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Phonological Short-Term (PSTM) and Reading Fluency in Greek: Typical and Dyslexic Readers in Inclusive Classrooms

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Abstract

Literacy and learning to read is foundational with reading fluency and comprehension to be essential skills. Reading fluency is considered a prerequisite for reading comprehension acting as a "bridge' between decoding and comprehension (De Jong & Van der Leij 2002). Research has indicated reading fluency to be the most reliable measure to discriminate typical children and adolescents from readers with reading disorders (Protopapas & Skaloumbakas, 2008). Further, poor PSTM is associated with poor reading skills in the first language (Talli, et al., 2016) and foreign language Kotsoni (2021) in dyslexic children. This study examined the association between PSTM and reading fluency in 72 children (49 typically developing and 23 dyslexic) aged 10-13 in inclusive classrooms. The research questions formulated were whether PSTM, as assessed in a NWR task, a) correlated and b) predicted first language reading fluency in both typically developing and dyslexic children and c) differed significantly between the two groups. Pearson correlations, univariate regression analysis, and independent-sample T-tests were conducted. Results indicated that PSTM was significantly associated and predicted reading fluency in the first language and that PSTM differed significantly between typically developing and dyslexic children. The importance of PSTM is indicated regarding reading fluency in both typical and non-typical young readers with implications for research and practice.

Keywords: *Dyslexia, phonological short-term memory, Greek, reading fluency, young learners*

1. Introduction

The ability to read is characterized by the related literature as a crucial foundation of literacy skills and the initial goal set by educators and educational systems around the world (Kotsoni & Talli, 2024). While young students, during their early education steps, begin to learn to read, they start developing skills such as phonemic awareness, decoding, reading fluency and then reading comprehension (Talli, Kotsoni, Stavrakaki, Sprenger-Charolles, 2023). Reading fluency is defined as "*the ability to read accurately and quicky*" (Kotsoni & Talli, 2024: 2) while precise and fast reading skills of a linked text, which is accepted as text reading or oral reading, has been indicated to constitute a strong predictive factor to reading comprehension (e.g. Kuhn & Stahl, 2003; Hudson, Pullen, Lane, & Torgesen, 2009; Kim, Petscher, Foorman, & Zhou, 2010; as cited in Kim et al., 2014; Kotsoni & Talli, 2024). Consequently, as an essential requirement leading to effective reading comprehension skills, reading fluency remains a crucial characteristic of the "learning to read" process (Ehri, 2017; Sprenger-Charolles, Colé & Serniclaes, 2006; as cited in Kotsoni & Talli, 2024) that also stays highly associated with the skills of decoding and reading comprehension during the early years of primary education in children (Ecalle, Dujardin, Gomes, Cros & Magnan, 2021; Fuchs, Fuchs, Hosp & Jenkins, 2001; Nevo, Vaknin-Nusbaum, Brande & Gambrell, 2020; Kotsoni & Talli, 2024).

2. Reading Fluency and Phonological Short-Term Memory

The first component of reading fluency, accuracy is defined as the skill to accurately be able to decode words and speed, the second component, speed, refers to how quickly a child can read the words accurately. It is widely accepted that reading fluency combines skills both at a lexical level, (e.g. recognition of words) and at a text level (words-in-context) (Rasinski, Reutzel, Chard & Linan-Thomson, 2012; Fuchs et al., 2001; Kuhn et al., 2010; as cited in Kotsoni & Talli, 2024) and is regarded as being "the bridge between decoding and reading comprehension" (De Jong & Van der Leij 2002; Kim, Park & Wagner, 2014; Kotsoni & Talli, 2024:2). What is more, reading fluency is considered as the most reliable measure to diagnose and differentiate young and teenage children with reading disabilities with impairment in reading from typical teenagers (Protopapas & Skaloumbakas, 2007, 2008).

Phonological short-term memory can be defined as the processing capacity of the phonological component of Baddeley & Hitch's (1974; Baddeley, 2003) multicomponent model of working memory and is indicated to be a strong learning predictor (Alloway, 2009; Maehler & Schuchardt, 2016; as cited in Kotsoni, 2026) as there is evidence illustrating the relationship between phonological skills and children's abilities to learn new words, to learn to read and to comprehend language (Maridaki-Kassotaki, 2002; Gathercole & Baddeley, 1993b).

A widely accepted task to measure phonological STM capacity is the non-word repetition task (NWR), despite the fact that researchers, in the related literature have consistently stated the NWR tasks tap many other language processes, such phonological encoding, phonological memory, speech perception, phonological assembly and articulation (Coady & Evans, 2008; Talli et al., 2023).

3. NWR and Reading Fluency in Typical and Dyslexic Children

As regards the relationship between NWR and reading fluency skills, research has showed that children's performance on NWR tasks has been corelated to reading skills (Conti-Ramsden and Durkin, 2007) and poor NWR performance has been correlated to poor reading skills such as decoding and reading fluency in dyslexic children (Talli et al., 2015, 2016) while children with a reading impairment have been found to have weak phonological STM (e.g., Fischbach et al., 2014; Schuchardt, K., Böckmann, A.-K., Bornemann, G., & Mähler, C. 2013; Talli et al., 2023).

Furthermore, the role of NWR has been investigated as an early predictor for the identification of at-risk children facing reading disorders. The study by Catts et al. (2015) showed that a battery of tests (letter naming fluency, phonological awareness, rapid naming) that also included a NWR task, administered to 366 children at kindergarten age, predicted their reading fluency skills and were successful identifiers of good and poor readers at the first-grade class (263 children). Further, the study by Rapala and Brady (1990) has showed that phonological processes are less accurate in poor readers compared to typical ones. For example, a NWR task significantly predicted phonological awareness skills (Erskine et al., 2020). In addition, Elhassan et al. (2017) indicated that phonological awareness was a significant contributor only to dysfluent children aged 9-12, suggesting that when reading automaticity is accomplished, the skills of phonological awareness do not affect reading skills (cited in Talli et al., 2023). Further, Kotsoni (2021) indicated that a NWR task significantly predicted foreign language vocabulary learning in both typical and dyslexic children aged 9-12.

As far as the Greek language is concerned, it is considered to be a transparent language with the research in NWR tasks to be restricted, though, with not much attention to be paid to the diagnostic importance of examining NWR skills in typical children (e.g., Masoura, 2006; Masoura & Gathercole, 1999) and in non-typical children, with DLD, and SLD, in their native language (e.g., Talli et al., 2016; Mengisidou & Marshall, 2019; Talli & Stavrakaki, 2020) and in the foreign language (Kotsoni, 2021, 2026). Additionally, research has indicated that TD children's NWR performance differed significantly compared to children with learning disabilities with impairment in reading (Kotsoni, 2021, 2026; Talli et al., 2016).

4. Aim & Research Questions

The aim of this study is to examine the association between phonological STM, assessed in a NWR task, and reading fluency in 72 Greek children aged 10-13 in their first language. The research questions are presented below:

1. Does phonological STM correlate with typical and dyslexic children's reading fluency in their first language?
2. Does phonological STM predict typical and dyslexic children's reading fluency in their first language?
3. Does phonological STM differ significantly in typical and dyslexic children?

5. Methodology

All participants were assessed individually by the researcher in a quiet room. Details regarding their age, typical or non-typical development, assessment, tools, and short description of the procedure are presented in Sections 5.1 and 5.2. The data were analyzed using the SPSS 29 program and the results are presented in Section 6.

5.1. Participants

The participants of this study were 72 children aged 10-13. 49 participants were considered typical by their school as they had never been assessed for a learning disability before and 23 had a formal state diagnosis for a reading impairment (dyslexia). To ensure participants' development and reading skills, so that they could be included in the study, it was decided to assess all participants for learning disabilities through the Giro giro oli test (Kotsoni & Talli, 2024). After the assessment, 49 children were indicated as being typically developing students while 23 of them were indicated as having a learning disability with impairment in reading (dyslexia).

5.2. Procedure

All children were administered: a) the NWR task (Talli, et al., 2023) test to assess their phonological STM, b) the Giro Giro Oli (Kotsoni & Talli, 2024) to assess their reading fluency in their first language, Greek and c) Raven's colored Progressive Matrices (Sideridis, Antoniou, Mouzaki, & Simos, 2015) to assess the participants' non-verbal IQ so that mental retardation was excluded. All participants were assessed individually by the researcher in a quiet classroom environment at their school.

6. Results

The first research question regarded the associations between phonological STM, through the administration of a NWR task, and children's reading fluency in their native language, Greek. To address the first research question Pearson correlations tests were conducted between participants' NWR scores and reading fluency scores in the combined sample of typically developing learners and learners with learning disabilities (N = 72). Results indicated that NWR scores (M = 97.64, SD = 9.18) were significantly negatively correlated with reading fluency scores (M = 200.97, SD = 50.13), r (70) = −.57, p < .001 (two-tailed). Higher NWR scores were associated with lower reading fluency scores.
The second research question was with regard to phonological STM being a predictor of reading fluency in children's first language. A simple linear analysis was conducted between phonological STM in NWR scores and reading fluency scores in the combined sample of typically developing learners and learners with learning disabilities (N=72). The regression was statistically significant, F (1, 70) = 33.17, p < .001, explaining 32.2% of the variance in reading fluency scores (R^2 = .322, adjusted R^2 = .312). Phonological short-term memory was a significant negative predictor of reading fluency scores, B = −3.10, SE = 0.54, β = −.57, t(70) = −5.76, p < .001, 95% confidence interval for B [−4.17, −2.03].
The third research question investigated any statistically significant differences between typical and dyslexic children's phonological STM. An independent-samples T test was conducted to examine differences in phonological short-term memory between typically developing students and students with learning disabilities. Typically developing students (n = 49, M = 101.49, SD = 5.81) scored significantly higher than students with learning disabilities (n = 23, M = 89.43, SD = 9.74), t (70) = 6.56, p < .001, Cohen's d = 1.66. The mean difference was 12.06 points, 95% CI [8.39, 15.72], indicating a large effect.

Discussion

The aim of this study was to investigate the relation between phonological STM through the assessment of a NWR task and reading fluency in the first language. The research questions were fully confirmed by the findings.
More specifically, the first research question investigated the association between phonological STM and children's reading fluency in their first language, Greek. The findings showed that phonological STM was significantly associated with reading fluency in both groups of children aged 10-13, typical and dyslexic ones receiving education in an inclusive environment. These findings are consistent with Maridaki-Kassotaki (2002) study, who found a strong relationship in Greek young children. Further, this study extends these findings to students aged 10-13 years old while also to readers with a reading disorder (dyslexia). In addition, this study is in accordance with Talli et al. (2023) study that reported a significant relationship between NWR and reading fluency scores in typically developing children.
The second research question examined whether phonological STM was a significant predictor of reading fluency in children's first language. The findings indicated that phonological STM significantly predicted typical and dyslexic children's reading fluency in their first language, Greek and the findings are consistent with Talli et al. (2023) in which a significant prediction between NWR and reading fluency

was reported in a group of typical 387 Greek children. Further, this study corroborates the results of previous studies (e.g., Conti-Ramsden and Durkin, 2007; Schuchardt et al., 2013) with both typical and non-typical populations indicating the predictive value of phonological STM to reading fluency skills.
The third research question investigated whether there is a statistically significant difference between typical and dyslexic children's phonological STM. The results indicated that phonological STM was significantly different between the two groups of children, typical and dyslexic ones. These findings are consistent with previous studies by Kotsoni (2021, 2026), Talli et al., (2023) and Talli et al., (2016) in which significant differences were registered in Greek children aged 7-13.
Overall, these results are important as phonological STM, examined in a NWR task, is associated with reading fluency extending previous evidence for the Greek language in both typical and dyslexic children aged 10-13. The significant relationships that were identified through the correlation and regression analyses reveal that NWR performance may provide relevant information about the processes that support reading and fluency in the first language in students' developing brain aged 10-13. In addition, the significant difference between typical and dyslexic students' phonological STM supports the sensitivity of phonological STM measures to learning disabilities in reading. Considering the contributing implications of this study, it adds to the assessment and screening field, and a NWR task may be suggested to be included along with reading fluency assessments in a broader assessment battery without it being presented as a diagnostic tool for reading disorders, though. From an educational perspective, NWR and reading fluency tasks could be considered to be incorporated as complementary components of a broader screening assessment procedure to help educators and specialists identify early at-risk students for learning disabilities in reading. Timely identification facilitates the implementation of early and appropriate interventions before reading difficulties become firmly established. Such supportive interventions could also minimize secondary academic and socio-emotional consequences including reduced academic confidence, frustration, reading avoidance, reduced academic motivation, and poor self-esteem. However, neither NWR nor reading fluency tasks should be used as a stand-alone diagnostic measure, and their results should be interpreted alongside battery assessments of cognitive abilities, language, and educational history. As regards the limitations and future research, this study would be important to be replicated with a larger sample of both typical and dyslexic children, and more importantly with older children of broader age groups.

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