Error		413.49	132	3.13			
Total	5390.02		203				

Table 5. RAN color pretest-posttest-follow-up test ANOVA results.

Source of Variance		KT	sd	KO	F	p	n^2
Between the subjects	3547.66		67				
Group		1890.40	1	1890.40	75.28	.000	.53
Error		1657.26	66	25.11			
Within the subjects	2127.99		136				
Measures		956.23	2	478.11	148.89	.000	.69
Group*Measures		747.88	2	373.94	116.44	.000	.63
Error		423.88	132	3.21			
Total	5675.65		203				

Table 6. TEL pretest-posttest-follow up test ANOVA results.

Source of Variance		KT	sd	KO	F	p	n^2
Between the subjects	7235.62		67				
Group		3693.25	1	3693.25	68.81	.000	.51
Error		3542.37	66	53.67			
Within the subjects	4643.99		136				
Measures		2604.48	2	1302.24	588.36	.000	.89
Group*Measures		1747.36	2	873.68	394.74	.000	.85
Error		292.15	132	2.21			
Total	11879.61		203				

experimental group demonstrated an improvement in their RAN object performance following the intervention and maintained this level of performance even after a 16-week interval.

Transer effect of interventions

As shown in Table 6, a significant difference was observed between the participants in the experimental and control groups before and after the intervention and in the follow-up study (F= (2, 132) =394.74, $p<.05$, $n^2=.85$). It is apparent that the effectiveness of the intervention was high. The experimental group's early literacy scores grew significantly from the pretest to the post-test and from the pretest to follow-up, as shown by the pairwise comparisons ($p<.05$). In contrast, the scores increased slightly from post-test to follow-up, and this increase was significant ($p<.05$). Figure 1 shows that the mean TEL post-test score ($\bar{x}$=53.79) was significantly higher than the mean pretest score ($\bar{x}$=40.29). When the mean TEL follow-up score ($\bar{x}$=54.35) was examined, it was found to be significantly higher than the pretest and it increased slightly compared to the post-test score. When the pretest ($\bar{x}$=40.05), post-test ($\bar{x}$=41.35) and follow-up mean scores ($\bar{x}$=41.50) of the control group were analyzed, it was evident that there was a very low increase in the post-test.

When the findings were analyzed, the experimental group performed better than the control group in terms of TEL performances after the intervention and maintained this performance after 16 wk. The average TEL score was 52; and children below this score were considered a risk group for learning disabilities. Before the intervention, the mean scores of the experimental and control groups were below 52 points, but after the intervention, the experimental groups performance was above the average.

Discussion

In this study, the TODI PA and RAN module aimed to improve the PA, RAN, and early literacy skills of preschool children from lower socioeconomic levels. The findings revealed a significant difference between the experimental and control groups in the post-test, and follow-up study results, indicating a substantial increase in phonological awareness scores among the participants in the experimental group. This increase persisted even after 16 wk. These results are consistent with previous research showing that phonological awareness interventions (Ambrose et al., 2012; Roth et al., 2006; Sucena et al., 2023) and RAN interventions (Heikkilä et al., 2013; Wolff, 2014) are effective in improving reading and writing skills in preschool children. The study emphasizes the significance of addressing the needs of children from low socioeconomic backgrounds through early childhood education interventions (Lonigan et al., 2013; Sucena et al., 2023). However, a study conducted by Vander Stappen & Van Reybroeck (2018) on a PA intervention showed transfer effects on sublexical spelling processes and improved word reading speed, providing preliminary evidence of the effectiveness of the intervention. Early childhood education programs targeting phonological awareness can help reduce achievement gaps (Sucena et al., 2023). The transparency of the phonological structure in Turkish facilitates a faster and more accurate acquisition of word decoding skills among first-grade students (Oney & Goldman, 1984). Our research findings indicate that students demonstrated nearly maximal performance in word-level tasks, with more modest improvements observed in phoneme-level tasks compared to pretest tasks that initially showed lower performance. These results reinforce the notion that phonemic awareness (PA) and phonemic instruction yield more pronounced early effects in transparent languages such as Turkish.

To date, there is limited evidence supporting the effectiveness of specific RAN training methods in significantly improving RAN. Some studies reported no significant effects of RAN training (de Jong & Vrielink, 2004; Wimmer et al., 2000). Further research is needed to explore the efficacy of RAN training methods for enhancing RAN skills. Vander Stappen & Van Reybroeck (2018)

conducted a study on a PA intervention that showed transfer effects on sublexical spelling processes, while the RAN intervention specifically improved word reading speed. Their study provided the first evidence of the effectiveness of the RAN-objects intervention (Vander Stappen & Van Reybroeck, 2018).

Our research has made a significant contribution by showing, for the first time, that RAN objects and colors can be effectively developed through a carefully planned instructional approach. This finding sheds new light on the potential for developing RAN skills. It highlights the importance of considering specific intervention strategies when designing programs to develop rapid automatic naming skills in children. The results suggest that implementing RAN interventions as part of early childhood education programs in Turkey could contribute to the development rapid automatic naming skills and close the gap among children from disadvantaged backgrounds.

Our results revealed the specific transfer effect of RAN and PA interventions on early literacy. Although the mean scores of the experimental and control groups were below 52 before the intervention, the performance of the experimental group exceeded the mean after the intervention. This suggests that the intervention was effective, and that children in the experimental group performed better in developing early literacy skills. This shows that the intervention had long-term effects. Sustainability of the skills acquired as a result of the intervention means that children can permanently improve their literacy skills, which can positively impact their academic achievement.

In Turkey, children's experiences with phonological awareness activities are limited due to the lack of awareness of the importance of phonological awareness and the lack of adequate coverage in preschool education programs (Akyüz & Doğan, 2019; Republic of Turkey Ministry of National Education, 2016). However, phonological awareness training is essential in preschool education programs in developed countries (OECD, 2019). In Turkey, parents and preschool or kindergarten teachers have limited knowledge and experience in early literacy and phonological awareness, and phonological awareness activities are rarely carried out at home or school (Ergül et al., 2014). Only in kindergarten do teachers involve children in phonological awareness activities to some extent and target only specific phonological awareness skills (Kargın et al., 2017). The most frequently used activity in kindergarten is to find objects, pictures, or names that begin with a particular sound, usually a vowel (Ergül et al., 2014). In addition, there is no training on rapid naming at any level of preschool education (Akyüz & Doğan, 2019; Republic of Turkey Ministry of National Education, 2016). Therefore, the findings of this study suggest that early childhood intervention programs can contribute to reducing the gap (Costa & Carnoy, 2015; VanDerHeyden et al., 2008). Research has shown that early intervention programs can support language and literacy acquisition, enhance school readiness, and improve future scholastic progress (Dicataldo et al., 2020; Moonsamy & Carolus, 2019). Addressing social and economic disparities in educational opportunities is vital, as students from low socioeconomic backgrounds often face barriers to academic success (Järvinen et al., 2023; Vadivel et al., 2023). By implementing targeted interventions and support, we can provide a bettert balance of educational opportunities and narrow the gap for children from low socioeconomic backgrounds (Costa & Carnoy, 2015; Díaz et al., 2020; VanDerHeyden et al., 2008).

Limitations and recommendation

This study had some limitations. First, as the study was conducted in a specific school in a single city, its generalizability may be limited. More information is needed on the applicability of the results to children in schools in different geographical regions or socioeconomic levels. Second, the limited number of participants between the experimental and the control groups is also a limitation. A larger sample size may increase statistical power and provide a more reliable interpretation of the results. Therefore, future studies with larger sample size may help to better understand these findings. Third, this study has limitations in terms of continuity. While the study's results assessed the impact of the intervention over 16 wk, a more extended follow-up period is needed to assess long-term effects. Monitoring children's progress in early literacy skills and other developmental areas over an extended period could provide a more comprehensive evaluation of the effectiveness of the intervention. Research can assess the effects of an intervention in terms of different parameters. For example, the effects of factors such as children's gender, age group, and language skills on the effectiveness of the intervention can be examined. Future research could study different intervention durations and intensities to determine the most effective duration and intensity.

Conclusion

In Turkey, this study has important implications for early childhood education and intervention programs. By highlighting the effectiveness of PA and RAN interventions, the findings provide valuable insights into improving early literacy skills among preschool children from lower socioeconomic backgrounds in Turkey. The results suggest that the implementation of these interventions as part of early childhood education programs can play an important role in closing the gap and promoting academic achievement among children facing socioeconomic disadvantages in Turkey.

Disclosure statement

No potential conflict of interest was reported by the authors.

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