Enhancing Reading Performance in Students With Diverse Educational Needs Using Reading Racetracks: A Single Case Study

Dilan Kisikyol
Matthias Grünke
Jennifer Karnes
Anne Barwasser
Department of Special Education & Rehabilitation, University of Cologne, Germany

This single case study (multiple baselines) evaluates the efficacy of an intervention called "reading racetracks" among three eight-year-old boys with diverse backgrounds, including learning disabilities, limited language proficiency due to migration, and socio-economic challenges. Conducted over three weeks, the training demonstrated notable improvements in the participants' ability to recognize and pronounce words quickly. Statistical analysis confirmed these results, with no baseline trends detected and a significant overall treatment effect indicated by a high Tau-U score. This finding suggests that reading racetracks can be an effective, universally applicable method of improving reading performance in diverse student populations.

Keywords: **reading performance, dyslexia, reading racetracks, diverse learners, single case study**

Introduction

In a knowledge-driven society, reading skills are indispensable for success across various domains of life (Pollatsek & Treiman, 2015). This proficiency is fundamental not only for academic achievement, where the ability to understand texts in subjects such as geography, history, and social studies is essential, but also for personal and professional development. In the workplace, reading skills are necessary for comprehending technical manuals, engaging in professional communication through emails and reports, and for continual learning and skill development. Similarly, in private life, reading enriches experiences through literature, provides information through news, and facilitates social connections through written communication on social media platforms (Beard, 2024; Kilpatrick, 2019).

Well-established precursor competencies are indispensable for developing proficient reading skills. Among these, phonological awareness plays a crucial role, followed by the development of stable grapheme–

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phoneme correspondences. Children must learn to blend letters and sounds, acquiring initial encoding skills. However, before achieving well-developed text comprehension, they need to acquire reading fluency, which depends on the automatic recognition of as many words as possible. Instead of decoding a word in a narrower sense, learners must be able to recognize it at a glance (Stuart & Stainthorp, 2015).

While most students develop sufficient reading skills during their elementary education, a notable portion do not, often due to deficits in automatic word recognition. Those grappling with severe reading challenges are susceptible to enduring learning disabilities, including dyslexia, underscoring the necessity for prompt and effective intervention for those facing persistent reading difficulties (Daly et al, 2015). In their recent seminal meta-analysis, "Forty Years of Reading Intervention Research for Elementary Students with or at Risk for Dyslexia: A Systematic Review and Meta-Analysis," Hall et al. (2023) elucidate the pivotal outcomes and implications of specialized reading interventions. Those that concentrate on enhancing automatic word recognition and reading fluency significantly bolster norm-referenced reading achievements among students either struggling with or at risk of dyslexia. The analysis further reveals that increasing the intensity of interventions by extending instructional hours amplifies reading improvements, highlighting the importance of customized support for these learners.

These strategies underscore the significance of the quality and quantity of reading support in addressing dyslexia and related reading difficulties. The aforementioned meta-analysis reveals that successful methods must be straightforward, provided they concentrate on fundamental reading abilities. Early identification and intervention can significantly mitigate the prolonged impact of reading problems, highlighting the necessity for initial screening and support in educational settings (Dougherty Stahl et al., 2019). Consistent practice is at the heart of this approach. Proficiency in reading is enhanced by frequent and intensive interaction with reading materials. Nevertheless, this approach poses a challenge for students who struggle, as they could perceive these practices as tedious and uninspiring (Özerk, 2020).

A promising solution to this issue is the integration of a playful element into the training exercises. Lämsä et al. (2018) suggest that educational games can alleviate the monotony of traditional drills, introducing a fun aspect into otherwise tedious sessions. Notably, reading racetracks, as described by Rinaldi and McLaughlin (1996) and Rinaldi, Sells, and McLaughlin (1997), stand out among the preferred methods. These racetracks are game boards designed to resemble Formula 1 circuits, complete with a specific number of blank cells (see Figure 1).

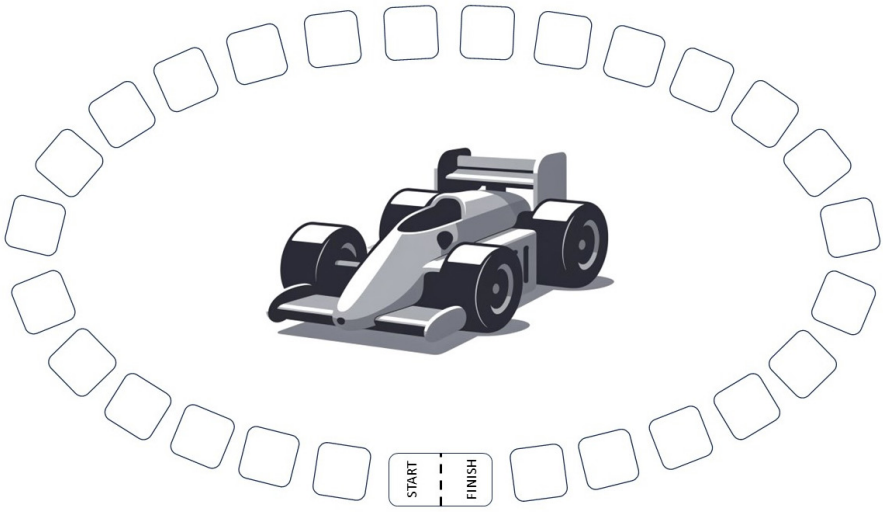

Figure 1. ***An example of a reading racetrack playing field***

In March 2024, we conducted a systematic literature search of several databases, including Academic Search Complete and ERIC, focusing on reading racetracks, resulting in 31 relevant articles published between 2011 and 2023. These studies, centered on diverse learning groups from elementary to high school levels, investigate the impact of reading racetracks on literacy enhancement, specifically targeting sight word recognition among students with learning challenges, behavioral issues, and other special needs. The consistent finding across these articles is the effectiveness of reading racetracks in achieving literacy improvement objectives.

While 31 studies on the topic could seem significant, in reality, it is not. Nearly all of these studies are based on single-case research using very small samples. The goal of achieving generalizability with such designs is to conduct multiple studies on the same topic. If a researcher conducted a controlled, randomized group trial with 200 children to evaluate the benefits of reading racetracks, the experiment's size would not face criticism. On the contrary, larger sample sizes are generally viewed positively. The same sample size using single case studies—presuming an optimistic average of five participants per study (a figure that frequently overstates the actual enrollment)—would require 40 trials to aggregate a sample of 200.

Furthermore, it should be noted that the samples in existing studies are relatively homogeneous. In the hustle and bustle of everyday school life, it is rarely possible to invest effort in diagnosing potential delays in children and offer them tailor-made interventions. The heterogeneity of the student body has

become too great. Thus, supportive measures that are as universally effective as possible are needed.

Thus, this study evaluates the effectiveness of a rapid word recognition intervention among eight-year-old boys with significant reading difficulties from diverse backgrounds. This group includes a student with a diagnosed learning disability, another with a migration background and limited proficiency in the national language, and a third from a family providing minimal support and living in adverse conditions. These risk factors reflect those commonly encountered in educational environments. The study aims to demonstrate that, despite the varied challenges these students face, applying a uniform intervention using reading racetracks would benefit them equally.

Method

The participating children were three boys: Aaron, Basir, and Conrad (names changed to ensure anonymity). They attended the 2nd grade of an inclusive elementary school in a large metropolitan region in western Germany. All were eight years old at the time of the study. In addition to the previously mentioned criteria (one with a diagnosed learning disability, one with limited knowledge of the national language, and one from socially disadvantaged circumstances), the students needed to be relatively capable of mastering grapheme–phoneme correspondence. At the same time, they needed to exhibit significant deficits in reading fluency. These criteria were assessed using the Salzburg reading and spelling test (SLRT II) by Moll and Landerl (2014). With the help of the class teacher and taking into account the inclusion criteria, three students with grapheme–phoneme correspondence ability within the normal range (T-score between 40 and 60) but extremely poor reading fluency (percentile rank below 5) were identified. According to the class teacher, a multi-professional team identified Aaron as having a learning disability. Basir had migrated from Afghanistan with his parents five years earlier and still had only limited German language skills. Based on the information provided by the class teacher, it is assumed that Conrad comes from a severely disadvantaged family. Conrad does not have a migration background. Nevertheless, Conrad's parents provided minimal support with German language acquisition.

A 31-year-old graduate in the Special Education Teaching program at a large German university delivered the intervention. This study was conducted as part of a practical semester, where students dedicate half a year to working at cooperative schools to carry out a practice-oriented small study. Her planning and execution efforts were primarily supported by the third author.

The graduate student created a DIN-A-3-sized racetrack with 30 cells, each paired with a card bearing one of the 30 most commonly used two-syllable German words sourced from a list provided by the University of Leipzig (https://

wortschatz.uni-leipzig.de/de). In addition, a stopwatch and die were provided, and a line diagram was prepared to track participant progress.

We employed a multiple baseline design (AB; Kazdin, 2020) to assess the intervention's effectiveness over three weeks, conducting five daily measurements each school week. The treatment's initiation varied among students, with baseline assessments lasting between four and six days. Participant allocation was randomized to enhance the study's validity. Automaticity, typically equated with reading speed, was a key measure (Paige, Rasinski, Magpuri-Lavell, & Smith, 2014).

At the end of each baseline or treatment session, the graduate university student collected the cards from the racetrack game, shuffled them, and presented each child with one word at a time. If the participant read the word correctly, they were immediately presented with the next card. If they made a mistake, they were promptly corrected and asked to repeat the word. After one minute, the graduate university student thanked the participant and escorted them back to the classroom.

During the study, every second period, the graduate student took one child to a well-equipped resource room for a 20-minute session, maintaining a quiet environment to minimize distractions. The order in which the participants attended the session rotated daily.

Under baseline conditions, the students solved simple mathematical problems for 15 minutes, followed by performance assessments. During training, they played the racetrack game, which involved each child rolling a die and moving forward the corresponding number of spaces on the game board. Each space contained a card, and printed on the back of each card was one of the 30 most commonly used two-syllable German words. The graduate student flipped over each card and showed it to the student, who was then expected to read the word quickly and accurately. If he read the word correctly, he was briefly praised (e.g., "Well done!"). Any mistakes were corrected, and the words were re-read, first by the graduate student and then by the child. Each session concluded with a performance assessment mirroring the baseline setup.

Results

The results for the three participants are presented in Figure 2. The graph indicates that all the students exhibited a significant increase in reading performance following the intervention. Aaron, Basir, and Conrad all demonstrate clear and continuous upward trends in the B-phase compared to the A-phase, where reading performance appears relatively stable with minor fluctuations. No value from the B-phase is lower than that from the measurement on the previous day. The graph clearly demonstrates an unusually substantial improvement in performance during the intervention.

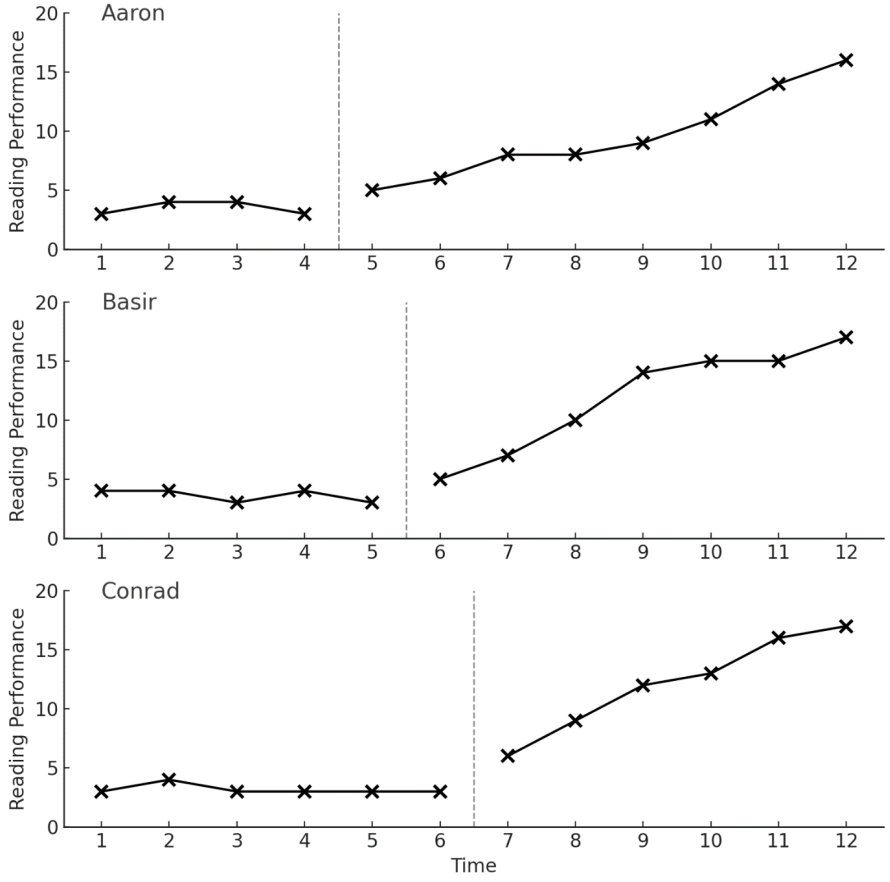

Figure 2. ***The effects of reading racetracks on the reading performance of the three participants***

The baseline phase (Phase A) and the intervention phase (Phase B) were analyzed for each participant, yielding insightful descriptive statistics. Specifically, Aaron exhibited a mean score of 3.50 (SD = 0.58) during Phase A, which significantly improved to a mean score of 9.63 (SD = 3.82) in Phase B. Basir's mean score increased from 3.60 (SD = 0.55) in Phase A to 11.86 (SD = 4.56) in Phase B. Similarly, Conrad showed improvement with a mean score rising from 3.17 (SD = 0.41) in Phase A to 12.17 (SD = 4.17) in Phase B. These figures articulate the enhancements in word recognition speed achieved through the treatment.

Although it seemed somewhat unnecessary given the clear performance improvements in all three students evident in Figure 2, we added a quantitative data analysis using the online calculator by Vannest et al. (2016; http://singlecaseresearch.org/calculators/tau-u). Trends in the baseline sessions were

analyzed for each participant to determine the need for baseline-corrected analysis (i.e., tau-U). No baseline trends were detected for any of the students, and a simple tau analysis was performed. Table 1 presents the results of the baseline–intervention phase comparisons using tau analysis. The Kendall score (S) sums the ranking differences between observations, while the pairs represent the number of compared data pairs. Tau (τ) is a statistic that measures the association degree between two sets of rankings, and the Z quantifies how many standard deviations a result is from the mean to assess the significance of tau.

Table 1. **Nonoverlap Tau analysis of baseline-intervention phase contrast for reading performance**

Student	S	Pairs	τ	Z	p	90% CI
Aaron	32	32	1.00	2.72	< .001	[.40, 1]
Basir	35	35	1.00	2.84	< .001	[.42, 1]
Conrad	36	36	1.00	2.88	< .001	[.43, 1]

The low *p* values suggest a very strong likelihood that the observed differences are not random, and the confidence intervals (CI) reflect a high degree of certainty that the interventions significantly improved the students' reading performance, with a strong effect size indicated by the upper bound reaching the maximum possible value for the tau statistic.

A combined effect size, reflecting the average improvements across participants, revealed a significant overall treatment effect: $\tau = 1.00$, $Z = 4.87$, $p < .001$, with a confidence interval of [.60, 1]. In summary, both visual and statistical analyses, utilizing tau for comparing baseline and intervention performances, indicate notable enhancements in reading abilities among all the participants due to the intervention.

Discussion

This single case study tested the effectiveness of a reading racetrack training in a notably diverse group of eight-year-old boys, including an individual with learning disabilities, one with limited national language proficiency due to a migration background, and one facing socio-economic challenges, and demonstrated its success and broad applicability. The treatment resulted in clear and significant improvements in word-naming speed, with all the participants showing substantial increases in their performance. Detailed analysis of the baseline and intervention phases revealed marked enhancements; each participant's mean scores rose significantly during the intervention phase compared to the baseline phase, which exhibited minimal variability.

Statistical evaluations using tau analysis confirmed these visual observations, with significant effect sizes indicating robust gains in reading abilities for each participant, underscoring the intervention's efficacy.

A potential limitation of the study is that it does not deliver groundbreaking results, as the efficacy of reading racetracks is well-documented. However, considering the prevalent challenges of conducting large-scale, randomized trials in educational research, this study's inclusion of participants with diverse backgrounds—such as those with learning disabilities, limited language proficiency, and minimal family support—marks a significant advancement in assessing the universal effectiveness of rapid word recognition interventions. This diverse sample not only reflects the complexity of real-world educational settings but also emphasizes the significance of this research in offering crucial insights for developing universally effective educational strategies.

A further limitation pertains to how performance was measured. The procedure was not fully standardized, as the timing of word presentations could vary slightly; a graduate university student might take a millisecond longer or shorter to present the next word after a child's response. This issue introduces an element of variability in the duration each participant spends during the session, potentially affecting the consistency of the intervention. However, when considering the clear improvement in performance during the intervention phase, these potentially small fluctuations are unlikely to compromise the effectiveness of the approach.

A final shortcoming is the absence of follow-up data collection. Nonetheless, existing studies on racetracks indicate that the benefits of the intervention are sustainable over time. It is reasonable to surmise that similar long-term benefits would have been observed in this unique and heterogeneous group of students.

Despite these limitations, the study results highlight the versatility and effectiveness of the reading racetracks intervention, which has demonstrated significant benefits across a diverse group of children. Given its ability to markedly improve direct word recognition among students facing reading challenges, the case for its widespread adoption in educational systems is compelling. Enhancing rapid word recognition is crucial for enabling students to fully participate in society, underscoring the importance of further disseminating and implementing this intervention.

References

Beard, R. (2024). *Reading: Multiple perspectives*. Routledge.

Daly, E. J., Neugebauer, S. & Chafouleas, S. M. (2015). *Interventions for reading problems: Designing and evaluating effective strategies*. Guilford.

Dougherty Stahl, K. A., Flanigan, K., & McKenna, M. C. (2019). *Assessment for reading instruction*. Guilford.

Hall, C., Dahl-Leonard, K., Cho, E., Solari, E. J., Capin, P., Conner, C. L., Henry, A. R., Cook, L., Hayes, L., Vargas, I., Richmond, C. L., & Kehoe, K. F. (2023). Forty years of reading intervention research for elementary students with or at risk for dyslexia: A systematic review and meta-analysis. *Reading Research Quarterly, 58*(2), 285–312. https://doi.org/10.1002/rrq.477

Kazdin, A. E. (2020). *Single-case research designs: Methods for clinical and applied settings*. Oxford University Press.

Kilpatrick, D. A., Joshi, M. R., & Wagner, R. K. (2019). *Reading development and difficulties: Bridging the gap between research and practice*. Springer.

Lämsä, J., Hämäläinen, R., Aro, M., Koskimaa, R., & Ayram, S.-M. (2018). Games for enhancing basic reading and math skills: A systematic review of educational game design in supporting learning by people with learning disabilities. *British Journal of Educational Technology, 49*(4), 596–607. https://doi.org/10.1111/bjet.12639

Moll, K., & Landerl, K. (2014). *Salzburg Reading and Spelling Test (SLRT II)*. Hogrefe.

Özerk, G. (2020). Academic boredom: An underestimated challenge in schools. *International Electronic Journal of Elementary Education, 13*(1), 117–125. https://doi.org/10.26822/iejee.2020.177

Paige, D. D., Rasinski, T., Magpuri-Lavell, T., & Smith, G. S. (2014). Interpreting the relationships among prosody, automaticity, accuracy, and silent reading comprehension in secondary students. *Journal of Literacy Research, 46*(2), 123–156.

Pollatsek, A., & Treiman, R. (2015). *The Oxford handbook of reading*. Oxford University Press.

Rinaldi, L., & McLaughlin, T. F. (1996). The effects of reading racetracks on the fluency of see-to-say words in isolation by a student with learning disabilities. *Journal of Precision Teaching and Celeration, 13*(2), 44–52.

Rinaldi, L., Sells, D., & McLaughlin, T.F. (1997). The Effects of reading racetracks on the sight word acquisition and fluency of elementary students. *Journal of Behavioral Education, 7*(2), 219–233. https://doi.org/10.1023/A:1022845209417

Stuart. M., & Stainthorp, R. (2015). *Reading development and teaching*. Sage.

Vannest, K. J., Parker, R. I., Gonen, O., & Adiguzel, T. (2016). *Single case research: Web based calculators for SCR analysis. (Version 2.0)* [Web-based application]. Texas A&M University. http://www.singlecaseresearch.org

Authors' Note

Correspondence concerning this article should be addressed to Dilan Kisikyol, Department of Special Education & Rehabilitation, University of Cologne, Klosterstr. 79b, Cologne, Northrhine-Westfalia, 50931, Germany, Email: dilan_kisikyol@hotmail.de