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WHO Collaborating Centre for Prevention of Deafness and Hearing Loss

Department of Speech-Language Pathology and Audiology

An investigation into etiological and background factors in the subtypes of Specific Learning Disorder (Developmental Dyslexia)

MODULE: KMP481

A research project in *embedded article format* for partial fulfilment of the requirements for the degree

BA: Speech-Language Pathology

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List of Abbreviations

Attention Deficit Hyperactivity Disorder (ADHD)

Auditory Processing Disorder (APD)

Atypical Sensory Processing Disorder (ASPD)

Autism Spectrum Disorder (ASD)

Children/Child with Dyslexia (CWD)

Developmental Coordination Disorder (DCD)

Developmental Dyslexia (DD)

Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-V)

Diagnostic and Statistical Manual of Mental Disorders Fifth Edition Text Revision (DSM-V-TR)

Language Processing Disorder (LPD)

Non-verbal Learning Disabilities (NVLD)

Obsessive-Compulsive Disorder (OCD)

Specific Learning Disorder (SLD)

Visual Perceptual Deficits (VPD)

To the examiner/s: please note that this format differs slightly from the KMP 481 study guide. The article – with the abstract – is in Chapter 3. Permission has been granted by the module coordinator to adjust for the embedded article format. Thank you.

Table of Contents

CHAPTER 1

Introduction and overview of existing literature

This chapter introduces the background rationale of the present study and highlights the factors investigated. Main concepts are established, and the chapter concludes with a subsequent research question.

Specific Learning Disorder

Specific Learning Disorder (SLD) manifests as a disorder in neurobiological anatomy and neurophysiological processes that are important for understanding and using both spoken and written language (Frolov & Schaepper, 2021). The individual with SLD presents with learning difficulties and impaired academic skills, expressed in one or more of the following symptoms: arduous word reading, struggling with reading comprehension, spelling, written expression, mastering number sense, number facts, and analytical reasoning. These symptoms must persist for six months despite intervention, for a diagnosis to be made. The physical impact of the presence of the disorder is visible in classroom participation, everyday activities, and social interactions. SLD is classified as a neurodevelopmental disorder as the onset will occur during the period when the individual's brain is still developing (American Psychiatric Association, 2022; American Psychiatric Association, 2013).

According to the American Psychiatric Association (2013; 2022) SLD may only become apparent in school-aged children as this is when they start using language to learn. The academic skills of these children are substantially and quantifiably below those expected for the chronological age of the individual and can thus cause significant limitations in academic and occupational functioning (Stark et al., 2022). The specifiers for severity can be found in the Diagnostic and Statistical Manual Fifth Edition (DSM-V) and Fifth Edition Text Revised

(DSM-V-TR) manual and severity ranges from mild to severe impairments (American Psychiatric Association, 2013; 2022).

Subtypes of SLD

There are many subtypes of SLD: reading, writing, and spelling disability (developmental dyslexia) (DD), dyscalculia, dysgraphia, auditory processing disorder (APD), visual perceptual deficits (VPD), language processing disorder (LPD) and non-verbal learning disabilities (NVLD). The definition of DD as stated in the DSM-V-TR includes the different subtypes. The American Psychiatric Association (2022) describes DD as a pattern of learning difficulties, which includes impairments in word recognition, decoding, and spelling abilities. DD may vary in severity according to the level of impairments in language, reading, writing, and spelling according to specific subtypes of DD. The disorder has many subtypes such as dysnemkinesia, dysphonesia, and dyseidesia (Geertsema et al., 2022). Dysnemkinesia is the poor development of motor engrams for written symbols. Dysphonesia (also known as auditory dyslexia) is the poor ability of phoneme-grapheme coupling affecting the child's ability to do phonetic word analysis and synthesis. Lastly, dyseidesia (or visual dyslexia) is the impairment in the discrimination of whole words as visual pictures and linking them with auditory sounds (Geertsema et al., 2022). Any combination of these subtypes may occur in a child with dyslexia (CWD).

Children with dyslexia (CWD) have normal intellectual abilities but still have difficulty with literacy acquisition. Other disorders related to DD include dyscalculia, dysgraphia, and co-occurring disorders such as APD, LPD, NVLD, and NVD. Dyscalculia is a very specific learning challenge manifested by difficulty mastering number sense, learning or memorising arithmetic facts, exact or fluent calculation, and analytical reasoning (Mahmud et al., 2020). Dysgraphia is difficulty with writing despite thorough instruction; for example, the individual may present with letter reversals, mixing upper- and lower-case letters, letter spacing, fine

motor coordination and general planning and execution of written assignments (Chung et al., 2020). These individuals may also have fine motor difficulties (Blanchet & Assaiante, 2022). Moreover, DD may co-occur with several medical and psychological conditions (Grigorenko et al., 2020).

Co-occurring conditions

SLDs such as DD may coincide with psychological disorders and medical conditions. Regarding medically related factors, CWD can have concomitant epilepsy and even schizophrenia (Grigorenko et al., 2020). According to Brimo et al. (2021), neurodevelopmental problems can co-occur with DD. These neurodevelopmental problems may include attention deficit hyperactivity disorder (ADHD), Developmental Coordination Disorder (DCD), autism spectrum disorder (ASD), and atypical sensory processing disorder (ASPD). Developmental language disorder (DLD) may also co-occur with DD (Habib, 2021b). Other conditions that can co-occur with DD are dyspraxia, Tourette syndrome, and obsessive-compulsive disorder (OCD) (Hettiarachchi, 2021). CWD also suffer from emotional and behavioural difficulties. Psychologically, CWD may present with negative, behavioural personality problems such as low self-esteem and poor social adaptive behaviours (Huang et al., 2020).

Diagnostic factors for SLD

According to the DSM-V-TR, SLD is associated with the relationship between genetic, epigenetic, and environmental factors all stemming from a biological origin (American Psychiatric Association, 2022). These factors may then, in turn, affect the ability of the brain to perceive or process language accurately (Muktamath et al., 2022). There are multiple explanations for the causes of SLD, including biological and environmental origins. One explanation for SLD may be attributed to neural structure and - functioning: specifically, as it pertains to the brain (Grigorenko et al., 2020). The brain has developed atypically, and this

affects the neural pathways necessary for optimal learning and language functioning. Impairments can include reduced grey matter and impaired structures in the left hemisphere of the brain, amongst others. Genetic factors such as structural variation in the genome and the history of SLD in the related family, may also contribute to the development of SLD (Grigorenko et al., 2020). These factors as well as environmental factors tend to co-occur, and all contribute to the expression of a SLD in the child. The diagnosis of SLD should be based on the child's sensory, intellectual, social, emotional, adaptive status, and their academic performance (Venkatesan, 2017).

Assessment of DD and SLD

The specific subtypes of DD are diagnosed by using direct assessment tools which will assess the individual's ability to decode, encode, and nemkinate (Zoubrinetzky et al., 2014). The assessment results need to adhere to the four criteria that have been stipulated in the DSM-V-TR for DD, before the individual may be diagnosed with DD and the specific subtype (Stark et al., 2022). A comprehensive assessment must be conducted in children who have a suspected SLD to determine the presence, severity, and subtypes of DD.

Assessment of children with SLD will include the following two aspects: a detailed clinical evaluation and standard psychometric assessments of the child's cognitive abilities and academic skills (Shah et al., 2019). DD may co-occur with other disorders and thus the assessment process must contain tests that assess multiple disorders and assess these disorders comprehensively. The Stark-Griffin™ Dyslexia Assessment (Stark, 2022) is a standardised and accredited tool used in South Africa to assess the various subtypes of DD. The outcomes of this tool include a centrally generated diagnostic report which indicates appropriate accommodations for the specific severity and subtypes of DD diagnosed.

Stark-Griffin™ Dyslexia Assessment Tool

The Stark-Griffin™ Assessment tool is used to diagnose a CWD. It is important to note that only a qualified professional, who completed the Stark-Griffin™ Dyslexia course, can assess, and diagnose DD in South Africa. The Stark-Griffin™ Assessment Tool can be used for children aged 9-18 years. The assessment starts with a parental questionnaire, to gather relevant information regarding the child and the presenting symptoms. Thereafter, a diagnostic assessment is conducted, which consists of three types of sub-assessments: a dyslexia screening assessment, followed by the full assessment which entails decoding, encoding, and written tests.

The diagnostic test yields outcomes in terms of the eidetic (sight word recognition) and phonetic (more complex phonetically balanced or imbalanced) decoding and encoding skills of the child. Following the complete diagnostic package, the child is diagnosed with one (or a combination of) the three main subtypes of DD mentioned earlier. The severity of presence is also indicated.

Differential diagnosis of the subtypes of SLD

According to the DSM-V, there are six types of differential diagnoses: normal variations in academic attainment, intellectual disability, learning difficulties due to neurological or sensory disorders, ADHD, and psychotic disorders (American Psychiatric Association, 2013). An SLD is distinguished from normal variations in academic attainment as the difficulties persist even with the same adequate educational opportunities and exposure as their peers. SLDs can occur in people with standard or above-average intelligence and in a person with an intellectual disability. In an SLD diagnosis, the learning struggles exceed what is usually expected in someone with an intellectual disability diagnosis. The clinical expression of SLD occurs during the developmental period (Shaywitz et al., 2021). A person with SLD does not decrease or worsen over time from a previous ‘normal’ (Shah et al., 2019). Clinically,

it is important to determine and recognise the different diagnostic factors present in an SLD as it may point professionals in the most optimal direction of treatment. Different types of SLDs may require different treatment approaches, and if the co-occurrence and correlational factors are known, the clinician can better optimise the treatment plan (Berninger & O'Malley May, 2011). Moreover, accurate differential diagnosis with overlapping diagnostic factors may prohibit the clinician from carrying out inappropriate interventions which may worsen the learning challenges of an individual. A uniquely tailored intervention program is crucial for any individual with SLDs needs to maximise outcomes. Considering these factors highlighting the novel need for the topic, the following research question was posited:

How do some of the etiological and background factors in the various subtypes of SLD (DD) associate with the different subtypes?

CHAPTER 2

Method

This chapter comprises an elaborate account of the method, ethical aspects, and statistical analyses for this study.

Research aim and objectives

- ◊ The main aim of this study was to investigate certain etiological and background factors of children with different subtypes of DD.
- ◊ The sub-aim is to determine whether there is a statistically significant difference between these factors and the different subtypes to clarify the presence of a potential associative relationship.

Objectives were to:

⇒ *describe and compare specific etiological and background factors related to speech -, language -, and auditory skills* in the seven subtypes of SLD (DD)

Ethical considerations

Research ethics consists of a set of principles (using the Nuremburg Code/Declaration of Helsinki) guiding the research design and data collection process. Table 1 reflects the different ethical factors and principles pertaining to this specific study.

TABLE 1: Ethical factors and principles applied

Ethical Principle	Application to Study
The research proposal should be submitted for consideration, comment, guidance, and approval to a research ethical committee (World Health Organization, 2021).	The Research Ethics Committee of the Faculty of Humanities from the University of Pretoria was approached for group ethical clearance. Prior to this committee perusal, the proposal was appraised by the Departmental Research Ethics Committee as well, and recommendations were addressed. Ethical clearance was subsequently granted (Appendix A).
Informed consent must be obtained from all study participants (University of Oxford, 2021).	Participants must be made aware that they are free to enter and leave the study with all the information about what it entails to take part in the study, and that they should grant informed consent and/or assent and/or permission before they enter the research. In this study the retrospective data sample already include such informed consent from the parents or caregivers upon entering a diagnostic assessment setting at any of the SGDA dyslexia specialists' practices. The comprehensive SGDA background information and questionnaire, and the diagnostic assessment itself, contains a section on confidentiality and anonymity of data used for research purposes, which the parents or caregivers signed. The children who were diagnosed also had access to an age-appropriate assent form where they could withdraw from the diagnostic assessment should they no longer wish to be assessed, at any time.
The researchers must ensure that all study participants' personal information remains confidential.	The information obtained from the participants will remain confidential via the informed consent process that ensures that their identity, personal information, and responses will not be shared with people outside the research group unless their permission is given (Holland

	& Linvill, 2019). For this study, the data sample were anonymised, and codes allocated to the different background questionnaires (etiological factors) and specific diagnostic outcomes: i.e. the sub-typing of the diagnoses, the severity of the diagnoses, and the subsequent allocated concessions. All these factors were only linked to the specifically earmarked code.
Recognition of sources.	Throughout the research the principal investigators and collaborators strived to process and cite correct and accurate recognition to the sources used in the research process.
Data storage and management.	In agreement with the University of Pretoria's research policy, coded data from this research study will be stored at the Department of Speech-Language Pathology and Audiology, in a locked cabinet in a locked Room 3-1, in hard copy, as well as in the electronic repository of the University of Pretoria, for a minimum of 10 years. Any identifying information of participants will be excluded from the data files stores, by assigning participant codes as explained in the foregoing principles. Certain files pertaining to this research may be uploaded to FigShare – the Research Data Management (RDM) repository of the University of Pretoria. FigShare is an international cloud-based Research Data Repository in support of the dissemination phase of the Research Data Management life cycle. FigShare helps with data publishing, sharing, and collaboration of academic research, which allows UP to preside over and, in some cases, showcase its data to the others in the research community.
The information presented in the proposal should be honest,	To the best knowledge of the principal investigators and the collaborators, the information in this research project and embedded article contains no discrepancies and are

clear and accurate (Brink et al., 2018).	factual. The information was proofread and edited carefully.

Research design, materials, and methods

Research design

This study was based on existing data from the Stark-Griffin™ Dyslexia Academy (SGDA) consisting of a correlational study, cross-sectional (once-off) retrospective (interpretation of existing data) design. A retrospective study design depicts a data interpretation method where data of an outcome occurring in the present is analysed by using collected data about the determinants in the past (Brink et al., 2018). A cross-sectional design is typically when the same data is collected from a specific group of participants at the same time (Cummings, 2018). Regarding the correlational aspect of the design, we sought to examine the relationships between two or more variables at a certain specific point in time, without variable manipulation and recognising that correlation does not imply causation regardless of existing relationships (Brink et al., 2018).

Participant sampling method and exclusion criteria

Purposive sampling was used in this study. School-aged participants with a stand-alone Stark-Griffin™ Dyslexia Academy (SGDA) diagnosis of developmental dyslexia (DD) or co-occurring with disorders such as ADHD and ADD were included in the study sample (Stark et al., 2022). Participants met a clear set of criteria to rule out exclusion factors such as primary diagnoses of cognitive impairment, scholastic deprivation and general reading and writing challenges as described in the previous version of the DSM-V (American Psychiatric Association, 2013) when the data was collected. In short, the participants had to adhere to all four criteria as described by the DSM-V as required for a SLD (DD) diagnosis.

Sample size and characteristics

The expected sample size was initially estimated to be 4370 school-aged participants with the SGDA diagnosis for DD. Any participants adhering to the inclusion criteria were used for this study. Thus, the final number of participants included in this study who met the inclusion criteria was 4370.

Data collection material

The initial data corpus in this retrospective sample comes from the SGDA data basis. The Stark-Griffin™ Dyslexia Assessment test (Stark-Griffin™ Dyslexia Determination Test, 2011) was administered to the sample of participants at different locations across South Africa by SGDA and HPCSA registered dyslexia specialists (Stark et al., 2022).

Data collection procedure

The Principal and Chief Executive Officer (CEO) of the SGDA, Mrs Sandra Stark, was contacted to request access to the data basis and the conduction of the present study (Appendix B). All data on the database of the SGDA includes pre-granted consent by parents / caregivers / clients that the anonymised data sets may be used for further research, training, and publication. Access to the database was granted and various etiological background factors were classified and described, applying different appropriate statistical analyses.

Statistical analysis

To determine, classify, compare, and correlate the distinct factors; the earmarked data sets in Excel sheets were captured. A statistician who is also a collaborator and co-author of this study was approached for expert advice regarding statistical analyses. Specific statistical calculations were discussed, described, and included in the data analyses section. Where warranted, specific correlations and other statistical comparative analyses are discussed:

Using the Software G*Power version 3.1.9.4 (Faul et al., 2007), the a-priori computation was done to compute the required sample size with the input parameters being: (i) level of significance = 0.05, (ii) minimum statistical power = 0.8, (iii) tails = 2 (for a two-tailed test), (iv) effect = 0.3 (to detect at least a medium effect size); small effect sizes were not considered as they may have statistical significance ($p < 0.05$), but not real-world or practical significance (Peeters, 2016).

Research collaborators

During the research process, several investigators were involved. The student-researchers were the principal investigators, with the main- and co-supervisors in supportive, study design, and guiding roles. All research collaborators are listed as co-authors alongside the principal investigator. The main supervisor - as the conceptual designer of this study - is the corresponding author.

CHAPTER 3

Chapter 3 takes account of the submitted article which is the main goal of this research module. The chapter was submitted for publication to the ***Journal of Research in Early Childhood Education*** **on the 9th of October 2024**. Proof of submission is reflected in **Appendix C**. The journal uses ScholarOne Manuscripts for peer review and the article followed the in-house style of word count, referencing, and formatting and templates. The referencing style follows the general style of this compilation manuscript, APA7th edition (Taylor Francis version). Font and font size remain Times New Roman 12, except for the main title which is 14. Line spacing is double. No colour graphs or tables are allowed in this article to wave publication fees. Headings are not numbered in the submitted article (*but for the sake of the index of this manuscript they are*), and they are typed in letter case with a side margin spacing of 2-2.5cm.

An Investigation into Etiological and Background Factors in the Subtypes of Specific Learning Disorder (Developmental Dyslexia)

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Abstract

Introduction: Understanding the etiological and background factors associated with Specific Learning Disorder (SLD), particularly Developmental Dyslexia (DD), is crucial for effective diagnosis and intervention. This study investigated these factors and their association with various subtypes of SLD to support tailored treatment plans for this vulnerable population.

Methods: Using existing data from the Stark-Griffin™ Dyslexia Academy (SGDA), a mixed-method retrospective, cross-sectional descriptive, and comparative research design was employed. Participants included school-aged individuals with a diagnosis of DD, either standalone or co-occurring with other disorders. Data was collected through the Stark-Griffin™ Dyslexia Assessment test administered by registered SGDA dyslexia specialists. Caregiver consent and child assent for the anonymised use for further research were obtained before the collection of these sets of data. Statistical analyses were conducted to determine, classify, compare, and associate distinct etiological and background factors.

Results: This study included 4370 participants meeting the inclusion criteria. For the present study specific factors such as late speech development, prior speech therapy and audiological consultations, and negative emotions (anger, frustration, depression), and gender were investigated. Statistical analyses revealed specific significant associations between these factors and different subtypes of DD.

Conclusion: The findings underscore the importance of recognising and understanding the various etiological and background factors associated with different subtypes of SLD. These factors can inform diagnosis and intervention strategies, leading to more effective treatment and improved outcomes for individuals with SLD.

Keywords: Specific Learning Disorder, Developmental Dyslexia, Etiological Factors, Background Factors, Association, Stark-Griffin™ Dyslexia Academy, Diagnosis, Intervention

3.1 Introduction

Specific Learning Disorder (SLD) is manifested as a disorder in neurobiological anatomy and neurophysiological processes that are important for understanding and using both spoken and written language (Frolov & Schaepper, 2021). SLD is classified as a Neurodevelopmental Disorder with its onset during the period when the brain of an individual is still developing (American Psychiatric Association [APA], 2013). The individual with SLD typically presents with learning difficulties and impaired academic skills, which would manifest in one or more of the following symptoms: arduous word reading, struggling with reading comprehension, spelling, written expression, mastering number sense, number facts, and analytical reasoning. These symptoms need to persist for six months despite intervention, for a diagnosis to be made (APA, 2013)*. The physical impact of the presence of the disorder is visible in classroom participation, everyday activities, and social interactions.

According to the APA (2013), SLD might only become apparent in school-aged children as this is when they start using language to learn formally. The academic skills of these children are substantially and quantifiably below those expected for the chronological age of the individual and can thus cause significant limitations in academic and occupational functioning (Stark et al., 2022). The specifiers for severity can be found in the DSM-V manual and severity ranges from mild to severe impairments (APA, 2013). There are several different subtypes of SLD. These can include dyscalculia, dysgraphia, auditory processing disorder (APD), visual perceptual deficits (VPD), language processing disorder (LPD), and non-verbal learning disabilities (NVLD) (Geertsema et al., 2022). The present study focussed on Developmental Dyslexia (DD) with its different subsequent classifications as recognised and classified by the Stark-Griffin™ Dyslexia Determination Test (SGDT).

*Note that we are using the 2013 version of APA (and the DSM-V) as the retrospective diagnostic data sets used are still based on this version

DD comprises impairments in word recognition, decoding, and spelling abilities (American Psychiatric Association, 2013). Dysnemkinesia, as a main type of DD, involves poor development of motor engrams for written symbols. Dysphonesia, another core category, affects phoneme-grapheme awareness hindering phonetic word analysis. Dyseidesia, a final major form of DD, impairs the discrimination of whole words as visual pictures and linking with auditory sounds (Stark et al., 2022). Combinations of the main types of DD, may also be diagnosed. For example, dysnemkinphonesia would be a combination of the initial two mentioned types (Stark et al., 2022).

DD may co-occur with dyscalculia, dysgraphia, APD, LPD, NVLD, and VPD (Geertsema et al., 2022). Dyscalculia manifests as difficulty mastering number sense, arithmetic facts, calculation, and analytical reasoning (Mahmud et al., 2020). Dysgraphia presents as writing difficulties despite instruction, including letter reversals, case mixing, spacing, and fine motor coordination issues (Chung et al., 2020). SLDs may co-occur with psychological disorders and medical conditions (Grigorenko et al., 2020). Moreover, Grigorenko and colleagues noted that - in addition to psychological disorders - specific medical conditions such as epilepsy and even schizophrenia can coincide with DD. Likewise, Brimo et al. (2021) found that neurodevelopmental problems may also overlap with DD. These neurodevelopmental problems may include Attention-Deficit-Hyperactivity-Disorder (ADHD), Developmental Coordination Disorder (DCD), autism spectrum disorder (ASD), and atypical sensory processing disorder. Developmental language disorder may also co-occur with DD (Habib, 2021b). Other co-occurring factors or diagnoses may include dyspraxia, Tourette syndrome, and obsessive-compulsive disorder (OCD) (Hettiarachchi, 2021). Children with DD (CWD) may correspondingly suffer from emotional and behavioural difficulties (Huang et al., 2020). Psychologically, they may present with negative, behavioural personality problems such

as low self-esteem and poor social adaptive behaviours (Huang et al., 2020). SLD is associated with various factors all stemming from one origin.

According to the DSM-V, SLD is associated with the relationship between genetic, epigenetic, and environmental factors all stemming from a biological origin (American Psychiatric Association, 2013). These factors may, in turn, affect the ability of the brain to perceive or process language accurately (Muktamath et al., 2022). There are multiple explanations for the causes of SLD. One such explanation for may be attributed to neural structure and - functioning: specifically, as it pertains to the brain (Grigorenko et al., 2020). Neuroimaging studies show indications that there are abnormalities in the striatum in individuals with language disorders (Krishnan et al., 2016). This may indicate that the brain has developed atypically, and thus affected the neural pathways necessary for optimal learning and language functioning. Genetic factors such as structural variation in the genome and the history of SLD in the related family, may also contribute to the development of SLD (Grigorenko et al., 2020).

Another strong predictor for developing SLD is environmental factors. These factors include culture, social strata, characteristics of schooling, family literacy environments, neighbourhood, and peer influences (Krishnan et al., 2016). These genetic as well as environmental factors tend to co-occur, and all contribute to the manifestation of an SLD such as DD, in an individual. Hence, a detailed assessment must be conducted in persons who present with a possible DD to determine the presence, severity, and subtypes of the DD. Such evaluations usually include clinical considerations and psychometric assessments. Additionally, these measurements should involve a direct evaluation of the ability of an individual to decode, encode, and write (Zoubrinetzky et al., 2014) while still adhering to DSM-V criteria (Stark et al., 2022).

According to the DSM-V (American Psychiatric Association, 2013) there are six types of differential diagnoses: normal variations in academic attainment, intellectual disability, learning difficulties due to neurological or sensory disorders, ADHD, and psychotic disorders (American Psychiatric Association, 2013). An SLD is distinguished from normal variations in academic attainment as the difficulties persist even with the same adequate educational opportunities and exposure as their peers (American Psychiatric Association, 2013). SLDs such as DD can occur in people with standard or above-average intelligence and a person with an intellectual disability (American Psychiatric Association, 2013).

In an SLD diagnosis, the learning struggles exceed what is usually expected in someone with an intellectual disability diagnosis. The clinical expression of SLD occurs during the developmental period (Shaywitz et al., 2021). Finally, it is important to note that a person with SLD does not decrease or worsen over time from a previous diagnostic baseline .

Given this background, it is clear that the assessment and diagnosis of DD should be based on the sensory, intellectual, social, emotional, adaptive status, and academic performance of an individual (Venkatesan, 2017). It is therefore logical that any SLD diagnosis warrants a thorough certified and endorsed assessment (Stark et al., 2022). As expected, this endorsement includes all diagnostic assessment tools for DD.

In South Africa, the Stark-Griffin^{TM} Dyslexia Assessment (Stark et al., 2022) is a registered and standardised tool used to generate diagnostic reports with tailored accommodations for the specific severity and subtypes of DD diagnosed. For the present study, the Stark-Griffin^{TM} Dyslexia Determination Test (SGDDT) was administered by trained and registered professionals to diagnose DD in children between nine and eighteen years. The assessment commences with a parental questionnaire to gather information regarding the child and their symptoms. Thereafter a diagnostic assessment is conducted, which assesses decoding, encoding, and writing skills. The diagnostic test yields result to diagnose the child with one (or

a combination of) the three main types of DD mentioned earlier. The severity is also indicated, and the report concludes with recommendations for further treatment and accommodations allowed in scholastic settings.

For our investigation, we included the following possible associated factors: *audiological consultations, late speech development, prior speech therapy, negative emotions (anger, frustration, and depression), and gender*. The aim was to establish possible associations between these factors and the presence of the different subtypes of DD.

Firstly, when looking at possible audiological associations, a wide range of possible associations may be ascertained. CWD have deficits in speech perception in noise which partly underlies their decoding deficits (Werfel et al., 2020). According to Werfel et al. (2020) study, 71% of their testing group who failed the hearing screening exhibited decoding deficits. Some researchers have also proposed that individuals with DD may have a deficit in the processing of rapid temporal auditory information (Rahimi et al., 2022). This theory suggests that the ability to perceive quick changes in sounds, which is crucial for distinguishing phonemes-the smallest units of sound in a language is impaired in certain individuals with DD. Studies using tasks that require processing of rapid auditory sequences, such as distinguishing between similar-sounding phonemes, have found that individuals with DD often perform worse than those without the disorder; indicating a probable association between auditory processing deficits and DD (Habib, 2021a). However, the relationship between audiological fallouts and DD is complex and not yet fully understood. While some studies have found associations, others have not; and there is an ongoing debate about the nature of these potential deficits (Gu & Bi, 2020). Yet, based on the 2020 meta-analyses findings of Chanyuan and Hong-Yang, for individuals with DD, the auditory processing deficit seems to persist into adulthood and remains typical in this population and age-group. The reasons for the inclusion of the main type of dysphonesia (or auditory dyslexia) in the SGDDT, is therefore apparent. Additionally, the

possibility for parents to look towards an audiologist for possible answers regarding the difficulties their children may experience, seems a likely starting point. However, the processing deficits extend beyond the audiological periphery. It is naturally expected that a child with a possible auditory deficit, will also exhibit late and disordered speech - and / or language development. In fact, being a late talker, also constitutes a risk factor for neurodevelopment, with its neurobiological basis recently explored with more rigorous studies, and linked to DD (Dynak et al., 2021). Late speech development was therefore the second factor attained as an objective.

Late talkers largely exhibit delays in language - and literacy development in the specific areas of grammar, phonology, and reading accuracy. In addition to these, CWD will also show impairments in the areas of vocabulary spelling, reading speed, and rapid automatised naming (Dynak et al., 2021). Near-overlapping traits are therefore similar in nature and upholds - collectively with other factors - the inclusion of delayed speech development as the second perused factor. This possible interconnection also leads unsurprisingly to the third factor: the pursuit and/or attendance of prior speech-language therapy services.

Parents seek out speech-language therapy services for their children in early childhood for several reasons. Parents might notice that their child is not meeting developmental milestones for speech and language, such as babbling, saying first words, or combining words into simple sentences at the expected ages. They may also observe difficulties with pronunciation, limited vocabulary, or problems understanding and following directions (Bernthal et al., 2018). However, a speech-language therapist referral related to emergent literacy and literacy skills usually lies with an informed educator or parent (Bridges & Kelley, 2023). Still, referrals may be compromised due to anecdotal and scientific evidence that several speech-language therapists in South Africa (Erasmus et al., 2013; Geertsema & Le Roux, 2020) and in the United States (Bridges & Kelley, 2023) do not have the confidence to work with

children with general literacy difficulties. Moreover, locally, many of our clinicians indicated that they do not assess or treat CWD, even though this falls into our field of expertise and practice (Geertsema & Le Roux, 2020). Initial referrals or visits from parents may therefore be due to either the delayed speech or problematic early or foundation phase literacy skills. This factor was included to see if, and when, the practice of such prior speech therapy attendance could be linked to specific subtypes of DD diagnoses.

Penultimately, the investigation aimed to delineate the probable negative emotions associated with DD. Feelings of anger, frustration, and depression, are not unexpected in this population, and largely attributed to the myriad of inherent challenges (Livingston et al., 2018). DD significantly impacts academic performance and emotional well-being, increasing the risk of negative outcomes in various domains (Livingston et al., 2018). Academic struggles, such as difficulties in reading, writing, and spelling, often lead to frustration and feelings of inadequacy. Individuals with DD may find it difficult to keep up with their peers in traditional academic settings, leading to heightened anxiety and a negative self-image. The constant challenges in academic and social settings can create intense feelings of sorrow and pain for individuals with DD (Lavoie, 2006).

Finally, we included gender as a possible associative factor, as differences in developmental disorders between males and females are widely known and reported. For example, ASD and ADHD are found to be more likely present in males (Simcoe et al., 2023). However, it is recognised that the reasons for these gender differences are also more complex than meets the eye, involving genetic, biological, and environmental factors. Regarding gender and SLDs, males are diagnosed with DD more frequently than females (Arnett et al., 2017). As such, according to Arnett and colleagues, there seems to be an overrepresentation of males in the low performance tail of reading distribution. However, these researchers found no gender difference at the high-performance tail.

Succinctly, different types of DD may require different approaches to treatment, and if the co-occurrence and associative factors are known, the clinician can better optimise the treatment plan (Berninger & O'Malley May, 2011). Moreover, accurate differential diagnosis with overlapping diagnostic factors, may prohibit the clinician from carrying out inappropriate interventions which may worsen a specific individual's learning challenges. A uniquely tailored intervention program is ultimately crucial for any individual with DD's needs to maximise outcome. The study therefore aimed to determine and describe some of the background and possible concomitant factors present in DD as a starting point of unique approaches and improved understanding of the treatment of DD in individuals.

3.1.1 Research question

How are some of the etiological and background factors in the various subtypes of SLD (DD) associated with the different subtypes of DD?

3.1.2 Research objectives

This study aimed to conduct a comprehensive research investigation into certain etiological and background factors in the subtypes of SLD (DD). The primary objective was to describe and compare various etiological and background factors across the seven subtypes of SLD (DD). Additionally, the sub aims of the study sought to establish possible associations between these factors and the different subtypes.

3.2 Method

We employed a mixed-method retrospective, cross-sectional descriptive, and comparative research design using existing data from the Stark-Griffin^{TM} Dyslexia Academy (SG^{TM}DA). Purposive sampling was used, and we included school-aged participants with a standalone Stark-Griffin™ Dyslexia Academy (SG^{TM}DA) diagnosis of DD or co-occurring

with disorders such as ADHD and ADD (Stark et al., 2022). Participants met a clear set of criteria as per the background information and interview reports to rule out exclusion factors such as primary diagnoses of cognitive impairment, scholastic deprivation, and general reading and writing challenges as described in the DSM-V (APA, 2013). More concisely, the participants had to adhere to all four criteria as described by the DSM-V as required for a SLD (DD) diagnosis. The initial sample size was 4370 school-aged participants with the SG^{TM}DA diagnosis of DD. Participants adhering to the inclusion criteria were used for this study. The following total number of responses were included for each factor correlating with DD for the parent / caregiver respondents who replied to the specifically related topic in regards to their child: late speech development (n=4311), prior speech therapy received (n=4062), audiological support sought (n=4063), feelings of negative anger (n=2772), feelings of negative frustration (n=2934), negative emotional experiences (n=3100), depression (n=2599), and corresponding gender of their child (n=4363).

Any participants adhering to the inclusion criteria were used for this study. The initial data corpus in this retrospective sample came from the SG^{TM}DA data basis. The Stark-Griffin^{TM} Dyslexia Assessment Test (Stark-Griffin^{TM} Dyslexia Determination Test, 2011) was administered to the sample of participants at different locations across South Africa by SG^{TM}DA and HPCSA registered DD specialists (Stark et al., 2022).

The Principal and Chief Executive Officer (CEO) of the SG^{TM}DA was contacted to request access to the data basis and the conduction of the present study. All data on the database of the SG^{TM}DA included pre-granted consent by parents / caregivers / clients that the anonymised data sets may be used for further research, training, and publication. Access to the database was granted and the different etiological background factors mentioned earlier, as well as the specific main and subtype diagnoses were investigated for the different statistical analyses in this research project. The Ethics Committee of the Department of Speech-Language

Pathology and Audiology, Faculty of Humanities, University of Pretoria, South Africa, also granted ethical clearance (SLPA2024/05).

To determine, compare, and statistically equate the distinct factors, we captured the earmarked data sets in Excel sheets and worked closely with our collaborating statistician who also is a co-author of this study. Specific statistical calculations are discussed, described, and included in the data analyses section.

3.3 Data analyses

The independent samples proportions test was used to test for statistically significant differences ($p < 0.05$) between proportions. Using G*Power software (Faul et al., 2007), the minimum required sample size for a small, medium, and large effect size to detect significant differences (two-tailed tests) between the specific groups compared are 398 (199 in each group), 64 (32 in each group), and 28 (14 in each group), respectively, to obtain a statistical power of at least 0.8. However, many researchers have suggested that it may be unnecessary to obtain the minimum sample size required to detect small effect sizes, as finding a statistically significant result for a small effect may have statistical significance ($p < 0.05$), but not real-world or practical significance (Baicus & Caraiola, 2009; Peeters, 2016). Say, for example, a small effect size of 0.008 is flagged as statistically significant, the question that researchers raise is whether that would have any real-world or practical significance. Thus, ignoring the minimum sample size requirement for a small effect size, a minimum sample size of 64 and 28 is required for medium and large effect sizes, respectively, as the aim had been to obtain at least 64 responses.

3.4 Results

Etiological and Background Factors in the Subtypes of SLD (DD)

The results of the investigated factors are presented in accordance with the order of the objectives of this study. An initial description of pre-diagnosis parental behaviour and child characteristics regarding the specific factors and subsequent diagnoses is offered. This is followed by certain resultant statistically significant comparisons between the different subtypes to highlight and triangulate certain patterns for discussion in the discussion section. In Tables 1 to 6, the proportions represent the number of people who have been diagnosed with a subtype. In Table 7, the proportions of gender distribution are given (i.e., the proportion of female and male).

Audiological Visits Prior to Diagnosis

The first factor relates to *audiological visits prior to being diagnosed* with DD. Of the total number of responses in this section (n=4063), 681 children visited an audiologist prior to their diagnosis. Of these, children with *dysphoneidesia* (the mixed visual-and-auditory DD subtype) represented the highest number (n=285; 41.85%). Those with *dysnemkinphoneidesia* (motor-visual-auditory DD) followed closely with n=218 (32.01%). Visual or sight-word/whole word decoding dyslexia (*dyseidesia)* only provided four positive responses (0.59%). Table 1 comprises all instances of positive caregiver reports on their child visiting an audiologist prior to a specific DD diagnosis. Attention is drawn to significant comparisons between the different subtypes to triangulate certain patterns of data.

Table 1: DD Subtype Differences: Audiological Visits Prior to Diagnoses

SUBTYPE COMPARISON	**PROPORTION INDICATING PRIOR VISIT**	**P-VALUE p<0.05 statistically significant (*)**
Dyseidesia Dysnemkineidesia	0.060 0.136	0.148
Dyseidesia Dysnemkinesia	0.060 0.143	0.131
Dysnemkineidesia Dysnemkinesia	0.136 0.143	0.913
Dysnemkineidesia Dysnemkinphoneidesia	0.136 0.188	0.312
Dyseidesia Dysnemkinphoneidesia	0.060 0.188	0.008 (*)
Dyseidesia Dysnemkinphonesia	0.060 0.172	0.019 (*)
Dyseidesia Dysphonedeidesia	0.060 0.161	0.026 (*)
Dyseidesia Dysphonesia	0.060 0.163	0.026 (*)
Dysnemkineidesia Dysnemkinesia	0.136 0.143	0.913
Dysnemkineidesia Dysnemkinphoneidesia	0.136 0.188	0.312
Dysnemkineidesia	0.136	0.483

Dysnemkinphonesia	0.172	
Dysnemkindeidesia Dysphoneidesia	0.136 0.161	0.607
Dysnemkinesia Dysnemkinphoneidesia	0.143 0.188	0.426
Dysnemkinesia Dysnemkinphonesia	0.143 0.172	0.606
Dysnemkinesia Dysphoneidesia	0.143 0.161	0.739
Dysnemkinesia Dysphonesia	0.143 0.163	0.716
Dysnemkinphoneidesia Dysnemkinphonesia	0.188 0.172	0.480
Dysnemkinphoneidesia Dysphoneidesia	0.188 0.172	0.053
Dysnemkinphoneidesia Dysphonesia	0.188 0.163	0.201
Dysnemkinphonesia Dysphoneidesia	0.172 0.161	0.572
Dysnemkinphonesia Dysphonesia	0.172 0.163	0.702
Dysphoneidesia Dysphonesia	0.161 0.163	0.901

In Table 1 (and additional tables up to and including Table 6), results are depicted and interpreted as per this initial in-depth elucidation of the values in the first row of Table 1. For *dyseidesia* and d*ysnemkineidesia* the proportions were 0.060 (*dyseidesia*) and 0.136 (*dysnemkineidesia*) for individuals with these subtypes. A p-value of 0.148>0.05 indicated that the two proportions (0.060 and 0.136) were not statistically significant in difference. However, for *dyseidesia* and *dysnemkinphoneidesia* the p-value 0.008 < 0.05, denoted that the discrepancy of percentage of children diagnosed with *dyseidesia* (6.0%) who visited an audiologist prior to diagnosis yielded a statistically significant difference in comparison to those diagnosed with *dysnemkinphoneidesia* (18.8%). This significant difference suggests an association with children diagnosed with *dysnemkinphoneidesia* being more likely to have visited an audiologist before diagnosis than those diagnosed with *dyseidesia*. The next factor described and similarly interpreted is late speech development and its link to the various subtypes of SLD (DD).

Late Speech Development

The second factor relates to parent/caregiver reports of delayed speech development in their CWD. Table 2 includes all the subtypes regarding this factor and the significant differences are tabulated. Perusing the complete number of completed responses to this sub-section (n=4311), 615 children were reported to exhibit late speech development according to the typical milestones provided. Of these, children with *dysphoneidesia*, once again represented the highest number (n=256; 41.6%). CWD with *dysnemkinphoneidesia* once more followed closely with n=201 (32.7%). Motor-based writing DD (*dysnemkinesia*) only provided a single yes-answer (0.2%).

Table 2: DD Subtype Differences: Late Speech Development

SUBTYPE COMPARISON	**PROPORTION OF REPORTED LATE SPEECH DEVELOPMENT**	**P-VALUE p<0.05 statistically significant (*)**
Dyseidesia Dysnemkineidesia	0.083 0.083	1.00
Dyseidesia Dysnemkinesia	0.083 0.019	0.127
Dysnemkineidesia Dysnemkinesia	0.136 0.143	0.913
Dysnemkineidesia Dysnemkinphoneidesia	0.136 0.188	0.312
Dyseidesia Dysnemkinphoneidesia	0.083 0.165	0.066
Dyseidesia Dysnemkinphonesia	0.083 0.170	0.062
Dyseidesia Dysphonedeidesia	0.083 0.137	0.194
Dyseidesia Dysphonesia	0.083 0.122	0.341
Dysnemkineidesia Dysnemkinesia	0.083 0.019	0.133
Dysnemkineidesia Dysnemkinphoneidesia	0.083 0.165	0.093
Dysnemkineidesia	0.083	0.087

Dysnemkinphonesia	0.170	
Dysnemkindeidesia Dysphoneidesia	0.083 0.137	0.235
Dysnemkinesia Dysnemkinphoneidesia	0.019 0.165	0.005 (*)
Dysnemkinesia Dysnemkinphonesia	0.019 0.170	0.004 (*)
Dysnemkinesia Dysphoneidesia	0.019 0.137	0.014 (*)
Dysnemkinesia Dysphonesia	0.019 0.122	0.026 (*)
Dysnemkinphoneidesia Dysnemkinphonesia	0.165 0.170	0.824
Dysnemkinphoneidesia Dysphoneidesia	0.165 0.137	0.028 (*)
Dysnemkinphoneidesia Dysphonesia	0.165 0.122	0.014 (*)
Dysnemkinphonesia Dysphoneidesia	0.170 0.137	0.078
Dysnemkinphonesia Dysphonesia	0.170 0.122	0.028
Dysphoneidesia Dysphonesia	0.137 0.122	0.342

As captured in Table 2, parent/caregiver reports on their CWD diagnosed with *dysnemkineidesia* (1.9%) and *dysphonesia* (16.5%) differed significantly regarding late speech development. Comparably, *dysnemkinesia* (1.9%) and *dysnemkinphonesia* (17.0%), indicated a substantial difference as the latter "auditory-and-motor" combined DD diagnosis, is amplified in its link to later speech development. Another noteworthy stronger link with later talkers, is highlighted by the substantive difference between *dysnemkinesia* (1.9%) and *dysphoneidesia* (13.7%) where the latter is clearly a clear-cut factor. Similar significant differences between *dysnemkinesia* (1.9%) and *dysphonesia* (17.0%) also solidify this "auditory" factorial link. For *dysnemkinphoneidesia* (16.5%) and *dysphoneidesia* (13.7%); *dysnemkinphoneidesia* (16.5%) and *dysphonesia* (12.2%); and *dysnemkinphonesia* (17.0%) and *dysphonesia* (12.2%), the p-value also yielded significance regarding late speech development. The ensuing factor interpreted is reported *negative anger* as experienced by the CWD and the relationship with various DD subtypes.

Negative Anger

The third factor relates to parent/caregiver indications of negative anger feelings in their CWD. Table 3 includes all the subtypes and significant differences. The overall number of positive responses to this question was 2772, of which n=1002 (36.1%) children were reported to display feelings of anger. Of these, children with *dysphoneidesia*, yet again represented the highest number (n=424; 42.3%). CWD with *dysnemkinphoneidesia* followed with n=317 (31.6%). Motor-based written DD (*dysnemkinesia*) proved to be the least affected, with only five positive answers (0.5%).

Table 3: DD Subtype Differences: Negative Anger

SUBTYPE COMPARISON	PROPORTION OF INDICATION OF NEGATIVE ANGER	P-VALUE
Dyseidesia Dysnemkineidesia	0.238 0.382	0.173
Dyseidesia Dysnemkinesia	0.238 0.217	0.850
Dyseidesia Dysnemkinphoneidesia	0.238 0.376	0.070
Dyseidesia Dysnemkinphonesia	0.238 0.350	0.152
Dyseidesia Dysphoneidesia	0.238 0.356	0.110
Dyseidesia Dysphonesia	0.238 0.376	0.079
Dysnemkineidesia Dysnemkinesia	0.382 0.217	0.189
Dysnemkineidesia Dysnemkinphoneidesia	0.382 0.376	0.945
Dysnemkineidesia Dysnemkinphonesia	0.382 0.350	0.710
Dysnemkineidesia Dysphoneidesia	0.382 0.356	0.749
Dysnemkineidesia	0.382	0.930

Dysphonesia	0.376	
Dysnemkinesia Dysnemkinphoneidesia	0.217 0.376	0.119
Dysnemkinesia Dysnemkinphonesia	0.217 0.350	0.196
Dysnemkinesia Dysphoneidesia	0.217 0.356	0.169
Dysnemkinesia Dysphonesia	0.217 0.376	0.127
Dysnemkinphoneidesia Dysnemkinphonesia	0.376 0,350	0.432
Dysnemkinphoneidesia Dysphoneidesia	0.376 0.356	0.337
Dysnemkinphoneidesia Dysphonesia	0.376 0.376	0.979
Dysnemkinphonesia Dysphoneidesia	0.350 0.356	0.860
Dysnemkinphonesia Dysphonesia	0.350 0.376	0.500
Dysphoneidesia Dysphonesia	0.356 0.376	0.488

As seen in Table 3, negative anger associated with DD yielded no significant subtype differences in the proportion of participants diagnosed with the sub-types. These outcomes differed slightly from the factor of negative frustration to follow.

Negative Frustration

The fourth factor relates to parent/caregiver indications of negative frustration experienced by their CWD. Of the total number of responses in this section (n=2934), 1477 CWD felt frustrated when having to deal with certain subtypes of DD. Of these, children with *dysphoneidesia*, represented the highest number (n=639; 43.3%). Those with *dysnemkinphoneidesia* (motor-visual-auditory DD) trailed with n=465 (31.5%). *Dysnemkinesia* only had 10 positive responses (0.68%). Table 4 comprises all instances of the proportion of children with negative frustration feelings due to DD.

Table 4: DD Subtype Differences: Negative Frustration

SUBTYPE COMPARISON	**PROPORTION OF INDICATION OF NEGATIVE FRUSTRATION**	**P-VALUE**
Dyseidesia Dysnemkineidesia	0.457 0.605	0.174
Dyseidesia Dysnemkinesia	0.457 0.357	0.401
Dyseidesia Dysnemkinphoneidesia	0.457 0.530	0.329
Dyseidesia Dysnemkinphonesia	0.457 0.509	0.512
Dyseidesia Dysphoneidesia	0.457 0.503	0.534
Dyseidesia	0.457	0.882

Dysphonesia	0.445	
Dysnemkineidesia Dysnemkinesia	0.605 0.357	0.046 (*)
Dysnemkineidesia Dysnemkinphoneidesia	0.605 0.530	0.364
Dysnemkineidesia Dysnemkinphonesia	0.605 0.509	0.261
Dysnemkineidesia Dysphoneidesia	0.605 0.503	0.215
Dysnemkineidesia Dysphonesia	0.605 0.445	0.059
Dysnemkinesia Dysnemkinphoneidesia	0.357 0.530	0.071
Dysnemkinesia Dysnemkinphonesia	0.357 0.509	0.126
Dysnemkinesia Dysphoneidesia	0.357 0.503	0.126
Dysnemkinesia Dysphonesia	0.357 0.445	0.366
Dysnemkinphoneidesia Dysnemkinphonesia	0.530 0.509	0.520
Dysnemkinphoneidesia Dysphoneidesia	0.530 0.503	0.217

Dysnemkinphoneidesia Dysphonesia	0.530 0.445	0.005 (*)
Dysnemkinphonesia Dysphoneidesia	0.509 0.503	0.869
Dysnemkinphonesia Dysphonesia	0.509 0.445	0.101
Dysphoneidesia Dysphonesia	0.503 0.445	0.046 (*)

Following Table 4, negative frustration associations with different types of DD seem to be more evident than anger, albeit still not as prevalent as some of the other factors. *dysnemkineidesia* (60.5%) and *dysnemkinesia* (35.7%) showed a significant decline from the combined visual-motor DD to the motor-based DD alone. Likewise, children with *dysnemkinphoneidesia* (53.0%) are significantly more frustrated than those with only *dypshonesia* (45%) based on the p-value of 0.005<0.05 for this cohort. Moreover, regarding frustration on the side of those with diagnoses of *dysphoneidesia* (50.3%) and *dysphonesia* (45.0%), a statistically significant difference is also present.

Depression

The fifth factor relates to indications of reported depression with a diagnosis of DD (Table 5). The total number of responses in this section (n=2599) CWD felt depressed when dealing with certain subtypes of DD. Of these, CWD with *dysphoneidesia* represented the highest number n=268 (50,76%). Those with *dysnemkinphoneidesia* trailed by n=152 (28,79%). *Dysnemkinesia* had the least number of positive responses (n=0). Table 5 highlights all instances of the proportion of children with depression due to DD.

Table 5: DD Subtype Differences: Depression associated with a diagnosis of DD.

SUBTYPE COMPARISON	**PROPORTION OF REPORTED DEPRESSION**	**P-VALUE p<0.05 statistically significant (*)**
Dyseidesia Dysnemkineidesia	0.154 0.138	0.855
Dyseidesia Dysnemkinesia	0.154 0.000	0.058
Dyseidesia Dysnemkinphoneidesia	0.154 0.096	0.515
Dyseidesia Dysnemkinphonesia	0.154 0.138	0.797
Dyseidesia Dysphoneidesia	0.154 0.235	0.235
Dyseidesia Dysphonesia	0.154 0.185	0.632
Dysnemkineidesia Dysnemkinesia	0.138 0.000	0.076
Dysnemkineidesia Dysnemkinphoneidesia	0.138 0.196	0.437
Dysnemkineidesia Dysnemkinphonesia	0.138 0.138	0.994
Dysnemkineidesia Dysphoneidesia	0.138 0.235	0.221
Dysnemkineidesia	0.138	0.527

Dysphonesia	0.185	
Dysnemkinesia Dysnemkinphoneidesia	0.000 0.196	0.024 (*)
Dysnemkinesia Dysnemkinphonesia	0.000 0.138	0.068
Dysnemkinesia Dysphoneidesia	0.000 0.235	0.011 (*)
Dysnemkinesia Dysphonesia	0.000 0.185	0.030 (*)
Dysnemkinphoneidesia Dysnemkinphonesia	0.196 0.138	0.037 (*)
Dysnemkinphoneidesia Dysphoneidesia	0.196 0.235	0.043 (*)
Dysnemkinphoneidesia Dysphonesia	0.196 0.185	0.334
Dysnemkinphonesia Dysphoneidesia	0.138 0.235	0.001
Dysnemkinphonesia Dysphonesia	0.138 0.185	0.128
Dysphoneidesia Dysphonesia	0.235 0.185	0.053

Regarding the response "yes" for feelings of depression, there is a statistically significant difference in proportions between respondents experiencing depression with *dysnemkinesia* and those experiencing it with *dysnemkinphoneidesia* at the 0.05 significance level. Regarding

dysnemkinesia and *dysnemkinphonesia,* and *dysphoneidesia* and *dysphonesia,* there are marginally statistically significant differences present. Similarly, for *dysnemkinesia* and *dysphoneidesia; dysnemkinesia* and *dysphonesia; dysnemkinphoneidesia* and *dysnemkinphonesia; dysnemkinphoneidesia* and *dysphoneidesia; dysnemkinphonesia* and *dysphoneidesia* significant differences were determined. In terms of associations, the statistically significant differences observed indicate that feelings of depression are present in all but associated differently across certain subtypes of DD.

Prior Speech Therapy

The penultimate factor relates to indications of reported speech therapy prior to diagnoses of DD. The number of responses to this question was 4062, of which n=1453 (35.8%) children visited a speech-language therapist prior to their diagnoses. Of these 1453, children with the combined diagnoses of subtypes, *dysphoneidesia* (n=611; 42.1%), represented the highest number. CWD with *dysnemkinphoneidesia* followed with n=430 (29.6%). *Dysnemkinesia* yielded only 16 speech therapy related answers (1.1%). Table 6 includes the statistical results regarding this factor where only one significant difference between (*dysnemkineidesia* (0.492) and *dyseidesia* (0.349) can be seen.

Table 6: DD Subtype Differences: Speech Therapy services prior to diagnoses

SUBTYPE COMPARISON	**PROPORTION OF PRIOR SPEECH THERAPY**	**P-VALUE**
Dyseidesia Dysnemkineidesia	0.448 0.492	0.623
Dyseidesia Dysnemkinesia	0.488 0.327	0.187

Dyseidesia Dysnemkinphoneidesia	0.488 0.371	0.207
Diyseidesia Dysnemkinphonesia	0.488 0.359	0.167
Diyseidesia Dysphoneidesia	0.488 0.359	0.167
Diyseidesia Dysphonesia	0.488 0.349	0.113
Dysnemkineidesia Dysnemkinesia	0.492 0.327	0.083
Dysnemkineidesia Dysnemkinphoneidesia	0.492 0.371	0.062
Dysnemkineidesia Dysnemkinphonesia	0.492 0.359	0.051
Dysnemkineidesia Dysphoneidesia	0.492 0.359	0.051
Dysnemkineidesia Dysphonesia	0.492 0.349	0.031 (*)
Dysnemkinesia Dysnemkinphoneidesia	0.327 0.371	0.527
Dysnemkinesia Dysnemkinphonesia	0.327 0.359	0.649

Dysnemkinesia Dysphoneidesia	0.327 0.359	0.649
Dysnemkinesia Dysphonesia	0.327 0.349	0.747
Dysnemkinphoneidesia Dysnemkinphonesia	0.371 0.359	0.682
Dysnemkinphoneidesia Dyphoneidesia	0.371 0.359	0.682
Dysnemkinphoneidesia Dyphonesia	0.371 0.349	0.385
Dysnemkinphonesia Dysphoneidesia	0.359 0.359	1.000
Dysnemkinphonesia Dysphonesia	0.359 0.349	0.750
Dysphoneidesia Dysphonesia	0.359 0.349	0.750

Gender

The final factor relates to gender differences pertaining to DD subtypes. Of the total number of 4363 parent/caregiver responses who opted to indicate their children's preferred gender, n=1626 (37.3%) were female, and n=2737 (62.7%) male.

Table 7 encompasses all the subtype comparisons regarding this factor, where the p-values of the independent sample's proportions test are shown.

Table 7: DD Subtype Differences: Gender

SUBTYPE COMPARISON	PROPORTION REFLECTING GENDER DISTRIBUTION	P-VALUE
Dyseidesia Dysnemkineidesia	(f: 0.417, m: 0.583) (f: 0.556, m: 0.444)	0.107
Dyseidesia Dysnemkinesia	(f: 0.417, m: 0.583) (f: 0.365, m: 0.635)	0.564
Dyseidesia Dysnemkinphoneidesia	(f: 0.417, m: 0.583) (f: 0.334, m: 0.666)	0.150
Dyseidesia Dysnemkinphonesia	(f: 0.417, m: 0.583) (f: 0.397, m: 0.603)	0.749
Dyseidesia Dysphoneidesia	(f: 0.417, m: 0.583) (f: 0.360, m: 0.640)	0.324
Dyseidesia Dysphonesia	(f: 0.417, m: 0.583) (f: 0.449, m: 0.551)	0.598
Dysnemkineidesia Dysnemkinesia	(f: 0.556, m: 0.444) (f: 0.365, m: 0.635)	0.042 (*)
Dysnemkineidesia Dysnemkinphoneidesia	(f: 0.556, m: 0.444) (f: 0.334, m: 0.666)	<0.001 (*)
Dysnemkineidesia Dysnemkinphonesia	(f: 0.556, m: 0.444) (f: 0.397, m: 0.603)	0.017 (*)
Dysnemkineidesia Dysphoneidesia	(f: 0.556, m: 0.444) (f: 0.360, m: 0.640)	0.002 (*)

Dysnemkineidesia Dysphonesia	(f: 0.556, m: 0.444) (f: 0.449, m: 0.551)	0.107
Dysnemkinesia Dysnemkinphoneidesia	(f: 0.365, m: 0.635) (f: 0.334, m: 0.666)	0.640
Dysnemkinesia Dysnemkinphonesia	(f: 0.365, m: 0.635) (f: 0.397, m: 0.603)	0.663
Dysnemkinesia Dysphoneidesia	(f: 0.365, m: 0.635) (f: 0.360, m: 0.640)	0.934
Dysnemkinesia Dysphonesia	(f: 0.365, m: 0.635) (f: 0.449, m: 0.551)	0.242
Dysnemkinphoneidesia Dysnemkinphonesia	(f: 0.334, m: 0.666) (f: 0.397, m: 0.603)	0.020 (*)
Dysnemkinphoneidesia Dysphoneidesia	(f: 0.334, m: 0.666) (f: 0.360, m: 0.640)	0.142
Dysnemkinphoneidesia Dysphonesia	(f: 0.334, m: 0.666) (f: 0.449, m: 0.551)	<0.001 (*)
Dysnemkinphonesia Dysphoneidesia	(f: 0.397, m: 0.603) (f: 0.360, m: 0.640)	0.155
Dysnemkinphonesia Dysphonesia	(f: 0.397, m: 0.603) (f: 0.449, m: 0.551)	0.092
Dysphoneidesia Dysphonesia	(f: 0.360, m: 0.640) (f: 0.449, m: 0.551)	<0.001 (*)

As seen in Table 7, for *dyseidesia* and *dysnemkineidesia*, the proportions were calculated as 0.417 (female) and 0.583 (male) for *dyseidesia* and 0.556 (female) and 0.444

(male) for *dysnemkineidesia*. Since the p-value (= 0.107) is greater than 0.05, the gender distribution of individuals diagnosed with *dyseidesia* did not differ statistically significantly from those with *dysnemkineidesia*. The rest of the results for this section are interpreted as indicated as per this initial section.

Of note regarding *dysnemkineidesia* and *dysnemkinesia*, the proportions were calculated as 0.556 (female) and 0.444 (male) for the former, and 0.365 (female) and 0.635 (male) for the latter. With a p-value< 0.05, the gender distribution of individuals diagnosed with these two subtypes differs significantly. These significant numbers are also reflected for *dysnemkineidesia* and *dysnemkinphoneidesia*, *dysnemkineidesia* and *dysnemkinphonesia*, *dysnemkineidesia* and *dysphoneidesia*, *dysnemkinphoneidesia* and *dysnemkinphonesia*, *dysnemkinphoneidesia* and *dysphonesia*, and lastly *dysphoneidesia* and *dysphonesia*. The results indicate that gender distribution varies significantly across certain subtypes of DD which was certainly unexpected if one considers the traditional reports.

3.5 Discussion

The focus of this research study aimed to identify biological and etiological factors that significantly differ within the seven subtypes of SLD (DD) to describe their impact. The findings relating to the main objective of describing and comparing the different factors, alluded that there are various comparable etiological and biological factors illustrated across the various subtypes of DD which are reflected in Tables 1-7.

Concerning the sub-aim of establishing associations between the factors and the seven subtypes of DD, several novel observations originated from the data corpus. In terms of the *Audiologist visited prior to diagnosis*, associations between *dyseidesia* (sight/whole word recognition) and the following subtypes were established: *dysnemkinphoneidesia*, *dysnemkinphonesia*, *dysphoneidesia*, and *dysphonesia*. According to Werfel et al. (2020),

CWD may present with deficits in speech perception in noise, which may explain some of these decoding deficit associations. For example, CWD may present with inadequate rapid temporal auditory information processing (Rahimi et al., 2022), explaining the required audiological assistance as the main type of dysphonesia ("auditory dyslexia") is present in all these associations. Naturally, it is expected that a child with any kind of audiological disorder will present with delayed speech - and language development (Dynak et al., 2021). Following, therefore, is the factor of *late speech development.*

For this factor, *dysnemkinesia* (the impaired written formation of graphemes) was found to significantly link to the following subtypes: *dysnemkinphoneidesia*, *dysnemkinphonesia*, *dysphoneidesia*, and *dysphonesia* (all related to the initial *dysnemkinesia*, and combined forms including whole/sight word decoding and more complex auditory decoding). It was subsequently concluded that there are significant differences between *dysnemkinphoneidesia*, *dysphoneidesia*, and *dysphonesia* as these relate to speech – and language development. Late talkers unsurprisingly exhibit delays in these developmental areas. However, they may also present with deferred delays in literacy development in the areas of grammar, phonology, and reading accuracy (Dynak et al., 2021) – all of which may logically explain these findings. According to Kim (2021) CWD have less knowledge pertaining to vocabulary, syntax and phonological language constructs. Moreover, for the ensuing factor of *prior speech therapy received* the subtype *dysnemkineidesia* associates with *dysphonesia*, which further ratifies the findings as these challenges as a whole, form part of the roles and practice scopes of speech-language therapists (Wium & Louw, 2013). Virlet et al. (2024) state that the use of a proprioceptive intervention plan can improve CWD's linguistic capabilities (phonics -, orthographic -, and morphological instructions) by improving reading performance, eye movements, and the recognition of written words.

Following this devastating path of exacerbating factors as the CWD grows older, it is

therefore not surprising that *depression* is significantly associated with a diagnosis of SLD, particularly between *dysnemkinesia* alone and the following three subtypes: *dysnemkinphoneidesia*, *dysphoneidesia*, and *dysphonesia*. These associations between the main – and combining subtypes of DD align with the findings of Sahoo et al. (2015) who reported that approximately 30% of learners with DD experience comorbid depression, anxiety, and suicidal tendencies. Furthermore, Ihbour et al. (2021) concluded that individuals with DD exhibit higher levels of anxiety, depression, and diminished self-esteem compared to their non-dyslexic peers. These findings underscore the profound psychosocial impact of SLD and its subtypes on mental health - especially depression. And, naturally, the more compounded the subtype (e.g., *dysnemkinphoneidesia*, and *dysphoneidesia*), the greater the chance of depression due to a mixed involvement of auditory, visual, and written factors which exacerbate the academic challenges and feelings of unworthiness (Ihbour et al., 2021).

In terms of *negative anger*, there is no statistical significance between the various subtypes of SLD. However, even though no specific significant associations are present between different subtypes, it is important to remember that CWD notably often suffer from anger, frustration, and low self-esteem (Kaisar, 2020). This conclusion emphasises the importance of identifying these children at an early stage to help them overcome their learning difficulties. Moreover, Wilmot et al. (2023) reported that many children with reading difficulties report experiencing heightened negative emotions such as anger, frustration, and sadness in the school context specifically. These negative feelings may further intensify difficulties associated with SLD, including academic performance and emotional well-being (Livingston et al., 2018). Unsurprisingly, negative performance and emotions are closely interrelated to negative frustration.

Negative frustration - as reported in the present study - is significantly correlated with a diagnosis of SLD, being particularly more present in children with *dysnemkinphoneidesia* (a

multifaceted combination of phonetic and phonological awareness -, motor -, and sight word recognition challenges) than *dysphonesia* (involving mostly phonetic reading and spelling difficulties). Theodoridou et al. (2021) concluded in their study that school children with DD often face constant fear, anticipated failure, and frustration, which adversely affects their academic skills and self-esteem, which broadly correlates with our more specific findings in this regard. Prolonged exposure to these negative experiences can lead to increased frustration, lack of motivation, and in some cases, aggressive behaviours. As such, these stressors may contribute to difficulties in coping with stress and frustration, combined with possible dysregulation, highlights the link between negative frustration and the impact of DD on children's well-being and academic achievement.

Additionally, our study reflects a statistical significance between the more complex *dysphoneidesia* and stand-alone *dysphonesia* diagnosis as it relates to negative frustration in CWD. Authors Khan and Malik (2018) reiterate that most preschool CWD begin to develop emotional and behavioural problems as early reading instruction fails to match their learning style. This inability to meet the CWD's learning style and additional confusion about what is expected of them further creates frustration. These supportive findings make sense as poor sight word recognition (*dyseidesia*) and the slightly more demanding levels of phonetic decoding (*dysphonesia*) overtly get under way in the early school phases when phonological and phonemic awareness demands increase. Where both occur simultaneously (such is the case with *dysphoneidesia*), frustration is assuredly going to increase.

Considering the gender distribution profiles, the significant number proportions, as explained in terms of the p-values, refers. Substantial differences are noted across the two genders for most of the subtypes of DD. Taking into account more historical findings that substantiate the presence of gender differences regarding SLD (Jiménez et al., 2011), it may be assumed that the generally agreed-on prevalence (3:1 to 4:1 ratios male: female) would justify

the present results, agreeing with Arnett et al. (2017) that males are more frequently diagnosed with DD compared to females. However, more recently, with the elucidation of SLD as a spectrum disorder, the numbers seem to be more equal than previously thought. The possibility of stealth dyslexia and its less overt symptom presentation – for example – may account for underdiagnosis in the female groups and the overrepresentation of males (Arnett et al., 2017). The latter also seem to present with different self-accommodating strategies than their male peers (Liapi et al., 2024). Still, the overall present results, are even now aligned with the more historical views. However, the unique diagnostic subtyping arising from the SGDA tests may credibly contradict the traditional possible gender differences through the unique nature of the subtypes, and the gender factors which may be revealing these fine genetic and neurobiological discrepancies, psychosocial factors, and educational practices mentioned. Our findings therefore agree with Granocchio et al. (2023) in suggesting that, in general, males may be more susceptible to DD due to neurobiological, hormonal, and genetic factors. However, the finer subtyping of visual -, auditory - , and written DD, should be further investigated in this regard.

3.6 Conclusion and recommendations

This study has provided initial novel evidence regarding certain significant associations between the described biological and etiological factors and the different subtypes of CWD within SLD. By examining the intricate relationships between these factors and the seven distinct subtypes, the study offers critical insights that can inform the development of targeted, individualised interventions within a team of collaborative professionals for individuals with SLD. The findings underscore the necessity of considering these underlying factors when designing treatment approaches, ensuring that therapeutic strategies are not only comprehensive but also tailored to the unique needs of each subtype and the aggravating dynamics accompanying certain more complex combinations of DD subtypes. Collaboration with professionals to support these CWD regarding their emotional health, is also highlighted.

Moreover, this research emphasises the importance of identifying and addressing the specific biological influences that may contribute to the manifestation of SLDs, ultimately supporting more precise clinical interventions.

However, it is essential to acknowledge the study's limitations, particularly its focus on South African participants. These factors may limit the generalisability of the findings as our very specific diagnostic subtyping of DD is not necessarily generalisable to other more compact ways of diagnosing DD globally. Future research should aim to expand the participant pool to include more diverse populations and consider additional background factors not included in this study (such as possible genetic links, specific language impairments, and possible speech sound disorder associations). This continued research will provide a more comprehensive understanding of the factors influencing SLD and contribute to refining intervention strategies for this population.

3.7 Acknowledgments

We would like to acknowledge all our contributing authors for their specific roles in concluding this research. Specific gratitude is expressed towards the Principal CEO of SGDA who granted us access to the databases.

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Appendix A: Declaration Plagiarism

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Student Number: 42152347O

Degree: BA Speech-Language Pathology

I declare that this research report is my own original work. Where secondary material is used, this has been carefully acknowledged and referenced in accordance with university requirements.

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Degree: BA Speech-Language Pathology

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Full name: Eileen Linda Olivier

Student Number: U21500763

Degree: BA Speech - Language Pathology

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DEPARTMENT SPEECH-LANGUAGE PATHOLOGY AND AUDIOLOGY

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Full name: Dandelion Sonika Valkenburg

Student Number: U21430927

Degree: BA Speech-Language Pathology

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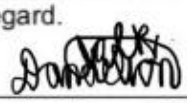

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Appendix B

Faculty of Humanities
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Lefapha la Bomotho

WHO Collaborating Centre for Prevention of Deafness and Hearing Loss

INFORMATION AND PERMISSION LETTER

Principal and CEO Sandra Stark

Stark Griffin™ Dyslexia Academy

3 Severn Drive
Three Rivers Vereeniging,

1935

29 October 2023

Dear Madam,

Re: Permission to use the Stark Griffin™ Dyslexia Data basis in research.

We are third-year students currently studying at the Department of Speech-Language Pathology and Audiology, at the University of Pretoria. This letter provides you with information to request permission to use your Stark Griffin™ Dyslexia Data basis in research.

Title of the study

An investigation into the differential diagnostic and etiological factors in the subtypes of Specific Learning Disorder (Developmental Dyslexia).

Purpose of the study:

Specific Learning Disorder (SLD) is manifested by a disorder in neurobiological anatomy and neurophysiological processes that are important for understanding and using both spoken and written language (Frolov & Schaepper, 2021). The individual with SLD will present with learning difficulties and impaired academic skills, which is manifested in one or more of the following symptoms: arduous word reading, struggling with reading comprehension, spelling, written expression, mastering number sense, number facts, and analytical reasoning.

There are many subtypes of SLD: reading disability (dyslexia), dyscalculia, dysgraphia, auditory processing disorder (APD), visual perceptual deficits (VPD), language processing disorder (LPD) and non-verbal learning disabilities (NVLD).

The specific subtypes of dyslexia are diagnosed by using direct assessment tools which will assess the individual's ability to decode, encode, and nemkinate (Zoubrinetzky et al., 2014). The assessment results need to adhere to the four criteria that have been specified in the DSM-V for dyslexia, before the individual may be diagnosed with dyslexia and the specific subtype (Stark et al., 2022).

Therefore, we want to determine, compare, and classify the different differential diagnostic and etiological factors in the seven subtypes of SLD (Specific Learning Disorder) (Developmental Dyslexia) and establish possible correlations between these factors.

Procedure

Once access is granted and the different differential diagnostic and etiological background factors, as well as the specific main and subtype diagnoses and their severity, and finally the specifically granted concessions for these diagnoses, will be classified, and investigated for the different statistical analyses.

Purposive sampling will be used in this research study. School-aged participants with a stand-alone Stark-Griffin™ Dyslexia Academy (SGDA) diagnosis of Developmental Dyslexia or co-

occurring with disorders such as Attention-Deficit-Hyperactivity-Disorder (ADHD) and attention deficit disorder (ADD) were included in the research study sample (Stark et al., 2022). Participants met a clear set of criteria to rule out exclusion factors such as primary diagnosis of cognitive impairment, scholastic deprivation and general reading and writing challenges as described in the DSM-V (American Psychiatric Association, 2013). In short, the participants must adhere to all four criteria as described by the DSM-V as required for a SLD (Developmental Dyslexia) diagnosis.

To determine, classify, compare, and correlate the distinct factors, we will capture the earmarked data sets in Excel sheets, and work closely with our collaborating statistician who will also be a co-author of this study. Specific statistical calculations will be discussed, described, and included in the data analyses section.

Data from this research study will be stored for 10 years in archive on a password protected computer in Room 3-1 at the Department of Speech-Language Pathology and Audiology at the University of Pretoria. Data will also be securely stored on the data repository of the University of Pretoria after the conclusion of the study for the same amount of time.

We will ensure not to misuse your data base, share, and distribute it or violate any copyright laws. After conducting our research, we will share our results and all other information with you as collaborator.

We therefore request permission in writing to conduct our research using your data basis to conduct our research study.

Please let us know if you require any further information.

Yours sincerely,

Researcher Group:

Name and Surname: Dandelion Valkenburg, Eileen Olivier, Isabel Turner, Kallyn van der Spuy and Cassidy Shaw, Salome Geertsema, Mia le Roux, and Heidi Mapisa.

Group leader: Cassidy Shaw

Contact number: 061 478 9363

Email address: u21523470@tuks.co.za

Supervisor:

Name: Prof. Salomé Geertsema

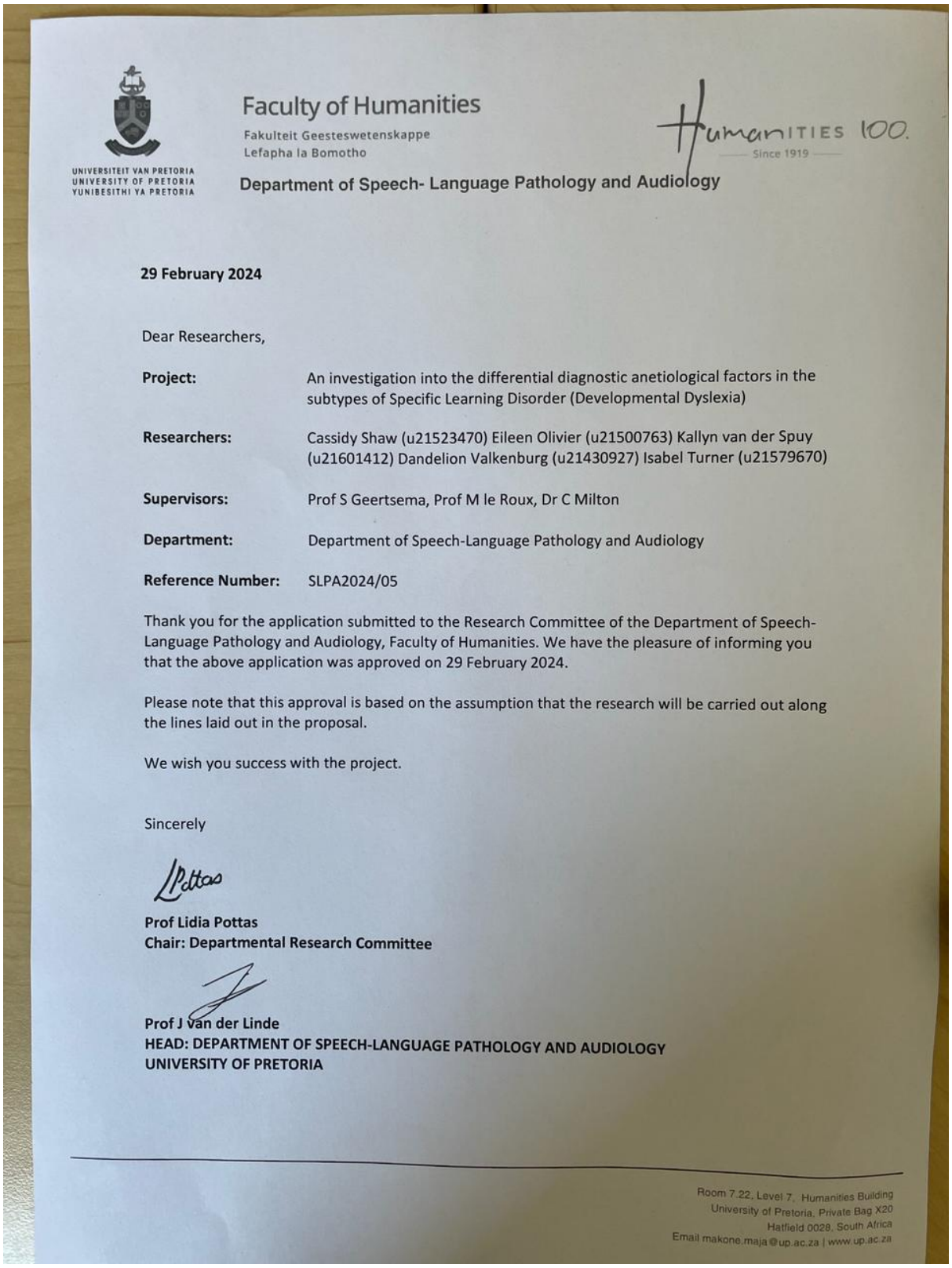
Contact number: 082 837 3640

Email address: salome.geertsema@up.ac.za

I, Mrs Sandra Stark, Principal and CEO of the Stark-Griffin™ Dyslexia Association, hereby grant this mentioned research team access to the data basis as requested. I understand that the anonymised data sets will only be used for the research purposes and planned scientific report which may stem from this research project.

Signed_____ Date: 2023-11-30

Appendix C



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Faculty of Humanities
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Humanities 100. Since 1919

Department of Speech- Language Pathology and Audiology

29 February 2024

Dear Researchers,

Project:	An investigation into the differential diagnostic anetiological factors in the subtypes of Specific Learning Disorder (Developmental Dyslexia)
Researchers:	Cassidy Shaw (u21523470) Eileen Olivier (u21500763) Kallyn van der Spuy (u21601412) Dandelion Valkenburg (u21430927) Isabel Turner (u21579670)
Supervisors:	Prof S Geertsema, Prof M le Roux, Dr C Milton
Department:	Department of Speech-Language Pathology and Audiology
Reference Number:	SLPA2024/05

Thank you for the application submitted to the Research Committee of the Department of Speech-Language Pathology and Audiology, Faculty of Humanities. We have the pleasure of informing you that the above application was approved on 29 February 2024.

Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal.

We wish you success with the project.

Sincerely

Prof Lidia Pottas
Chair: Departmental Research Committee

Prof J van der Linde
HEAD: DEPARTMENT OF SPEECH-LANGUAGE PATHOLOGY AND AUDIOLOGY
UNIVERSITY OF PRETORIA

Room 7.22, Level 7, Humanities Building
University of Pretoria, Private Bag X20
Hatfield 0028, South Africa
Email makone.maja@up.ac.za | www.up.ac.za

Appendix D

09-Oct-2024

Dear Professor Geertsema:

Your manuscript entitled "An Investigation into Etiological and Background Factors in the Subtypes of Specific Learning Disorder (Developmental Dyslexia)" has been successfully submitted online and is presently being given full consideration for publication in Journal of Research in Childhood Education.

Your manuscript ID is UJRC-2024-0224.

Please mention the above manuscript ID in all future correspondence or when calling the office for questions. If there are any changes in your street address or e-mail address, please log in to Manuscript Central at https://mc.manuscriptcentral.com/ujrc and edit your user information as appropriate.

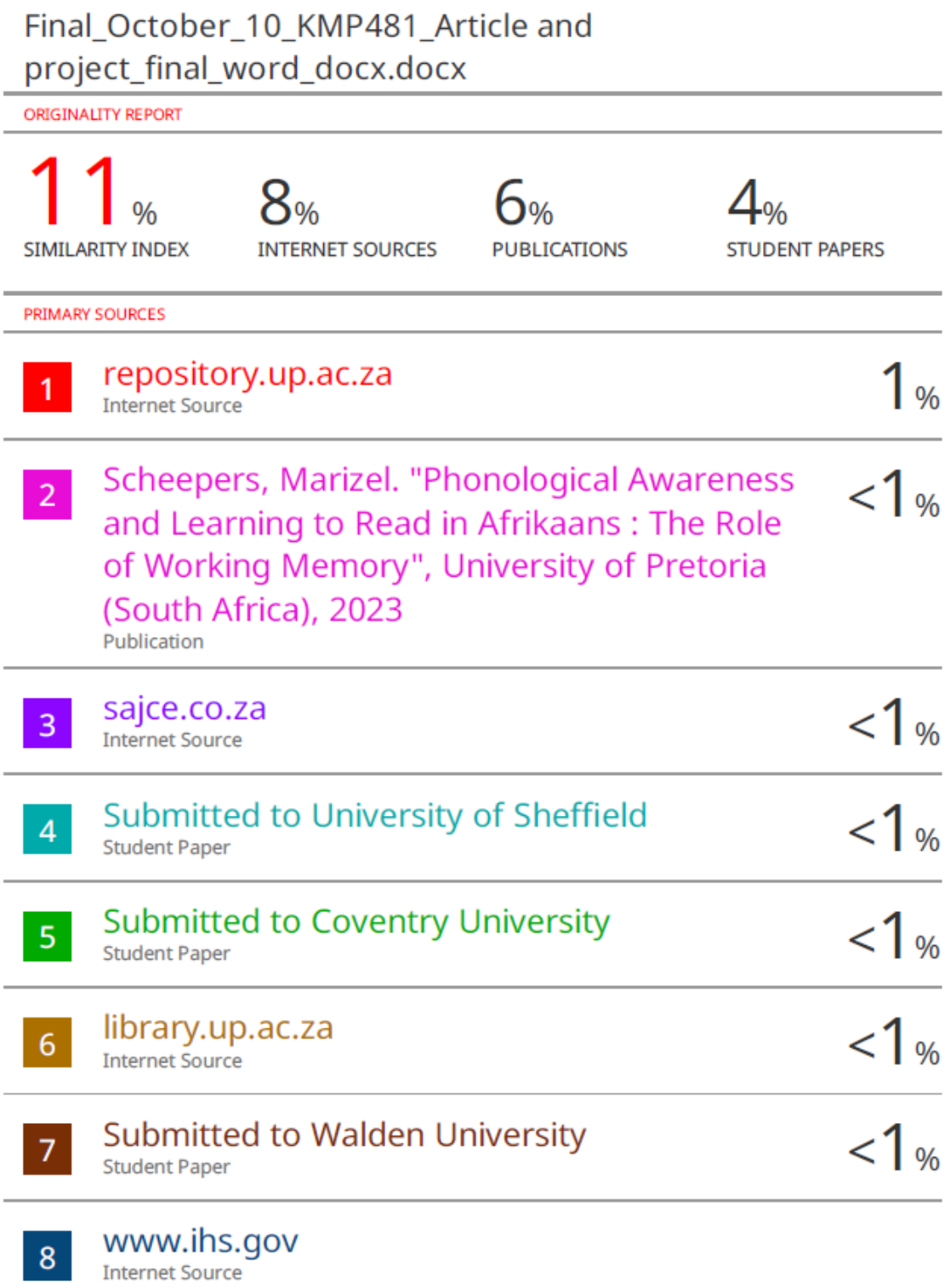
If you haven't already done so, Journal of Research in Childhood Education would like to encourage you to add an ORCiD ID to this submission. Please log in to Manuscript Central at https://mc.manuscriptcentral.com/ujrc to add your ORCiD ID to the article's information by adjusting your account settings.

You can also view the status of your manuscript at any time by checking your Author Center after logging in to https://mc.manuscriptcentral.com/ujrc.

Thank you for submitting your manuscript to Journal of Research in Childhood Education.

Sincerely

Appendix E



Final_October_10_KMP481_Article and project_final_word_docx.docx

ORIGINALITY REPORT

11%	8%	6%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	repository.up.ac.za Internet Source	1%
2	Scheepers, Marizel. "Phonological Awareness and Learning to Read in Afrikaans : The Role of Working Memory", University of Pretoria (South Africa), 2023 Publication	<1%
3	sajce.co.za Internet Source	<1%
4	Submitted to University of Sheffield Student Paper	<1%
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