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The efficacy of the reading racetrack intervention in enhancing sight-word fluency among elementary students with reading difficulties

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Abstract

This study examines the effectiveness of combining the Reading Racetrack intervention with flashcards and positive reinforcement to enhance sight-word fluency in struggling third-grade readers. A multiple baseline design across participants (baseline, intervention, and maintenance) was employed to evaluate the intervention's impact. Three students diagnosed with reading disabilities, aged 7 to 8 years, participated in the study. The results indicated that all participants demonstrated significant improvements in sight-word fluency and maintained the gains two weeks post-intervention. The participants and their teachers also rated the intervention as highly acceptable, feasible, and beneficial. We recommend exploring the effectiveness of the RRT intervention in home settings. Furthermore, we suggest comparing the efficiency of the RRT intervention versus the use of flashcards with social reinforcement to determine which technique yields more improvements in sight-word fluency.

Keywords: Flashcards, Reading racetrack, Sight-word fluency, Struggling readers, Students with reading difficulties.

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1. Introduction

Reading disorders refer to an individual's inability to possess basic reading skills, which affects their writing, listening, and speaking abilities. These issues are not associated with cognitive and sensory impairments, levels of intelligence, learning opportunities, or lack of language ability [1]. Globally, the percentage of individuals with reading disabilities is estimated to

be between 10% and 12% [2]. This number increased due to the pandemic, reaching 64% of 10-year-old children who struggle to meet basic reading proficiency [3].

Several factors might affect students to read adequately, including parents' socioeconomic status (educational level, financial situation), poor home environment, and lack of students' reading strategies [4]. Likewise, Mohammed and Amponsah [5] reported school environment, including lack of teachers' skills and training, teachers' attitudes, inappropriate curriculum, inadequate reading resources, insufficient time for teaching, students' low self-confidence, motivation, and poor phonological skills are school factors associated with students' poor reading abilities. As a result, they are more likely to have low academic attainment [6], drop out of school, have fewer employment opportunities, live independently, and be at risk of developing mental health issues such as depression, anxiety [7], and suicide attempts [8] [9]. Thus, there is a necessity to develop reading intervention programs to meet the crucial needs of poor readers.

Struggling readers exhibit difficulties in word decoding (word sound), fluency, and reading comprehension [10]. However, developing sight-word fluency is a primary skill in reading to enhance an individual's ability to reach a satisfactory level of reading [11]. Therefore, the current research intends to develop an intervention to enhance sight-word fluency for elementary school students with reading difficulties.

1.1. Prior Research

A Reading Racetrack (RRT) is an educational practice that was first developed and used by Rinaldi et al. [12] to assist struggling readers in acquiring or improving their sight word recognition, reading fluency, and comprehension skills through repeated and timed word reading organized in a racetrack format. This process of the RRT technique involves creating sets of unknown words selected by the interventionist based on a pre-assessment. Each set of words is distributed in a circular format (racetrack). The interventionist asks the student to correctly read aloud the list of words within a minute and record the responses, providing feedback on correct and incorrect answers. This process is repeated until the student reaches mastery level. In turn, Flashcards are small, simple cards that contain words or phrases delivered by interventionists through presentation, prompting, modeling, corrective feedback, and repetition to reinforce students' reading [13]. This practice is sometimes used with RRTs by distributing the flashcards with targeted words on the racetrack, with each word on a flashcard, which allows the interventionist to change the word order as needed. Furthermore, Positive reinforcement is a cornerstone technique in Applied Behavior Analysis (ABA) designed to increase the probability of a desired behavior recurring. It achieves this by introducing a rewarding stimulus immediately following the behavior, strengthening the association between the action and its positive outcome [14].

Nemours peer-tutoring interventions have been implemented using the reading racetrack (RRT) approach with flashcards [15, 16] or the motivational peer-tutorial reading racetrack [17, 18] to enhance sight word fluency in students with learning disabilities (LD) and/or behavioral challenges. Findings from these studies indicate that peer-mediated RRT effectively improves sight word fluency, with participants maintaining these gains following the intervention. Similarly, Barwasser et al. [19] investigated the comparative effects of peer-mediated RRT with and without self-graphing on word reading, academic engagement, and disruptive behavior. Their results demonstrated that RRT with self-graphing was more effective in increasing word reading and reducing disruptive behavior than RRT without self-graphing; however, no significant effects were observed on academic engagement.

Moreover, RRT has also been adapted to enhance mathematical fluency. Erbey et al. [20] investigated the effects of flashcards and racetrack interventions on the acquisition of sight words, phonics, and basic math facts among second-grade students with LD. Their findings demonstrated that all participants showed improvement in the targeted skills and maintained these gains after the intervention. Similarly, Math Racetrack interventions (MRT) combined with Direct Instruction flashcards and positive reinforcement were employed to improve multiplication fact fluency. Skarr et al. [21] found significant improvements in the fluency of 100 basic multiplication facts, while Karnes et al. [22] reported that students with LD exhibited substantial gains in single-digit multiplication fluency, with all participants maintaining these improvements three weeks post-intervention.

Furthermore, Barwasser et al. [23] found that peer-tutoring RRT was particularly effective in enhancing word reading when self-graphing was incorporated. However, no correlation was identified between reading and spelling. Additionally, motivational RRT with self-graphing, delivered through peer-mediated flashcards, was successful in increasing the automation of common German sub-lexical patterns among elementary school students with behavioral difficulties and with/without LD, for whom German is a second language. These improvements were sustained two months post-intervention [24].

Beyond peer-mediated interventions, RRT has also been implemented by teachers and practitioners to support students with special educational needs. Studies have demonstrated that RRT interventions are effective in improving sight word fluency among elementary students with LD and speech delays [25] and among students with LD struggling with reading German as a second language, Sperling et al. [26] and Grünke and Barwasser [27]. Othman and Tahar [28] reported that students with LD who received RRT interventions incorporating flashcards exhibited increased sight word recognition and maintained these gains after the intervention ended. Similarly, [29] found that elementary students with autism successfully acquired and retained sight words following a combination of Direct Instruction flashcards and RRT. Davenport et al. [30] further reinforced these findings, reporting that RRT with flashcards effectively enhanced sight word fluency among kindergarten students with reading difficulties, with gains maintained two weeks post-intervention. Additionally, teachers demonstrated high fidelity in implementing the intervention after receiving Behavioral Skills Training (BST). Renfro et al. [31] also reported that the combination of RRT and repeated reading interventions significantly improved reading accuracy and fluency in elementary students with LD.

Several studies have examined the effects of Reading Racetrack (RRT) interventions with and without Direct Instruction (DI) flashcards and/or positive reinforcement. However, few studies have evaluated the combined impact of all three techniques: RRT, DI flashcards, and positive reinforcement. Additionally, limited research has assessed the maintenance and generalization of sight-word fluency, with most studies focusing on a single cultural or linguistic background (e.g., German). To address these gaps, the present study aims to extend previous research by addressing these limitations and investigating the effects of a reading racetrack intervention incorporating DI flashcards and positive reinforcement to enhance sight-word fluency for three elementary students with reading disabilities in Jordan. A multiple-baseline design (baseline–intervention–maintenance) will be employed to evaluate the effectiveness of the RRT intervention. lastly, social validity questionnaires will be administered to assess teachers' and students' perceptions of the intervention.

1.2. Research Questions

Research question 1: What are the effects of RRT, DI flashcards, and positive reinforcement when combined to teach sight-word fluency to students with reading disabilities?

Research question 2: Do the participants maintain the acquired words after the intervention completion?

Research question 3: Do teachers and participants perceive the RRT intervention as acceptable and beneficial?

1.3. Materials and Methods

A multiple baseline design across participants (Baseline-intervention-maintenance) [32] was conducted to evaluate the effect of RRT intervention on the acquisition of sight word fluency. The study attempts to find a functional relationship between the independent variables (RRT, flashcards, and positive reinforcement) and the dependent variable (30 sight words fluency).

1.4. Participants

A total of three elementary school students were selected for the current intervention. All the participants were diagnosed with reading disabilities and attended an inclusive school in Irbid City, Northern Jordan. Parental consent was signed by the parents or legal guardians prior to the implementation of the intervention. The authors set a group of criteria for selecting the participants to minimize the external factors that might influence the study's results, including: i) having been diagnosed with learning disabilities; ii) having reading fluency issues; iii) attending the same classroom setting; iv) a similar socio-economic environment.

Participant A is a 10-year-old third-grade student in an inclusive setting. She has experienced reading difficulties since first grade and has no known health or physical issues. Diagnosed with a reading disability using the Michael Best Test for Learning Disabilities [33], she exhibits attention deficits, distractibility, frequent daydreaming, anxiety, and shyness. She struggles to follow classroom instructions, lacks participation in reading and writing tasks, and shows low engagement. Her current performance level was assessed using an informal test.

Participant B is a 12-year-old third-grade student in an inclusive public school setting. Diagnosed with a learning disability in third grade using the Michael Best Test for Learning Disabilities [33], she displays attention deficits, hyperactivity, anxiety, self-harm tendencies, aggression, and anger. Her current performance level was assessed using an informal test.

Participant C is a 10-year-old third-grade student in an inclusive public school setting. She was diagnosed with a learning disability in third grade using the Michael Best Test for Learning Disabilities [33], and presents with attention deficits, hyperactivity, anxiety, aggression, mood instability, and disobedience. Her current performance level was assessed using an informal test.

1.5. Setting and Materials

The study was conducted in a 4×4 meter resource room on the school's first floor. The room had tables, chairs, a whiteboard, a computer, and a projector. The instructional materials included PowerPoint slides displayed on a laptop (Apple MacBook Air), presenting a list of 100 words. These slides were used during the pre-assessment phase to determine the number of known and unknown words and to select the target words for the intervention. Additionally, a racetrack board, designed by the first author, contained 30 empty spaces corresponding to flashcards representing 30 unknown words. A timer was used to measure the number of words read per minute, and a data sheet was used by the interventionist to record the number of correct and incorrect responses for each session.

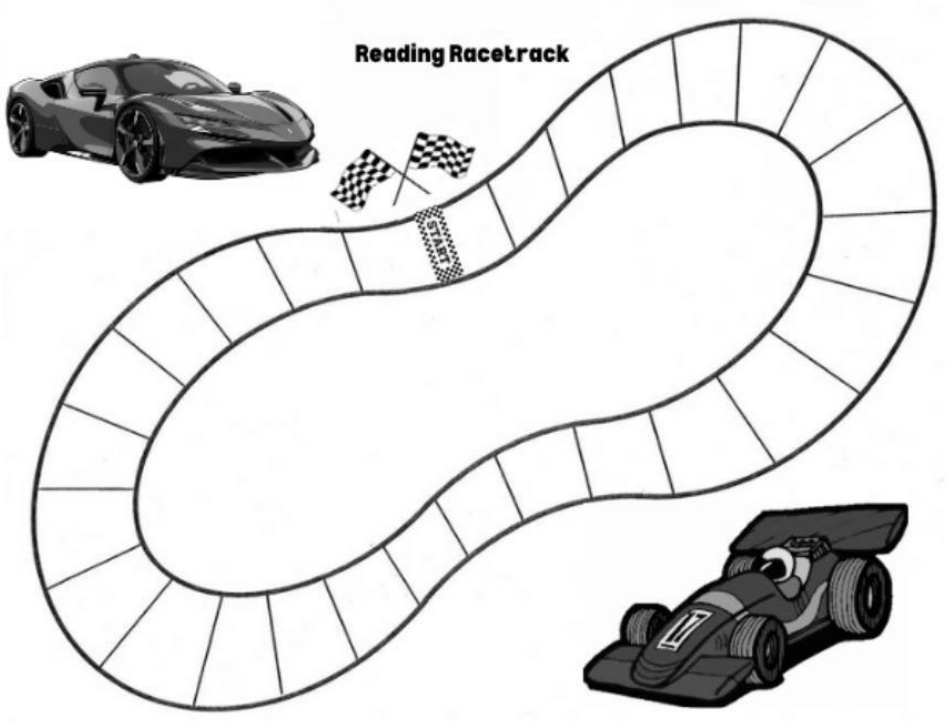

Figure 1.
Example of Reading Racetrack board game.

1.6. Procedures

1.6.1. Pre-assessment

Before initiating the baseline phase, two pre-assessment sessions were conducted to determine the number of known and unknown words for each participant. A set of 100 words was selected from a common Arabic communication word list developed by Buckwalter and Parkinson [34]. Participants were asked to read each word aloud as it was presented on individual PowerPoint slides, with each slide displaying a single word for one second, as recommended by Ehri [35]. The interventionist recorded correct and incorrect responses on assessment sheets. A word was marked as correct if the participant read it within one second with accurate pronunciation. If the participant hesitated or mispronounced the word, it was recorded as incorrect. Based on these assessments, thirty unfamiliar words were identified for each participant and written on flashcards for use in the intervention.

1.6.2. Baseline

Two consecutive baseline sessions were conducted to assess the stability of participants' reading performance before the intervention. Each participant was individually escorted to the resource room and seated across from the interventionist. The interventionist provided instructions and asked the participant to read each word aloud from the flashcards without receiving feedback, stating: “I will present a set of flashcards, each containing a word. Please read the word to the best of your ability. If you cannot read it, say 'pass' and move to the next card. When I say 'go,' you may begin. Ready? Go!” A timer was set to check how many words the participant could read in a minute. Then, the correct and incorrect responses were recorded on the assessment sheet. Words that participants read correctly were excluded, and only unfamiliar words were included in the intervention. Each participant had a total of 30 unknown words.

1.6.3. Intervention

The RRT was introduced after selecting the targeted words for each participant. The interventionist sat opposite the student, placed the RRT board on the table, and introduced the activity using familiar words to ensure the student understood the procedure before presenting unfamiliar words. Subsequently, the flashcards were placed on the RRT board, and each participant was asked to move the race car on the flashcards placed on the racetrack board, respectively. The flashcard was then revealed, and the student was instructed to read the word to the best of their ability. If the student hesitated or misread the word, the interventionist provided corrective feedback and prompted the student to reread it, first with assistance and then independently. Flashcards with correctly read words were placed face up, and the participant received positive reinforcement. However, incorrectly read words were placed face down on the RRT board, with a two-space gap, to increase the chances of the participants recalling the word and reading it correctly. This process was repeated until each participant mastered all the

words on the RRT board and read each targeted word correctly three times. Additionally, the interventionist recorded correct and incorrect responses on assessment sheets after each round, and a timer was set to measure how many words the participants could read in a minute.

1.6.4. Maintenance

Participants were reassessed two weeks post-intervention, using the targeted words under baseline conditions, without the racetrack intervention (RRT), instructions, or feedback.

1.7. Social Validity

The social validity of the Reading Racetrack (RRT) intervention was assessed using a teacher questionnaire and a student questionnaire. Both used a 4-point Likert scale, ranging from 0 ("Totally Disagree") to 4 ("Totally Agree"). The student questionnaire included six items: (1) "The racetrack intervention helped improve my sight-word fluency," (2) "I learned a lot during the program," (3) "I am happy participating in the program," (4) "I am satisfied with the support I received from my teacher," (5) "I would participate in the RRT intervention again," and (6) "I recommend this intervention to other students with reading difficulties."

Similarly, the teacher questionnaire included five items: (1) "The intervention was feasible and easy to implement" (2) "Students enjoyed the RRT game," (3) "The intervention contributed to improving sight-word fluency for all participants," (4) "I would use the RRT intervention with other struggling readers," and (5) "I recommend this intervention to other teachers for use with their students."

2. Results

All data were recorded by the interventionist (teacher) using an assessment sheet to document the number of correct and incorrect words read by each participant, along with the duration of each session. These records were used to assess improvements in sight-word fluency. The collected data were subsequently analyzed using Microsoft Excel.

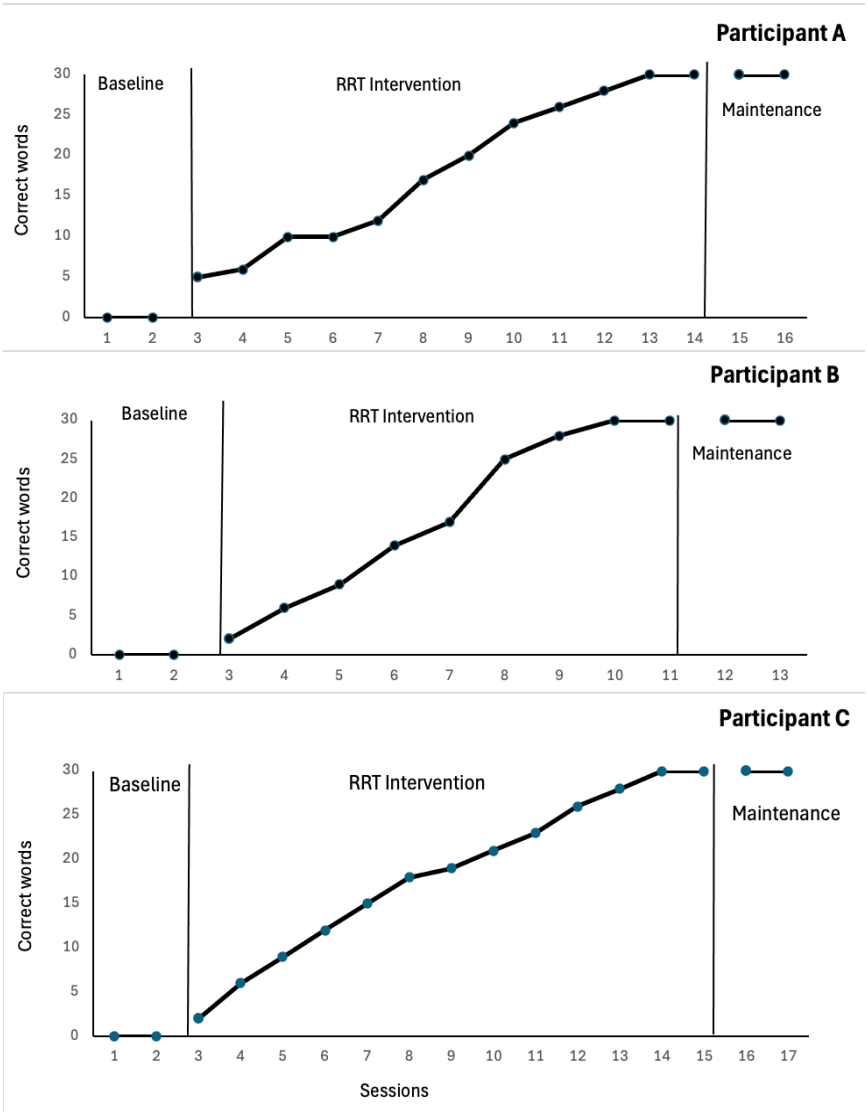

Figure 2.
Presents the results of the participants, illustrating the number of correct words throughout the intervention.

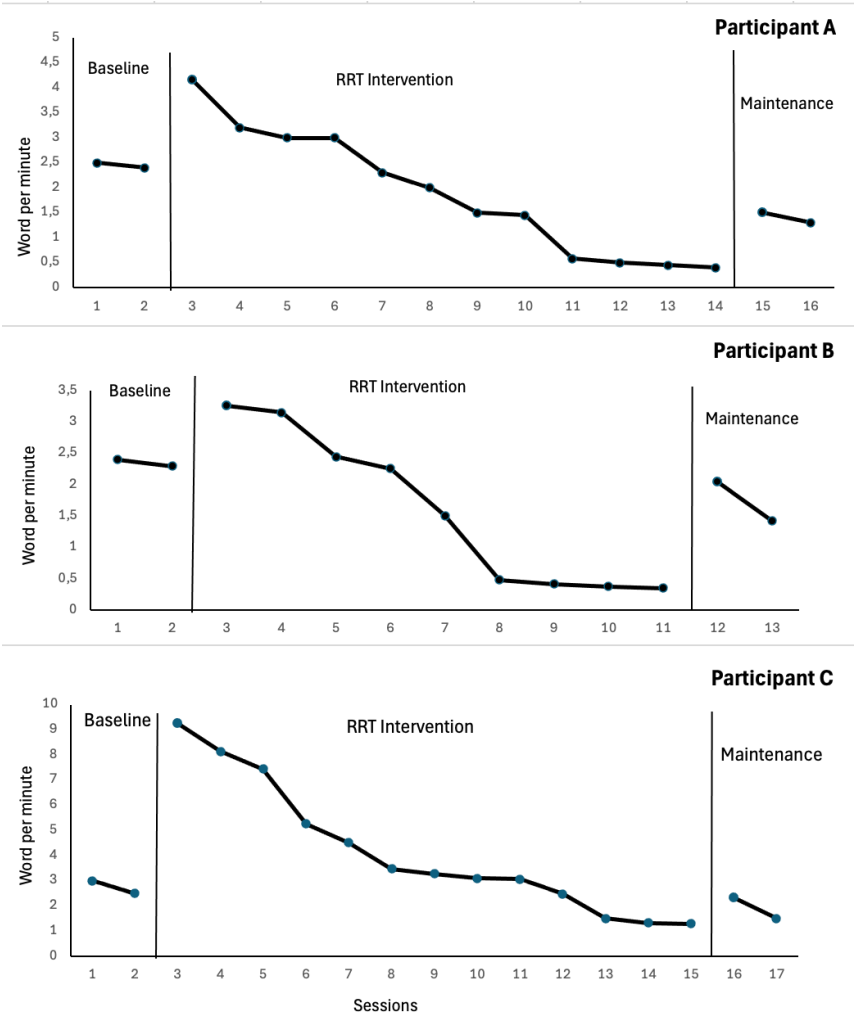

Figure 2.
Presents the results of the participants, illustrating changes in sight-word fluency throughout the intervention.

2.1. Baseline Phase

The 30 unfamiliar words identified for each participant during the pre-assessment phase were used throughout the baseline and racetrack intervention phases. During the baseline phase, all three participants (A, B, and C) scored zero correct words across both baseline sessions (Sessions 1 and 2). None of the participants demonstrated accurate word recognition, as reflected by the flat trend line in Figure 1, indicating stability in their initial performance. The mean time to attempt all 30 words was 2.45 seconds for Participant A, 2.35 seconds for Participant B, and 2.75 seconds for Participant C. However, these results do not accurately reflect word fluency, as participants were instructed to say "skip" or "I don't know" without receiving corrective feedback from the interventionist.

2.2. RRT Intervention Phase

Following the implementation of the racetrack intervention, all participants demonstrated gradual improvements in sight-word recognition. Figure 2 shows that Participant A made consistent progress, accurately identifying all 30 words by session 14. The mean number of correctly identified words was 18 (Min = 5, Max = 30), with a decline in incorrect words (M = 11.8). Additionally, Figure 3 illustrates a significant improvement in word fluency for Participant A, as evidenced by a decrease in the time required to read correct words, with an average time of 1.93 seconds.

Participant B mastered all 30 words by session 11 (Min = 2, Max = 30), with a mean of 17.9 correct and 12 incorrect words (see Figure 2). Furthermore, word fluency improved throughout the intervention, with an average reading time of 1.58 seconds per correct word, as shown in Figure 3.

Participant C also demonstrated consistent improvement throughout the intervention. Figure 2 shows that the participant correctly identified all 30 words by session 15. The mean number of correct words was 18.4 (Min = 2, Max = 30), with an average of 11.6 incorrect words. Additionally, word fluency increased steadily over the intervention period, with an average reading time of 4.1 seconds per correct word, indicating significant improvement (Figure 3).

2.3. Maintenance Phase

Two weeks after the intervention, the practitioner conducted two maintenance sessions under baseline conditions, without implementing the racetrack intervention, to assess whether participants retained their gains. All three participants (A,

B, and C) correctly identified all 30 words. Additionally, they maintained satisfactory word fluency, with mean reading times of 1.4 seconds for Participant A, 1.7 seconds for Participant B, and 1.9 seconds for Participant C. These results suggest that all three participants successfully retained their word fluency improvements two weeks post-intervention.

2.4. Social Validity

The social validity survey results indicated a high acceptance of the Reading Racetrack (RRT) intervention among students and their teacher. All three participants rated the intervention as highly feasible and beneficial, responding with the highest rating (4 = "Totally Agree") on all survey items. These items included: (1) "The racetrack intervention helped improve my sight-word fluency," (2) "I learned a lot during the program," (3) "I am happy participating in the program," (4) "I am satisfied with the support I received from my teacher," (5) "I would participate in the RRT intervention again," and (6) "I recommend this intervention to other students with reading difficulties." Similarly, the teacher reported a positive perception of the intervention, also providing the highest rating (4 = "Totally Agree") across all survey items. These included: (1) "The intervention was feasible and easy to implement," (2) "Students enjoyed the RRT game," (3) "The intervention contributed to improving sight-word fluency for all participants," (4) "I would use the RRT intervention with other struggling readers," and (5) "I recommend this intervention to other teachers for use with their students." These findings suggest that the RRT intervention is well-received and practical in educational settings.

3. Discussion

This study aimed to evaluate the effectiveness of the Reading Racetrack (RRT) intervention in improving sight-word fluency among struggling readers. The findings indicate that the RRT intervention was effective in enhancing sight-word fluency, consistent with prior research on structured sight-word interventions [15-19, 23-27].

All three participants demonstrated significant progress in acquiring previously unknown words, supporting prior findings that repeated exposure and active engagement contribute to sight-word acquisition [23, 27]. Specifically, Participant A mastered all 30 target words after 14 racetrack sessions, Participant B required 11 sessions, and Participant C achieved mastery in 15 sessions. These results align with previous studies showing that repeated practice and structured learning strategies facilitate rapid word recognition [26]. Furthermore, all participants retained their gains, accurately identifying all 30 words two weeks post-intervention, reinforcing previous research on the long-term retention benefits of systematic sight-word interventions [16, 17].

Additionally, the participants and their teacher rated the intervention as highly acceptable, feasible, and beneficial, mirroring findings from past research on the practicality and positive reception of the RRT intervention in educational settings [15-17, 19, 25]. The results suggest that the racetrack intervention, combined with engaging and repetitive practice, effectively increases sight-word fluency and retention among struggling readers.

3.1. Limitations

Some limitations must be acknowledged when interpreting the findings of this study. First, the racetrack intervention was implemented with only three participants, which constrains the generalizability of the results. However, the multiple baseline design is more effective than larger sample designs in demonstrating the functional relationship between the intervention and behavior change [36]. Second, the study did not incorporate a generalization phase to determine whether participants could transfer the acquired vocabulary to novel texts or sentence contexts. Third, the maintenance phase was conducted only two weeks post-intervention due to the conclusion of the academic year, which limits the assessment of long-term retention and prevents the planned evaluation of generalization. Furthermore, interobserver agreement assessments could not be conducted to establish the study's reliability, as parental concerns regarding privacy precluded video recording of the participants. Lastly, the study focused on 30 unfamiliar words selected from a corpus of 100 commonly used Arabic communication words identified by Buckwalter and Parkinson [34], which may limit the applicability of the findings to a broader vocabulary set.

3.2. Future Directions

Future research should extend the implementation of the racetrack intervention to a larger sample size to enhance the robustness and generalizability of the results. Additionally, studies should incorporate maintenance and generalization phases to determine whether participants can retain and apply their learning to different sentences, passages, or texts. Furthermore, extending the intervention to include more than 30 words would also provide valuable insights into its effectiveness with larger vocabulary sets.

3.3. Conclusion

Overall, the findings of the present study reveal that the RRT intervention combined with flashcards and social reinforcement was effective in teaching sight word fluency for third-grade struggling readers, who maintained the gains after two weeks post-intervention. Additionally, students and their teacher reported positive perceptions and high acceptance of the intervention. The promising outcomes of the RRT intervention underline the need for further research, including the implementation of the RRT intervention to a larger sample size to improve the strength and generalizability of the findings, as well as conducting long-term follow-up and generalization assessments. Moreover, there is a notable gap in research regarding the RRT intervention delivered through parents. The feasibility of this approach may urge future research to explore the effectiveness of the RRT intervention in home settings. Furthermore, the authors suggest comparing the efficiency of the

RRT intervention versus the use of flashcards with social reinforcement solely to determine which technique yields greater improvements in sight-word fluency.

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