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An International Perspective

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LEARNING DISABILITIES - AN INTERNATIONAL PERSPECTIVE

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Notice

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Meet the editor

Dr. Carolyn S. Ryan is a Licensed Psychologist, Licensed Behavior Analyst, and Board Certified Behavior Analyst-Doctoral. Dr. Ryan has served the field of autism, learning and developmental disabilities, and other related disorders and disabilities for over 25 years. Dr. Ryan earned her Ph.D., as well as her undergraduate and two masters degrees at Queens College and the Graduate Center of the City University of New York, CUNY. She owns her own company and has consulted through a variety of private and public situations while serving others. She is the author and co-author of several research articles, book chapter, and books in behavior analysis. Her articles appear in *Journal of Applied Behavior Analysis, Research in Autism Spectrum Disorders, The Behavior Analyst Today, The Psychological Record, Journal of Autism and Developmental Disorders, Behavioral Intervention, and Perceptual and Motor Skills.* Dr. Ryan made numerous presentations of data at local, invited addresses, state, national, and international conferences. She has served others by designing and directing programs, providing trainings, designing curriculum for students, supporting staff and students in educational and home settings, teaching undergraduate- and graduate-level coursework, supervising those pursuing the BCBA, assisting on boards, volunteering in the field, and providing behavior analytic services.

Contents

Preface

Learning disabilities are conditions that are associated with difficulties in knowledge and skill acquisition to the level expected of same-age peers, especially when the issues are not necessarily associated physical disabilities. Learning disabilities are neurological impairments. Individuals affected by learning disabilities may have difficulty in one or more areas, such as, reading, writing, spelling, reasoning, recalling, or organizing information independently. Typically, learning disabilities present life-long challenges for individuals. With proper assessment, support, and intervention, individuals with learning disabilities can succeed in educational and social situations. Support for individuals with learning disabilities may take many forms, such as, assessing individual skills, encouraging strengths, targeting deficits, understanding educational systems, presenting preventative measures, working with professionals, learning about strategies for dealing with specific challenges, intervening using effective methods, and conducting ongoing research.

The current text is an international examination of assessment methods, preventative measures, intervention, and research with those individuals with learning disabilities. International contributions are obtained from authors in the United States of America, Europe, Asia, and Africa. Current descriptions of learning disabilities are guided by the current versions of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, DSM-V, (2013) and the International Statistical Classification of Diseases and Related Health Problems, ICD-10, (2015). The book is divided into three main sections: Assessment of Learning Disabilities; Prevention and Intervention for Learning Disabilities; Research in Learning Disabilities.

The initial section on Assessment of Learning Disabilities investigates areas of classification of specific language impairments (Chapter 1), detection of learning disabilities in those with rasopathies (Chapter 2), and dyslexia (Chapter 3). The second section on Prevention and Intervention for Learning Disabilities pertains to prevention methods for those with reading and writing learning disabilities (Chapter 4), early intervention (Chapter 5) and response to intervention (Chapter 6). The final section on Research in Learning Disabilities presents methods of developing automaticity in children with learning disabilities (Chapters 7 and 8) and an examination of societal views (Chapter 9).

The text contributes to a broad understanding of world-views on learning disabilities. Each dedicated author presents unique perspectives on the topic of learning disabilities. Accordingly, the range of areas presented is unique. As editor, I am truly grateful for the opportunity to provide my support in the dissemination process that may inform future work in the field of learning disabilities.

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Section 1

Assessment of Learning Disabilities

Chapter 1

Classification and Detection of Specific Language Impairments in Children Based on their Speech Skills

Pavel Grill and Jana Tučková

Additional information is available at the end of the chapter

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Abstract

The ability to use the spoken language is one of the most important characteristics in child development. Speech is difficult to replace in real life, although there are several other options for communication. Inabilities to communicate with speech skills can isolate children from society, especially children with specific language impairments. This research study focused on a specific disorder, known as specific language impairment (SLI); in the Czech language, it is specifically known as developmental dysphasia (DD). One major problem is that this disorder is detected at a relatively late age. Early diagnosis is critical for successful speech therapy in children. The current chapter presents several different approaches to solve this issue, including a simple test for detecting this disorder. One approach involves the use of an original iPad application for detecting SLI based on the number of pronunciation errors in utterances. One advantage of this method is its simplicity; anyone can use it, including parents.

Keywords: specific language impairment, developmental dysphasia, pathological children speech, children speech database, artificial neural networks, formants

1. Introduction

Specific language impairment (SLI) [1–4] is a diagnosis in children with disordered or delayed language development without any reason for the disorder or delay. In children with this disorder, there are specific delays in the mastery of language skills without other developmental delays or hearing loss. Other names for this disorder include developmental dysphasia (DD), which it is frequently referred to in the Czech language, as well as language delay or developmental language disorder. Developmental language disorders are among the most

common learning disorders in children. Approximately 5–7% of all children aged 4–12 years old have these disorders [5]. The impact of these disorders in real life is that a child does not have the same speech skills as other children of the same age because his or her speech skills are delayed. Children with SLI fail to acquire their native language properly or completely despite having normal nonverbal intelligence, a lack of hearing problems, a lack of known neurological dysfunctions and a lack of behavioral, emotional or social problems [4]. These experiences can disrupt children's social lives and separate children from their contemporaries, which can create a specific social barrier. There is a relationship between the development of a child's language skills, age and success with treatment.

The determination that SLI includes a significant genetic component was demonstrated in various studies of heritability, for example, in a study of genetic etiology, a study of twins and a study of family evaluations [6]. SLI affected more boys than girls in another study [5]. The manifestation of the disorder primarily occurs in manipulating the linguistic rules of derivation and inflection, resulting in incorrect syntactic structures in their native tongue. Furthermore, there is reduced development of vocabulary at early ages. Usually, the production of language for those with the disorder is worse than their language comprehension. Various difficulties can be present in children with SLI in nonlinguistic cognitive skills, for example, motor ability, mental rotation or executive functions [7]. Other difficulties can be associated with impairments in reading and problems with working memory [8–11]. Many studies evaluate the problem underlying and causing the observed language difficulties. In these studies, theories of language acquisition as well as language representation and processing have been applied [4, 12]. The most frequently listed hypotheses for the causes of SLI are as follows:

(a) Slower linguistic processing despite relatively normal linguistic representation [4, 12];

(b) Normal linguistic and other cognitive skills with later timing in the onset or triggering of language acquisition processes, leading to developmental delay in language acquisition [13]; and

(c) Problems with grammar and specific subgroups of grammar, while cognitive abilities are relatively intact [14, 15].

The Laboratory of Artificial Neural Network Applications (LANNA) [16] at the Czech Technical University in Prague, with the participation of R&D Laboratory at the Military Technical Institute, collaborates on a project with the Department of Paediatric Neurology, 2nd Faculty of Medicine of Charles University in Prague, and with the Motol University Hospital. The project focuses on children with SLI. A partial aim of this project is to obtain data about SLI and speech disorders using automatic utterance analysis by self-organizing neural networks. The goal of this research is to determine the parameters that correspond to correlations across the results generated from diagnostics (from several different specialists, for example, speech therapists and specialists, psychologists, neurologists, and EEG and MRI tractography) and tests. LANNA uses methods based on computer speech analysis to determine whether children have SLI.

2. Methods

2.1. Ethical statement

The research was performed in compliance with ethical standards and was in accordance with the ethical standards of the Ethics Committee of Motol University Hospital in Prague, Czech Republic. The parents of the participants were informed and provided written informed consent for participation in this research.

2.2. Speech databases and participants

To investigate the effects of speech problems on children with SLI, it was necessary to create a speech database. The LANNA research group created the database [17]. The stimulus for its creation came from cooperation with the Department of Paediatric Neurology in the 2nd Faculty of Medicine of Charles University in Prague and Motol University Hospital, which was supported by grants from IGA MZ CR (Science Foundation of the Ministry of Health of the Czech Republic). The database contained three partial databases of speech recordings of the speech from the following different speaker types: H-CH (children without speech disorders), SLI-CH I (children with SLI), and SLI-CH II (children with SLI with three different degrees of diagnosis severity, which include mild, moderate and severe). This classification of degrees was chosen based on the decisions of speech therapists and specialists from Motol Hospital.

A total of 54 native Czech participants with SLI-CH II (hereafter referred to as *"cases"*) consisted of 35 boys and 19 girls, aged 70–131 months (mean age = 96 ± 16.3 months and median age = 94 months). The participants included in the study had to be examined by a clinical psychologist. The examinations were performed in the Department of Pediatric Neurology of the 2nd Faculty of Medicine of Charles University in Prague. The examination lasted all day, and the parents were present during the exam. The participants (children) were subjected to the following tests over one day: the Stanford-Binet Intelligence Test (Fourth Edition) [18]; Gessel Developmental Diagnosis [19], another standardized and specialized test for the Czech language (world differentiation and sound differentiation tests, auditory analysis and synthesis test); special graphomotor and perceptual skills tests; a test for visuomotor coordination; a test of figure drawing and tracing; and, finally, spontaneous talk evaluations [1, 2, 20, 21]. The inclusion criteria were the following: performance intelligence quotient (PIQ) ≥ 70; disturbed phonemic discrimination; and disturbed language at various levels, which included phonologic, syntactic, lexical, semantic and pragmatic levels [22]. The participants were assessed by other specialists. Neurological examinations showed no abnormalities. Motor milestones were within normal ranges. None of the children had hearing impairments. None were receiving antiepileptic medications. No child was diagnosed with a pervasive developmental disorder or other dominating behavioral problem. None of the children had a history of language or other cognitive regression [22].

A total of 44 native Czech participants from the H-CH subgroup (hereafter referred to as the *"controls"*) with no history of neurological and/or communication disorders were recruited

as a control group. There were 35 boys and 19 girls who were 70–124 months old (mean age = 106 ± 15.4 and median = 110 months). None of the controls underwent voice therapy.

All recordings, data and applications were saved on the server of the LANNA research group, and they are available to authorized users or those who have access to the server of the LINDAT/CLARIN Centre for Language Research Infrastructure. The saved data lack identifying information and are free to use, for scientific purposes, on the server of the LINDAT/CLARIN (http://hdl.handle.net/11372/LRT-1597) [23].

2.3. Procedures and speaking tasks

The selected utterances and first seven tasks, with the English translations of the original Czech utterances used in the current research, are listed in **Table 1**. Only words (a total of 38), no phrases or sentences, were chosen for inclusion from all suitable utterances.

Task code	Description	# Patterns	Language	Utterances
[T1]	Vowels	5	Czech	*„a – e – i – o – u“*
			English	*„a – e – i – o – u“*
[T2]	Consonants	10	Czech	*„m - b - t - d - r - l - k - g - h – ch“*
			English	*„m - b - t - d - r - l - k - g - h – ch“*
[T3]	Syllables	9	Czech	*„pe - la - vla - pro - bě - nos - ber - krk – prst“*
			English	*„pe - la - vla - for - bě - nose - take - neck – finger“*
[T4]	Two-syllable words	5	Czech	*„kolo - pivo - sokol - papír – trdlo“*
			English	*„wheel - beer - falcon - paper – boob“*
[T5]	Three-syllable words	4	Czech	*„dědeček - pohádka - pokémon – květina“*
			English	*„grandfather - fairy tale - Pokemon – flower“*
[T6]	Four-syllable words	3	Czech	*„motovidlo - televize – popelnice“*
			English	*„niddy noddy - television – dustbin“*
[T7]	Five-syllable words	2	Czech	*„různobarevný – mateřídouška“*
			English	*„varicoloured – thyme“*

Table 1. List of the vocal tasks.

Clinical psychologists and speech therapists collaborated on the selection of suitable utterances, and they formulated the test based on their own experience and acknowledged tests. With this test, the participants repeated spoken utterances, which were necessary to ensure the same conditions for all participants because the younger children could not yet read. The structures of the utterances included a range of words and phrases for a total of 68 different utterances. All utterances were previously described [17].

Only the participants and speech therapist were present during the recordings to maintain the participant's attention during the recording. The procedure of recording the participant was as follows. The participant repeated text after the speech therapist. The same conditions were used for both groups of participants (controls and cases). The recording equipment consisted of digital devices, specifically a digital Dictaphone from Sony Corporation (MD SONY MZ-N710) and an iBook laptop computer by Apple Inc., with professional solution software by Avid Technology, Inc. More information about the recordings of the H-CH and SLI-CH II subgroups can be found in a previously published study [17].

2.4. Processing the recordings and the software used

The following programs were used: Cool Edit Pro 2 [24] and Labelling [25, 26]. The Labelling program was used to segment the speech signal. It was written in the MATLAB programming environment as part of the SOMLab [26] programming system, which was developed in the LANNA. Statistics Toolbox in MATLAB [27] and R software were used for statistical computing [28]. The R Project for Statistical Computing is a language and environment for statistical computing and graphics. It is a GNU project that was developed at Bell Laboratories by John Chambers.

3. Error analysis: transcriptional analysis

In this part of the chapter, a new method, called error analysis, is presented to identify cases based on the number of pronunciation errors in the utterances. Pronunciation requires the ability to distinguish the sounds of spoken language via hearing. The cases had a distinctly impaired ability to aurally differentiate phonemes, and they could not distinguish acoustically similar words. These problems occur in the perception and processing of verbal stimuli, storage in memory and recall, including memory learning. These problems are related to acoustic-verbal processes. One requirement of pronunciation is the ability to distinguish the sounds of spoken language by hearing. Analysis was performed by comparison of the words pronounced by the cases versus the words pronounced by the controls, and it was focused on the description of errors in individual words. During the research on the cases, their utterances included many more errors than controls. These errors occurred across all age categories (our research included children aged 39–131 months).

3.1. Description

Three matrices, that is, reference matrix *[RM]*, test matrix *[TM]* and confusion matrix *[CM]*, and two parameters of utterance, that is, utterance of speech therapist $[ut_1]$ and utterance

of participant $[ut_2]$ (see **Table 1**), comprise the basic input for this method. *RM* is defined as a square reference matrix with *k* parameters. *K* is characterized as the number of phonemes in ut_1 or ut_2 depending on the size, where a larger *K* is more decisive (see the following equations):

$$RM = \begin{pmatrix} rm_{11} & rm_{12} & rm_{13} & \dots & rm_{1n} \\ rm_{21} & rm_{22} & rm_{23} & \dots & rm_{2n} \\ rm_{31} & rm_{32} & rm_{33} & \dots & rm_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ rm_{m1} & rm_{m2} & rm_{m3} & \dots & rm_{mn} \end{pmatrix} \quad (1)$$

$$\sum_{i=1}^{k} r\, m_{kk} = k \quad (2)$$

The number of errors is obtained as a penalty score from comparing the phonemes from ut_1 and ut_2 (see the following equation):

$$PS = wp + up + mp \quad (3)$$

where *PS* is the penalty score, *wp* is the number of incorrect phonemes, *up* is the number of unspoken phonemes and *mp* is the number of missing phonemes. A detailed description of the error analysis and all algorithms are provided in Ref. [29]. The input data for error analysis were the recorded ut_1 and ut_2, and the output from error analysis was a *PS* of the analyzed ut_2. In simple terms, comparison of the *TM* and *RM* matrices generates the *CM* matrix. The *CM* matrix contains all information about the errors in *ut2*.

3.2. Statistical evaluation and results

Research data were divided into two groups, controls (*p_h*) and cases (*p_sli*). The Shapiro-Wilk test for normality was used to determine that the data were statistically normal. The obtained scores (*p_h: W* = 0.9175, *p-val* = 0.00444; *p_sli: W* = 0.83, *p-val* = 2.28e−06) were too small to confirm the hypothesis that the groups had a normal distribution. The Wilcoxon's rank-sum test is a nonparametric test used as a substitute for the *t*-test. The obtained scores for *p_h* vs. *p_sli* (*w*) were as follows: *p-val* = 1.01e−15, *zval* = -8.3166 and *ranksum* = 963. The *p*-value was less than the significance level of 0.05; therefore, the null hypothesis of equal medians was rejected. There was sufficient evidence in the data to suggest that the controls and cases were not the same at the default 5% significance level, which was sufficient for significant contention. These results could be considered correct, and it could be argued that there was a significant difference in the number of errors in the speech of the cases and controls.

The results of the analyses of utterance errors are displayed in **Figure 1**, which presents all participants included in our current study.

The controls are displayed in red (or at a higher position), and the cases are displayed in blue (or at a lower position) or in grayscale. Pronunciation errors are displayed in the upper graph. A higher value indicates more errors. The cases had a total number of errors in their

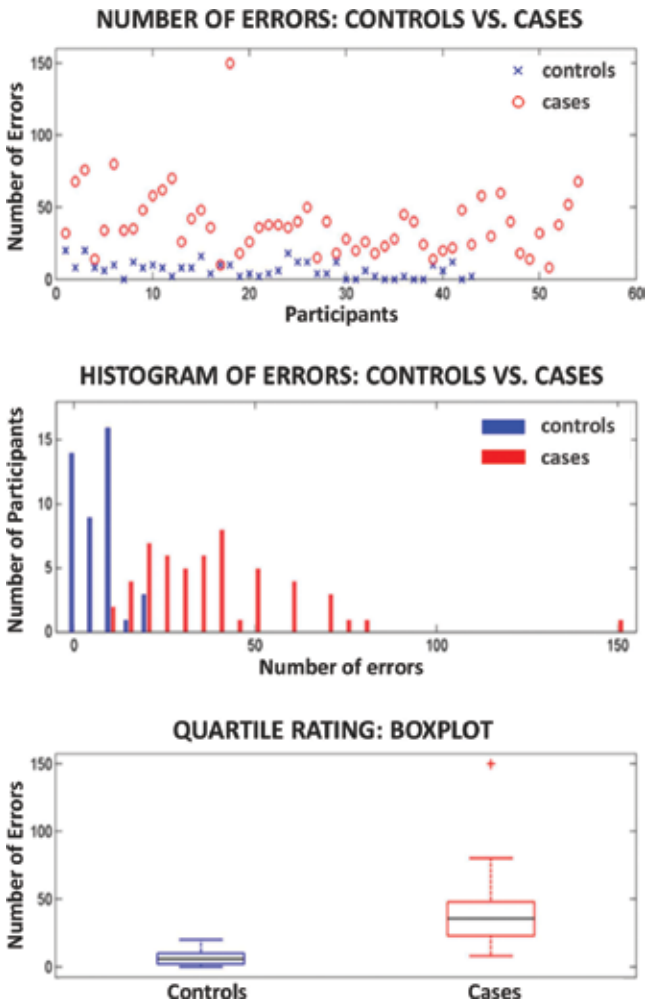

Figure 1. Evaluation of the error analysis. Data from controls are shown in blue (or at a lower position), and data from cases are shown in red (or at a higher position) or in grayscale. Samples with more errors are at a higher position in the upper graph. The histogram of the errors for each participant is shown in the middle graph. Boxplots represent the distributions of the numbers of utterance errors for controls and cases in the bottom chart.

utterances that was much greater than the number of errors for the controls. The distributions of utterance errors of the controls and cases are displayed in the middle graph. The distribution of utterance errors of the controls was clustered around the lower values compared with the distribution of the cases. Box plots representing the distributions of utterance errors of the controls and cases show clear differences between these groups. The cases made more errors in their utterances than controls of the same ages. **Table 2** shows the difference in the average number of errors between controls and cases.

The final evaluation of the error analysis results is shown in **Table 3**. The percentage success rate for the best method, *HM* (*"hand-made"*), was 93.81%. It was necessary to set the limits for each group as the thresholds using the maximum and minimum values from both groups.

Error analysis: controls vs. cases: participants					
Age category	**Average error**		**Difference 2 vs. 1**	**Comparison**	**Difference [%]**
	Cases (2)	**Controls (1)**			
All	38.89	4.93	33.96	2 vs. 1	688.84

Table 2. Error analysis: comparison of both groups: average number of errors for controls and for cases.

Error analysis: the success of classification				
Methods	**HM (%)**	**ANN1 (%)**	**ANN2 (%)**	**ANN3 (%)**
Classification for controls (*p_h*)	**95.35**	81.40	97.67	97.67
Classification for cases (*p_sli*)	**92.60**	88.89	83.33	87.04
Final classification	**93.81**	85.14	90.50	92.36

Table 3. Final results for classifiers based on the HM and ANN methods. The method with the highest rate of success in bold.

Classification labeled as misclassification (*"misclass"* in **Figure 2**) indicates the values located outside these limits. As the final criterion for the classification of several words containing an error, the group of cases comprised all children who had more than six words with any error during testing. Self-Organizing Maps (SOMs) [30], a subgroup of an Artificial Neural Network (ANN) [31], was the basis for the other three methods. Parameters for the ANN were set with a standard approach, that is, ratios were 0.7 for training, 0.15 for testing and 0.15 for validation. Differences were observed in the values for weights. ANN1 comprised original default values, ANN2 comprised minimum and maximum values from both groups and ANN3 comprised the weights set to the mean values of these groups. **Figure 2** provides a process diagram for the classification of the error analysis method.

Approximately the same final results are observed for both classifiers, but the HM classifier is easier to implement and use. The results indicate that children with SLI had a greater number of errors in their utterances than typical children.

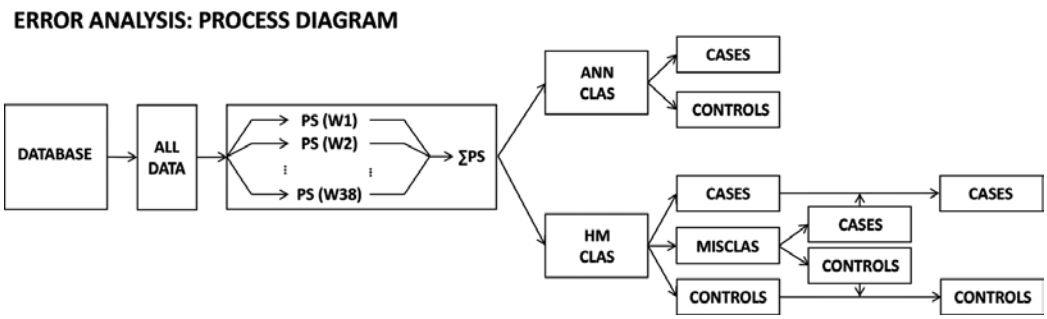

Figure 2. Process diagram illustrating the principle of error analysis. Overview and comparison of the classification through ANN and HM method.

4. Feature analysis: acoustic analysis

This part of the chapter presents a method, called feature analysis, based on the analysis of acoustic speech features. Children with SLI have a specific problem with the production and perception of spoken language as well as show signs of motor, auditory and phonology difficulties.

Achievements in the recognition of emotions were the inspiration for the use of this method of speech processing. An analogy between the research of emotions and the research of pathological speech, that is, speech of children with SLI, can be made. Typical children, who lack pathological changes in speech and a diagnosis of any disease, can be compared with a neutral emotion. Children with SLI can be compared with some unspecified emotion, for example, anger or fear.

This method is focused on acoustic speech parameters from individual words. Analysis was performed by comparing the words pronounced by the cases versus the words pronounced by the controls. The aim is to identify features that can be used to uniquely identify cases.

4.1. Description

The examined issue, the classification of children with SLI, has the following implementation structure. The implementation can be divided into four parts whose respective key components can be described as follows:

(a) Input data: The data used to identify children with SLI were selected from our speech database, particularly from the H-CH (44 participants from controls) and SLI-CH II (54 participants from cases) subgroups.

(b) Feature extraction: The OpenSMILE toolkit [32] was used to extract acoustic speech parameters. This software pack can produce a wide range of acoustic speech features. The obtained feature set for description of the speech signal contains a total of 1582 acoustic features, that is, 21 statistical functionals used for 34 low-level descriptors (LLDs) and their deltas, which were calculated every 25 ms from the speech signal. The names and numbers of the 34 low-level descriptors as they appear in the output file are as follows: *pcm_loudness (1), mfcc (15), logmelfreqband (8), lspfreq (8), f0finenv (1) and voicingfinalunclipped (1)*. The names of the 21 functionals are as follows: *maxpos, minpos, amean, linregc1, linregc2, linregerra, linregerrq, stddev, skewness, kurtosis, quartile1, quartile2, quartile3, iqr1-2, iqr2-3, iqr1-3, percentile1.0, percentile99.0, pctlrange0-1, upleveltime75 and upleveltime90*. A more detailed description is given in the openSMILE toolkit tutorial [32].

(c) Many features increase the probability of successful classification as well as increase the possibility of calculating redundant or irrelevant data. The procedure of feature selection was as follows: a value of 1 indicates correct classification, and a value of 2 indicates incorrect classification or so-called *"misclassification."* The whole process is provided in **Figure 3**, and more information is provided in a previous study [17]. Finally, those features that have the best classification rate are selected.

(d) Classification: The classification of the children into two groups, controls and cases, was relatively simple. The evaluation of the selected speech features of all words (selected words listed in **Table 1**) in this study was performed. The resulting classification for each participant was evaluated from the winning class based on the number of classifications (i.e., a value of one corresponded to the correct classification, and a value of two corresponded to a misclassification). Two different approaches of feature selection were used (FS: constant and FS: variable) for classification. For the variable type, properties with the highest accuracy rate (with more than a 90% success of classification for each word) were selected. For the constant type of feature selection, participants were classified using 268 features obtained from 38 words. If a constant number of features (with the 30 best parameters for each word) was used, each participant was classified using 760 features. The entire process of identifying the children with SLI is shown in **Figure 4**. Comparison of the approaches of feature selection is shown in **Figure 5**. The success rate of classification of the FS variable is shown in red (or is presented as the top values), and that of the FS constant is shown in blue (or is presented as the bottom values) or by grayscale. The horizontal line in this chart is the critical line for classification success. The x-axis represents all words, and the y-axis represents the success rate as a percentage.

4.2. Statistical evaluation and results

The data were divided into four groups depending on the classification, that is, correct or incorrect classification for controls (*p_h*) and correct or incorrect classification for cases (*p_sli*). The number of classifications was based on the evaluation of features. Statistical tests evaluated the correct versus incorrect classification of selected features for both groups of children.

The scores of the Shapiro-Wilks test for normality are as follows: for *p_h*, correct: $W = 0.5969$ and $p\text{-}val = 8.965e{-}10$ and wrong: $W = 0.5678$ and $p\text{-}val = 3.567e{-}10$; for *p_sli*, correct: $W = 0.7825$ and $p\text{-}val = 1.598e{-}07$ and wrong: $W = 0.7898$ and $p\text{-}val = 2.344e{-}07$. These values were too small ($p\text{-}val < 0.05$) to use to confirm the hypothesis that the groups have a normal distribution. The

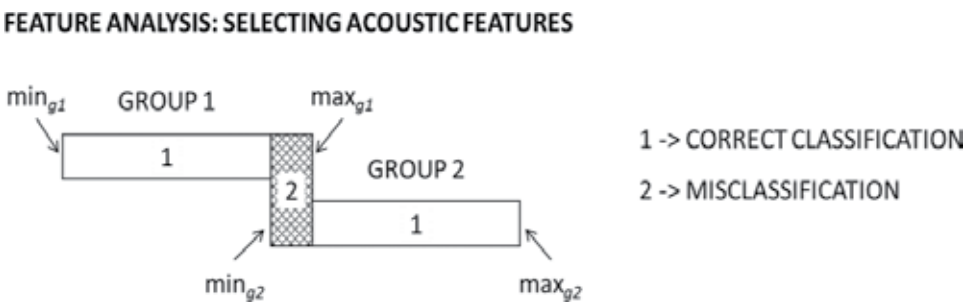

Figure 3. Procedure for selecting appropriate acoustic features. The value of 1 indicates correct classification, and the value of 2 indicates incorrect classification. Parameters "max_{g1}" and "min_{g2}" indicate maximum and minimum threshold limits for incorrect classification.

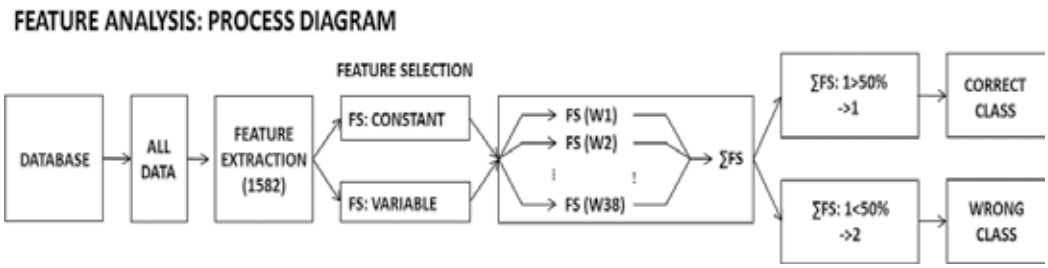

Figure 4. Process diagram illustrating the principle of feature analysis. Overview of the classification individual groups.

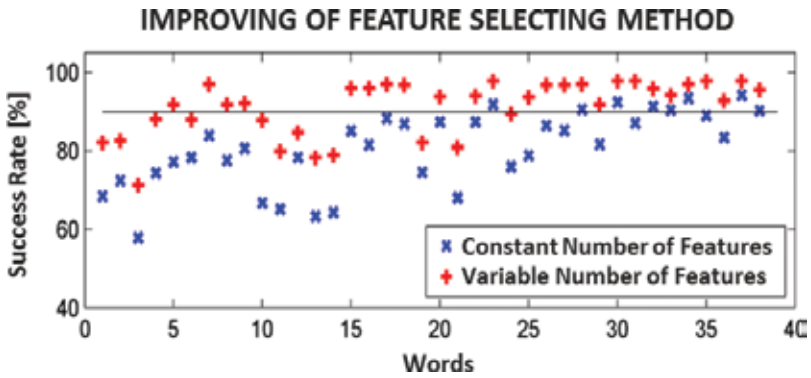

Figure 5. Feature analysis: improving of feature selection method. The success rate of classification of the FS variable is shown in red (or is presented as the top values), and that of the FS constant is shown in blue (or is presented as the bottom values) or by grayscale.

scores of the Wilcoxon rank-sum test, which was used as a substitute for the *t*-test, are as follows: for *p_h*, correct vs. wrong: *p-val* = 1.7510e−15, *zval* = 7.9578 and *ranksum* = 2911; for *p_sli*, correct vs. wrong: *p-val* = 3.3145e−19, *zval* = −8.9577 and *ranksum* = 1485. The null hypothesis of equal medians was rejected because the p-values were too small, that is, a smaller one than the significance level was set, and the values for the group were not the same at this significance level. These results indicate significant differences in the number of classifications between wrong and correct evaluations for controls and cases.

Table 4 presents the final evaluation used to distinguish the two groups, that is, controls vs. cases. The success rate was almost 97%, exactly 96.94%. Three participants (from controls) out of 98 were classified incorrect. Obtained results proved that it is possible to find method based on the acoustic features that can distinguish typically children from children with SLI with high accuracy.

The results of the feature analyses for all participants are displayed in **Figure 6**. Correct classifications of the control group are displayed in blue (or at a higher position), and incorrect classifications of the cases are displayed in red (or at a lower position) or by grayscale. The upper graph showed the total number of classifications where the values in the higher positions indicate a more successful classification. The middle histogram represents the

Feature analysis: evaluation of percent success rate				
Age category	**Classification of participants**			**Success rate [%]**
	Group	**Correct**	**Wrong**	
All	P_SLI (2)	54	0	100.00
	H-CH (1)	44	41	93.18
	∑(1 + 2)	**98**	**95**	**96.94**

Table 4. Evaluation of percent success rate of method based on the acoustic features. The final success rate is in bold.

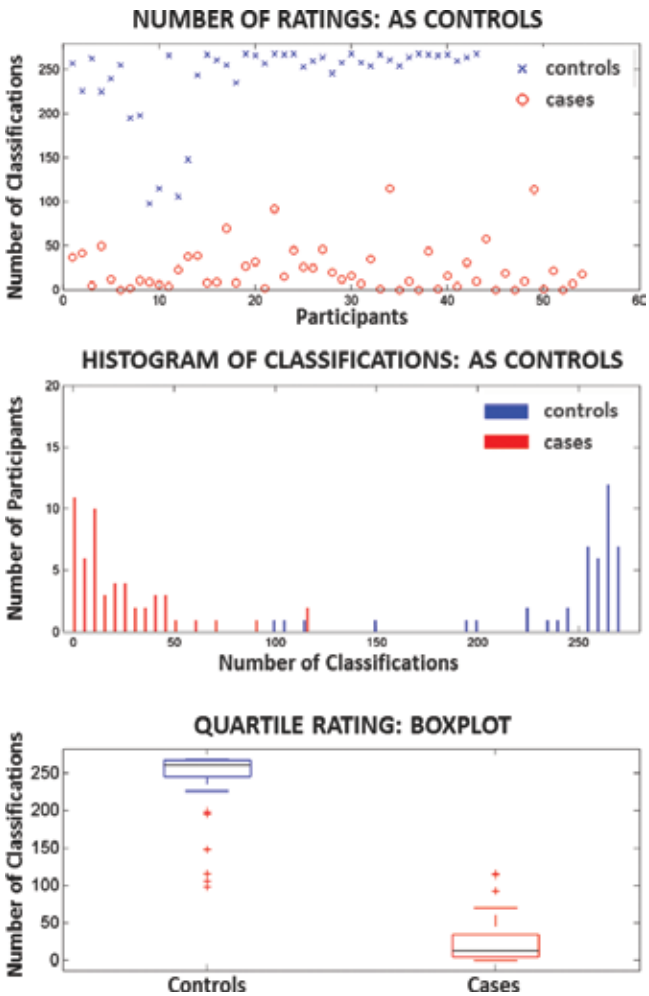

Figure 6. Evaluation of the feature analysis for cases. The correct classification is shown in blue (or at a higher position), and incorrect classification is shown in red (or at a lower position) or in grayscale. Samples with a more successful classification are at a higher position in the upper graph. The histogram represents the distributions of the correct classifications of controls and incorrect classifications of cases (more classifications in the right) in the middle graph. The boxplots show significant differences between the correct (the left boxplot) and incorrect classifications (the right boxplot) in the bottom chart.

distributions of the correct classifications of controls and incorrect classifications of cases. Participants in the higher positions (in the right part of the chart) have more successful classifications. The bottom boxplots show significant differences between the correct (blue or the left boxplot) and incorrect classifications (red or the right boxplot). There was an analogous situation for cases.

5. Time duration analysis

The children with language impairment, regardless of the severity, had reduced processing and response speeds on a range of tasks. Generally, it can be assumed that analogies to this issue will be related to questions about the average duration of spoken utterances.

The procedure of the experiment was as follows. The average duration was calculated for all words and all participants. Obtained values were divided into two groups. The first group contained the values from controls, and the second group contained the values from cases. Both groups were compared with an average duration of each word.

The evaluation of the time duration is displayed in **Figure 7**. The x-axis represents all words, and the y-axis represents time (s). The time values for cases are displayed in blue (the lower curve), and the time values for controls are displayed in red (the upper curve) or grayscale. **Table 5** illustrates the average duration of all words for both groups. The result is an average duration for cases that is approximately 27.56% higher than that of controls.

The table and figure show that the children with SLI had a longer duration of words than the typical children. This experiment verified the hypotheses about the speed of processing and response for a range of tasks.

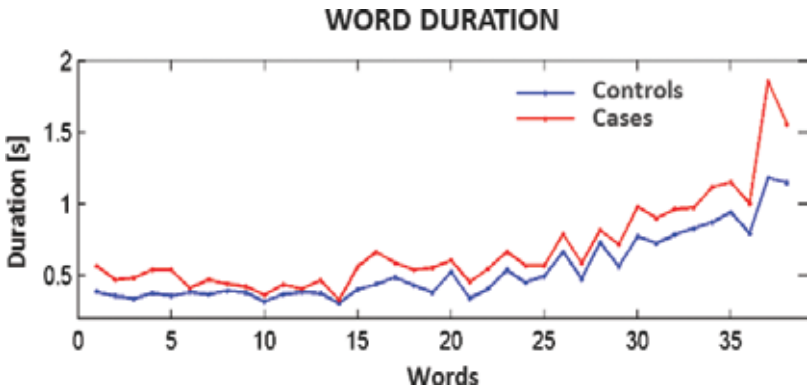

Figure 7. Average duration of words at controls and cases. The time values for cases are displayed in blue (the lower curve), and the time values for controls are displayed in red (the upper curve) or grayscale.

Word duration: controls vs. cases				
ID	**Group**	**Average duration [s]**	**Comparison**	**Difference [%]**
1	Controls	0.54		
2	Cases	0.69	2 vs. 1	**27.51**

The percentage rates of correct classification of the method used to distinguish the two groups.

Table 5. The success of classification. The final percent rate of difference of the time duration between controls and cases in bold.

6. Formant analysis

The ability to produce and perceive speech originates in certain parts of the human brain. SLI is described as a neurological disorder of the brain [20–22]. Formants are normally defined as the spectral peaks of the sound spectrum of the voice (or the concentration of acoustic energy in the vicinity of a specific frequency). In speech frequency, there are multiple instances of such peaks (or formants) and each of them is found at a different frequency. A physical dimension of the formants as a classification parameter is based on the presence of an acoustic energy across the speech spectrum, that is, the formants are affected by the movement of the articulatory system based on the human brain activity. This hidden relationship of formants can be used for classifying children with SLI. One of the conditions for using formants as classification parameters is the ability to calculate formants with a minimal error rate. Originally, the extraction of formant frequencies from speech signals was done by using PRAAT [33] acoustic analysis software. However, since the use of the PRAAT software produced formant classification errors in the course of the analysis, the results obtained using this approach could not be treated as relevant (specifically the use of Burg's algorithm to compute formants with method: *"To Formants (burg)…"*). To acquire suitable formants (formants with a minimal error rate), FORANA, a software tool, was developed [34].

Formants provide information about the vowels in the frequency spectrum when the two conditions are fulfilled, that is, the formants must be correctly classified and the utterance must be properly spoken. Especially if we put the first two formants (F1 and F2) into context with each other, we get what we refer to as vocalic triangle. The triangle divides individual vowels into three different categories, depending on the position of the given formant. The first category is represented by the vowel *"a"*, the second category is represented by *"e"* and *"i"* and the third category is represented by *"o"* and *"u"* for the Czech speech. The main idea of using formants and vocalic triangle is to verify the correctness of the spoken utterances by using precisely defined vowel locations in the vocalic triangle. Participants from cases (children with SLI) have problems with correctly speaking difficult utterances or words compared with participants from controls (typically children). Formant analysis clearly verifies whether the vowels are correctly pronounced. Otherwise, if there are any errors in the analyzed vowel, there is a shift in the frequency spectrum. This observation means that the speakers have articulatory organs in a bad position and the distribution of articulatory cavities is the wrong shape for forming vowels. This positioning leads to the malfunction of speech control in the brain, which can be used to classify and identify children with SLI. More about this issue can be found in prior studies [35–38].

http://dx.doi.org/10.5772/intechopen.69464

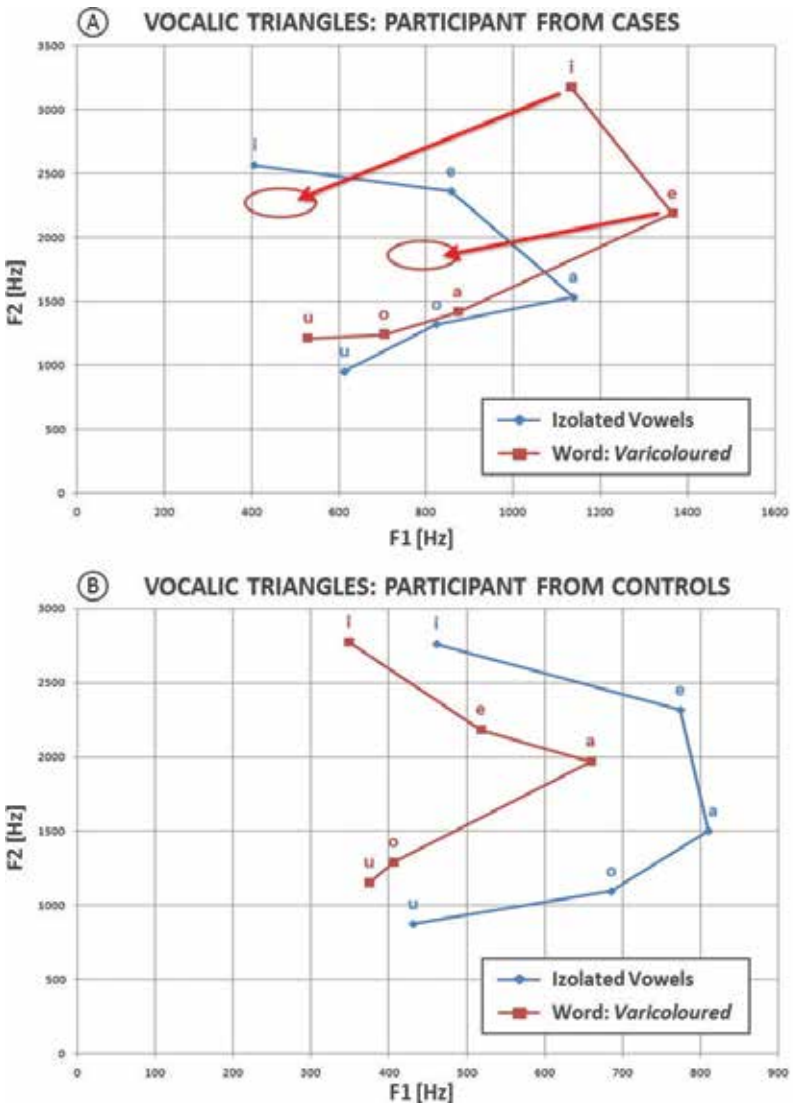

Figure 8. Vocalic triangles, upper chart, obtained from child with SLI and vocalic triangles, lower chart, obtained from typically child. Both children were at age 10 years.

This experiment is based on the comparison of two different vocalic triangles for all tested individuals. Speech signal analysis was performed for the following two types of participants. Participants were chosen randomly, and both were at the same age. One was from cases (from the SLI-CH II group), and the other was from controls (from group H-CH). Both participants were analyzed by using the same utterances, namely isolated vowels and word "*různobarevný*" (in en: "*varicoloured*"). This particular word contains all vowels, and it therefore makes it possible for us to make a comparison between the different vowels. The upper chart (part A in **Figure 8**) represents participant from cases, and the bottom chart (part B in **Figure 8**) represents participant from controls. Both charts show two vocalic triangles, a blue (or the one on the left) one for the isolated vowels and a red (or the one on the right) one for the vowels

in *"různobarevný"* (in en: *"varicoloured"*). The vocalic triangle is presented for simple speech, that is, for isolated vowels; on the other side, the vocalic triangle is absent for more complex speech, that is, for word "různobarevný" (in en: "varicoloured"). The arrows point to the positions where the vowels should be located under ideal circumstances. This corresponds to the situation in the upper chart (part A in **Figure 8**). This particular example can be used to demonstrate a relationship between the complexity of the words being spoken and the shift in the speech sound frequency spectrum in children with specific language impairments. Bottom chart (part B in **Figure 8**) shows the vocalic triangles obtained from participant from controls; the triangle is present for both situations (simple speech and speech that is more complex).

Formant analysis: vocalic triangle classification			
Participants	Classification		
	Correct	**Wrong**	**Not**
24	21	1	2
Success rate [%]	87.50	4.16	8.34

Twenty-one participants were classified into the correct class, controls vs. cases, one participant was classified into the wrong class and two participants were not classified (based on real example, two recordings were analyzed for one participant; the result obtained from the first recording was determined as controls, and the result obtained from the second recording was determined as controls).

Table 6. Success rate of method is based on the vocalic triangle classification.

The experiment only involved participants from cases. A total of 24 participants were randomly selected with 54 recordings. Some participants had one speech recording on record, and some had several. The whole experiment was based on the comparison of the two different vocalic triangles, namely isolated vowels (*"a"*, *"e"*, *"i"*, *"o"*, *"u"*) and multisyllabic word *"různobarevný"* (in en: *"varicoloured"*). A prerequisite of this method is the difference in the shape of the vocalic triangles, that is, for isolated vowels, it has the correct shape, while the shape for multisyllabic word is misshapen. The three possible classifications were obtained, that is, correct, wrong and not classified. The results obtained from the vocalic triangle classification method are shown in **Table 6**.

7. SLIt tool

The test of Specific Language Impairments (SLIt tool) is a tablet application that uses a very simple test for identifying children with SLI on an iOS platform (Apple, Inc.), specifically for use on an iPad (iPad third generation or newer) that is based on the procedures used in error analysis. The aim was to create a simple tool that is user-friendly and is easy to use for anyone, for example, parents. Devices such as tablets are light and portable. The test is possible to perform anywhere, for example, at home, instead of only in a specialized clinic.

Figure 9 shows an application SLIt Tool. An application is divided onto four parts. Part 1 contains text from the research for testing children (see **Table 1**). Part 2 contains tools for recording speech. Part 3 contains the corrective mechanisms from error analysis. In the last part (4), a final evaluation of the test is performed. It is possible to view general information about our research on children with SLI and about this application, for example, description of SLI, specification of users, advantages of application and information about the supporting grant.

The test for a child is a very simple, and the course of recordings proceeds the same way as in our research. The procedure is as follows:

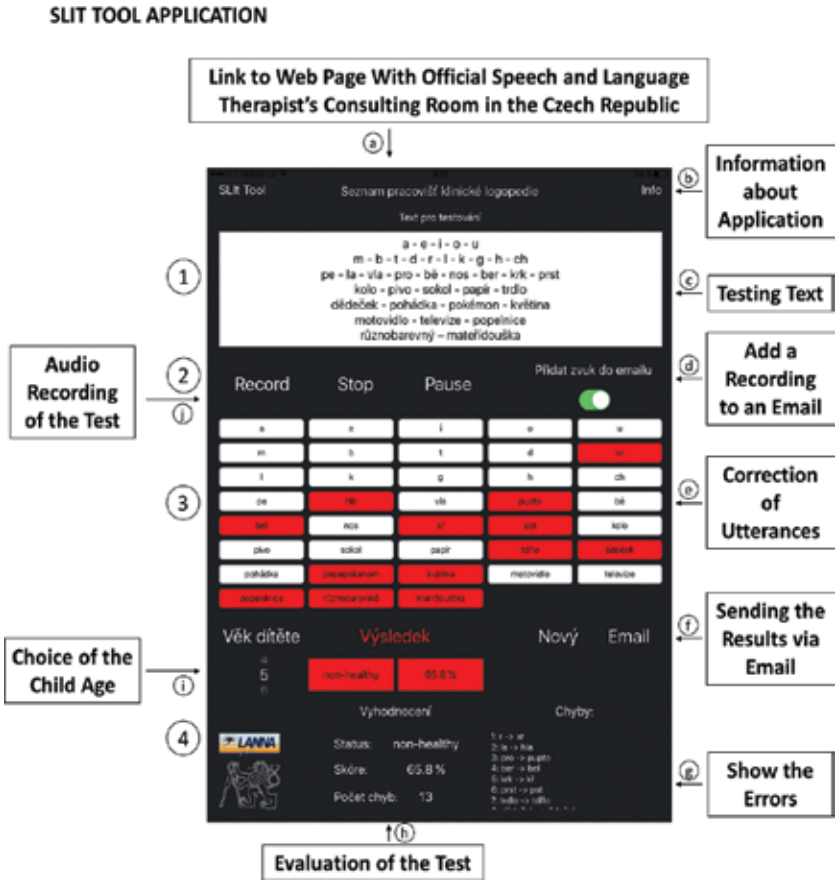

Figure 9. Screen shot of SLIt Tool application on an iOS platform. This figure shows a basic window for testing of the children. Labels inside the rectangular black boxes describe the main functions and possibilities of using this application (description using the letters beside the arrows): (a) link to web pages of the professional association of clinical speech pathologists; (b) complete description and instructions for use an application; (c) text for testing children; (d) the possibility of choosing to send an audio recording of the test via email; (e) the possibility to make corrections in spoken words; (f) the possibility of choosing to send the test via email to speech and language pathologist; (g) all errors of the test are displayed in this part; (h) final evaluation of the test is displayed in this part; (i) choice of child's age and (j) possibility to make an audio recording of the test.

(a) A parent or someone else reads the text, and the child repeats the same text (see **Table 1**).

(b) The child's speech can be recorded for later replay and evaluation.

(c) The text box for the correction of spoken words is pre-filled. The wrong form of a spoken word needs to be replaced, for example, changing the wrong form of the word *"nos"* (in en: *"nose"*) to "*los*" (based on real example).

(d) The final evaluation, test results and recording of the child's speech can be sent to a speech therapist for a more detailed classification.

The application allows for viewing of a list of therapeutic consulting rooms, which are associated with the professional association of clinical speech pathologists in the Czech Republic (AKL CR). Here, it is possible to identify concrete speech and find a language pathologist who can evaluate the results via email. This email with the test evaluation also contains information about the test, the obtained errors, a recommendation based on the final score and an audio recording of test. Audio recordings can be especially beneficial in a comprehensive report on the possible language and speech difficulties of a child. The SLIt Tool is free to use and is available from iTunes.

8. Artificial neural networks analysis

The Supervised Self-Organizing Map (supervised SOM, or SSOM) is based on clustering. These maps and their subsequent visualization help to monitor the progress of trends and magnitude of the degree of impairment. The algorithm of the SSOM represents a very effective classification approach, but it is only effective for well-known input data or for well-known classes of input data. ANNs were selected because of their notable robustness and strong ability to perform data visualization; hence, they can also process less qualitative signals.

8.1. Description of method

This study included 72 controls and 14 cases. The goal was to categorize the subjects into two classes, controls vs. cases. We obtained the results from the speech analysis via vowel mapping with speech from cases by SSOM.

SSOM classification: SSOM was formed by a two-dimensional map with 24 × 24 units. The type of map had a hexagonal grid with a random initialization of the vectors. The following two stages of training were used:

(a) The first stage (rough): The Batch Map algorithm was used with the Gaussian neighborhood function, which decreased monotonically from 24 to 1. The training steps were set to 5000.

(b) The second stage (fine): The Batch Map algorithm was used with the Gaussian neighborhood function, which decreased monotonically from 2 to 0. The training steps were set to 1000.

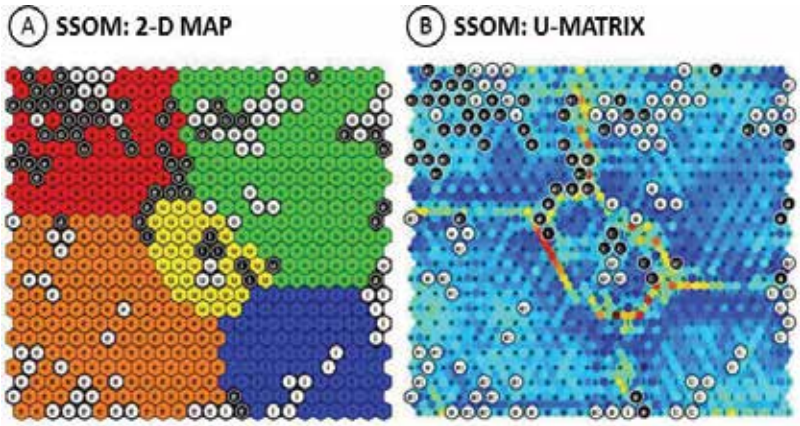

Figure 10. The results of the vowel classification by using SSOM maps. Part A represents a 2-D map, and part B represents a U-matrix.

8.2. Evaluation and results

The training data were set to the dimension of 31,475 × N, where N represents several speech coefficients. The number of wav-files was 1495, and the number of phonemes was 2299. **Figure 10** shows the classification via SSOM trained for vowels for cases. The left panel or part A of the chart represents a 2-D map, and the right panel or part B of the chart represents a U-matrix. These colors or parts of the map represent the vowels in the map; a red color (or the upper left part) represents *"a"*, an orange color (or the lower left part) represents *"e"*, a blue color (or the lower right part) represents *"i"*, a green color (or the upper right part) represents "o" and a yellow color (or the middle part) represents "u".

For the training set, the utterances of all controls and cases were classified with these maps. A white color indicates a successful classification, while a black color indicates a failed classification. For cases, there are characteristic replacements for these vowels, that is, *"o"* behind *"e"* and *"u"* behind *"i"*. These replacements are specific for cases and is not observed in controls. This method obtained a success rate for detecting children with SLI of more than 85%.

9. Conclusion

The methods described in this chapter were developed to analyze disordered speech in children, specifically in children with language impairments. The research was conducted over 10 years. The description is focused on the classification, data collection and data analysis of these children. For analysis, only speech skills of children with SLI were used and compared with typical children. The main benefit of this study includes the methods that were developed to classify children with SLI based on direct database processing. The implementation of these approaches in clinical practice could elucidate the progression and treatment of the disease and facilitate efficient disease treatment.

The first method, called error analysis, is based on the number of pronunciation errors in the utterances. A significant advantage is that its function does not require complex computational methods and can be performed by anyone. The success rate in distinguishing between children with SLI and typical children was 93.81%. The second method, called feature analysis, is based on the auditory signal features that are specific to the acoustic features of speech. These features can easily be obtained and calculated without complicated modifications of the speech signal. The success rate was 96.94%, and only three out of 98 participants were classified as incorrect. The third approach, based on the time duration of utterances, verified the hypotheses on the speed of processing and response for a range of tasks. Children with SLI have a longer duration of words than typical children, that is, the difference was 27.51%. In formant analysis, each vowel has a clearly defined location in the vocalic triangle. The difference between children with SLI and typical children is in the possibility (for typical children) or inability (for children with SLI) to create two vocalic triangles. The vocalic triangle for vowels from a multisyllabic word is misshapen in 87.5% of the analyses of children with SLI. The tablet application SLIt Tool uses an algorithm derived from error analysis, which facilitates the testing of children. The output verifies speech skills with possible consultation about the results via email with a speech and language pathologist.

The obtained results demonstrate that it is possible for children with SLI to be clearly identified and distinguished from typical children. The approach combined traditional and alternative procedures to address this issue and generated a resistance tool that is not dependent on the weaknesses of individual methods.

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References

[1] Bishop DVM. Uncommon Understanding (Classic Edition): Development and Disorders of Language Comprehension in Children. England: Psychological Press; 2014. ISBN: 9780203381472

[2] Leonard LB. Children with Specific Language Impairment. MA: MIT Press; 2014. ISBN: 9780262027069

[3] Hulme C, Snowling MJ. Developmental Disorders of Language Learning and Cognition. Chichester, U.K.; Wiley; 2009. ISBN: 9780631206118

[4] Specific Language Impairment. (2017) Available from: http://www.nidcd.nih.gov/health/voice/pages/specific-language-impairment.aspx [Accessed: February 2, 2017]

[5] Tomblin JB, Records NL, Buckwalter P, Zhang X, Smith E, O'Brien M. Prevalence of specific language impairment in kindergarten children. Journal of Speech, Language, and Hearing Research. 1997;**40**:1245-1260. DOI: 10.1044/jslhr.4006.1245

[6] Schuller B, Steidl S, Batliner A, Burkhardt F, Devillers L, Müller Ch, Narayanan S. Paralinguistics in speech and language—state-of-the-art and the challenge. Computer Speech and Language. 2013;**27**(1):4-39. ISSN: 0885-2308

[7] Bishop DVM, Adams CV, Norbury CF. Distinct genetic influences on grammar and phonological short-term memory deficits: Evidence from 6-year-old twins. Genes, Brain and Behavior. 2006. PMID: 16507007. DOI: 10.1111/j.1601-183x.2005.00148.x

[8] Kohnert K, Windsor J, Ebert KD. Primary or/specific/language impairment and children learning a second language. Brain and Language. 2009;**109**(2-3);101-111. DOI: 10.1016/j.bandl.2008.01.009

[9] Archibald LM, Gathercole SE. Short-term and working memory in specific language impairment. International Journal of Language & Communication Disorders. 2006;**41**:675-693. Blackwell Publishing Ltd, U.K.; DOI: 10.1080/13682820500442602

[10] Montgomery JW, Magimairaj BM, Finney MC. Working memory and specific language impairment: An update on the relation and perspectives on assessment and treatment. American Journal of Speech-Language Pathology. 2010;**19**:78-94. DOI: 10.1044/1058-0360

[11] Bishop DVM, Snowling MJ. Developmental dyslexia and specific language impairment: Same or different? Psychological Bulletin. 2004;**130**(6):858-886. DOI: 10.1037/0033-2909.130.6.858

[12] van Weerdenburg M, Verhoeven L, Bosman A, van Balkom H. Predicting word decoding and word spelling development in children with specific language impairment. Journal of Communication Disorders. 2011;**44**(3):392-411. DOI: 10.1016/j.jcomdis.2010.12.002

[13] Locke JL. Gradual emergence of developmental language disorders. Journal of Speech Language and Hearing Research. 1994;**37**(3):608. DOI: 10.1044/jshr.3703.608

[14] Clahsen H. The grammatical characterization of developmental dysphasia. Linguistics. 1989; **27**(5), pp. 897-920. DOI: 10.1515/ling.1989.27.5.897

[15] Gopnik M, Dalalakis J, Fukuda SE, Fukuda S, Kehayia E. Genetic language impairment: Unruly grammars. In: Runciman WG, Maynard J, editors. Evolution of Social Behaviour Patterns in Primates and Man. Proceedings of the British Academy. Vol. 88. Oxford, UK: Oxford University Press; 1996

[16] LANNA. Laboratory of Artificial Neural Network Applications. (2016) Prague: Department of Circuit Theory at the FEE-CTU. Available at: http://amber.feld.cvut.cz/lanna/en/index.asp?page=lanna

[17] Grill P, Tučková J. Speech databases of typical children and children with SLI. PLoS One. 2016;**11**(3):e0150365. DOI: 10.1371/journal.pone.0150365

[18] Knobloch H, Stevens F, Malone AF. Manual for Developmental Diagnosis. The Administration and Interpretation of the Revised Gesell and Amatruda Developmental and Neurologic Examination. Hagerstown: Harper and Row; 1980

[19] Thorndike RL, Hagen EP, Sattler JM. Stanford-Binet Intelligence Test (Terman-Merrill): Fourth Revision. Itasca, IL: Riverside Publishing; 1995

[20] Swierkoszova J. Specific Learning Disabilities (in Slovak). Bratislava: SPN; 1990. ISBN: 80-08-00447-9

[21] Vranova M, Tuckova J, Kyncl M, Grill P, Komarek V, et al. MRI abnormalities of speech and computerised processing of speech of children with developmental dysphasia (in Czech). In: AKL Congress; Tabor, Czech Republic. 2011

[22] Tučková J, Komarek V. Effectiveness of speech analysis by self-organizing maps in children with developmental language disorders. Neuroendocrinology Letters. 2008;**29**(6), pp. 939-948. ISSN: 0172-780X

[23] Tučková J, Grill P, Vavřina J, Bártů M. Speech Databases of Typical Children and Children with SLI. LINDAT/CLARIN Digital Library at Institute of Formal and Applied Linguistics, Charles University in Prague. 2013. Available from: http://hdl.handle.net/11372/LRT-1597

[24] Cool Edit Pro 2 Adobe Systems Inc. (2003). Available at: http://www.adobe.com/special/products/audition/syntrillium.html [Accessed: February 11, 2016]

[25] Tuckova J, Bartu M, Zetocha P. Applications of Artificial Neural Networks for Signal Processing (in Czech). Prague: Czech Technical University in Prague; 2009. ISBN: 978-80-01-04400-1

[26] Zetocha P. SOM laboratory for speech analysis. In: ECMS 2007 & Doctoral School 8th International Workshop on Electronics, Control, Modelling, Measurement and Signals 2007 & Doctoral School (EDSYS, GEET); 21-23 May 2007; Liberec, Czech Republic. 2007

[27] MATLAB MathWorks Inc. (2016). Available at: http://www.mathworks.com/products/matlab/ [Accessed: February 11, 2016]

[28] The R Project for Statistical Computing. (2016). Available at: http://www.r-project.org/index. html [Accessed: February 11, 2016]

[29] Grill P. Specific language impairments and possibilities of classification and detection from children's speech. Prague: Czech Technical University in Prague; 2015. Available from: https://dspace.cvut.cz/bitstream/handle/10467/62582/Disertace_Grill_2015.pdf?sequence=1

[30] Kohonen T. Self-Organizing Maps. Springer Series in Information Sciences. 3rd ed. Berlin, Heidelberg: Springer-Verlag; 2001. ISBN: 3-540-67921-9

[31] Tučková J. Selected Applications of the Artificial Neural Networks at the Signal Processing (in Czech). Prague: Czech Technical University in Prague; 2009. ISBN: 978-80-01-04229-8

[32] Eyben F, Wöllmer M, Schuller B. openSMILE—The Munich versatile and fast open-source audio feature extractor. In: Proceedings of the ACM Multimedia (MM). Florence, Italy: ACM; 2010. pp. 1459-1462. ISBN: 978-1-60558-933-6. DOI: 10.1145/1873951.1874246

[33] PRAAT: Doing Phonetics by Computer. (2016) Available at: http://www.fon.hum.uva.nl/praat/ [Accessed: December 11, 2016]

[34] Grill P, Tučková J. FORANA. In: Technical Computing Prague 2009. Praha: Humusoft; 2009. pp. 32-39. ISBN: 978-80-7080-733-0

[35] Grill P. Vliv věku na rozložení formantů v řečovém signálu [bachelor thesis]. 2006

[36] Grill P. Automatic detection of formants from speech signal with the use to the classification of children with neurological disorder [doctoral thesis statement]. Prague: Czech Technical University in Prague; 2011

[37] Grill P, Tučková J. Formant analysis—Vowel detection of children with developmental dysphasia. In: Digital Technologies 2010. Žilina: TU v Žilině; 2010. ISBN: 978-80-554-0304-5

[38] Grill P, Tučková J. Formants application to diagnose of children developmental dysphasia. In: 9th Czech-Slovak Conference Trends in Biomedical Engineering. Ostrava: VŠB; 2011. pp. 98-101. ISBN: 978-80-248-2475-8

Chapter 2

Learning Disability in RASopathies

Ilaria Maccora, Matteo Della Monica, Giovanna Traficante, Gianpaolo De Filippo and Stefano Stagi

Additional information is available at the end of the chapter

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Abstract

Learning disabilities are relatively common conditions in pediatric population. The incidence of learning disability ranges from 1% to 17%, reflecting that learning disability may be not a single clinical entity but a wide distribution of cognitive traits in the population. As reported by the American Association on Intellectual and Developmental Disabilities (AAIDD), among the prenatal learning disability causes, chromosomal disorders, genetic syndromes, and inborn errors of metabolism must be taken into account. In this chapter, we will focus the attention on RASopathies, genetic disorders characterized by germline mutations in the RAS-MAPK pathway whose role is crucial in the regulation of the cell cycle, differentiation, growth, and cell senescence. This group of disorders includes Noonan syndrome, neurofibromatosis type 1, Costello syndrome (CS), Legius syndrome, Noonan syndrome with multiple lentigines, and cardiofaciocutaneous syndrome. Mutations in RAS-MAPK pathways lead to impairments in synaptic plasticity, necessary for normal brain function, especially for learning and memory. Variation across the RAS/MAPK pathway syndromes suggests that different gene mutations affecting this pathway can have markedly different developmental effects.

Keywords: learning disabilities, RASopathy, long-term potentiation, RAS, ERK, MAPK, neurofibromatosis, Noonan syndrome, Costello syndrome, Legius syndrome, LEOPARD, CFC

1. Introduction

Learning disabilities are relatively common pediatric conditions, and there is no universal consensus establishing what a learning disability represents [1, 2]. The American Pediatrics Association subcategorizes specific learning disorder as reading, written expression, or

mathematics skills that are substantially lower than expected for the individual's age, measured intelligence, and age-appropriate education level or when achievement falls below a set standard definition [3]. The International Classification of Disease (ICD) identifies learning disability as a condition of arrested or incomplete development in cognitive functioning or in adaptive behavior in the developmental period [4]. It can be evaluated with the general intelligence functioning and supplemented by scales.

Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V) is available from 2013. The DSM-V now indicates a unique new category or diagnosis of "specific learning disorder" for issues previously differentiated as: dyslexia, dyscalculia, dysgraphia, and dysorthography. The change was made because there had been no support for a continued distinction among the terms. The single definition joined the "specifiers," and for each of them, the deficit capacities are mentioned with reference to the reading, calculation, and the written language. The DSM-V state classifies the disorder in mild, moderate, and severe. In addition, the risk factors are confirmed as the disturbance of language, familiarity, co-morbidity [5].

During last decades, many studies have been conducted to understand the basis of these neurodevelopmental disorders, leading to the identification of some altered specific neural networks although the mechanisms are not fully understood [6–9].

In this context, the American Association on Intellectual and Developmental Disabilities (AAIDD) identifies prenatal, perinatal, and postnatal causes. Among the prenatal causes, chromosomal disorders, Syndrome disorders (RASopathies), and inborn errors of metabolism can be taken into account; perinatal and postnatal causes often encompass infectious and traumatic etiologies. Several cognitive deficits may be caused by a single-gene mutation and can be classified into discrete clinical conditions with specific diagnoses [10, 11]. Notwithstanding distinct clinical entities could rise from the interaction between genes and environment.

A better understanding of pathophysiological mechanisms that lead to learning disability could provide new insights in knowledge and therapy of intellectual and learning disabilities.

2. RASopathies

RASopathies are a group of genetic developmental syndromes with phenotypic overlapping features caused by germline mutation in genes that encode components or regulators of RAS/mitogen-activated protein kinase (MAPK) pathway. Approximately, these syndromes affect 1 in 1000 live births, being one of the most common group syndromes. This group includes neurofibromatosis type I (OMIM #162200), Legius syndrome (OMIM #611431), Noonan syndrome (OMIM #163950), Noonan syndrome with multiple lentigines (formerly called LEOPARD syndrome, OMIM #151100), Costello syndrome (CS) (OMIM #218040), cardiofaciocutaneous (CFC) syndrome (OMIM #115150), Noonan-like syndrome, hereditary gingival fibromatosis, and capillary malformation-arteriovenous malformation [9–14]. Several functionally related genes, such as *PTPN11* (OMIM *176876, mapped in 12q24.13 region), *SOS1* (OMIM *182530, 2q22.1), *KRAS* (OMIM *190070, 12p12.1), *BRAF* (OMIM *164757, 7q34), *RAF1* (OMIM *164760, 3p25.2), *MAP2K1* (OMIM *176872, 15q22.31), *MAP2K2* (OMIM *601263, 19p13.3), *RIT1* (OMIM

*609591, 1q22), *NRAS* (OMIM *164790, 1p13.2), *RRAS* (OMIM *165090, 19q13.33), *SOS2* (OMIM *601247, 14q21.3), *SHOC2* (OMIM *602775, 10q25.2), *CBL* (OMIM *165360, 11q23.3), *NF1* (OMIM *613113, 17q11.2), *HRAS* (OMIM *190020, 11p15.5), and *SPRED1* (OMIM *609291, 15q14), have been associated to the pathogenesis of these disorders [12–32].

Although clinical presentation can be similar, every disorder has its peculiar features (as shown in **Table 1**). They share common central nervous system dysfunction leading to learning disability-intellectual disability, cardiovascular abnormalities, dismorphic features, short stature, skeletal malformation, coetaneous lesions (tumors, spots, vascular malformation), and increasing risk of benign or malignant tumors (e.g. **Figure 1**).

Syndrome	Gene	Phenotypic features
Neurofibromatosis type I (NF1)	*NF1*	Multiple café-au-lait spots, skin-fold freckling, neurofibromas, short stature, macrocephaly, Lisch nodules, vasculopathy, aneurysm, stenosis, arteriovenous malformation, optic pathway glioma
Noonan syndrome	*PTPN11*, *SOS1*, *RAF1*, *RIT1*, *KRAS*, *NRAS*, *BRAF*, *RRAS*	Relative macrocephaly, distinctive facial features, short stature, mild developmental/cognitive impairment, webbed neck, cryptorchidism, Pectus excavatum, myeloproliferative disorder, cardiovascular abnormalities (pulmonary stenosis, atrial septal defect and others)
Noonan syndrome with multiple lentigines (LEOPARD)	*PTPN11*, *RAF1*, *BRAF*	Multiple lentigines, electrocardiographic conduction abnormalities, ocular hypertelorism, pulmonary stenosis, abnormal genitalia, retardation of growth and sensorineural deafness, hypertrophic cardiomyopathy
Legius syndrome	*SPRED1*	Multiple café-au-lait spots, skin-fold freckling, macrocephaly, learning disability, lipomas, NS-like face/characteristics
Costello syndrome	*HRAS*	Failure to thrive, distinctive facial features, feeding difficulties, short stature, curly hair, palmar keratosis, increased risk of malignant tumors (~10–15%), congenital heart defects, hypertrophic cardiomyopathy
Cardiofaciocutaneous (CFC) syndrome	*BRAF*, *MAP2K1*, *MAP2K2*, *KRAS*	Failure to thrive, distinctive facial features, skin abnormalities including nevi, lentigines and palmarplantar keratosis, curly hair, severe intellectual disability, seizure, pulmonary valvular stenosis, hypertrophic cardiomyopathy, septal defects, cardiac valve anomalies
Noonan-like syndrome	*SHOC2*, *CBL*	Macrocephaly, short stature with growth hormone deficiency, fine, sparse and easily pluckable hair, mild neurocognitive impairment, hyperpigmented skin lesions, microcephaly, cardiovascular abnormalities
Hereditary gingival fibromatosis	*SOS1*	Gingival fibromatosis
Capillary malformation-arteriovenous malformation	*RASA1*	Capillary malformation, arteriovenous malformation

Table 1. Classification of RASopathies with gene correlation and phenotypic features.

Figure 1. Typical signs of RASopathies: a) Pterigium colli (the clinical signs are wanted); b) Pectus escavatum; c) Cubitius valgus; d) Axillary freckling: a sign which initially show; e) From strains to nodules and fibroids.

Such complex phenotypes derive from mutation in the Ras/mitogen-activated protein kinase (MAPK) pathway which plays an essential role in regulation of cell cycle, differentiation, growth and cell senescence [12, 15, 16]. Focusing on these signaling alterations, there was a hyperactivation of extracellular-regulated kinase 1/2 (ERK1/2; member of the MAPK superfamily) in all of these disorders. This kind of signal could be induced by mutations in positive regulators, producing gain-of-function alleles or in negative regulators (neurofibromin 1), loss-of-function alleles, of the RAS/ERK signaling pathway. Oyshi et al. ruled out this mechanism only in Noonan syndrome with multiple lentigines (LEOPARD syndrome), where mutation in the gene *PTPN11* (Y729C and T468M) encoding for protein tyrosine phosphatase SHP-2 results in a loss-of-function and a decrease in the level activity of ERK1/2 [33].

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Variation across the Ras/MAPK pathway syndromes suggests that different mutant alleles of gene can have markedly various developmental effects, flowing in several syndromes. At the same time, the same allele mutant can produce different phenotypes because of the interaction with the environment, the epigenetic variation, and the action of others gene.

Recent advances in genetic analysis technologies, including whole-exome sequencing, have identified potential new genes for RASopathies [12].

2.1. The Ras/mitogen-activated protein kinase (MAPK) pathway

The Ras/mitogen-activated protein kinase (MAPK) pathway has a crucial role in regulating cell cycle and development, transducting signals from membrane receptors activated by growth factors to the cytoplasm and nucleus. This cascade is tightly regulated [16, 23, 34, 35]. For a better understanding, see **Figure 2**.

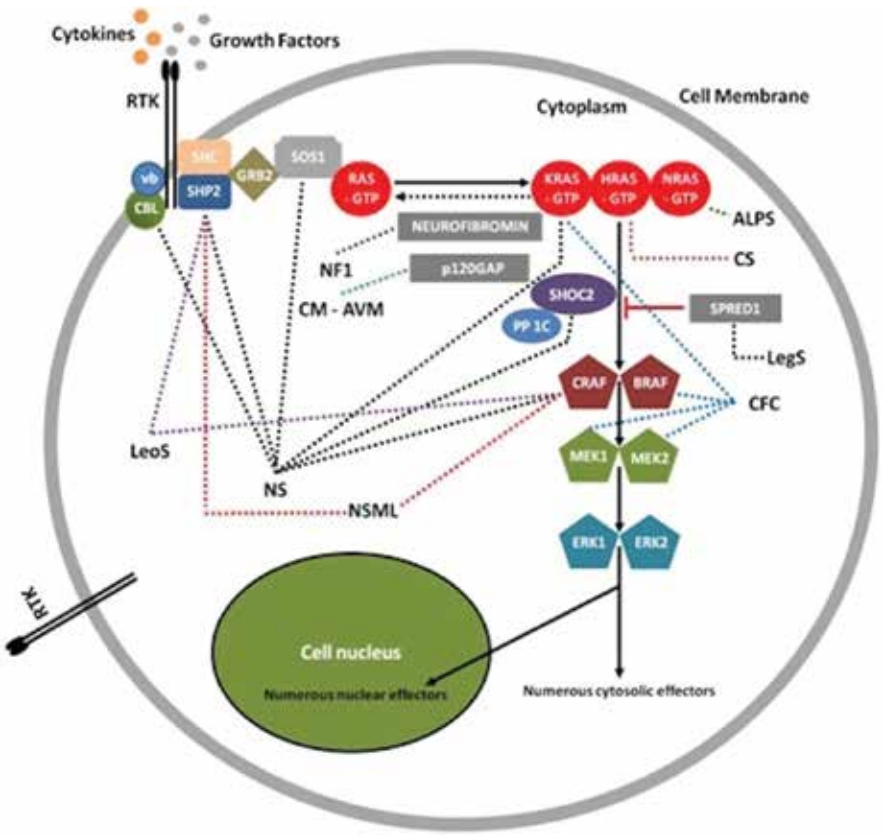

Figure 2. The Ras/MAPK signal transduction pathway of protein kinases is critically involved in cellular proliferation, differentiation, motility, apoptosis, and senescence. Mutation of genes encoding components or regulators of the Ras/MAPK pathway (indicated by *dashed lines*) cause medical genetics syndromes named RASopathies. These disorders include neurofibromatosis type 1 (NF1). Noonan syndrome (NS), Noonan syndrome with multiple lentigines (NSML), capillary malformation-arteriovenous malformation syndrome (CM-AVM), Costello syndrome (CS), cardio-facio-cutaneous syndrome (CFC), Leopard syndrome (LeoS), Legius syndrome (Legs), and ALPS (Autoimmune lymphoproliferative syndrome). RTK is the Receptor Tyrosine Kinase.

RAS genes, including *HRAS*, *NRAS* and *KRAS*, encode for small guanosine nucleotide-bound GTPases which are positively matched with different kind of receptors, inducing a transformation in an active GTP-bound form and an inactive Guanosine Diphosphate (GDP) bound form. Activation of RAS through receptor tyrosine kinases (RTKs) occurs thanks to recruitment of the adaptor protein growth factor receptor bound protein 2 (GRB2) and son of sevenless (SOS) which increase the level of active GTP-bound Ras [36–38].

After RAS activation, the signaling cascade is turned on with the activation of RAF (ARAF, BRAF, and/or CRAF), which activates, phosphorylating the MAPK kinases, MEK1 and/or MEK2 and, in turn, ERK1 and ERK2. ERK1 and ERK2 are the effectors of the cascade and control a large number of nuclear and cytosolic molecules owning as target cell cycle progression, cellular differentiation, and cellular growth.

Among the negative regulators of this cascade, neurofibromin 1 (*NF1*) is a GTPase-activating protein that is a negative regulator of RAS (RAS-GAP) and the Sprouty-related protein with an EVH-1 domain *SPRED1* [16, 35–39].

2.2. Basis of learning disability in RASopathies

Since 1997 the central role of RAS-ERK signaling has been identified in long-term potentiation (LTP), in long-term depression (LTD), in synaptic plasticity, in memory formation and learning during the development, including spatial learning and fear conditioning, therefore not only in cell growth, proliferation, migration, and survival [40–45].

So far, many studies have neglected the psychological and psychiatric profile of RASopathies, but new contributions of literature are proving that it is just the tip of the iceberg [46].

In central nervous system (CNS), synaptic plasticity is a prerequisite for learning and memory. First studies in animal models of RASopathies have provided interesting findings on the biological basis of these disabilities, examining the RAS/ERK functions that unfortunately are not completely understood.

The long-term potentiation (LTP) and the long-term depression (LTD) are prerequisite for synaptic plasticity in key areas as hippocampus, amygdala, insular cortex, and prefrontal cortex. N-methyl-D-aspartate (NMDA) receptors and α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid receptors (AMPA) are closely related to these mechanisms. After high-frequency release of glutamate and activation of AMPA receptors, NMDA magnesium block is removed resulting in a more sustained excitatory. NMDA receptors lead to intracellular calcium influx and AMPA phosphorylation of AMPA receptors and movement to the cell surface bringing to an increasing answer to glutamate release. Furthermore, calcium influx can promote the transcription of crucial gene for the LTP trough cAMP-dependent signaling cascade involving PKA, mitogen-activated protein kinases (MAPK), and the transcription factor cAMP-responsive element binding protein (CREB). On the other hand, low-frequency stimulation induces LTD through a weak calcium influx inducing dephosphorylation and endocytosis of AMPA receptors [47].

Increased activity of RAS-ERK pathway in keys areas of the brain (as hippocampus, parahippocampus, amygdale, prefrontal) can lead, on the one hand, to an increased activity of

GABAergic interneurons, and on the other hand, to an impaired signaling in glutamatergic synapses and consequently to dysruption of synaptic plasticity through LTP or LTD. In GABAergic synapses, RAS-MAPK pathway regulates the phosphorylation of synapsin I in presynaptic neurons, where it is critically involved in maintaining the vesicle reserve pool and regulating the rate of neurotransmitter vesicle release. Neurofibromin 1 negatively regulates Ras/MAPK signaling pre-synaptically in hippocampal-GABAergic neuron; as a matter of fact, mutations in the gene of NF1 induce an enhanced GABA release. As for glutamatergic synapses, RAS-ERK pathway is activated by tyrosine kinase receptors (TRK) or calcium influx activated through N-methyl-ᴅ-aspartate (NMDA) receptors or voltage-gated calcium channels, playing a key role in the transcription of many crucial genes for long-term potentiation. Modulation of glutamatergic synapses is necessary to modify AMPA (α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid receptor) receptor expression on cells surface, enhancing the basal excitatory synaptic transmission, blocking further potentiation of synaptic strength. Consistently, an hyper-activation of RAS-ERK signaling, for example, could be also due to a SHP2 mutation, enhancing the basal excitatory synaptic transmission, facilitating the synaptic trafficking of AMPA receptors to synapses with the subsequent events before described (for more information see: [45, 47–53]).

Recently, the importance of RAS-MAPK pathway has been also revealed in differentiation of neuron progenitor cells. Disruption of this cascade can result in an imbalance between neurogenesis and glycogenesis [35].

Several neurophysiological studies have been conducted in patients with RASopathies by using transcranial magnetic stimulation (TMS), a noninvasive and safe way to investigate neuronal plasticity. Several experimental paradigms applying the so-called paired associative stimulation (PAS) have demonstrated that patients with neurofibromatosis type I and Noonan syndrome have reduced LTP-like synaptic plasticity depending on an increased intracortical inhibition. On the contrary, TMS studies in Costello syndrome (CS) patients have shown enhanced LTP-like synaptic plasticity related to reduced inhibition [51, 54–56].

In summary, there are strong evidences that the deregulation of activity of RAS-MAPK signaling can lead to LTP impairment and altered neuronal plasticity resulting in learning and memory impairment.

3. Focus on learning disability in every RASopathy

3.1. Neurofibromatosis type 1

Neurofibromatosis type I was the first RASopathies identified, it is a genetic disorder caused by mutations in the neurofibromin 1 gene (*NF1*) at locus 17q11.2, resulting in loss-of-function of its protein product. Neurofibromatosis type I has an autosomal dominant inheritance, as homozygous mutations appear to be lethal and has an incidence of approximately 1 in 2600–3000 individuals [39, 57, 58].

This syndrome is characterized by the presence of café-au-lait maculae (spots), (axillary and inguinal) intertriginous freckling, neurofibromas and plexiform neurofibromas, iris Lisch

nodules, osseous dysplasia, optic pathway glioma, and/or a first-degree relative with NF1. Up to 65% of NF1 patients show cognitive impairments which frequently involve executive and higher order cognitive domain [14, 16, 39, 48, 49, 57–59].

Neurofibromin acts as a RAS-GAP (GTPase activating protein) and negatively regulates Ras signaling, also working as an activator of adenylate cyclase. Its mutation brings to a hyperactivation of the RAS-MAPK signaling cascade and to an increased GABA-mediated inhibition of interneurons, significantly reducing long-term potentiation in hippocampus and amygdala. The role of NF1 is crucial in maintaining the balance between RAS- and cAMP-dependent signaling [38, 47, 48, 56–58].

Reading/vocabulary, visuospatial functions, motor coordination, planning, and organizational skills are often impaired. High co-morbidity with attention deficit hyperactivity disorder (ADHD) is explained by frequent impairment of working memory, cognitive flexibility, and inhibitory control. Patients with NF1 show both *nonverbal* (poor performance in tests of visuospatial functioning and spatial learning, impairments in the ability to perceive social cues, poor organizational skills, and increased impulsiveness) and *verbal-type learning disability* (expressive and receptive language, vocabulary, visual naming, and phonologic awareness). A single mutation can give rise to a complex spectrum of learning disabilities [39, 60, 61].

Emerging insights from the pathophysiology of this syndrome have provided new potential targets for learning disability therapy. A randomized, double-blind, placebo-controlled study evaluated the influence of lovastatin on impaired synaptic plasticity in patients with NF1. By decreasing the ERK basal activation, lovastatin reduces RAS-pathway hyperactivity with a significant improvement in verbal and nonverbal memory, visual attention, and efficiency [15, 54, 56, 58, 61].

3.2. Noonan syndrome

Noonan syndrome is an autosomal dominant genetic disorder with a prevalence approximately of 1 every 1000–2500 live births, caused by activating germline mutations in the *PTPN111* gene in 50% of affected individuals, but other cases have shown to be caused by gain-of-function mutations in *KRAS* (fewer than 50%), *SOS1* (approximately in 13%), *RAF1*, and *RIT1* (in 5%). Other genes have been reported in literature which is associated with Noonan syndrome, for example, NRAS, BRAF, and MAP2K1 [14, 55, 62–66].

Mutation in *PTPN11* induces alteration of function in the protein SHP2 (nonreceptor tyrosine phosphatase) which loses its ability to switch from the active to the inactive protein conformation, causing an increased signaling in Ras/MAPK cascade. Its role is crucial in determining neuronal cell fate and regulating the generation of oligodendrocytes. Hyperactivity of Ras/MAPK cascade increases delivery of AMPA receptors to the synapses, enhancing the basal excitatory synaptic transmission. Mutations in SOS1 induce loss-of-function in auto-inhibition and gain-of-function in the protein product RAS-GEF protein which acts as a stimulator of the conversion of RAS from the inactive to the active form. Mutations of KRAS and BRAF also determine RAS/MAPK up-regulation [35, 62–66].

This syndrome is typically characterized by facial anomalies, short stature, family history, chest carinatum/excavatum, congenital heart defects (pulmonary valve stenosis, septal defects and hypertrophic cardiomyopathy, atrial and ventricular septal defects, branch pulmonary artery stenosis, and tetralogy of Fallot), lymphatic dysplasia, cryptorchidism, varied coagulation defects, and learning disabilities [64, 65].

A wide variability of cognitive complaints has been recognized ranging from absent or mild learning problems to severe intellectual disabilities and depends on type of mutation. Patients with *SOS1* mutations performed significantly higher on both verbal and nonverbal cognitive tests than individuals with PTPN11 and other kinds of mutations. Several studies have demonstrated that these patients have a greater risk to have impaired performance in verbal free recall task than in visual and spatial recognition memory tasks. Furthermore, Pierpont et al. showed that children with Noonan syndrome have different performance on verbal memory tasks, on visual memory, or working memory. Better performances have been obtained in immediate verbal memory than in delayed free recall tasks; a more pronounced hippocampal and prefrontal cortex dysfunction may probably reflect RAS-MAPK aberration in memory formation and consolidation [62, 63, 65–67].

Likewise, NF1 promising studies on the therapeutic effect of lovastatin in mice with mutation in PTPN11 are currently underway thanks to its action in decreasing basal Erk activation and seem to represent a therapeutic strategy for learning deficits Noonan syndrome [68].

3.3. Legius syndrome (NF1 like)

Legius syndrome is an autosomal dominant genetic disorder caused by germline mutations in the SPRED1 which induce loss-of-function in the product protein. It is typically characterized by multiple café au lait macules without neurofibromas or other tumors, intertriginous freckling, lipomas, macrocephaly, and learning disabilities/ADHD/developmental delays [57, 69].

SPRED1 is a negative regulator of the Ras/MAPK pathway, being a substrate of SHP2, and its mutation leads to a hyperactivation of this cascade, and in animal models, it also has been seen that mice have some deficits in hippocampus-dependent spatial learning and in several phases of visual discrimination learning [35, 70].

3.4. LEOPARD syndrome

LEOPARD syndrome (Noonan syndrome with multiple lentigines) is an autosomal dominant genetic disorder, caused by mutation in *PTPN11* (p.Y279C and p.T468P) and *RAF1*. Phenotypically, they have the same features of Noonan syndrome patient but with multiple lentigines, electrocardiogram abnormalities, pulmonary valve stenosis, abnormal genitalia, growth retardation, and ocular hypertelorism [14, 16, 17, 35, 71].

Several studies conducted in vitro have demonstrated that mutation in PTPN11 leads to a reduced catalytic activity in SHP2 causing a loss-of-function, despite studies conducted in animal models have demonstrated that this residual activity is sufficient to generate a gain-of-function like phenotype in the cascade that leads to a hyperactivation of Ras/MAPK pathway [14, 16, 35, 71].

In this syndrome, learning disability are reported in the 30% of cases [54] and are more evident in verbal recall memory performance but relative sparing of visual and spatial recognition memory [16, 66, 71].

3.5. Costello syndrome

Costello syndrome is one of the rare syndromes of the group of RASopathies. It is caused by heterozygous activating germline mutations in *HRAS*. Typically, it is a missense mutation that induced the reduction of the intrinsic GTPase activity of RAS, which remains in the active form facilitating the synaptic trafficking of AMPA receptors. Besides, it has been seen that its action occurs in the spine dendritic structures too, which presents an increased density [14, 16, 35, 72].

This syndrome is phenotypically characterized by failure to thrive; short stature; developmental delay or intellectual disability; coarse facial features, curly, or sparse fine hair; loose, soft skin with deep palmar and plantar creases; papillomatosis of the face and perianal region; diffuse hypotonia and joint laxity; cardiac involvement (cardiac hypertrophy, valvar pulmonic stenosis, arrhythmia); relative or absolute macrocephaly Chiari I malformation with associated anomalies including hydrocephalus or syringomyelia. Moreover, they present an increased risk, approximately 15%, to malignant tumors [14, 16, 72].

Particularly, in these patients, it has been observed that verbal learning and memory are impaired but are better than the nonverbal cognitive abilities, while the visual associative memory is performed in the mildly disabled, but the related data are not completely clear [35, 73].

3.6. CFC syndrome

Cardiofaciocutaneous (CFC) syndrome is a very rare RASopathy. It is caused by heterozygous activating mutations in *BRAF* (~75%), *MAP2K1,* and *MAP2K2* (~25%), *KRAS* (<2%) that cause a deregulation of the RAS-MAPKinase cascade in a positive way. It is inherited in an autosomal dominant manner [14, 16, 74, 75].

CFC is characterized by craniofacial dysmorphology, congenital heart disease (pulmonic stenosis and other valve dysplasias, septal defects, hypertrophic cardiomyopathy, and rhythm disturbances), dermatologic abnormalities (xerosis, hyperkeratosis, ichthyosis, keratosis pilaris, ulerythema ophryogenes, eczema, pigmented moles, hemangiomas, and palmoplantar hyperkeratosis), growth retardation, and intellectual and learning disability [14, 16, 74, 75].

Assessing the learning ability, CFC patients present significant delay in adaptive skills, impaired spatial learning, and hippocampal long-term potentiation. It has been evidenced disability in verbal skills, especially the communication abilities were more impaired than the comprehension and in spatial learning [35, 75].

Mutations in MAP2K1, which are frequently associated with neurological complications and intellectual disability, can be associated with a milder clinical and neurocognitive profile more typical of individuals with Noonan syndrome. Variability of expression may arise from a complex interplay between RAS/MAPK pathway genotype, epigenetics, medical and obstetric factors, and environmental influences [76].

4. Conclusion

Children with RASopathies show commonly learning disabilities, such as impaired reading/vocabulary, visuospatial functions, motor coordination, planning, and organizational skills. Variability of expression may arise from a complex interplay between RAS/MAPK pathway genotype, epigenetics, medical and obstetric factors, and environmental influences. Emerging insights from the pathophysiology of these different genetic syndromes may facilitate the development of mechanism-based individualized treatment and may provide new potential targets for learning disability therapy in patients with RASopathies.

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References

[1] Altarac M, Saroha E. Lifetime prevalence of learning disability among US children. Pediatrics. 2007 Feb;**119**(Suppl 1):S77–S83

[2] Lagae L. Learning disabilities: Definitions, epidemiology, diagnosis, and intervention strategies. Pediatric Clinics of North America. 2008 Dec;**55**(6):1259-1268, vii. DOI: 10.1016/j.pcl.2008.08.001

[3] Moeschler JB, Shevell M; Committee on Genetics. Comprehensive evaluation of the child with intellectual disability or global developmental delays. Pediatrics. 2014;**134**: e903-e918. DOI: 10.1542/peds.2014-1839

[4] National Collaborating Centre for Mental Health (UK): Challenging Behaviour and Learning Disabilities: Prevention and Interventions for People with Learning Disabilities Whose Behaviour Challenges. London: National Institute for Health and Care Excellence (UK); 2015 May. Clinical Guidelines

[5] American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th ed. Arlington, VA: American Psychiatric Association; 2013

[6] Moreau D, Waldie KE. Developmental learning disorders: From generic interventions to individualized remediation. Frontiers in Psychology. 2016;**6**:2053. DOI: 10.3389/fpsyg.2015.02053

[7] Davis S, Laroche S. Mitogen-activated protein kinase/extracellular regulated kinase signalling and memory stabilization: A review. Genes, Brain and Behavior. 2006;**5**:61-72. DOI: 10.1111/j.1601-183X.2006.00230.x

[8] Samuels IS, Saitta SC, Landreth GE. MAP'ing CNS development and cognition: An ERK some process. Neuron. 2009;**61**:160-167. DOI: 10.1016/j.neuron.2009.01.001

[9] Atkins CM, Selcher JC, Petraitis JJ, Trzaskos JM, Sweatt JD. The MAPK cascade is required for mammalian associative learning. Nature Neuroscience. 1998;**1**:602-609. DOI: 10.1038/2836

[10] Schalock RL, Luckasson R. A systematic approach to subgroup classification in intellectual disability. Intellectual and Developmental Disabilities. 2015;**53**:358-366. DOI: 10.1352/1934-9556-53.5.358

[11] Tassé MJ, Luckasson R, Nygren M. AAIDD proposed recommendations for ICD-11 and the condition previously known as mental retardation. Intellectual and Developmental Disabilities. 2013;**51**:127-131. DOI: 10.1352/1934-9556-51.2.127

[12] Aoki Y, Niihori T, Inoue S, Matsubara Y. Recent advances in RASopathies. Journal of Human Genetics. 2016;**61**:33-39. DOI: 10.1038/jhg.2015.114

[13] Aoki Y, Niihori T, Narumi Y, Kure S, Matsubara Y. The RAS/MAPK syndromes: Novel roles of the RAS pathway in human genetic disorders. Human Mutation. 2008;**29**:992-1006. DOI: 10.1002/humu.20748

[14] Tidyman WE, Rauen KA. The RASopathies: Developmental syndromes of Ras/MAPK pathway dysregulation. Current Opinion in Genetics & Development. 2009;**19**:230-236. DOI: 10.1016/j.gde.2009.04.001

[15] Bezniakow N, Gos M, Obersztyn E. The RASopathies as an example of RAS/MAPK pathway disturbances—Clinical presentation and molecular pathogenesis of selected syndromes. Developmental Period Medicine. 2014;**18**:285-296

[16] Rauen KA. The RASopathies. Annual Review of Genomics and Human Genetics. 2013;**14**:355-369. DOI: 10.1146/annurev-genom-091212-153523

[17] Korf B, Ahmadian R, Allanson J, Aoki Y, Bakker A, Wright EB, Denger B, Elgersma Y, Gelb BD, Gripp KW, Kerr B, Kontaridis M, Lazaro C, Linardic C, Lozano R, MacRae CA, Messiaen L, Mulero-Navarro S, Neel B, Plotkin S, Rauen KA, Roberts A, Silva AJ, Sittampalam SG, Zhang C, Schoyer L. The third international meeting on genetic disorders in the RAS/MAPK pathway: Towards a therapeutic approach. American Journal of Medical Genetics. Part A. 2015;**167A**:1741-1746. DOI: 10.1002/ajmg.a.37089

[18] Tartaglia M, Mehler EL, Goldberg R, Zampino G, Brunner HG, Kremer H, van der Burgt I, Crosby AH, Ion A, Jeffery S, Kalidas K, Patton MA, Kucherlapati RS, Gelb BD. Mutations in PTPN11, encoding the protein tyrosine phosphatase SHP-2, cause Noonan syndrome. Nature Genetics. 2001;**29**:465-468. DOI: 10.1038/ng772

[19] Tartaglia M, Pennacchio LA, Zhao C, Yadav KK, Fodale V, Sarkozy A, Pandit B, Oishi K, Martinelli S, Schackwitz W, Ustaszewska A, Martin J, Bristow J, Carta C, Lepri F, Neri C, Vasta I, Gibson K, Curry CJ, Siguero JP, Digilio MC, Zampino G, Dallapiccola B, Bar-Sagi D, Gelb BD. Gain-of-function SOS1 mutations cause a distinctive form of Noonan syndrome. Nature Genetics. 2007;**39**:75-79. DOI: 10.1038/ng1939

[20] Aoki Y, Niihori T, Kawame H, Kurosawa K, Ohashi H, Tanaka Y, Filocamo M, Kato K, Suzuki Y, Kure S, Matsubara Y. Germline mutations in HRAS proto-oncogene cause Costello syndrome. Nature Genetics. 2005;**37**:1038-1040. DOI: 10.1038/ng1641

[21] Aoki Y, Niihori T, Banjo T, Okamoto N, Mizuno S, Kurosawa K, Ogata T, Takada F, Yano M, Ando T, Hoshika T, Barnett C, Ohashi H, Kawame H, Hasegawa T, Okutani T, Nagashima T, Hasegawa S, Funayama R, Nagashima T, Nakayama K, Inoue S, Watanabe Y, Ogura T, Matsubara Y. Gain-of-function mutations in RIT1 cause Noonan syndrome, a RAS/MAPK pathway syndrome. American Journal of Human Genetics. 2013;**93**:173-180. DOI: 10.1016/j.ajhg.2013.05.021

[22] Razzaque MA, Nishizawa T, Komoike Y, Yagi H, Furutani M, Amo R, Kamisago M, Momma K, Katayama H, Nakagawa M, Fujiwara Y, Matsushima M, Mizuno K, Tokuyama M, Hirota H, Muneuchi J, Higashinakagawa T, Matsuoka R. Germline gain-of-function mutations in RAF1 cause Noonan syndrome. Nature Genetics. 2007;**39**:1013-1017. DOI: 10.1038/ng2078

[23] Roberts AE, Araki T, Swanson KD, Montgomery KT, Schiripo TA, Joshi VA, Li L, Yassin Y, Tamburino AM, Neel BG, Kucherlapati RS. Germline gain-of-function mutations in SOS1 cause Noonan syndrome. Nature Genetics. 2007;**39**:70-74

[24] Cordeddu V, Di Schiavi E, Pennacchio LA, Ma'ayan A, Sarkozy A, Fodale V, Cecchetti S, Cardinale A, Martin J, Schackwitz W, Lipzen A, Zampino G, Mazzanti L, Digilio MC, Martinelli S, Flex E, Lepri F, Bartholdi D, Kutsche K, Ferrero GB, Anichini C, Selicorni A, Rossi C, Tenconi R, Zenker M, Merlo D, Dallapiccola B, Iyengar R, Bazzicalupo P, Gelb BD, Tartaglia M. Mutation of SHOC2 promotes aberrant protein N-myristoylation and causes Noonan-like syndrome with loose anagen hair. Nature Genetics. 2009;**41**:1022-1026. DOI: 10.1038/ng.425

[25] Cordeddu V, Yin JC, Gunnarsson C, Virtanen C, Drunat S, Lepri F, De Luca A, Rossi C, Ciolfi A, Pugh TJ, Bruselles A, Priest JR, Pennacchio LA, Lu Z, Danesh A, Quevedo R, Hamid A, Martinelli S, Pantaleoni F, Gnazzo M, Daniele P, Lissewski C, Bocchinfuso G, Stella L, Odent S, Philip N, Faivre L, Vlckova M, Seemanova E, Digilio C, Zenker M, Zampino G, Verloes A, Dallapiccola B, Roberts AE, Cavé H, Gelb BD, Neel BG, Tartaglia M. Activating mutations affecting the Dbl homology domain of SOS2 cause Noonan syndrome. Human Mutation. 2015;**36**:1080-1087. DOI: 10.1002/humu.22834

[26] Dentici ML, Sarkozy A, Pantaleoni F, Carta C, Lepri F, Ferese R, Cordeddu V, Martinelli S, Briuglia S, Digilio MC, Zampino G, Tartaglia M, Dallapiccola B. Spectrum of MEK1 and MEK2 gene mutations in cardio-facio-cutaneous syndrome and genotype-phenotype correlations. European Journal of Human Genetics. 2009;**17**:733-740. DOI: 10.1038/ejhg.2008.256

[27] Pasmant E, Sabbagh A, Hanna N, Masliah-Planchon J, Jolly E, Goussard P, Ballerini P, Cartault F, Barbarot S, Landman-Parker J, Soufir N, Parfait B, Vidaud M, Wolkenstein P, Vidaud D, France RN. SPRED1 germline mutations caused a neurofibromatosis type 1 overlapping phenotype. Journal of Medical Genetics. 2009;**46**:425-430. DOI: 10.1136/jmg.2008.065243

[28] Sarkozy A, Carta C, Moretti S, Zampino G, Digilio MC, Pantaleoni F, Scioletti AP, Esposito G, Cordeddu V, Lepri F, Petrangeli V, Dentici ML, Mancini GM, Selicorni A, Rossi C, Mazzanti L, Marino B, Ferrero GB, Silengo MC, Memo L, Stanzial F, Faravelli F, Stuppia L, Puxeddu E, Gelb BD, Dallapiccola B, Tartaglia M. Germline BRAF mutations in Noonan, LEOPARD, and cardiofaciocutaneous syndromes: Molecular diversity and associated phenotypic spectrum. Human Mutation. 2009;**30**:695-702. DOI: 10.1002/humu.20955

[29] Cirstea IC, Kutsche K, Dvorsky R, Gremer L, Carta C, Horn D, Roberts AE, Lepri F, Merbitz-Zahradnik T, König R, Kratz CP, Pantaleoni F, Dentici ML, Joshi VA, Kucherlapati RS, Mazzanti L, Mundlos S, Patton MA, Silengo MC, Rossi C, Zampino G, Digilio C, Stuppia L, Seemanova E, Pennacchio LA, Gelb BD, Dallapiccola B, Wittinghofer A, Ahmadian MR, Tartaglia M, Zenker M. A restricted spectrum of NRAS mutations causes Noonan syndrome. Nature Genetics. 2010;**42**:27-29. DOI: 10.1038/ng.497

[30] Flex E, Jaiswal M, Pantaleoni F, Martinelli S, Strullu M, Fansa EK, Caye A, De Luca A, Lepri F, Dvorsky R, Pannone L, Paolacci S, Zhang SC, Fodale V, Bocchinfuso G, Rossi C, Burkitt-Wright EM, Farrotti A, Stellacci E, Cecchetti S, Ferese R, Bottero L, Castro S, Fenneteau O, Brethon B, Sanchez M, Roberts AE, Yntema HG, Van Der Burgt I, Cianci P, Bondeson ML, Cristina Digilio M, Zampino G, Kerr B, Aoki Y, Loh ML, Palleschi A, Di Schiavi E, Carè A, Selicorni A, Dallapiccola B, Cirstea IC, Stella L, Zenker M, Gelb BD, Cavé H, Ahmadian MR, Tartaglia M. Activating mutations in RRAS underlie a phenotype within the RASopathy spectrum and contribute to leukaemogenesis. Human Molecular Genetics. 2014;**23**:4315-4327. DOI: 10.1093/hmg/ddu148

[31] Schubbert S, Zenker M, Rowe SL, Böll S, Klein C, Bollag G, van der Burgt I, Musante L, Kalscheuer V, Wehner LE, Nguyen H, West B, Zhang KY, Sistermans E, Rauch A, Niemeyer CM, Shannon K, Kratz CP. Germline KRAS mutations cause Noonan syndrome. Nature Genetics. 2006;**38**:331-336. DOI: 10.1038/ng1748

[32] Martinelli S, De Luca A, Stellacci E, Rossi C, Checquolo S, Lepri F, Caputo V, Silvano M, Buscherini F, Consoli F, Ferrara G, Digilio MC, Cavaliere ML, van Hagen JM, Zampino G, van der Burgt I, Ferrero GB, Mazzanti L, Screpanti I, Yntema HG, Nillesen WM, Savarirayan R, Zenker M, Dallapiccola B, Gelb BD, Tartaglia M. Heterozygous germline mutations in the CBL tumor-suppressor gene cause a Noonan syndrome-like phenotype. American Journal of Human Genetics. 2010;**87**:250-257. doi: 10.1016/j.ajhg.2010.06.015

[33] Oishi K, Zhang H, Gault WJ, Wang CJ, Tan CC, Kim IK, Ying H, Rahman T, Pica N, Tartaglia M, Mlodzik M, Gelb BD. Phosphatase-defective LEOPARD syndrome mutations in PTPN11 gene have gain-of-function effects during Drosophila development. Human Molecular Genetics. 2009;**18**:193-201. DOI: 10.1093/hmg/ddn336

[34] Boguski MS, McCormick F. Proteins regulating Ras and its relatives. Nature. 1993;**366**:643-654. DOI: 10.1038/366643a0

[35] Ryu HH, Lee YS. Cell type-specific roles of RAS-MAPK signaling in learning and memory implications in neurodevelopmental disorders. Neurobiology of Learning and Memory. 2016;**135**:13-21. DOI: 10.1016/j.nlm.2016.06.006

[36] Friedman A, Perrimon N. A functional RNAi screen for regulators of receptor tyrosine kinase and ERK signalling. Nature. 2006;**444**:230-234. DOI: 10.1038/nature05280

[37] Ashton-Beaucage D, Therrien M. The greater RTK/RAS/ERK signalling pathway: How genetics has helped piece together a signalling network. Médecine Sciences (Paris). 2010;**26**:1067-1073. DOI: 10.1051/medsci/201026121067

[38] Rebay I, Chen F, Hsiao F, Kolodziej PA, Kuang BH, Laverty T, Suh C, Voas M, Williams A, Rubin GM. A genetic screen for novel components of the Ras/Mitogen-activated protein kinase signaling pathway that interact with the yan gene of Drosophila identifies split ends, a new RNA recognition motif-containing protein. Genetics. 2000;**154**:695-712

[39] Shilyansky C, Lee YS, Silva AJ. Molecular and cellular mechanisms of learning disabilities: A focus on NF1. Annual Review of Neuroscience. 2010;**33**:221-243. DOI: 10.1146/annurev-neuro-060909-153215

[40] English JD, Sweatt, JD. Activation of p42 mitogen-activated protein kinase in hippocampal long term potentiation. The Journal of Biological Chemistry. 1996;**271**:24329-24332

[41] English JD, Sweatt JD. A requirement for the mitogen-activated protein kinase cascade in hippocampal long term potentiation. The Journal of Biological Chemistry. 1997;**272**:19103-19106

[42] Brambilla R, Gnesutta N, Minichiello L, White G, Roylance AJ, Herron CE, Ramsey M, Wolfer DP, Cestari V, Rossi-Arnaud C, Grant SG, Chapman PF, Lipp HP, Sturani E, Klein R. A role for the Ras signalling pathway in synaptic transmission and long term memory. Nature. 1997;**390**:281-286. DOI: 10.1038/36849

[43] Silva AJ, Frankland PW, Marowitz Z, Friedman E, Laszlo GS, Cioffi D, Jacks T, Bourtchuladze R: A mouse model for the learning and memory deficits associated with neurofibromatosis type I. Nature Genetics. 1997;**15**:281-284. DOI: 10.1038/ng0397-281

[44] Fasano S, Brambilla R. Ras-ERK signaling in behavior: Old questions and new perspectives. Frontiers in Behavioral Neuroscience. 2011;**5**:79. DOI: 10.3389/fnbeh.2011.00079

[45] Ryu HH, Lee YS. Cell type-specific roles of RAS-MAPK signaling in learning and memory: Implications in neurodevelopmental disorders. Neurobiology of Learning and Memory. 2016;**135**:13-21. DOI: 10.1016/j.nlm.2016.06.006

[46] Sznajer Y. Neurobehavioural vulnerability and autistic traits in RASopathies. Developmental Medicine and Child Neurology. Volume 59, Issue 5, Page 461 May 2017. DOI: 10.1111/dmcn.13409

[47] Stornetta RL, Zhu JJ. Ras and Rap signaling in synaptic plasticity and mental disorders. The Neuroscientist. 2011;**17**:54-78. DOI: 10.1177/1073858410365562

[48] Costa RM, Federov NB, Kogan JH, Murphy GG, Stern J, Ohno M, Kucherlapati R, Jacks T, Silva AJ. Mechanism for the learning deficits in a mouse model of neurofibromatosis type 1. Nature. 2002;**415**:526-530. DOI: 10.1038/nature711

[49] San Martín A, Pagani MR. Understanding intellectual disability through RASopathies. Journal of Physiology, Paris. 2014;**108**:232-239. DOI: 10.1016/j.jphysparis.2014.05.003

[50] Costa RM, Silva AJ. Molecular and cellular mechanisms underlying the cognitive deficits associated with neurofibromatosis 1. Journal of Child Neurology. 2002;**17**:622-626. DOI: 10.1177/088307380201700813

[51] Mainberger F, Langer S, Mall V, Jung NH. Impaired synaptic plasticity in RASopathies: A mini-review. Journal of Neural Transmission (Vienna). 2016;**123**:1133-1138. DOI: 10.1007/s00702-016-1609-3

[52] Darcy MJ, Jin SX, Feig LA. R-Ras contributes to LTP and contextual discrimination. Neuroscience. 2014;**277**:334-342. DOI: 10.1016/j.neuroscience.2014.07.010

[53] Cui Y, Costa RM, Murphy GG, Elgersma Y, Zhu Y, Gutmann DH, Parada LF, Mody I, Silva AJ. Neurofibromin regulation of ERK signaling modulates GABA release and learning. Cell. 2008;**135**:549-560. DOI: 10.1016/j.cell.2008.09.060

[54] Mainberger F, Jung NH, Zenker M, Wahlländer U, Freudenberg L, Langer S, Berweck S, Winkler T, Straube A, Heinen F, Granström S, Mautner VF, Lidzba K, Mall V. Lovastatin improves impaired synaptic plasticity and phasic alertness in patients with Neurofibromatosis type 1. BMC Neurology. 2013;**13**:131. DOI: 10.1186/1471-2377-13-131

[55] Mainberger F, Zenker M, Jung NH, Delvendahl I, Brandt A, Freudenberg L, Heinen F, Mall V. Impaired motor cortex plasticity in patients with Noonan syndrome. Clinical Neurophysiology. 2013;**124**:2439-2444. DOI: 10.1016/j.clinph.2013.04.343

[56] Dileone M, Profice P, Pilato F, Alfieri P, Cesarini L, Mercuri E, Leoni C, Tartaglia M, Di Iorio R, Zampino G, Di Lazzaro V. Enhanced human brain associative plasticity in Costello syndrome. Journal of Physiology. 2010;**588**:3445-3456. DOI: 10.1113/jphysiol.2010.191072

[57] Rauen KA, Huson SM, Burkitt-Wright E, Evans DG, Farschtschi S, Ferner RE, Gutmann DH, Hanemann CO, Kerr B, Legius E, Parada LF, Patton M, Peltonen J, Ratner N, Riccardi VM, van der Vaart T, Vikkula M, Viskochil DH, Zenker M, Upadhyaya M. Recent developments in neurofibromatoses and RASopathies: Management, diagnosis and current and future therapeutic avenues. American Journal of Medical Genetics. Part A. 2015;**167A**:1-10. DOI: 10.1002/ajmg.a.36793

[58] Williams VC, Lucas J, Babcock MA, Gutmann DH, Korf B, Maria BL. Neurofibromatosis type 1 revisited. Pediatrics. 2009;**123**:124-133. DOI: 10.1542/peds.2007-3204

[59] Acosta MT, Bearden CE, Castellanos FX, Cutting L, Elgersma Y, Gioia G, Gutmann DH, Lee YS, Legius E, Muenke M, North K, Parada LF, Ratner N, Hunter-Schaedle K, Silva AJ. The Learning Disabilities Network (LeaDNet): Using neurofibromatosis type 1 (NF1)

as a paradigm for translational research. American Journal of Medical Genetics. Part A. 2012;**158A**:2225-2232. DOI: 10.1002/ajmg.a.35535

[60] Hyman SL, Shores A, North KN. The nature and frequency of cognitive deficits in children with neurofibromatosis type 1. Neurology 2005;**65**:1037-1044. DOI: 10.1212/01.wnl.0000179303.72345.ce

[61] Payne JM, Barton B, Shores EA, North KN. Paired associate learning in children with neurofibromatosis type 1: Implications for clinical trials. Journal of Neurology. 2013;**260**:214-220. DOI: 10.1007/s00415-012-6620-5

[62] Pierpont EI, Pierpont ME, Mendelsohn NJ, Roberts AE, Tworog-Dube E, Seidenberg MS. Genotype differences in cognitive functioning in Noonan syndrome. Genes, Brain, and Behavior. 2009;**8**:275-282. DOI: 10.1111/j.1601-183X.2008.00469.x

[63] Turner AM. Noonan syndrome. Journal of Paediatrics and Child Health 2014;**50**: E14-E20. DOI: 10.1111/j.1440-1754.2010.01970.x

[64] Allanson JE, Roberts AE. Noonan syndrome. In: Pagon RA, Adam MP, Ardinger HH, Wallace SE, Amemiya A, Bean LJH, Bird TD, Ledbetter N, Mefford HC, Smith RJH, Stephens K, editors. SourceGeneReviews® [Internet]. Seattle (WA): University of Washington, Seattle; 1993-2017. 2001 Nov 15 [updated 2016 Feb 25]

[65] Pierpont EI, Tworog-Dube E, Roberts AE. Learning and memory in children with Noonan syndrome. American Journal of Medical Genetics. Part A. 2013;**161A**:2250-2257. DOI: 10.1002/ajmg.a.36075

[66] Alfieri P, Cesarini L, Mallardi M, Piccini G, Caciolo C, Leoni C, Mirante N, Pantaleoni F, Digilio MC, Gambardella ML, Tartaglia M, Vicari S, Mercuri E, Zampino G. Long term memory profile of disorders associated with dysregulation of the RAS-MAPK signaling cascade. Behavior Genetics. 2011;**41**:423-429. DOI: 10.1007/s10519-011-9446-5

[67] Pierpont EI, Ellis Weismer S, Roberts AE, Tworog-Dube E, Pierpont ME, Mendelsohn NJ, Seidenberg MS. The language phenotype of children and adolescents with Noonan syndrome. Journal of Speech, Language, and Hearing Research 2010;**53**:917-932. DOI: 10.1044/1092-4388(2009/09-0046)

[68] Lee YS, Ehninger D, Zhou M, Oh JY, Kang M, Kwak C, Ryu HH, Butz D, Araki T, Cai Y, Balaji J, Sano Y, Nam CI, Kim HK, Kaang BK, Burger C, Neel BG, Silva AJ. Mechanism and treatment for learning and memory deficits in mouse models of Noonan syndrome. Nature Neuroscience. 2014;**17**:1736-1743. DOI: 10.1038/nn.3863

[69] Stevenson D, Viskochil D, Mao R. Legius syndrome. In: Pagon RA, Adam MP, Ardinger HH, Wallace SE, Amemiya A, Bean LJH, Bird TD, Ledbetter N, Mefford HC, Smith RJH, Stephens K, editors. SourceGeneReviews® [Internet]. Seattle (WA): University of Washington, Seattle; 1993-2017. 2010 Oct 14 [updated 2015 Jan 15]

[70] Denayer E, Ahmed T, Brems H, VanWoerden G, Borgesius NZ, Callaerts-Vegh Z, Yoshimura A, Hartmann D, Elgersma Y, D'Hooge R, Legius E, Balschun D. Spred1 is

required for synaptic plasticity and hippocampus dependent learning. The Journal of Neuroscience. 2008;**28**:14443-14449. DOI: 10.1523/JNEUROSCI.4698-08.2008

[71] Sarkozy A, Digilio MC, Dallapiccola B. Leopard syndrome. Orphanet Journal of Rare Disease. 2008;**3**:13. DOI: 10.1186/1750-1172-3-13

[72] Gripp KW, Lin AE. Costello syndrome. In: Pagon RA, Adam MP, Ardinger HH, Wallace SE, Amemiya A, Bean LJH, Bird TD, Ledbetter N, Mefford HC, Smith RJH, Stephens K, editors. GeneReviews® [Internet]. Seattle (WA): University of Washington, Seattle; 1993-2017. 2006 Aug 29 [updated 2012 Jan 12]

[73] Axelrad ME, Schwartz DD, Katzenstein JM, Hopkins E, Gripp KW. Neurocognitive, adaptive, and behavioral functioning of individuals with Costello syndrome: A review. American Journal of Medical Genetics. Part C, Seminars in Medical Genetics. 2011;**157C**(2):115-122. DOI: 10.1002/ajmg.c.30299

[74] Rauen KA. Cardiofaciocutaneous syndrome. In: Pagon RA, Adam MP, ArdingerHH, WallaceSE, AmemiyaA, BeanLJH, BirdTD, LedbetterN, MeffordHC, SmithRJH, StephensK, editors. GeneReviews® [Internet]. Seattle (WA): University of Washington, Seattle; 1993-2017. 2007 Jan 18 [updated 2016 Mar 3]

[75] Pierpont ME, Magoulas PL, Adi S, Kavamura MI, Neri G, Noonan J, Pierpont EI, Reinker K, Roberts AE, Shankar S, Sullivan J, Wolford M, Conger B, Santa Cruz M, Rauen KA. Cardio-facio-cutaneous syndrome: Clinical features, diagnosis, and management guidelines. Pediatrics. 2014;**134**: e1149-e1162. DOI: 10.1542/peds.2013-3189

[76] Pierpont El, Semrud-Clikeman M, Pierpont ME. Variability in clinical and neuropsychological features of individuals with MAP2K1 mutations. American Journal of Medical Genetics. Part A. 2017;**173**:452-459. DOI: 10.1002/ajmg.a.38044

Chapter 3

Developmental Dyslexia in Spain

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Additional information is available at the end of the chapter

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Abstract

Spanish-speaking children learn to read words written in a relatively transparent orthography. Variations in orthographic transparency may shape the manifestation of developmental dyslexia. In Spanish, as in other transparent orthographies, reading speed/fluency seems to be more evident and relevant than accuracy problems. In addition, the prevalence of dyslexia is much lower in Spanish than in less consistent or less transparent orthographies. Spanish students with developmental dyslexia have numerous lags in several cognitive (e.g., phonological awareness, rapid naming, verbal and visual-spatial working memory, and executive functioning), academic (e.g., pseudoword reading, spelling, and vocabulary), and emotional (e.g., reading self-concept, engagement, and reading motivation) areas. Intervention programs developed with Spanish children with dyslexia have ranged from phonological-based programs to fluency-based programs, with and without a computer.

Keywords: developmental dyslexia, Spanish, cognitive deficits, motivation, intervention

1. Introduction

Spain is a European country with a Human Development Index of 0.87, which means it ranks 26th out of 188 countries. The Human Development Report [1] provides a composite measure of three dimensions of human development: living a long and healthy life, being educated, and having a decent standard of living.

In Spain, the Spanish language is spoken. Spanish is classified as an Indo-European language of the romance subfamily. Spanish has a shallow and fine-grained orthography. That is, the orthography-phonology mapping is completely rule-governed across the language, although it is less transparent in writing. Specifically, the Spanish orthography has 27 graphemes (five vowels

and 22 consonants), each of which represents a unique sound, and five digraphs (ch, ll, rr, gu, and qu). The last three are considered positional variants of the phonemes/r/, /g/ and /k/; two diacritical marks: stress mark or acute accent (′), and dieresis (¨). Therefore, grapheme-phoneme correspondences are predictable in reading, but this does not occur in writing, where inconsistent phoneme-grapheme correspondences are added, producing phonemes that correspond to several graphemes. For example, eight consonant phonemes can be represented using more than one grapheme: /b/(B, V, W), /k/(K, QU, C), /g/(G, GU), /x/(G, J), /j/(Y, LL), /rr/(R, RR), /Ø/(Z, C), /s/(S, X).

In addition, Spanish is regarded as a syllable-timed language [2], whereas English is considered stress timed [3]. Syllables are the most consistent sub-lexical units in regular orthographies such as Spanish [4], and 88.73% of the Spanish syllables have a very simple syllabic structure with the CV, CVC, V, or VC combination [5]. The longest syllable has five graphemes with a maximum of two initial consonants that rarely appear in coda position. Some geographic varieties of Spanish differ from each other in terms of phonology, but this does not seem to cause comprehension problems between speakers [3]. Fundamental supra-segmental features are stress and intonation. The stress in Spanish marks intensity, and it falls on one of the last three syllables in the word, counting from the end (e.g., paroxytone words, oxytone words, and proparoxytone words). Intonation is the melodic curve the voice traces when uttering sentences. On the basis of their direction and the extent of the intonation contour, five types of final inflections have been distinguished that maintain distinctive characteristics surrounding the assertion, interrogation, exclamation, and appeal modes [6].

Thus, the grapheme-phoneme correspondence is predictable in reading. That is, an expert reader is capable of unequivocally determining the correct pronunciation of a written word or a pseudoword based on correspondence rules. However, this situation does not occur in writing, where inconsistent phoneme-grapheme correspondences are added, producing doubts because a single phoneme can correspond to several graphemes, which affects the transparency of the code.

Intercultural studies suggest that the level of orthographic transparency determines the reading performance of children with dyslexia [7–9]. Thus, the characteristics of the Spanish language influence, in part, the prevalence and manifestations of dyslexia in Spanish.

2. Learning disabilities in Spain

In Spain, the term learning disabilities has been used for many years in a general sense. It has been considered synonymous with the broader concept of special educational needs [10–12]. According to this conceptualization, learning disabilities were not considered a specific diagnostic condition; instead, the term referred to problems or difficulties a student could have with learning, regardless of their cause. However, the publication of the *Ley Orgánica de Educación* (Organic Education Law) [13] and the *Ley Orgánica para la Mejora de la Calidad Educativa* (Organic Law for Improving the Quality of Education) [14] marked a major change because the term *special educational needs* was replaced by the expression *specific needs for educational support* due

to special educational needs, specific learning disabilities, giftedness, or late entrance into the school system [15]. Developmental dyslexia falls within the category of specific learning disabilities. Spain is organized into 17 autonomous regions and two autonomous cities. Some regional governments like Andalusia, Canary Islands, Catalonia, Murcia, and Navarra have adopted definitions of specific learning disabilities, based essentially on significantly lower achievement on an individualized normative test ($P_c < 25$) and exclusionary criteria (sensory impairments, intellectual disability, etc.).

The educational response to learning disabilities takes place through different service arrangements in schools. In Spain, treatment for learning disabilities involves evaluation, educational counseling, and educational support using ordinary resources such as small group attention or individual attention and extraordinary measures such as individual curricular adaptations (ACIs; *Adaptaciones Curriculares Individualizadas*). Children with learning disabilities receive some special classes in resource rooms during 3 h in a week.

In Spain, three types of interconnected professional groups provide support to children with learning disabilities: (a) special education teachers; (b) speech and language disorders teachers, who carry out individualized treatments; and (c) professionals in educational psychology. In Spain, they are called *Equipos de Orientación Escolar y Psicopedagógica* (School Counselling and Psychoeducational Teams) or *Servicios Psicopedagógicos Escolares* (School Psychoeducational Services) [10–12, 15].

3. Prevalence of dyslexia in Spain

Developmental dyslexia is a specific reading disorder of neurological origin that persists throughout life despite having adequate intelligence, education, and socioeconomic background to learn to read [16]. Individuals with dyslexia have difficulties with accurate or fluent word recognition [17, 18]. Thus, the most consistent and enduring core of any definition of dyslexia is probably its conception as an *unexpected* difficulty in reading [12, 17].

The prevalence of dyslexia has been estimated at 5–15% of school-aged children, depending on the language and culture [16]. Researchers have argued that the difference in the prevalence of dyslexia in different languages might primarily be due to inherent differences in the regularity of the grapheme-phoneme correspondence [8, 19]. As far as reading is concerned, Spanish is a clear example of a transparent orthographic system. The prevalence of dyslexia is much lower in transparent orthographies than in opaque orthographies [8]. Specifically in Spain, the estimated prevalence of developmental dyslexia ranges from 3.2 to 5.9% in elementary school students [20] and from 3.5 to 5.6% in secondary school students [21], or 11.8% if spelling difficulties are included with dyslexia [22].

In addition, dyslexia is typically more prevalent in males than in females in both referred and research-identified samples, and the ratio of males to females is greater in more severely affected samples [16]. Nevertheless, a recent study [23] provided little (1.4:1 male to female ratio) or no evidence for gender-related differences in the prevalence of reading disabilities in a transparent orthography.

4. Reading-related cognitive deficits in dyslexia and emotional problems

Although developmental dyslexia has traditionally been defined as an unexpected disorder in reading, accumulated evidence suggests that students with developmental dyslexia can show a range of reading-related cognitive deficits [24]. Students with reading disabilities have numerous lags in several cognitive (e.g., phonological awareness, rapid naming, verbal and visual-spatial working memory, and executive processing) and academic (e.g., pseudoword reading, spelling, and vocabulary) areas, compared to average reading students. However, reading speed/fluency is considered the main indicator of dyslexia in the Spanish language, whereas reading accuracy is relatively intact [24–28]. Furthermore, some studies [29, 30] have shown that the percentages of dyslexic subtypes in Spanish and opaque orthographies are quite different. Specifically, between 45.5 and 53% were classified as surface dyslexics, and between 18 and 22.8% were classified as phonological dyslexics, respectively.

The most important breakthrough was probably the discovery that the link between oral language and written language resided in the phonological structure of speech. Thus, children with dyslexia commonly present difficulties in acquiring phonological awareness. Because reading acquisition requires the child to learn the phoneme-grapheme correspondences, problems with phonological information lead to difficulties in reading acquisition. Different studies carried out in the Spanish language using reading-age- and chronological-age-matched designs have also found a deficit in phonological awareness in children with dyslexia [25, 26, 30–34]. However, some studies [34–36] have shown that the origin of this phonological deficit is a deficit in speech perception, as they also found temporal-processing problems in speech perception in children with dyslexia [35].

In addition to segmental phonology, recent studies have shown the role of suprasegmental phonology or prosody, such as skills in detecting accents, pauses, or intonation, in the population with dyslexia. For example, one recent study [37] showed that Spanish children with dyslexia performed worse on stress awareness in words and pseudowords than control children.

Naming speed, defined as the ability to name highly familiar visual stimuli as fast as possible, has been shown to be a strong concurrent and longitudinal predictor of reading ability in both consistent and inconsistent orthographies (see review [38]). In addition, many studies have indicated that reading disabilities appear to be accompanied by impairments in naming speed, and these impairments are found regardless of the orthography of the language in which children learn to read. Several studies carried out in Spanish have shown that naming speed tasks (e.g., rapid automatized naming) are capable of discriminating between children with dyslexia and reading-age- and chronological-age-matched typical readers [26, 39–42].

Other studies have shown that children with dyslexia who show both phonological and naming speed deficits have greater reading difficulties than those with only one deficit [41, 43, 44].

Processes related to memory, specifically verbal working memory and phonological short-term memory, have been some of the most extensively researched cognitive processes in children with reading disabilities in the past 30 years. Recent studies carried out in Spanish [26, 30, 33] indicated that children with reading disabilities showed impairments on short-term measures

requiring the recall of digit sequences or repetition of Latin words, and on working memory measures requiring the simultaneous processing and storage of digits within sequences and final words from unrelated sentences.

In recent years, a growing body of evidence suggests that children and adolescents with developmental dyslexia also manifest difficulties with executive functioning. Executive function is a multidimensional construct involving skills such as planning, initiation, working memory, self-control (inhibition and monitoring of performance), processing speed, attention, and task switching, all of which are important in the deliberate control of goal-oriented actions [45]. Some studies [46, 47] using behavioral rating questionnaires of executive functioning showed that children and adolescents with dyslexia were rated by both parents and teachers as having more frequent executive function problems in day-to-day life, with these difficulties centering on metacognitive processes (initiation, working memory, planning, task monitoring, and planning organization), rather than on the regulation of emotion and behavior.

Recent studies [48, 49] revealed that dyslexia persists into adulthood. In general, these studies showed that Spanish adults with dyslexia present problems in reading words, pseudowords, reading comprehension, fluency, and reading motivation. In addition, Spanish-dyslexic adults, as in opaque orthographies, continue to have difficulties on phonological awareness tasks, rapid naming, short-term memory, working memory, executive functioning, reading, and spelling.

In recent decades, a large body of research has focused on the cognitive consequences of dyslexia. However, less research has focused on analyzing the motivational consequences of dyslexia, even though expanded cognitive-learning models have included motivational beliefs. Some studies [49–51] have shown that children with dyslexia have a more negative self-concept, experience greater feelings of helplessness, avoid reading activities, and show less emotional self-regulation. In addition, two very distinct attributional profiles in students with learning disabilities (the helplessness profile and the adaptive profile) have been described [52].

More specifically, a recent study [53] using a reading self-report scale showed that children with dyslexia had more negative perceptions of themselves as readers: they saw themselves as less competent in reading, had more difficulty with reading, and liked to read less than their peers. Therefore, children with developmental dyslexia may be less motivated to engage in reading activities. Likewise, teachers of children with dyslexia consider that they have less reading motivation, both extrinsic and intrinsic, than their average peers, and that they are less engaged in reading activities [54].

5. Intervention trends in developmental dyslexia in Spain

In Spain, a noteworthy effort has been made in recent decades to develop intervention programs and analyze their effectiveness that had not previously been seen in the field of learning difficulties. Clearly, this increase in intervention studies did not occur by chance, but rather it has accompanied advances made in characterizing the problems experienced by

children with reading problems [55]. Although evidence-based intervention programs for children with dyslexia are scarce, they seem to reflect the different explanatory theories for reading difficulties.

Most interventions have been designed to remediate the *phonological-processing deficit*, proposed as the main deficit in all dyslexics. These studies have evaluated the efficacy of different approaches to treatment, mainly based on a combination of training in phonological skills and phonemic awareness. The first programs developed for students with dyslexia incorporated instruction in identifying phonemes, adding phonemes, and writing a word. The results showed that instruction produces a significant improvement in the subject's ability to write down dictated sentences and passages. Although this training favored the acquisition of metalinguistic skills (tasks such as reversal, addition, and omission of phonetic sounds), the children's reading level did not improve [56–58]. Thus, training in phonemic awareness does not have a positive effect on reading in children with dyslexia. These results are consistent with the conclusions of a meta-analysis on reading intervention studies with children with learning difficulties [59]. They suggest that phonemic awareness is an important skill, but not sufficient to improve reading, especially in older children with reading difficulties.

Some researchers have suggested that the difficulties experienced by children with dyslexia could be based on a specific difficulty with the perceptual processing of speech. Therefore, one of the components introduced in phonological skill-training programs involves training in speech perception. For example, the effects of two types of phonological training on children with dyslexia were examined [60]. The two programs consisted of intensive, systematic instruction in letter-sound correspondence and phonemic awareness using five different tasks (see description in **Table 1**).

Letter-sound correspondence. First, a trainer showed a consonant and vowel combination on a magnetic board. The children had to give the sound for each letter and each combination of letters. The linguistic structure of these combinations could consist of consonant-vowel, vowel-consonant-vowel, consonant-consonant-vowel, considering all the possible or likely phonemic combinations in the Spanish language.

Phoneme identification. The children were shown a magnetic lowercase letter and had to say words that began with this letter. Then, the trainer read them six or seven words aloud, and the children had to say whether each word contained the phoneme and where.

Segmentation. The children had to pronounce all the phonemes in a word read aloud by the trainer. As they pronounced each phoneme, the trainer provided them with visual feedback for the phoneme by placing the corresponding letter on the magnetic board. The task contained seven words that were presented to the children.

Phoneme deletion. This task consisted of 13 words. In the first six words, the children had to delete the final phoneme, and in the following seven words, they had to delete the initial phoneme (e.g., "Say Cat. Now say it again, but don't say/K/"). After the child had said each word with the missing phoneme, the trainer provided him/her with a feedback by putting the word on the board and removing the deleted phoneme.

Phoneme blending. In each session, one of the children was provided with a magnetic board where a word with the phoneme being taught was placed. That child had to pronounce each phoneme in the given word. The other children had to guess the word and say it out loud. Visual feedback for each word was provided by the child who was presenting the word on the magnetic board. Seven words were presented in this task.

Table 1. Description of letter-sound correspondence and phonemic awareness training tasks.

Subjects differed only in speech perception training, which was introduced only in the second training condition. The first part of each session involved instruction in three tasks that trained speech perception (see description in **Table 2**). There were 20 training sessions lasting for 20 min each in both intervention conditions over a period of 4 weeks. The children received training in a specific phoneme in each training session, following this order of presentation: /m/, /f/, /ř/, /b/, /n/, /p/, /l/, /s/, /d/, /t/, /k/, /g/, /x/, /r/, /Ø/. In the last five sessions, the most difficult phonemes were reviewed. In the training sessions, words with different syllabic structures (consonant-vocal, consonant-vocal-consonant, and consonant-consonant-vocal) were presented. The results of this study [60] indicated that both experimental groups improved on phonemic awareness compared to the control group, but only the children with speech perception plus letter-sound correspondences with phonemic awareness scored higher than the control group on reading. Thus, speech perception training shows promise for use with children with dyslexia.

On the other hand, some researchers [61, 62] have used computerized speech-based reading in experiments on dyslexia remediation. Specifically, the program called TEDIS (Tratamiento Experimental de la Dislexia; in English, Experimental Treatment of Dyslexia) has been investigated. The participants were randomly assigned to five groups: (a) the whole-word training group, (b) the syllable training group, (c) the onset-rime training group, (d) the phoneme training group, and (e) the untrained control group. For 30–40 min for 5 days a week, they were individually trained. The control group followed the standard reading program, which included oral comprehension, spelling, reading aloud, and reading comprehension activities. However, they did not receive any of the sound spelling units in which the experimental participants participated. During 15 sessions in the TEDIS program, children are trained with this "talking" computer program, which provides support and feedback through digitized speech in four experimental conditions: full word, phonemes, syllables, and onset-rime segments. Children could request more speech feedback by clicking the mouse on each item. During the computer-based word reading, when the child made three mistakes in the same word, a new word was presented. The results indicate that the experimental groups that participated in the phoneme and syllable conditions improved their word recognition in comparison with the

Phoneme discrimination in syllables. The trainer read aloud a series of eight syllables that differed only on the initial phoneme (e.g., pe, te, le, me, se, te, me, le) and contained a target syllable (e.g., me). The children had to raise their hands if they heard the target syllable. This task presented four sets of syllables and four target syllables. In each set of syllables, the possible linguistic structures were CV, CVC, or CCV.

Word pair categorization. This task was designed to teach the discrimination of consonant contrasts in word pairs. The task contained four pairs of words: two differed only on one consonant (e.g., alba, alga) and two were the same (e.g., toga, toga). The children listened to a pair of words and had to give an oral response of *same* or *different* after each trial.

Phoneme discrimination in words. The trainer read a set of five words aloud; of them, only one was different (e.g., puente, puente, fuente, puente, puente). The children had to raise their hands if they heard the word that was different. After each trial, the trainer provided a feedback by saying the set of words and having the children repeat them. This task contained three sets. In each set, the two words differed on only one consonant. The presentation of the sets was from less to more difficult (e.g., set 1/m/contrasted with/g/; set 3/p/contrasted with/b/.

Table 2. Description of speech perception training tasks.

control group. In addition, dyslexics who participated in the phoneme, syllable, and onset-rime conditions made a greater number of requests during computer-based word reading under conditions that required extensive phonological computation (low-frequency words and long words). However, the reading time was higher for long words in the phoneme group. These results show that training in phonological processes improves word recognition in children with dyslexia who learn to read in a consistent orthography.

Another study [63] analyzed whether the *Tradislexia* videogame affected phonological awareness, considering separately the complexity of the syllable structure and the type of phonological awareness task, and word recognition in children with dyslexia. The results showed that when the phoneme position was controlled, multimedia training in segmentation and blending with words that include consonant-vowel syllables was a better predictor of improvements in word-decoding processes.

Unfortunately, programs designed to remediate the deficit in phonological processing, although beneficial, are not sufficient to achieve fluent word recognition in children with dyslexia. In fact, 90% of intervention studies include measures of reading accuracy, but not reading fluency [64]. Consequently, in recent years, some studies [65–68] have analyzed the efficacy of intervention programs mainly designed to improve reading fluency.

For example, one study analyzed the efficacy of a multicomponent program to improve reading fluency in Spanish children with dyslexia, called Velocilector [65–68]. This program integrates multiple instructional components that meet rigorous scientific standards for effectiveness (see **Table 3** for a description of instructional components). Special needs teachers were trained in the application of the program. Instruction was delivered one to one. The effects of the training program were evaluated using gains in scores on word and pseudoword reading and text-reading fluency, as well as on a text comprehension test. Results showed that children who participated in the intervention obtained statistically significant gains on the reading measures used, with the exception of text comprehension, spelling, and reading motivation [62, 66–68].

Another study [65] analyzed the effectiveness of a computerized reading acceleration program (RAP), which is a different approach to improving reading fluency problems. The Spanish version consists of 600 sentences with comprehension questions with three alternative answers. Each child was trained during 20 sessions lasting for 30 min each over a period of 4 weeks (about 10 h of training). In each session, the children worked individually on the computer with 30 sentences with the corresponding questions, under the supervision of a previously trained graduate student. The sentences appeared one at a time on the computer screen. After reading a sentence, the children pressed the space bar, and the text disappeared. Next, a comprehension question appeared with three alternative answers. The children had to choose the correct answer by pressing a key on the computer. During the training, all the children were presented with the same set of sentences in the same order. The results of the accelerated reading training showed that children with dyslexia improved their reading speed on sentences, their level of reading comprehension, and their naming speed on letter and pseudoword-reading time, providing empirical evidence for the acceleration phenomenon in Spanish.

Component	Instructional steps			
Repeated readings	(a) The child read the material aloud.			
Material: letters/ syllables, words, passages/texts.	(b) The teacher provided a model of fluent reading (prosodic reading).			
	(c) The child reread the material four times (silent reading).			
	(d) The child read the material from the session aloud again.			
	(e) The teacher gave the correct answers for reading errors. To do so, the teacher said the words correctly and asked the student to repeat them. Feedback was provided about each child's improvements in reading speed or accuracy.			
Phonemic awareness and grapheme-phoneme rules	The following sequence is used on the mistakes the student makes:			
	(a) The child reads the word aloud, with help if necessary.			
	(b) The child pronounces the word in syllables with the support of letters.			
	(c) The child pronounces the word's phonemes with the support of letters (phoneme-grapheme correspondence rules).			
	(d) The child rereads the word silently three times and, finally, reads the word aloud.			
	(e) Finally, the child blends the phonemes to say the whole word. If incorrect, s/he has to repeat it			
Motivation	**Adaptive attributions**		**Maladaptive attributions**	
Social reward and attribution retraining	**Success**	**Failure**	**Success**	**Failure**
	Effort	Low effort	Luck/help from others	Not talented enough
	Strategy use	No strategy use	Easy task	Bad luck

Table 3. Instructional components of the Velocilector multicomponent program.

6. Conclusions

Spanish-speaking children learn to read words written in a relatively transparent orthography. That is, the orthography-phonology mapping is completely rule-governed across the language, although it is less transparent in writing. Thus, to some extent, the characteristics of the Spanish language influence the prevalence and manifestations of dyslexia in Spanish.

Mainly during the past three decades, many studies have addressed the analysis of the characteristics and manifestations of dyslexia in Spanish. In general, the research carried out has followed in the wake of studies developed in less transparent languages [65], although there was no educational legislation in Spain that explicitly includes specific learning difficulties such as dyslexia [10–12]. Thus, several studies have shown that in Spanish, as in other transparent orthographies, reading speed/fluency seems to be more evident and relevant than accuracy.

In addition, the prevalence of dyslexia is much lower in Spanish than in less transparent orthographies, ranging from 3 to 6%, approximately, with little (1.4:1 male to female ratio) or no evidence of gender-related differences in transparent orthographies. Therefore, the existence of dyslexic subtypes could be the consequence of differences in orthographic systems, and the percentages of dyslexic subtypes in Spanish and opaque orthographies are quite different [69]. For this reason, surface dyslexics were classified between 45.5 and 53% and phonological dyslexics between 18 and 22.8%, respectively.

Different studies using reading-age- and/or chronological-age-matched designs have also found that Spanish students with developmental dyslexia have numerous lags in several cognitive (e.g., phonological awareness, speech perception, temporal processing, rapid naming, verbal and visual-spatial working memory, and executive functioning domains) and academic (e.g., pseudoword reading, spelling, and vocabulary, prosody) areas. In fact, these cognitive and academic difficulties persist into adulthood.

Many children who feel like failures in school, for one reason or another, tend to have low expectations of learning achievement, a poorer academic self-concept, a maladaptive attributional pattern for their successes and failures, and little motivation to read or be involved in school activities that require reading. Thus, children with dyslexia have a lower self-concept, and even a lower-reading self-concept, presumably caused by their academic failure. Moreover, studies that have analyzed the attributional patterns of children with dyslexia show that although some students have an adaptive attributional pattern, other students with dyslexia have a completely maladaptive pattern. In other words, they explain their successes by referring to external causes (luck, low difficulty level of the task, help from others, etc.), and their failures tend to be attributed to internal and uncontrollable causes, such as low ability.

Finally, research carried out to analyze the efficacy of intervention procedures with students with dyslexia in the Spanish language is quite scarce, compared to research developed to characterize their difficulties in different areas [55]. Most interventions have evaluated the efficacy of different treatment approaches, mainly based on a combination of intensive, systematic training in letter-sound correspondence, phonemic awareness, and even speech perception. In recent years, different fluency-based programs have emerged. One of them is a multicomponent program that combines repeated readings with phonemic awareness and grapheme-phoneme rules, along with a motivational component with social reward and attributional retraining. Another one is the application of a computerized-reading acceleration program. In general, the remediation research developed in Spain follows the program development tendencies found in international research, especially in less transparent languages.

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References

[1] United Nations Development Programme. Human Development Report 2015. Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience. New York, NY: UNDP; 2016

[2] Berg T. Phonological processing in a syllable-timed language with a pre-final stress: Evidence from the Spanish language. Language and Cognitive Processes. 1991;**6**:265-301

[3] Defior S, Serrano F. Aspectos diacrónicos y sincránicos del español: Relación con la adquisición del lenguaje escrito [Diachronic and synchronic aspects of Spanish: the relationship with literacy acquisition]. Estudios de Psicología. 2014;**35**(3):450475

[4] Carreiras M, Grainger J. Sublexical representations and the "front end" of visual word recognition. Language and Cognitive Processes. 2004;**19**:321-331

[5] Guerra R. Estudio estadístico de la sílaba en español [Statistical study of the syllable in Spanish]. In Esgueva M, Cantarero M, editors. Estudios de Fonética I. Madrid: Consejo Superior de Investigaciones Científicas; 1983. pp. 9-112

[6] Alarcos Llorach E. Gramática de la Lengua Española [Grammar of the Spanish Language]. 22nd ed. Madrid: Espasa Calpe; 2007

[7] Seymour PHK, Aro M, Erskine JM. Foundation literacy acquisition in European orthographies. British Journal of Psychology. 2003;**94**:143-174

[8] Wydell TN. Cross-cultural/linguistic differences in the prevalence of developmental dyslexia and the hypothesis of granularity and transparency. In: Wydell TN, editor. Dyslexia – A comprehensive and international approach. Croatia: InTech; 2012. pp. 1-14 Available from: http://www.intechopen.com/books/dyslexia-a-comprehensive-and-international-approach/cross-culturallinguistic-differences-in-the-prevalence-of-developmental-dyslexia-and-the-hypothesis

[9] Ziegler J, Goswami U. Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. Psycholinguistic Bulletin. 2005; **131**:3-29

[10] Fidalgo R, Robledo R. The field of specific learning disabilities in Spain after the 2006 Education Act. Papeles del Psicólogo. 2010;**31**(2):171-182

[11] Jiménez JE, Hernández-Valle I. A Spanish perspective on learning disabilities. Journal of Learning Disabilities. 1999;**32**:267-275

[12] Soriano-Ferrer M. Dificultades en el aprendizaje [Learning Disabilities]. 2nd ed. Granada: Grupo Editorial Universitario; 2014

[13] Ley Organica 2/2006 de Educación [Organic Law of Education]. Boletín oficial del Estado BOE N° 106. I Disposiciones Generales. España: Jefatura del Estado; 2006

[14] Ley Organica 8/2013 para la Mejora de la Calidad Educativa LOMCE [Organic Law for Improving the Quality of Education]. Boletín oficial del Estado BOE N° 295. I Disposiciones Generales. España: Jefatura del Estado; 2013

[15] Soriano-Ferrer M, Echegaray-Bengoa J, Joshi MR. Knowledge and beliefs about developmental dyslexia in pre-service and in-service Spanish-speaking teachers. Annals of Dyslexia. 2016;**66**(1):91-110

[16] American Psychiatric Association. Manual Diagnóstico y Estadístico de los Trastornos Mentales. DSM-5. [Diagnostic and Statistical Manual of Mental Disorders. 5th ed] Madrid: E. Médica Panamericana; 2014

[17] Shaywitz SE, Morris R, Shaywitz BA. The education of dyslexic children from childhood to young adulthood. Annual Review of Psychology. 2008;**59**:451-475

[18] Snowling MJ, Hulme C. Children's reading impairments: From theory to practice. Japanese Psychological Research. 2012;**55**(2):186-202

[19] Joshi RM, Aaron PG, editors. Handbook of Orthography and Literacy. Mahwah, NJ: Lawrence Erlbaum Associates; 2006

[20] Jiménez JE, Guzmán R, Rodríguez C, Artiles C. Prevalencia de las dificultades específicas de aprendizaje: La dislexia en español [Prevalence of specific learning disabilities: Dyslexia in Spanish]. Anales de Psicología. 2009;**25**(1):78-85

[21] González D, Jiménez, JE, García E, Díaz A, Rodríguez C, Crespo P, Artiles C. Prevalencia de las dificultades específicas de aprendizaje en la educación secundaria obligatoria [Prevalence of specific learning disabilities in compulsory secondary education]. European Journal of Education and Psychology. 2010;**3**(2):317-327

[22] Carrillo MS, Alegría J, Miranda P, Sánchez N. Evaluación de la dislexia en la escuela primaria: Prevalencia in Español [Evaluating dyslexia in primary school children: Prevalence in Spanish]. Escritos de Psicología. 2011;**4**(2):35-44

[23] Jiménez JE, García de la Cadena C, Siegel LS, O'Shanahan I, García E, Rodríguez C. Gender ratio and cognitive profiles in dyslexia: A cross-national study. Reading and Writing. 2011;**24**(7):729-747

[24] Vellutino F, Fletcher JM, Snowling MJ, Scanlon D M. Specific reading disability (dyslexia): What have we learned in the past four decades? Journal of Child Psychology and Psychiatry. 2004;**45**:2-40

[25] Serrano F, Defior S. Dyslexia speed problems in a transparent orthography. Annals of Dyslexia. 2008;**58**:81-95

[26] Soriano-Ferrer M, Miranda-Casas A. Developmental dyslexia in a transparent orthography: A study of Spanish dyslexic children. In: Scruggs TE, Mastropieri MA, editors, Literacy and Learning. Advances in Learning and Behavioral Disabilities. Amsterdam (The Netherlands): Emerald Group Publishing Limited; 2010. pp. 95-114

[27] Suárez-Coalla P, Cuetos F. Reading strategies in Spanish developmental dyslexics. Annals of Dyslexia. 2012;**62**(2):71-81

[28] Davis R, Cuetos F, González-Seijas RM. Reading development and dyslexia in a transparent orthography: A survey of Spanish children. Annals of Dyslexia. 2007;**57**:179-198

[29] Jiménez JE, Ramírez G. Identifying subtypes of reading disabilities in the Spanish language. Spanish Journal of Psychology. 2002;**3**:37-46

[30] Jiménez JE, Rodríguez C, Ramirez G. Spanish developmental dyslexia: Prevalence, cognitive profile and home literacy experiences. Journal of Experimental Child Psychology. 2009;**103**:167-185

[31] Jiménez JE. A reading-level match study of phonemic processes underlying reading disabilities in a transparent orthography. Reading and Writing. 1997;**9**(1):23-40

[32] Jiménez JE, Hernández I. Word identification and reading disorders in the Spanish language. Journal of Learning Disabilities. 2000;**33**:44-60

[33] Soriano-Ferrer M, Nievas F, Sánchez P, Félix V, González JA. Reading-related cognitive deficits in Spanish developmental dyslexia. Procedia, Social and Behavioral Science. 2014;**132**:3-9

[34] Ortiz R, Jiménez JE, Miranda EG, Rosquete RG, Hernández-Valle I, Rodrigo M, et al. Locus and nature of perceptual phonological deficit in Spanish children with reading disabilities. Journal of Learning Disabilities. 2007;**40**(1):80-92

[35] Ortíz R, Jiménez JE, Muñetón M, Rojas E, Estévez A, Gúzman R, Rodríguez C, Naranjo F. Desarrollo de la pecepción de habla en niños con dislexia [Development of speech perception in children with dyslexia]. Psicothema. 2008;**20**(4):678-683

[36] Ortíz R, Estévez A, Muñetón M. El procesamiento temporal en la percepción de habla de los niños con dislexia [Temporal processing in speech perception of children with dyslexia]. Anales de Psicología. 2014;**30**(2):716-724

[37] Jiménez-Fernández G, Gutiérrez-Palma N, Defior S. Impaired stress awareness in Spanish children with developmental dyslexia. Research in Developmental Disabilities. 2015;**37**:152-161

[38] Georgiou GK, Parrilla R, Liao ChH. Rapid naming speed and reading across languages that vary in orthographic consistency. Reading and Writing. 2008;**21**:885-903

[39] Wiig EH, Langdon HW, Flores N. Rapid automatized color-form naming by Spanish-speaking, bilingual and monolingual children. Revista de Logopedia, Foniatría y Audiología. 2001;**21**(3):106-117

[40] Guzmán R, Jímenez JE, Ortiz R, Hernández-Valle I, Estévez A, Rodrigo M, et al. Evaluación de la velocidad de nombrar en las dificultades de aprendizaje de la lectura [Naming speed assessment in reading disabilities]. Psicothema. 2004;**16**(3):442-447

[41] López-Escribano C. Evaluation of the double-deficit hypothesis subtype classification of readers in Spanish. Journal of Learning Disabilities. 2007;**40**(4):319-330

[42] Jiménez JE, Rodríguez C, Guzmán R, García E. Desarrollo de los procesos cognitivos de la lectura en alumnos normolectores y alumnos con dificultades específicas de aprendizaje [Development of cognitive processes in reading in normal readers and children with reading disabilities]. Revista de Educación. 2010;**353**:361-386

[43] López-Escribano C. Reading acquisition in monolingual Spanish-speaking first grade children. British Journal of Education, Society & Behavioral Science. 2012;**2**(3):290-306

[44] Jiménez JE, Hernández-Valle I, Rodríguez C, Guzmán R, Díaz A, Ortíz R. The double-deficit hypothesis in Spanish Developmental dyslexia. Topics in Language Disorders. 2008;**28**(1):46-60

[45] Zelazo PD, Blair CB, Willoughby MT. Executive Function: Implications for Education (NCER 2017-2000). Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education; 2016

[46] Soriano-Ferrer M, Joshi RM. Funcionamiento Ejecutivo y Síntomas de TDAH en niños con Dificultades en el Aprrendizaje de la Lectura [Executive function and symptoms of ADHD in children with reading difficulties]. In: Paper presented at IV International Congress of Educational Sciences and Development; Spain: Santiago de Compostela; 2016

[47] Piedra-Martínez E, Soriano-Ferrer M, Joshi RM, Echegaray-Bengoa J. Executive functioning among adolescents with developmental dyslexia. In: Paper presented at XXIII Annual Meeting of Society for The Scientific Study of Reading. Portugal: Porto; 2016

[48] Suárez-Coalla P, Cuetos F. Reading difficulties in Spanish adults with dyslexia. Annals of Dyslexia. 2015;**65**(1):33-51

[49] Piedra-Martínez E. Dislexia en adolescentes y jóvenes adultos: Caracterización cognitiva y Afectivo-Motivacional [Dyslexia in Adolescents and Young Adults: Cognitive and Affective-Motivational Characterization] [Doctoral thesis]. University of Valencia; 2016

[50] Núñez, JC, González S, González JA. Autoconcepto en niños con y sin dificultades de aprendizaje [Self-concept in children with and without learning disabilities]. Psicothema. 1995;**7**(3):587-604

[51] Soriano-Ferrer M, Echegaray-Bengoa J, Gómez-Merino N, Soriano-Ferrer E. Test differences in the assessment of reading motivation among disabled and normal readers. In: Paper presented at 10th International Conference on Child and Adolescent Psychopathology. UK: London; 2015

[52] Núñez JC, González-Pienda JA, González-Pumariega S, Roces C, Álvarez L, González P. Subgroups of attributional profiles in students with learning disabilities and their relation to self-concept and academic goals. Learning Disabilities Research and Practice. 2005;**20**(2):86-97

[53] Soriano-Ferrer M, Rodriguez-Miguel C, Soriano-Ferrer E. Reading self-concept of children with dyslexia: Do they differ from their peers? In: Veiga F, editor. Students' Engagement in School: International Perspectives of Psychology and Education. Lisboa: Instituto de Educação da Universidade de Lisboa; 2014. pp. 445-459

[54] Soriano-Ferrer M, Morte-Soriano M. Teacher perceptions of reading motivation in children with developmental dyslexia and average readers. Procedia, Social and Behavioral Sciences. 2017;**237**:50-56

[55] Soriano M. La investigación en dificultades de aprendizaje: Un análisis documental [Research in learning disabilities: A documentary analysis]. Revista de Neurología. 2005;**41**(9):550-555

[56] Rueda M, Sánchez E. Relación entre conocimiento fonémico y dislexia: Un estudio instruccional. Cognitiva. 1996;**8**(2):215-234

[57] Rueda M, Sánchez E, González L. El análisis de la palabra como instrumento de rehabilitación de la dislexia [Analysis of the spoken word as an instrument for dyslexia rehabilitation]. Infancia y Aprendizaje. 1990;**49**(9):39-52

[58] Sánchez E, y Rueda M. Segmental awareness and dyslexia: Is it possible to learn to segment well and yet continue to read poorly? Reading and Writing. 1991;**3**(11):11-18

[59] Swanson HL. Reading research for students with LD: A meta-analysis of intervention outcomes. Journal of Learning Disabilities. 1999;**32**(6):504-532

[60] Ortiz MR, García AI, Guzmán R. Remedial interventions for children with reading disabilities: Speech perception- an effective component in phonological training? Journal of Learning Disabilities. 2002;**35**(4):334-342

[61] Jiménez JE, Ortíz R, Rodrigo M, Hernández-Valle I, Ramírez G, Estévez A, et al. Do the effects of computer-assisted practice differ for children with reading disabilities with and without IQ-achievement discrepancy. Journal of Learning Disabilities. 2003; **36**(1):34-47

[62] Jiménez JE, Hernández-Valle I, Ramírez G, Rodrigo M, Estévez A, et al. The size of spelling-to-sound unit in a transparent orthography. The Spanish Journal of Psychology. 2007;**10**(1):52-67

[63] Jiménez JE, Rojas E. Efectos del videojuego Tradislexia en la conciencia fonológica y reconocimiento de palabras en niños disléxicos [Effects of Tradislexia Videogame on phonological awareness and word recognition in dyslexic children]. Psicothema. 2008;**20**(3):347-353

[64] Necoechea DM, Swanson HL. The role of reading intervention research in the identification of children with reading disabilities: A meta-analysis of the literature funded by the NICHD. Advances in Learning and Behavioral Disabilities. 2003;**16**:83-161

[65] López-Escribano C. Training reading fluency and comprehension of Spanish children with dyslexia. In: Khateb A, Bar-Kochva I, editors. Reading Fluency, Literacy Studies 12. Switzerland: Springer; 2016. pp. 141-161

[66] Soriano-Ferrer M, Miranda A, Soriano E, Nievas F, Félix V. Examining the efficacy of an intervention to improve fluency and reading comprehension in Spanish children with reading disabilities. International Journal of Disability, Development and Education. 2011;**58**(1):47-59

[67] Soriano-Ferrer M, Félix V, Soriano E, Jarque S, Nievas F, Descals A. El Programa Velocilector: Variables predictivas de su eficacia en estudiantes con dislexia evolutiva [The Velocilector program: Predictive variables of its effectiveness in students with developmental dyslexia]. In: Navarro J, Fernández MT, Soto FJ, Tortosa F, editors. Respuestas flexibles en Contextos Educativos Diversos. Murcia: Consejería de Educación, Formación y empleo; 2012. pp. 1-6. Available from: http://diversidad.murciaeduca.es/publica.php

[68] Soriano-Ferrer M. Eficacia de un programa multicomponencial sobre la fluidez lectora, la ortografía y sobre la motivación lectora de los alumnos con dislexia evolutiva [Efficacy of a multicomponent program on reading fluency, spelling and reading motivation of students with developmental dyslexia]. In: Paper presented at IV Congreso Internacional en Contextos Psicológicos, Educativos y de la Salud. Spain: Almería; 2016

[69] Jimenez JE. The role of phonological processing in dyslexia in the Spanish language. In: Wydell TN, editor. Dyslexia – A Comprehensive and International Approach. Croatia: InTech; 2012. pp. 29-46. Available from: http://www.intechopen.com/books/dyslexia-a-comprehensive-and-international-approach/the-role-of-phonological-processing-in-dyslexia-in-the-spanish-language

Section 2

Prevention and Intervention for Learning Disabilities

Chapter 4

Current Perspectives on Prevention of Reading and Writing Learning Disabilities

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Additional information is available at the end of the chapter

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Abstract

This chapter intends firstly to analyze the problem of identifying learning disabilities, from the standpoint of competing diagnostic models. The controversy between different models for identifying learning disabilities was presented, contrasting the characteristics of diagnostic models and models based on response to intervention. Second, an analysis of the main predictive factors of reading and writing was offered, using recent results from research carried out in different languages. The most often studied predictors—phonological awareness, speech perception, the alphabetic principle, rapid automatic naming, and vocabulary—were analyzed for their relationship to reading and writing. Finally, a discussion follows on the effects of certain programs that have been developed in different countries to prevent reading and writing learning disabilities. Most of these programs have been developed in the United States or Spain; they have also been implemented in other countries such as Canada, Australia, Mexico, Chile, and Israel.

Keywords: LD identification, reading, writing, predictive factors, prevention program

1. Introduction

The prevention of learning disabilities has always been and continues to be a topic of great relevance in the clinical and educational areas. There is limited research, however, on the effects of implementing programs to prevent these difficulties. One reason for this is the lack of consensus about the conceptualization of learning disabilities, and the use of different models to identify them. In this chapter, the problem of identifying learning disabilities is analyzed, including the characteristics of different diagnostic models, such as discrepancy models, models based on response to intervention, and main component models.

Another reason has been the diversity of theories and hypotheses to explain the appearance of learning disabilities, the variety of factors that produce them, and the few studies that have analyzed predictive factors of reading and writing. An analysis of the main predictive factors of reading and writing will be offered here, based on recent research results in studies with different languages.

Finally, this chapter provides an analysis of the effects of some programs that have been developed to prevent reading and writing learning disabilities in different countries. We analyze the characteristics of the primary prevention programs, such as Success For All (SFA), Starting Out Right (SOR), Comprehensive Early Literacy Learning (CELL), and the Prevention Program of Reading and Writing Learning Disabilities (PREDALE).

2. Competing diagnostic models for identifying learning disabilities

An important issue in the study of learning disabilities has been to reach a consensus on the definition of LDs and the criteria for identifying them. Since 1963, when Kirk first coined the term learning disabilities, a number of definitions have appeared to characterize these problems. Most of these definitions have focused more on what LDs are not, instead of what they actually are.

In recent decades, the definition established in 1994 by the National Joint Committee on Learning Disabilities (NJCLD) and backed by the main international diagnosis systems (e.g., the International Statistical Classification of Diseases and Related Health Problems (ICD-10) in 2015, and Diagnostic and Statistical Manual of Mental Disorders (DSM-5) in 2013) has become more widely accepted. Exclusion criteria are predominant in this definition, although the best procedures for quantifying these are not specified. Learning disabilities are considered to be a heterogeneous group of disorders that are manifest as significant difficulties in acquiring and using the skills of reading, writing, and solving mathematical problems. These disorders are intrinsic to the person: there may be accompanying handicaps (e.g., intellectual disabilities, severe emotional disorders, and sensory deficits), or extrinsic influences (such as cultural differences, and insufficient or inappropriate instruction), but learning disabilities are not the result of these conditions or deficits (NJCLD and DSM-5).

Learning disabilities are neurologically based–processing problems. These processing problems can interfere with learning basic skills such as reading, writing, and/or math. They can also interfere with higher-level skills such as organization, time planning, abstract reasoning, long- or short-term memory, and attention. Learning disabilities can affect an individual's life beyond academics and can impact relationships with family, friends, and in the workplace.

Recent research yields a diversity of models for identifying specific learning disabilities. Difficulties in learning reading and writing have received the most attention [1]. The identification of reading-writing LDs has varied in recent decades, differing between countries and over the years [1].

The traditional model for identifying these problems in many countries has been and continues to be a diagnostic criteria-based model [1]. These models have been the most popular for

assessing specific learning disabilities, most notably models based on the concept of discrepancy [1]. The IQ/achievement discrepancy model is used internationally and has continued in use for longer [1]. This model claims that persons with reading-writing LDs are characterized by a discrepancy between their IQ and their achievement, that is, they have normal IQ but their reading and writing achievement is below the 20th percentile [2, 3].

Some authors defend the discrepancy model, but specify discrepancies between oral comprehension and achievement as an alternative to the IQ/achievement discrepancy, asserting that IQ is not relevant in diagnosing reading and writing LDs [2, 3]. Elsewhere, other researchers have questioned the discrepancy model as a means of defining and identifying students with specific learning disabilities [4–8]. These researchers have recently proposed other diagnostic criteria not relating to discrepancy. Low achievement scores have been suggested as being sufficient to identify reading-writing LDs, given that the purpose is to identify a need for intervention, not IQ or an IQ/achievement discrepancy. Still, other authors look more to low scores in phonological awareness [9] or in cognitive processes, as diagnostic criteria for reading and writing LDs [10].

A more recent model in use today is based on the response to intervention model (RTI) [4–6, 10]. In 2004, the Individuals with Disabilities Education Improvement Act (IDEIA), in accordance with the Commission on Excellence in Special Education and the Office of Special Education and Rehabilitation Services of the US Department of Education, and with the National Associations of School Psychologists (NASP), proposed that the IQ/achievement discrepancy model be abandoned in favor of the RTI model. This means a considerable change in the conceptualization and identification of these problems. Since 2004, studies on the RTI model have become increasingly prevalent, having a substantial presence in the most prestigious journals, such as the *Journal of Learning Disabilities*, *Learning Disabilities Quarterly*, *Reading & Writing*, and *Reading & Writing Quarterly*.

This move toward RTI, however, has not occurred in every country or at the same time. For example, the change occurred earlier in Australia than in other countries (2001), and in the United Kingdom, Japan, and Germany, the IQ/achievement discrepancy model was never adopted, or it was abandoned more quickly, focusing more on the criterion of these children's need for reeducation [1, 11]. Based on this model, a child with difficulty learning to read and write is identified as having specific LDs based on his/her immediate response to instruction in written language, as long as there is severely low achievement and unexpected early difficulty in learning, manifest as a failure to respond to standardized instruction [4–6, 12, 18].

Even though most current studies defend the RTI model, some authors indicate that this model is effective for improving achievement in reading and writing only if certain conditions are met. Some studies show that the RTI model is effective for identifying these problems only at early ages (4–6-year-olds); it cannot adequately predict later reading achievement, and it may present many false positives [13, 14]. In other words, the RTI model is insufficient for identifying children with specific LDs, and it does not offer greater benefits than other models mentioned above [15].

Consequently, other studies [16, 17] put forward a new diagnostic model, the component model of reading (CMR), including three significant domains for identifying these problems:

cognitive components (e.g., phonological awareness, decodification, vocabulary and comprehension), psychological components (e.g., motivation, locus of control, teacher expectations, gender differences, and learned helplessness), and ecological components (e.g., behavior at home, culture and parental involvement, classroom environment, peer influences, and dialects) [16, 17]. This model assesses reading and writing performance from a multidimensional perspective, and facilitates more adequate, individualized instruction, with better chances for success [17].

Finally, based on these research studies, some authors have proposed a fusion of the diagnostic and RTI models. This solution serves to evaluate students' skills and determine their academic needs, so that they may receive special education that is adequate for their needs [18]. There is a great need for further objective research.

3. Main predictive factors of reading and writing

A large number of studies have been carried out over the years, with different individuals at different ages and in different languages, in order to explain reading and writing and the appearance of learning disabilities. These studies assign varying degrees of importance to the various factors [19–28]. We analyze below some of the main predictive factors that have been recognized as important in a majority of studies from recent decades.

3.1. Phonological awareness

Phonological awareness makes it possible for the individual to operate with segments of speech, and refers to the awareness that words are made up of linguistic units like the syllable and the phoneme [20]. Different levels of phonological awareness are identified: syllabic, intrasyllabic, and phonemic. The literature includes many research studies that demonstrate that syllabic knowledge and especially phonemic knowledge are strong predictors of reading and writing in students with and without dyslexia at early ages (4–7-year-olds), and in languages with differing orthographic consistency such as Spanish, Italian, Greek, English, Chinese, Arabic, and others [21–28].

Most of these studies emphasize that phonological awareness is responsible for grasping the grapheme-phoneme relationship needed for reading and writing words of different lengths, consistency, and frequency. They also note that the relationship between phonological awareness and written language is stronger in transparent languages, and at early ages. The relationship declines with age [23, 24, 26, 29], and phonological awareness relates differently to different ways of measuring reading: accuracy, speed, and efficiency/fluency [21, 23–26, 28–30]. There is current debate about what variables intervene in reading in languages with different linguistic consistencies, at what age they have the greatest influence, and how these variables relate to other cognitive variables such as phonological memory, letter knowledge, and rapid automatic naming [25].

3.2. Speech perception

Processes of speech perception refer to the preliminary, auditory perceptual analysis of words, taking into account their phonetic and auditory characteristics, and how their phonological representation is formed [19]. Speech perception has been investigated in children of different ages with and without dyslexia [31–34]. Ref. [31] analyzes the relationship between speech perception and reading of words, presenting word segments of progressively greater length. Speech perception is found to predict reading in novice readers but not in expert readers. Other authors consider that speech perception loses importance in typical readers as they acquire experience [25].

Some studies have found that deficits in phonetic discrimination produce errors in phonological representations of the lexicon, and therefore in phonological decodification [32–34]. Thus, readers with dyslexia present deficits in phonological processes due to difficulty creating phonological representations based on acoustic signals of speech [32]. In other words, they present difficulties in identifying and discriminating speech segments, specifically, identifying and discriminating consonants that differ in the place and manner of articulation and sonority [33, 34].

On the other hand, the relationship between speech perception and phonological awareness is unclear. Some authors indicate that children with dyslexia have deficits in phonological awareness due to their deficits in speech perception [35], and that speech perception is not directly related to reading words [36]. Others consider that speech perception is unrelated to phonological awareness [37] and that it is independently related to reading in the case of readers with dyslexia, but not in typical readers [38].

In conclusion, there is controversy about whether speech perception is a predictor of written language or of learning disabilities, and whether speech perception is related to reading in a direct, independent relationship [33, 34, 36–38]. There seems to be more agreement, however, that this relationship varies with the student's age and experience.

3.3. Alphabetic principle

The alphabetic principle, or letter knowledge, is based on the correspondence between speech sounds (phoneme) and a written graphic transcription (grapheme). The alphabetic principle is based on the grapheme-phoneme conversion and makes it possible to decode a word by applying systematic association rules and joining the sounds to form words [19]. Children use letter knowledge for spelling and internally store the pronunciation of the word in order to facilitate access to the lexicon.

The importance of the alphabetic principle in written language depends on age and reading experience. Namely, there is a critical relationship between the alphabetic principle and reading when one first begins to read and write. In Ref. [39], letter knowledge is found to be one of the best predictors of reading words in 4-year-olds. Similarly, the importance of letter knowledge has been demonstrated in children with and without dyslexia between the ages of 4 and 7 years [40, 41].

Elsewhere, there is some controversy about the influence of letter knowledge in languages with different orthographic consistency. Some studies indicate that letter knowledge is more strongly related to reading in transparent languages than in nontransparent languages [19, 23], and others indicate that it is not relevant in the latter, given that there is no direct correspondence between graphemes and phonemes [28].

Other studies have demonstrated that letter knowledge is also strongly related to PA at early ages in languages with different orthographic consistency [39, 42], but they do not establish the nature of these relationships. More research is needed to determine relations between PA, letter knowledge, and reading-writing of words, in order to establish what variable precedes the others in languages with different linguistic consistency.

3.4. Rapid automatic naming

Rapid automatic naming, or naming speed, consists of naming different high-frequency visual stimuli, such as colors, objects, letters, and numbers, that are presented on multiple occasions in controlled fashion [43]. Rapid automatic naming is considered to be a measurement or index of phonological and visual recovery, depending on whether the items are alphanumeric (letters and numbers) or nonalphanumeric (colors and objects) [44].

Studies have focused mainly on the relationship of rapid automatic naming to reading, in students with and without dyslexia, at different ages and in different languages. Children with dyslexia have been found to be slower in naming high-frequency visual stimuli than children without dyslexia [45–47]. In Ref. [45], rapid naming was found to have a strong relationship with word-reading speed in children with dyslexia, but not with word-reading accuracy.

Most studies consider alphanumeric rapid naming to be a predictor of several reading measures in typical learners [21, 25, 44, 47]. By contrast, there is no consensus on the influence of nonalphanumeric naming: some studies find no relationship to reading measures, while others do [21, 24, 25, 40, 41, 44, 48, 49]. Consensus is also lacking as to what measure of reading is influenced by rapid naming, at what age, and with what type of language. Some studies find that rapid naming influences only measures of speed, at early ages, and more strongly in nontransparent languages, while others also find a relationship with reading accuracy, at a later age and in transparent languages [23, 25, 26, 40, 46, 48–51].

Finally, there are studies that try to clarify how rapid automatic naming relates to phonological awareness and other cognitive variables, in order to explain reading and writing in languages of different linguistic complexity. Some find that rapid naming is independent of phonological awareness and contributes differently to the explanation of word and pseudoword recognition [21, 45, 52, 53]. For others, rapid naming is indirectly related to reading, through phonological processing [54].

3.5. Vocabulary

The meanings of words constitute a representational system that makes up the lexicon of a language. When we speak of vocabulary, we refer to words that we know, in order to communicate with each other, both orally and in writing.

Vocabulary is also considered an important factor in the acquisition of reading and writing; when children have difficulties in vocabulary, they have also been shown to present problems in reading and writing. Some studies find that vocabulary is a facilitator in word recognition, in fluency, and also in reading comprehension for children with and without dyslexia [40, 55, 56]. A vocabulary deficit is reflected in problems with fluency and reading comprehension [57].

Vocabulary is also related to phonological skills. Phonological representations start becoming more specific with the development of vocabulary [31]; word codification and recovery require analysis of the linguistic segments that words are made of. In this way, deficits in vocabulary are accompanied by poor phonological representations, and therefore by difficulty with decoding processes that are involved in reading and writing [19].

Other authors find that vocabulary differences between children with and without dyslexia generally appear at older ages, when children already have a scholastic history. These authors consider that difficulties with written language are themselves the cause of these differences [58]. Some research defends a combination of vocabulary and other phonological measures in order to better explain problems with written language [48].

In conclusion, there is much need for research that analyzes the combined contribution of the main predictive factors. More clarification is needed as to how these factors affect different measures of reading and writing, in languages with different orthographic consistency or transparency, and at different ages [22, 24, 29].

4. Programs for preventing reading and writing learning disabilities

There are not many studies that design programs to prevent disabilities in learning written language, and that analyze their effects on students' achievement. Consequently, in the United States, the National Institute of Child Health and Human Development (NICHD) and the National Research Council's (NRC) Committee on Preventing Difficulties in Young Children have established the need for a National Reading Panel (NRP) that would agree on topics for reading instruction and for preventing reading disabilities.

Most programs that have been designed for this purpose seek to offer instruction in concrete aspects known to facilitate reading and writing and to present a global model that considers different instructional components. In this section, we present the characteristics and general objectives of some programs that consider different instructional components in an integrated fashion, and analyze the effects that these produce in students. These programs have been developed in the United States and in some cases have been implemented in other English- or Spanish-speaking countries.

4.1. Success For All

The objective of the program Success For All is to prevent difficulties in scholastic learning through a change in curriculum content during early childhood and primary education [59]. It was developed at the Center for Research on the Education of Students Placed at Risk, at

Johns Hopkins University in Baltimore, and has been implemented in various states of the United States, as well as in Canada, Australia, Mexico, and Israel. This program consists of an intensive early intervention where students at risk for learning disabilities are able to meet curriculum-related objectives and avoid the need for special educational services. Reading and writing are emphasized as a strategic metacognitive process. The program does not defend a clear conceptual model of reading, but its foundational bases can be distinguished. Teacher training is a key element for program success. Coordination between classroom teachers and the reading specialist is ongoing. Mainstream teachers apply instructional strategies to all the students, and specialists do so at the individual level. The SFA program is implemented by an expert teacher who works directly with mainstream teachers and specialists who apply the program, helping them resolve any type of difficulty that appears.

The SFA program contains two subprograms: Reading Roots (3-to 6-years old) and Reading Wings (7-to 11-yeras old). Both have been adapted to Spanish and to Latin American culture [60].

The instructional components of Reading Roots are as follows:

(a) Oral language. By telling and retelling stories and sharing books, the program fosters an understanding of story structure, comprehension, and the mechanics of writing.

(b) Auditory discrimination. Listening to and isolating sounds in words in order to decode them.

(c) Phonological awareness. Presentation, identification, and production of rhymed endings and initial sounds in order to establish the sound-letter relationship.

(d) Knowledge of the alphabet. Letter knowledge connected to stories and to daily routine.

(e) Vocabulary. Development of basic concepts and lexical families.

(f) Emergent writing. Knowledge of the utility and purpose of writing through scribbling, formation of letters and words, connecting the dots to form letters, and so on.

The instructional components of Reading Wings are as follows:

(a) Oral comprehension. Listening to stories read by the teacher, identifying their meaning (characters, situation, solution, etc.), establishing the purpose of the reading, introducing new vocabulary, and discussing the story.

(b) Reading comprehension. Selecting main ideas, drawing conclusions, and contrasting ideas, through daily independent reading.

The effects of SFA have been analyzed by the American Institute of Research and the Thomas Fordman Foundation, as well as others. An effect size of 0.50 percentage points in the reading average has been demonstrated for each school year. Children at risk gained more than one full point in the first year, and this increased exponentially through the fourth year and was maintained over the long term [61, 62]. Another finding was that the percentage of students referred to special education was lower among students trained with SFA in comparison to

control students. In third grade, 2.2% of students in the trained group went referred to special education, and in the control group, 8.8% were referred [61]. Finally, the effects of gains from SFA are also noticeable in the second year, when reading and writing achievement of these students was compared to that of students who received the intervention accelerated schools [63].

4.2. Starting Out Right

Another program whose objective is to prevent learning disabilities is the Starting Out Right program, with planned instruction for both the school and family contexts, from the first months of life until third grade [62]. This program is sponsored by the Committee on the Prevention of Reading Difficulties in Young Children, of the National Research Council, and the National Academy of Sciences.

The SOR program is implemented from the first months of life until third grade, and includes family and school involvement [64]. It contains two subprograms: Growing up to Read (0-to 4-years old) and Becoming Real Readers (5-to 8-years old).

The instructional components of Growing up to Read are as follows:

(a) Oral language and vocabulary. Understanding new meanings through conversations and dramatic play and understanding stories read aloud to them.

(b) Phonological awareness. Identification of phonemes that make up words, detecting and building rhymes, segmenting words, dividing syllables, spelling words, and so on.

(c) Speech discrimination. Detecting the differences between words that sound similar.

(d) Knowledge of the alphabet. Letter and word recognition.

(e) The concept of writing. Knowledge about directionality in writing, spacing between words, and so on.

(f) Knowledge of narrative. Detecting elements and parts of a story.

(g) Awareness of handwriting and books. Awareness that letters are in written stories and in stories read aloud.

(h) Knowledge of the function of writing and reading. Awareness of the utility of writing and developing positive feelings toward written language.

Some of the instructional components of Becoming Real Readers are similar to those of Growing up to Read, although others are added to foster more complex processes. These components are as follows:

(a) Awareness of handwriting and of books and phonological awareness. Identifying phonemes in different positions in oral and written words, composing and decomposing words in syllables and phonemes, segmenting words into syllables and phonemes, and so on.

(b) Oral comprehension and vocabulary. Acquisition of new meanings through comments about texts read aloud or narrated.

(c) Letter and word recognition. Identification of all letters in any word position.

(d) Writing and spelling. Tracing letters in lower and uppercase, spelling words with different linguistic complexity, preparing texts with different purposes, following punctuation rules.

(e) Reading comprehension and fluency. Locating the main idea, making connections and inferences, and semantic maps or diagrams.

(f) Meta-comprehension. Developing self-control over the reading process itself, using strategies for predicting, asking, summarizing, and clarifying the text information.

There is a need for relevant research studies that analyze the effects of the program on scholastic achievement, and its repercussions in decreasing scholastic learning disabilities [19].

4.3. Comprehensive Early Literacy Learning

The Comprehensive Early Literacy Learning (CELL) program seeks to avoid the appearance of learning disabilities, to improve students' performance, and to further teachers' professional development, by training teachers in processes for teaching reading and writing and in how to prioritize reading and writing in the classroom [65]. This program has been implemented in several states in the United States, as well as in Canada, Australia, Chile, and Mexico. It is characterized by giving priority to the teaching of reading and writing through the school curriculum, and to teacher training, as key elements in the prevention of LDs. The program is designed for 3- to 8-years old, although a continuation was designed later on, for children through 13 years old (ExLL). A Spanish version is available, entitled *Enseñanza inicial de la lectura y la escritura* (EILE), designed for the Spanish-speaking population in the United States [66].

The instructional components that make up this project are as follows:

(a) Oral and spoken language. Fostering listening skills and verbal discussion, telling stories and explaining stories that were heard.

(b) Knowledge of sound, symbol, and structure. Development of phonemic knowledge (segmenting words, identifying rhymes, isolating initial and final phonemes, etc.), and knowledge of writing (directionality in writing words, structure of sentences and texts, etc.).

(c) Reasoning skills. Letter and word recognition and phonological decoding (knowing the grapheme-phoneme rules).

(d) Reading and comprehension strategies. Reading to and with the children (independent reading, silent reading, reading aloud, guided reading, and shared reading with books of different formats and genres), comprehension strategies and reading speed (prediction and meaning summaries), and diversification of reading (critical, reflective reading of different types of texts in different areas of study).

(e) Writing, vocabulary, and spelling. Spelling and writing letters, words and a variety of stories, respecting spelling rules, and using different grammatical uses and text structures, both interactively and independently.

Application effects of the CELL program have been assessed in different schools in different states of the United States (California, Utah, Montana, Kentucky, Nevada, etc.) and in Mexico and Chile [65–67]. Children trained with CELL were shown to have higher levels of reading comprehension, reading fluency, vocabulary, and writing (spelling and composition) than control groups who were trained with only the ordinary curriculum, from first to sixth grades. Learning outcomes were also greater in mathematics, language arts, and sciences, from third to fifth grades, in English- and Spanish-speaking children who were trained with CELL [65–67].

4.4. Program for the prevention of learning disabilities in reading/writing

The program for the prevention of learning disabilities in reading/writing (PREDALE, for its initials in Spanish) was designed to prevent these disabilities in Spanish pupils from the ages of 4–7 years [68–71]. Its objective is to prioritize reading and writing and to foster cognitive-linguistic skills through all curriculum subjects, in order to avoid or minimize risks of specific learning disabilities and to improve performance in reading, writing, and mathematics at these ages. The program is applied daily by mainstream teachers in the ordinary classroom, where children devote approximately 3 h to reading and writing, using this method as a procedure for learning scholastic content. During the first hour, activities are carried out to foster phonological awareness and oral language. Afterward, reading and writing are focused on through the reading of stories and/or textbooks on different school subjects.

Activities are assigned progressively, with increasing difficulty, for each instructional component of this program, throughout early childhood education (3-to 5-years old) and the first 2 years of primary education. The easiest activities are carried out between the ages of 4 and 5 years, with more complex activities at ages 6 and 7 [68–71].

(a) Phonological awareness

Syllabic awareness

- Counting syllables in words
- Identifying initial and final syllables
- Identifying rhymes
- Adding syllables to form new words
- Omitting syllables to form new words
- Substituting syllables to form new words
- Linking words by using the final syllable of one word to start a new word

Phonemic awareness

- Identifying vowels and consonants in words
- Recognizing the vocalic structure of words
- Counting phonemes in words
- Adding phonemes to form new words
- Omitting phonemes to form new words
- Substituting phonemes to form new words
- Linking words by using the final phoneme of one word to start a new word
- Making words with jumbled letters
- Guessing words from their spelling
- Spelling backwards

(b) Vocabulary and morphosyntax

Vocabulary

- Defining drawings (persons, objects, and actions)
- Drawing-word associations
- Choosing the term to define a drawing (persons, objects, and actions)
- Forming sets of drawings in different categories
- Drawing-phrase associations
- Classifying drawings and words by semantic category
- Oral definition of words
- Identifying synonyms and antonyms
- Identifying absurd content
- Constructing and solving word search puzzles
- Solving crosswords
- Use of the dictionary

Morphosyntax

- Putting drawings in order to make a story
- Putting words in order to make a sentence
- Completing sentences of varying length, with and without alternative choices

- Putting sentences in order to make a story
- Transforming words into masculine and feminine, plural and singular
- Detecting malformed sentences that lack subject-verb agreement
- Identifying interrogatory and exclamatory sentences
- Transforming negative statements into affirmative
- Placing punctuation marks in a text

(c) Grapheme-phoneme correspondence

- Articulate and discriminate sounds of letters
- Reading vowels and consonants
- Reading syllables with CV, VC, and CVC structures
- Reading words of varying length and familiarity
- Copying and taking dictation of vowels and consonants
- Copying and taking dictation of syllables with CV, VC, and CVC structures
- Copying and taking dictation of words of varying length and familiarity

(d) Reading and writing fluency

- Reading phrases of varying length
- Reading short stories
- Reading with intonation, respecting punctuation marks (periods, commas, exclamation points, question marks, etc.)
- Copying and taking dictation of sentences of varying length
- Taking dictation of texts of varying length
- Following basic spelling rules in writing: punctuation marks, m before p and b, capitalizing proper nouns and first word of a sentence
- Spacing, organization, and directionality when writing on paper

(e) Reading comprehension and written composition

- Comprehension of words
- Comprehension of phrases and stories of varying length
- Reading comprehension strategies: identifying main ideas, oral and written summaries, changing the end of a story, creating a title for a text, and predicting the end of a story

- Regulation strategies for reading comprehension: rereading, dictionary use, and self-questions
- Composition guided by drawings, words, and phrases
- Spontaneous composition of texts (special occasions, requests, stories, etc.)
- Written composition strategies: selection and organization of ideas
- Strategies of self-regulated writing: self-correction, self-questions

The effects of program application have been assessed in different studies; improvements were found in academic achievement, oral language, reading and writing in children with and without risk for presenting specific learning disabilities, from 4- to 7-years old, and a decrease in the percentage of these problems from 5- to 7-years old [68–72]. More research is needed to confirm whether these gains are maintained in the long term.

5. Conclusion

The use of diverse methods to identify learning disabilities, and a lack of consensus on the factors that explain their appearance, together account for a dearth of studies on programs applied to prevent these problems. In the case of models used to identify learning disabilities, we find a controversy between diagnostic models and models based on response to intervention. As for predictive factors, there seems to be a consensus on the importance of certain aspects: phonological knowledge, speech perception, letter knowledge, naming speed, and vocabulary. Agreement has not been reached, however, on how these factors relate to each other or on how much weight each one carries at different ages and in languages with different spelling transparency.

Finally, we note that the programs that have been designed for preventing learning disabilities share an emphasis on systematically fostering oral and written language in the classroom, and they begin to teach reading and writing from a young age. The benefits attained include reducing learning disabilities by a high percentage, and improved reading, writing, and mathematics, in the best cases.

In conclusion, more research is needed to help identify the risk factors for these problems, so that preventive programs that are effective in both the short and long term may be designed.

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References

[1] González-Valenzuela MJ, Soriano-Ferrer M, Delgado-Ríos M, Félix-Mateo V. How are reading disabilities operationalized in Spain? A study of practicing school psychologists. Journal of Childhood & Developmental Disorders. 2016;**2**:3-23. DOI: 10.4172/2472-1786.100031

[2] Stanovich K. Discrepancy definitions of reading disability: Has intelligence led us astray? Reading Research Quarterly. 1991;**26**:1-7

[3] Kaufman AS, Kaufman NL. Specific Learning Disabilities and Difficulties in Children and Adolescents. 1st ed. New York, NY: Cambridge University Press; 2001

[4] Denton C, Fletcher J, Anthony J, Francis D. An evaluation of intensive intervention for students with persistent reading difficulties. Journal of Learning Disabilities. 2006;**39**(5):447-466

[5] Fletcher J, Coulter W, Reschly D, Vaughn S. Alternative approaches to the definition and identification of learning disabilities: Some questions and answers. Annals of Dyslexia. 2004;**54**(2):304-331

[6] Fuchs LS, Fuchs D. Treatment validity: A unifying concept for reconceptualizing the identification of learning disabilities. Learning Disabilities Research & Practice. 1998;**13**:204-219

[7] Klasen RM, Neufeld P, Munro F. When IQ is irrelevant to the definitions of learning disabilities. School Psychology International. 2005;**26**(3):297-316

[8] Jiménez JE. Response to intervention (RTI) model: A promising alternative for identifying students with learning disabilities? Psicothema. 2010;**22**(4):932-934

[9] Rodrigo M, Jiménez JE. IQ vs phonological recoding skill in explaining differences between poor readers and normal readers in word recognition: Evidence from a naming task. Reading and Writing: An international Journal. 2000;**12**:129-142

[10] Kavale KA, Forness SR. What definitions of learning disability say and don´t say: A critical analysis. Journal of Learning Disabilities. 2000;**33**:239-256

[11] Hallahan DP, Keough BK. Research and Global Perspectives in Learning Disabilities: Essays in Honour of Williams M. Cruickshank. Mahwah, NJ: Lawrence Erlbaum; 2001

[12] Fuchs D, Dreshler D. What we need to know about responsiveness to intervention (and shouldn´t be afraid to ask). Learning Disabilities Research and Practices. 2007;**22**:129-136

[13] Kavale KA, Kauffman AS, Bachmeier RJ, LeFevers GB. Response-to-intervention: Separating the rhetoric of self-congratulation from the reality of specific learning disability identification. Learning Disabilities Quarterly. 2008;**31**:135-150

[14] Catts HW, Petscher Y, Schatscheneider C, Brigdes MS, Mendoza K. Floor effects associated with universal screening and their impact on the early identification of reading disabilities. Journal of Learning Disabilities. 2009;**42**(2):163-176

[15] Wagner R. Rediscovering dyslexia: New approaches for identification and classification. In Reid G, Fawcett AJ, Manis F, Siegel LS, editors. The Sage Handbook of Dyslexia. Thousand Oaks, CA: Sage Publication; 2009. pp. 174-191

[16] Aaron PG, Joshi R, Boulware-Gooden R, Bentum K. Diagnosis and treatment of reading disabilities based on the component model of reading: An alternative to the discrepancy model of reading. Journal of Learning Disabilities. 2008;**41**:67-84

[17] Carreker S, Joshi RM. Response to intervention: Are the emperor´s clothes new? Psicothema. 2010;**22**(4):943-948

[18] Feifer SG. Integrating response to intervention (RTI) with neuropsychology: A scientific approach to reading. Psychology in the School. 2008;**45**:812-825

[19] González MJ. Prevención de las Dificultades de Aprendizaje. Madrid: Pirámide; 2012

[20] Morais J. Constraints on the development of phonemic awareness. In Brady SA, Shankweiler DP, editors. Phonological Processes in Literacy. Hillsdale: Lawrence Erlbaum Associates; 1991

[21] Aguilar-Villagrán M, Navarro-Guzmán JI, Menacho-Jiménez I, Alcalde-Cuevas C, Marchena-Consejero E, Ramiro-Oliver P. Velocidad de nombrar y conciencia fonológica en el aprendizaje inicial de la lectura. Psicothema. 2010;**22**(3):436-442

[22] Caravolas M, Lervåg A, Defior S, Málková GS, Seidlová F, Hulme C. Different patterns, but equivalent predictors, of growth in reading in consistent and inconsistent orthographies. Psychological Science. 2013;**20**(10):1-10

[23] Furnes B, Samuelsson S. Preschool cognitive and language skills predicting kindergarten and grade 1 reading and spelling: a cross-linguistic comparison. Journal of Research in Reading. 2009;**32**(3):275-292

[24] Georgiou GK, Parrilla R, Papadopoulos TC. Predictors of word decoding and reading fluency across languages varing in orthografic consistency. Journal of Educactional Psychology. 2008;**100**(3):466-580

[25] González-Valenzuela MJ. Díaz-Giráldez F, López Montiel MD. Cognitive predictors of word and pseudoword reading in Spanish first-grade children. Frontiers in Psychology. 2016;**7**(774):1-12. DOI: 10.3389/fpsyg.2016.00774

[26] Landerl K, Ramus F, Moll K, Lyytinen H, Leppänen PHT, Lohvansuu K, et al. Predictors of developmental dyslexia in European orthographies with varying complexity. The Journal of Child Psychology and Psychiatry. 2012;**54**(6):686-694

[27] Li H, Shu H, McBride-Chang C, Liu H, Peng H. Chinese children's character recognition: Visuo-orthographic, phonological processing and morphological skills. Journal of Research in Reading. 2012;**35**(3):287-307

[28] Tolchinsky L, Levin I, Aram D, McBrigde-Chang C. Building literacy in alphabetic, abjad and morphosylabic systems. Reading and Writing. 2012;**25**:1573-1598

[29] Ziegler J, Bertrand D, Tóth D, Csépe V, Reis, A, Faísca, L, et al. Orthographic depth and its impact on universal predictors of reading: A cross-language investigation. Journal of the Association for Psychological Science. 2010;**20**(10):1-9

[30] Suárez-Coalla P, García de Castro M, Cuetos F. Variables predictoras de la lectura y la escritura en castellano. Infancia y Aprendizaje. 2013;**36**(1):77-89

[31] Metsala J. Spoken word recognition in reading disabled children. Journal of Educational Psychology. 1997;**1**:149-158

[32] Blomert L, Mitterer H. The fragile nature of the speech-perception deficit in dyslexia: Natural vs. synthetic speech. Brain and Language. 2004;**8**:21-26

[33] Maassen B, Groenen P, Crul T, Assman-Hulsmans C, Gabreels F. Identification and discrimination of voicing and place-of articulation in developmental dyslexia. Clinical Linguistics and Phonetics. 2001;**4**:319-339

[34] Ortiz MR, Jiménez JE, Guzmán R, Hernández-Valle I, Rodrigo M, Estévez A, et al. Locus and nature of the perceptual phonological deficit in reading disabilities. Journal of Learning Disabilities. 2007;**40**(1):80-92

[35] Adlard A, Hazan V. Speech perception in children with specific reading difficulties (dyslexia). Quarterly Journal of Experimental Psychology: Human Experimental Psychology. 1998;**1**:153-177

[36] McBride-Chang C, Wagner RW, Chang L. Growth modelling of phonological awareness. Journal of Educational Psychology. 1997;**89**:621-630

[37] Jiménez JE, Artiles C, Rodríguez C, Naranjo F, González D, Crespo P, et al. Dificultades específicas de aprendizaje: Mirando hacia el futuro. Revista Electrónica de Dificultades de Aprendizaje. 2009;**1**(1):1-8

[38] Ortiz R, Guzmán R. Contribución de la percepción del habla y la conciencia fonémica a la lectura de palabras. Cognitiva. 2003;**5**(1):3-17

[39] Muter V, Hulme C, Snowling M, Stevenson J. Phonemes, rimes, vocabulary, and grammatical skills as foundations of early reading development: Evidence from a longitudinal study. Developmental Psychology. 2004;**40**(5):665-681

[40] Aarnoutse C, van Leeuwe J, Verhoeven L. Early literacy from a longitudinal perspective. Educational Review and Research. 2005;**11**(3):253-275

[41] Landerl K, Wimmer H. Development of word reading fluency and spelling in a consistent orthography: An 8-year follow-up. Journal of Educational Psychology. 2008;**100**(1): 150-161

[42] Storch S, Whitehurst G. Oral language and code-related precursors to reading: Evidence from a longitudinal structural model. Developmental Psychology. 2002;**38**(6):934-947

[43] Denckla MB, Rudel RG. Rapid automatized naming (RAN): Dyslexia differentiated from other learning disabilities. Neuropsychologia. 1976;**4**:471-479

[44] Compton DL. Modeling the relationship between growth in rapid naming speed and decoding skill in first-grade children. Journal of Educational Psychology. 2003;**95**:225-239

[45] Wolf M, Bowers PG. The double-deficit hypothesis for the developmental dyslexia. Journal of Educational Psychology. 1990;**91**:415-438

[46] McBride-Chang C, Lam F, Lam C, Chan B, Fong C, Wong T, et al. Early predictors of dyslexia in Chinese children: Familial history of dyslexia, language delay, and cognitive profiles. Journal of Child Psychology and Psychiatry. 2010;**52**(2):204-211

[47] Thomson JB, Chenault B, Abbott RD, Raskind WH, Richards T, Aylward E, et al. Converging evidence for attentional influences on the orthographic word form in child dyslexics. Journal of Neurolinguistics. 2005;**18**(2):93-126

[48] Lei L, Pan J, Liu H, McBride-Chang C, Li H, Zhang,Y, et al. Developmental trajectories of reading development and impairment from ages 3 to 8 years in chinese children. Journal of Child Psychology and Psychiatry. 2008;**52**(2):212-220

[49] Olofsson A. Naming speed, phonological awareness and the initial stage of learning to read. Logopedis, Phoniatris y Vocologic. 2000;**25**:35-40

[50] Vaessen A, Blomert L. The cognitive linkage and divergence of spelling and reading development. Scientific Studies of Reading. 2013;**17**:89-107

[51] Xue J, Shu H, Li, H, Wenliong L, Tian X. The stability of literacy-related cognitive contributions to Chinese character naming and reading fluency. Journal of Psycholinguistic Research. 2013;**42**:433-450

[52] Bowey J, McGuigan M, Ruschena A. On the association between serial naming speed for letters and digits and word-reading skill: Towards a developmental account. Journal of Research in Reading. 2005;**28**(4):400-422

[53] Guzmán R, Jiménez JE, Ortiz R, Hernández-Valle I, Estéve, A, Rodrigo M, et al. Evaluación de la velocidad de nombrar en las dificultades de aprendizaje de la lectura. Psicothema. 2004;**16**(3):442-447

[54] Wagner RK, Torgersen JK, Rashotte CA, Hecht SA, Barker TA, Burguess SR, et al. Changing relations between phonological processing abilities and word-level reading as children develop from beginning to skilled readers: A 5 year longitudinal study. Developmental Psychology. 1997;**33**:468-479

[55] Miller P. The importance of vowel diacritics for reading in Hebrew: What can be learned from readers with prelingual deafness? Reading and Writing. 2004;**7**(6):593-615

[56] Snowling MJ, Gallagher A, Frith U. Family risk of dyslexia in continuous: Individual differences in the precursors of reading skill. Child Development. 2003;**4**:358-373

[57] Tabors PO, Snow CE. Young bilingual children and early literacy development. In: Neuman SB, Dickinson DK, editors. Handbook of Early Literacy Research. New York, NY: The Guilford Press; 2001

[58] Vellutino FR, Fletcher JM, Snowling MJ, Scanlon DM. Specific reading disability (dyslexia): What have we learned in the past four decades? Journal of Child Psychology and Psychiatry. 2004;**45**(1):2-40

[59] Slavin RE, Karweit NL, Madden NA. Effective Programs of Students at Risk. Boston: Allyn & Bacon; 1989

[60] Fashola OS, Slavin RE, Calderon M, Duran R. Effective programs for Latino students in elementary and middle schools. In: Calderon M, Slavin RE, editors. Effective Programs for Latino Students. Mahwat, NJ: Lawrence Erlbaum Associates, Publishers; 2001

[61] Slavin RE, Madden NA, Liang C. Effects of Success for All on SAT-9 Reading: A California Statewide Evaluation. Baltimore: Johns Hopkins University; 2002

[62] Slavin RE, Madden NA. Success for All/Roots and Wings. Summary of Research on Achievement Outcomes. Baltimore: Johns Hopkins University, CRESPAR; 2003

[63] Ross SM, Alberg M, Mc Nelis M, Smith L. Evaluation of Elementary School-Wide Programs: Clover Park School District Year 2: 1997-1998. Memphis: University of Memphis, Centre for Research in Educational Policy; 1998

[64] Burns MS, Griffin P, Snow CE. Starting Out Right: A Guide to Promoting Children´s Reading Success. Specific Recommendations from America´s Leading Researchers on How To Help Children become Successful Readers. Washington, DC: National Academy Press; 1999

[65] Swartz SL, Shook RE. California Early Literacy Learning. Good First Teaching for all Children, Technical Report. Redlands, CA: Foundation for California Early Literacy Learning; 1994

[66] Swartz SL, Klein AF, Shook R, Hagg, C. Enseñanza Inicial de la Lectura y la Escritura. México, DF: Editorial Trillas; 2001

[67] Swartz SL, Shook R, Klein AF. Guided Reading and Literacy Centres. Carlsbad, CA: Dominie Press; 2003

[68] González-Valenzuela MJ, Delgado-Ríos M. Enseñanza-aprendizaje de la escritura en educación infantil y primaria. Electronic Journal of Research in Educational Psychology. 2007;**5**(3):302-321

[69] González-Valenzuela MJ, Delgado-Ríos M. Rendimiento académico y enseñanza-aprendizaje de la lectoescritura en educación infantil y primaria: Un estudio longitudinal. Infancia y Aprendizaje. 2009;**32**(3):265-276

[70] González-Valenzuela MJ, Martin-Ruiz I. Effects on reading of an early intervention program for Spanish children at risk of learning disabilities. Remedial and Special Education. 2017;**38**(2):67-75

[71] González-Valenzuela MJ, Martin-Ruiz I, Delgado-Ríos M. Teaching literacy and decreased risk of learning disabilities. Revista de Psicodidáctica. 2012;**17**(2):253-270

[72] González-Valenzuela MJ, Martin-Ruiz I. Intervención temprana del desarrollo del lenguaje oral en niños en riesgo de dificultades de aprendizaje: Un estudio longitudinal. Revista Mexicana de Psicología. 2016;**33**(1):50-60

Chapter 5

Multiple Intelligences and Videogames: Intervention Proposal for Learning Disabilities

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Additional information is available at the end of the chapter

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Abstract

In recent years, there has been much research into the possibilities offered by digital tools for intervention in learning disabilities. The most recent studies have found that these tools can have positive effects on diverse aspects of learning, such as the acquisition of reading, writing, vocabulary and mathematics, as well as improvement of executive functioning and behavioural control skills. Despite the results showing the positive effects of using digital tools for students with learning disabilities, it remains necessary to widen their use in areas such as identification, assessment and intervention as early as possible. Within the current chapter, the application of the conceptual framework of multiple intelligences to the design of educational video games is proposed to facilitate diagnosis and improve intervention success in cases of learning disability. In this regard, a proposed novel tool is presented that may be used for the evaluation and intervention for students with learning disabilities.

Keywords: multiple intelligences, learning disabilities, evaluation, intervention, serious games, gamification, game-based learning

1. Introduction

Throughout history, our concept of intelligence has evolved from restrictive ideas positing a direct, unidirectional, static relationship between intelligence, learning ability and academic achievement, to current approaches characterising intelligence from a non-unitary perspective. These new approaches try to understand the relationships between intelligence, learning and academic achievement from a more complex, bi-directional and dynamic perspective.

This new perspective highlights the multiplicity of capabilities, structures and processes involved in intelligent behaviour, as well as the possible contributions teaching can make to the improvement and optimisation of intellectual skills and learning abilities [1–4]. Within these non-unitary theories, there is one which stands out: Howard Gardner's Theory of Multiple Intelligences. This theory postulates that intelligence is composed of a mixture of abilities, skills and capabilities called intelligences, which are independent of each other, and which may be found in everybody waiting to be developed [2]. These postulates can be considered in the development of serious games.

In recent years, there has been much research into the possibilities offered by digital tools for intervention in learning disabilities. The latest research has found that these tools can have positive effects on various aspects such as the acquisition of reading skills [5, 6]; the development of vocabulary, language and listening skills [7]; treatment of dysgraphia [8]; mathematics learning [9–11]; and improvement in executive functioning in students with attention deficit hyperactivity disorder (ADHD) [12–14].

Despite these studies showing the positive effects of digital tools, it is still necessary to look more closely at the usefulness of these tools in the identification, evaluation and earliest possible treatment of those students with learning disabilities.

What is proposed here is the fusion of two aspects—the postulates of the Theory of Multiple Intelligences and the use of digital tools—with the aim of designing and testing a tool that facilitates the diagnosis and treatment of students with learning disabilities.

The current state of the art on digital tools applied to learning difficulties identification and intervention is presented below. Multiple intelligences postulates are also described in relation to the new tool, Boogies Academy.

2. Learning disabilities and digital tools

The term 'learning disabilities' refers to a heterogeneous group of disorders which manifest as significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning or mathematical skills [15]. The DSM-5 [16], the primary reference in professional and research practice in this field, includes difficulties in writing, reading and calculating, along with unspecified difficulties in a category called Specific Learning Disorders. These disorders are understood to be intrinsic to the individual, supposedly due to a dysfunction of the central nervous system, and may occur at any time throughout a person's life. Nonetheless, extrinsic circumstances arising from an individual's surrounding context, such as inappropriate teaching, or the presence of comorbid conditions such as ADHD, can have a strong influence on the diagnosis and progress of learning disabilities [17, 18].

Many studies emphasise the need for identification, evaluation and intervention as early as possible for students with learning disabilities. To expedite early diagnosis, newly developed, empirically substantiated and validated strategies can be implemented to complement the

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various mechanisms for identification, reinforcement and support already in use with students with learning disabilities.

These new techniques must also be consistent with new ways of student learning and the growing changes in society in which communication and information technologies play an increasing role. One example of this type of methodology is the use of digital tools developed through gamification in the form of educational video games or 'serious games' [19]. According to Sánchez-Peris [20], the use of these types of games is an excellent way to improve a player's concentration, effort and motivation, due to the recognition, success, competition, collaboration, self-expression and educational power inherent in such recreational activities. Recent studies [21] concluded that serious games could be stimuli which encourage the development of multiple intelligences, as they already have the multi-sensorial components which favour learning contexts capable of grabbing the player's attention and keeping them involved in the game.

Serious games share technology with video games, but, compared to video games, the aims and uses of serious games is outcome-driven and extremely varied [22]. For this reason, it is fundamentally necessary to define the objectives, content, skills and behaviours to develop, while not forgetting aesthetic, narrative and technical resources to encourage engagement and playability [21, 23, 24].

Thus, digital tools can bring together the necessary requirements to facilitate diagnosis and intervention in specific groups. It must be remembered that, as with all individuals, students with learning problems present unique characteristics, interests and needs when it comes to learning. The current paradigm advocates education that is centred on the person and considers individual differences. This approach makes it necessary to develop learning systems and contexts which are adapted, as far as possible, to each student's characteristics.

In terms of potential usefulness of serious games, it is important to note that, in comparison with traditional educational tools, digital systems have the advantage of presenting content in a variety of formats (written texts, images, animation, sound, etc.) [25]. A benefit of this is that the images, sounds, text and other methods of presentation are present at the same time, so simultaneous activation of both verbal/auditory and visual channels is possible. In addition, working in this kind of environment gives the learner better control over their learning processes by, for example, allowing them to choose a specific sequence.

Another characteristic of these systems is that information is organised in the same way that the human mind processes information—that is, in knowledge structures represented by interconnected networks of concepts. These structures are made up of nodes, with ordered relationships connecting them in such a way that distinct content that is related can be activated simultaneously and very rapidly [26]. Compared to traditional forms of organising information, such as the linear organisation used in textbooks, this type of organisation has been shown to have advantages as it encourages content acquisition and retention, and makes the learning process easier, which in turn has been shown to have its own impact on levels of student motivation [27, 28].

The benefits of using digital tools have been demonstrated in various studies of students with learning disabilities. The use of these systems has been shown to have positive effects on the acquisition of reading skills [5, 6]; acquisition of vocabulary, language and listening skills [7]; on the treatment of dysgraphia [8]; and on learning mathematics [9–11]. Its effects have also been studied in cases involving ADHD. Students with this developmental disorder face problems including abnormal executive functioning or the reduced capacity to control behaviour, and difficulties in regulating emotion, motivation and arousal or activation in general. These problems have been shown to be reduced by using digital tools [12–14]. In an earlier study [29], the use of this type of tool demonstrated a positive effect on academic achievement in a sample of students with ADHD, while more recent studies [30] found that students with ADHD exhibited increased levels of attention and better achievement in tasks when they were shown simultaneous videos, images and short narrations, whereas they demonstrated more difficulties when presented information in the form of linear texts. One of the explanations for these results is linked to the inherent properties of digital tools—that is, they make it easy to receive information through multiple channels. So, if one channel is being ignored, the information may be captured via another channel instead of being lost. Thus, presenting information through multiple channels increases the probability of relevant information being retained [28].

A very important aspect to consider is the level to which these new systems are adaptive [8]—that is, whether the functioning and difficulty levels adapt to variables of individual students, such as previous knowledge or pace of learning. While there is a lot of current research into the impact of digital tools on learning disabilities and ADHD, investigations into the adaptability of these tools when used in this population has so far been limited. Some exceptions include programs such as Number Race [31] for the treatment of dyscalculia and Agent-Dysl for dyslexia [32], both of which are aimed at treating students in primary education.

Number Race [31], primarily for children aged 4–8, is especially designed to address mathematical learning disabilities (dyscalculia) by strengthening the brain circuits for representing and manipulating numbers. Children who are making their first steps with numbers learn the basic concepts of number and arithmetic, while older children, who are already familiar with numbers, build their fluency in arithmetic and in mapping numbers to quantities (number sense).

The objective of Agent-Dysl [32] is to help narrow the gap between good and poor (due to dyslexia) readers in school-aged children. Agent-Dysl is an intelligent assistive reading system that gives personalised treatment, customising the presentation of the reading material (usually study material for a school lesson) to help each child improve their reading. The system builds and maintains individual profiles by observing each child reading the text on the system's viewing area and recognising the reading errors. The individual profiles are then used to customise text presentation for that individual so that each child's reading performance is improved. By employing image analysis techniques, the system can also assess the child's emotional and physical state and dynamically adapt the document presentation accordingly. Similar system adaptability should be considered and incorporated during the future development of tools designed for the contexts of learning disabilities and ADHD also.

The studies described above demonstrate how digital resources, utilised in the right way, can bring about improvements in students with learning disabilities. However, there have also

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been studies which demonstrate the potential that these types of systems have in evaluation and early diagnosis of these problems. Two completed studies [33] propose early evaluation systems for the identification of students in primary education at risk of presenting with learning disabilities, and which provide predictions of student learning based on a profile of performance in digital environments. Although the diagnostic efficacy of both systems is still being tested, positive data have already been acquired demonstrating the diagnostic efficacy of this type of instrument and indicating some of the required fundamental aspects for these systems: that they have a high level of automation and are accessible for use by teachers; that they offer relevant information on the student's effective learning and acquired skills; that the data provided is persistent over time; and that they have an accumulative character, allowing the student to be evaluated in different stages.

Despite the novelty of these systems in the context of intervention and evaluation in learning disabilities, something they suffer from in some cases is the presence of a stable theoretical reference framework. The current proposal is to begin with Gardner's paradigm of multiple intelligences, an aspect of which is that individuals possess different capabilities which can be gateways to facing their weaknesses. A new digital tool, called Boogies Academy, can hopefully utilise these individual capabilities in both the identification of and intervention in learning disabilities.

3. The Theory of Multiple Intelligences

The Theory of Multiple Intelligences is one of the most prevalent in the context of non-unitary theories of intelligence. This theory emphasises a combination of skills, abilities and capabilities that are independent of each other and are present in everyone, to a greater or lesser extent, waiting to be developed. Gardner called these abilities 'intelligences' and his theory considers each individual to exhibit a unique profile of intelligences. That is, although we are all born with these intelligences, there are no two people who have identical intelligences in the same combinations [34]. In accordance with these ideas, Gardner defined intelligence as a biophysical potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture [34]. He originally identified seven intelligences: musical, bodily kinaesthetic, logical-mathematical, linguistic, spatial, interpersonal and intrapersonal; he later added naturalistic intelligence to his theory [34]. Gardner did not only identify these types of intelligences. He also equated them with linguistic and mathematical intelligence as, at that time, these where considered key to determining an individual's intelligence and were the only intelligences used as references in traditional tests of capability [2, 3, 15–38].

This theory was the subject of great interest in the educational community and gave rise to a concept of education far removed from the uniform school model. It proposed individual-centred teaching that considered each student as distinct in terms of the level and combination of intelligences they possessed. Thus, it suggested that different students should not have the same content, methods or evaluations [2, 3, 35, 36, 38, 39].

The fundamental aspect of this approach is the need to discover the intellectual capabilities and outstanding aptitudes of each individual in order to develop them from the very earliest stages of education by designing learning tasks which foster development of the basic skills and abilities of each intelligence [2]. The theory focused not only on the need to evaluate the skills that stand out the most but also on seeking ways in which this information could be used to modify methodologies for individual needs and thus foster academic achievement and adaptation to school [2, 36, 38–40].

Once evaluation has identified stronger areas (areas in which a student exhibits better motivation and more confidence), it is necessary to move to the key step, which is intervention.

This intervention utilises the concept that these skills or strong points can be used to 'bridge the gap' in areas where the student has difficulties [2]. Thus, there are two necessary phases of a procedure incorporating this theory: it must begin with an evaluation of the individual's abilities and strong points, and then an intervention must be prepared which uses those strong points as a way to improve weak or problematic areas.

4. Evaluation of multiple intelligences

Evaluation means gathering information about the abilities and potential of the subjects that is useful both to the individual being evaluated and to the community around them [2]. Gardner [34] thought that finding reliable, valid measures of intelligence was of great interest to educationalists. However, his theory criticises the view that there is only a single intelligence that may be measured by the Intelligence Quotient and standardised tests [2]. Therefore, in this approach, it is suggested that we cannot continue measuring intelligence as we have up to now, and that it is necessary to develop a different, better way of thinking about human intellect [34], along with more appropriate ways of unbiasedly evaluating people with differing intellectual profiles [2, 3, 38, 41, 42].

It should be noted that it is essential to evaluate intelligences using methods which are neutral with respect to the intelligences, that is, using methods that directly examine the intelligences rather than through instruments which depend on linguistic or logical intelligence, such as traditional pen and paper instruments [34]. In this sense, evaluation instruments and materials that are usually applied cannot be considered neutral, and the use of materials that are familiar, motivating and relevant to the child's context will allow better evaluations of an individual's level of competence [36–38, 43]. This raises the need for an evaluation system that can unbiasedly detect students' capabilities, abilities and interests in order to provide educational experiences which encourage students to capitalise on strong areas, while addressing and aiming to improve detected weaknesses [36, 38, 39, 43].

The first and most significant experience of this kind of evaluation was 'Project Spectrum' [43–45]. The aim was to evaluate intelligences and encourage development of processes and skills implicit in them, as well as seek ways in which teachers could use this information to better adapt their methodologies to individual needs. The types of activities used in this

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project allowed for the evaluation of children while they were playing, rather than needing to use the written word. Therefore, the evaluation was of intelligence functioning in natural settings and in situations involving the resolution of everyday problems [36, 38, 39, 45]. These activities have been shown to be valid, reliable instruments for the evaluation of multiple intelligences [36, 37, 46].

Although this model of evaluation, a long way from traditional tests and pen and paper assessments, is the ideal proposed by Gardner for the very young, it has the disadvantage of being rather laborious to implement, so it is not used very widely in either the educational field or in research into multiple intelligences. One way to overcome this limitation may be to use interactive digital evaluation instruments that can be applied easily to evaluate all the intelligences described by Gardner. This requires the use of instruments that, in addition to being evaluation tools, are also learning experiences [2]; conform to the characteristics for evaluation proposed by Multiple Intelligences Theory (continuous, systematic, varied, dynamic, contextualised, meaningful and motivating) [36–38, 45]; and are sufficiently practical to be used in both education and research.

In this sense, digital tools offer numerous possibilities both in research and in intervention, using the Theory of Multiple Intelligences as a point of reference.

5. A digital tool based on multiple intelligences: Boogies Academy

Boogies Academy is a library of video games designed to evaluate and improve multiple intelligences in primary education. It was created with the aim of giving families and education professionals a tool which was both attractive and motivating for students and easy to use in both educational and research and evaluation settings.

The design and development was done using a proprietary methodology called the tree of intelligences (TOI) method. This methodology has, at its roots, the fundamental Theory of Multiple Intelligences from Gardner [2, 29, 47] added to the design of educational video games. The result is an algorithm which allows the real-time measurement of a player's achievement, providing information about their profile of intelligences, as well as advice for improving strong areas and compensating for weaker areas.

To make the information measurable, the Boogies Academy tool is constructed on two fundamental foundations: instructional design, that is, the planning, preparation and design of resources so that learning happens [48]; and the idea of intelligence as the ability needed to resolve problems or create products which are important in a specific cultural context or community [2].

The game mechanics, content and evaluation criteria were defined following instructional design, allowing data to be recovered and difficulty levels to be set. For video games to be catalysts capable of activating multiple intelligences, thought must be given to the content, skills and abilities they aim to develop, without forgetting the aesthetics, narratives and video game techniques which encourage engagement and guarantee playability [21–24]. To that

end, once the instructional design was done, the game was given shape by illustrators and graphic designers before programming was completed by the technical team.

It should be noted that the game mechanics were designed with regard to the concept of intelligence being the ability needed to resolve problems or create worthwhile products [2], while bearing in mind that intelligences always work synergistically [2, 49], and that there are different ways of being intelligent within a single intelligence [49].

Each game presents the gamer with a problem to solve. Depending on the skills or abilities the challenge requires, one principal intelligence and one or more secondary intelligences are activated. In this manner, one problem may require speed of reaction (activating visual-spatial and bodily kinaesthetic intelligences), whereas another may ask for knowledge of various animal species (activating naturalistic intelligence).

When creating the problems and defining the game mechanics, the designers considered the key abilities Gardner and his colleagues recognised in Project Spectrum [43–45], such as musical perception or sensitivity to rhythm in the case of musical intelligence.

To date, a total of 10 games have been designed and developed, covering at least one key ability [43–45] from each of the 8 intelligences recognised by the theory. The games are:

- Tool time: classification of objects according to similarity to geometric shapes (visual-spatial and logical-mathematical intelligence).
- Electric colours: perception and recognition of primary colours and simple mixtures of colour (visual-spatial and logical-mathematical intelligence).
- Marathon Boogie: performing mathematical operations to develop mental arithmetic skill (logical-mathematical intelligence).
- Rubbish rush: classification of rubbish according to material (naturalistic intelligence). The mechanics also need hand-eye coordination to classify the rubbish (visual-spatial and bodily kinaesthetic intelligences).
- Catch the cakes: reaction speed and hand-eye coordination (bodily kinaesthetic and visual-spatial intelligences).
- Photo booth Boogie: perception and identification of feelings from body, facial and gestural expressions (interpersonal and intrapersonal intelligences).
- Word-search: recognition of words and basic vocabulary management (linguistic and visual-spatial intelligences).
- Exploding keys: recognition of letters and writing training through widgets (linguistic, visual-spatial and bodily kinaesthetic intelligences).
- Musical Drops: listening, recognition, identification and discrimination of sounds and rhythmic patterns (musical and linguistic intelligences).
- Yog's band: recognition and identification of instruments and their sounds (musical intelli gence).

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One of the strengths of the Boogies Academy tool is the real-time result readout. This means that the tool is not limited to classification as it can also provide feedback to help the player address their skills and abilities by, for example, offering a learning itinerary of suggested games that will use the player's stronger skills and abilities to work on their weaker points. According to Gardner [2], psychologists spend too much time classifying individuals and not enough time trying to help them. Hopefully, thanks to Boogies Academy, education professionals, as well as parents, will be able to identify a student's strong points in addition to the weaker areas in their capability profile, and use this information to, among other things, guide the search for educational experiences that best fit the student's profile and will bring about development and strengthening of their different intelligences and abilities, as well as guide their future study or work in subsequent stages of education [2, 49].

6. Conclusions and future perspectives

Digital tools may constitute an appropriate dynamic process for evaluating multiple intelligences as long as there are activities which work on the basic skills that define each learning area, and as long as these activities are planned within a meaningful and motivating learning context [23]. These types of tools also allow the introduction of evaluation and educational objectives without sacrificing entertainment and using a motivating and meaningful methodology [24]. Thanks to technological development, the current potential for digital tools is limitless. Based on these new methodologies, it is now possible to formulate an educational system capable of unbiasedly detecting students' skills, abilities and interests; the design of such a system must provide the opportunity to create intervention contexts which support and utilise student strengths while addressing and improving student weaknesses, especially in cases where there is a learning disability [36–38, 43].

Gardner's Theory of Multiple Intelligences has significant educational implications, in that identified skills and abilities speak to the student's learning preferences, methods and styles, as well as their strengths. This is a fundamental element of the current educational context, and, even more so, in the context of learning disabilities, it involves a radical change in perspective as models based on deficits are rejected in favour of a model based on abilities and strengths [50, 51]. Thus, as students have different learning capabilities and these are expressed in multiple facets, a deficit in one specific area may be compensated by strengths in others [52].

In addition, these intelligences are measurable and may be revealed in various contexts in day-to-day life, particularly in the classroom [53]. Increasingly, teachers are recognising that students learn and excel in a wide variety of ways, and if strengths in their intelligences can be identified, the processes of teaching-learning will be enhanced. A class which offers a variety of learning opportunities increases its students' chances of success [51, 54].

In terms of intervention, the study of multiple intelligences is currently a promising field of research. Many researchers are adopting this perspective as a way of including alternatives for improving the acquisition of language, reading and mathematics, as well as basic skills of

behaviour control and attentional processes, with positive results [50, 51, 55, 56]. They have also found positive effects on motivation, self-concept, self-efficacy and, in general, academic achievement in students of varying ages with and without learning disabilities. One study [57] analysed the effect of instruction based on multiple intelligences in a sample of fourth year students and found improvements in academic achievement and school self-concept.

Taken together, these studies provide empirical evidence supporting the use of a perspective based on multiple intelligences in evaluation of, and intervention in, learning disabilities, although they also indicate the need for additional research in this field. Accordingly, and aware of what new technologies and digital tools have been shown to offer to these processes, the principal use proposed here is to combine both perspectives (digital systems and multiple intelligences) in tools which allow identification and intervention in cases of learning disability. Therefore, by incorporating these perspectives with the results of previous research, we have developed a digital tool which combines a series of educational video games based on the postulates of the Theory of Multiple Intelligences: Boogies Academy.

Having developed the tool, our current objective is the analysis of its use as a complement in evaluation of and intervention in students with learning disabilities. More specifically, current research is aimed at two fundamental aspects: firstly, at the delimitation of students' profiles of intelligences, which will provide information on key points and highlight skill areas; and secondly, at the study of effects of the Boogies Academy software on levels of attention, motivation and anxiety in a sample of 80 students with learning disabilities aged 6–12. To do this, pre-test and post-test evaluations will be done, and a control group will receive intervention with the tool once the study is complete. The hope is that this intervention will produce positive results in the experimental group, specifically increased levels of attention, increased motivation to learn, and reduction of anxiety when compared to the control group.

Although Boogies Academy is a newly created tool, it is hoped future research will produce positive results regarding its use as a complementary method of evaluation and intervention in school-aged children. In terms of future perspectives, there is a plan to create a new tool for use by older children, and to use the current tool in other populations with different problems, such as ADHD. This research will allow us to have a more accurate understanding of the potential of these digital tools, based on multiple intelligences, in different age groups and populations.

Based on the studies that are being conducted using the new tool, it is expected that Boogies Academy will be a reliable and valid assessment measure of multiple intelligence components, whose factorial structure fits the multiple intelligences model previously described. This type of evaluation seeks to go beyond traditional intelligence tests, providing a more comprehensive view of an individual's intelligence, skills, strengths and weaknesses. We expect that the different tests that comprise the Boogies Academy tool will show good reliability and validity, as well as significant correlations with other standardised intelligence tests.

On the other hand, it is also expected that this new tool will have an important impact on current intervention practices, by giving some clues on how to design and implement intervention programmes adjusted to individuals' intelligence profiles. The main objective in this sense is to design a tool that offers a tailored training itinerary, based on the analysis of intelligence profiles. For this purpose, Boogies Academy is intended to take advantage of an

individual's strengths and use them as starting points to offset possible difficulties. It is also important to note the wide range of options that this new tool will offer to researchers, as it can provide real-time data. Given its characteristics, the designed tool should also be helpful when conducting research on multiple intelligences in individuals with learning disabilities and associated clinical conditions (e.g. attentional problems, low motivation or self-esteem).

Overall, it is expected that the current research on digital tools opens a new and promising path in the field of evaluation and interactive intervention in students with different learning difficulties.

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References

[1] Coll C, Onrubia J. Psychological factors and processes involved in school learning. In: Coll C, Palacios J, Marchesi A, editors. Psychological development and education. Scholar education psychology. Madrid: Alianza Editorial; 2001. pp. 189-210

[2] Gardner H. Multiple Intelligences: The Theory in Practice. Barcelona: Paidós; 2013

[3] Hernández-Torrano D, Ferrándiz C, Ferrando M, Prieto L, Fernández M. The theory of multiple intelligences in the identification of high-ability students. Anales de Psicología. 2014;**30**(1):192-200. DOI: 10.6018/analesps.30.1.148271

[4] Sternberg R. Beyond I.Q. Cambridge: Cambridge University Press; 1985

[5] Coleman-Martin M, Heller K, Cihak D, Irvine K. Using computer-assisted instruction and the nonverbal reading approach to teach word identification. Focus on Autism and Other Developmental Disabilities. 2005;**20**(2):80-90. DOI: 10.1177/10883576050200020401

[6] Luckevich D. Computer assisted instruction for teaching vocabulary to a child with Autism. Florida: Nova Southeastern University; 2008

[7] Massaro D. Read my lips: The importance of the face in a computer-animated tutor for vocabulary learning by children with autism. Autism. 2006;**10**(5):495-510. DOI: 10.1177/1362361306066599

[8] Polat E, Adiguzel T, Akgun OE. Adaptive web-assisted learning system for students with specific learning disabilities: A needs analysis study. Educational Sciences: Theory & Practice. 2012;**12**(4);3243-3258.

[9] Andrade-Aréchiga M, López G, López-Morteo G. Assessing effectiveness of learning units under the teaching unit model in an undergraduate mathematics course. Computers & Education. 2012;**59**(2):594-606. DOI: 10.1016/j.compedu.2012.03.010

[10] Butterworth B, Laurillard D. Low numeracy and dyscalculia: Identification and intervention. ZDM. 2010;**42**(6):527-539. DOI: 10.1007/s11858-010-0267-4

[11] Cueli M, González P, Rodríguez C, Núñez JC, González-Pienda JA. Effect of a hypermedia tool on the affective-motivational variables related to mathematics. Educación XX1. 2015:1-21

[12] Shaw R. Inhibition, ADHD, and computer games: The inhibitory performance of children with ADHD on computerized tasks and games. Journal of Attention Disorders. 2005;**8**(4):160-168. DOI: 10.1177/1087054705278771

[13] Slusarek M, Velling S, Bunk D, Eggers C. Motivation effects on inhibitory control in children with ADHD. Journal of the American Academy of Child Psychiatry. 2001; **40**:355-363. DOI: 10.1097/00004583-200103000-00016

[14] Xu C, Reid R, Steckelberg A. Technology applications for children with ADHD: Assessing the empirical support. Education & Treatment of Children. 2002;**25**:224-248

[15] National Joint Committee on Learning Disabilities. Operationalizing the NJCLD definition of learning disabilities for ongoing assessment in schools. Learning Disability Quarterly. 1998;**21**:186-193

[16] American Psychiatric Association (APA). Diagnostic and Statistical Manual of Mental Disorders. 5th ed. Arlington, VA: APA; 2013

[17] García T, Rodríguez C, González-Castro P, Álvarez D, Cueli M, González-Pienda JA. Executive functioning in children and adolescents with attention deficit hyperactivity disorder and reading disabilities. International Journal of Psychology and Psychological Therapy. 2013;**13**(2):179-194

[18] Rodríguez C, Grünke M, González-Castro P, García T, Álvarez-García D. How do students with attention-deficit/hyperactivity disorders and writing learning disabilities differ from their nonlabeled peers in the ability to compose texts? Learning Disabilities. 2015;**13**(2):157-175

[19] Zyda M. From visual simulation to virtual reality to games. Computer. 2005;**38**(9):25-32. DOI:10.1109/MC.2005.297

[20] Sánchez i Peris FJ. Gamification. Theory of Education. Education in the Knowledge Society. 2015;**16**(1):13-15

[21] del Moral M, Fernández-García L, Guzmán A. Videogames: Multisensorial incentives for strengthening multiple intelligences in primary education. Revista Electrónica de Investigación Psicoeducativa Psicopedagógica. 2017;**13**(2):243-227. DOI: 10.14204/ejrep.36.14091

[22] Arambarri Basáñez J, Armentia Lasuen L, Baeza Santamaría U. Serious games for the value of culture. A case study: SUM. Virtual Archaeology Review. 2012;**3**(7):65. DOI: 10.4995/var.2012.4388

[23] Marín V, García MA. Video games and their didactic-formative capacity. Pixel-Bit. Revista de Medios y Educación. 2005;**26**:113-119

[24] Starks K. Cognitive behavioral game design: A unified model for designing serious games. Frontiers in Psychology. 2014;**5**(28):1-10. DOI: 10.3389/fpsyg.2014.00028

[25] Mayer RE. The Cambridge handbook of multimedia learning. NewYork: Cambridge University Press; 2005

[26] Graff M. Learning from web-based instructional systems and cognitive style. British Journal of Educational Technology. 2003;**34**:407-418. DOI: 10.1111/1467-8535.00338

[27] Calcaterra A, Antonietti A, Underwood J. Cognitive style, hypermedia navigation and learning. Computers & Education. 2005;**44**(4):441-457. DOI: 0.1016/j.compedu.2004.04.007

[28] Fabio RA, Antonetti A. Effects of hypermedia instruction on declarative, conditional and procedural knowledge in ADHD students. Research in Developmental Disabilities. 2012;**33**:2028-2039. DOI: 10.1016/j.ridd.2012.04.018

[29] Mautone JA, DuPaul GJ, Jitendra AK. The effect of computer-assisted instruction on the mathematics performance and classroom behavior of children with ADHD. Journal of Attention Disorders. 2005;**9**:301-312. DOI: 10.1177/1087054705278832

[30] Solomonidou C, Garagouni-Areou F, Zafiropoulou M. Information and communication technologies (ICT) and pupils with attention deficit hyperactivity disorder (ADHD) symptoms: Do the software and the instruction method affect their behavior? Journal of Educational Multimedia and Hypermedia. 2004;**13**:109-128

[31] Wilson AJ, Dehaene S, Pinel P, Revkin SK, Cohen L, Cohen D. Principles underlying the design of "The Number Race", an adaptive computer game for remediation of dyscalculia. Behavioral and Brain Functions. 2006;**2**:1-14. DOI: 10.1186/1744-9081-2-19

[32] Tzouveli P, Schmidt A, Schneider M, Symvonis A, Kollias S. Adaptive reading assistance for the inclusion of students with dyslexia: The AGENT-DYSL approach. In: Proceedings of the 8th IEEE International Conference on Advanced Learning Technologies ICALT. 2008, Santander, Spain

[33] Villagrá-Arnedo JC, Gallego-Durán FJ, Llorens-Largo F, Compañ-Rosique P, Satorre-Cuerda R, Molina-Carmona R. Early detection of learning disabilities. Tool for predicting student performance. En Actas del III Congreso Internacional sobre Aprendizaje, Innovación y Competitividad CINAIC. 2015, Madrid, España

[34] Gardner H. Intelligence Reframed: Multiple Intelligences for the 21st Century. Barcelona: Paidós; 2013

[35] Armstrong T. Multiple Intelligences in the classroom. Buenos Aires: Ediciones Manantial; 1999

[36] Ballester P. Multiple intelligences: A new approach to assessing and favoring cognitive development (thesis). Murcia: Universidad de Murcia; 2001

[37] Ferrándiz C. Multiple intelligences and school curriculum (thesis). Universidad de Murcia; 2000

[38] Gomis N. Assessment of multiple intelligences in the educational context through experts, teachers and parents (thesis). Alicante: Universidad de Alicante; 2007

[39] Prieto MD, Ferrándiz C. Multiple Intelligences and School Curriculum. Málaga: Aljibe; 2001

[40] Prieto MD, Ballester P. Multiple Intelligences. Different ways of teaching and learning. Madrid: Pirámide; 2003

[41] Hernández D. High ability and expert skills (thesis). Murcia: Universidad de Murcia; 2010

[42] Sternberg RJ, Grigorenko EL. The theory of successful intelligence as a basis for gifted education. Gifted Child Quarterly. 2002;**46**:265-277. DOI: 10.1177/001698620204600403

[43] Gardner H, Feldman D, Krechevsky M. Project Spectrum: Early Learning Activities. Tomo II. Madrid: Ediciones Morata; 2001

[44] Gardner H, Feldman D, Krechevsky M. Project Spectrum: Building on Children ´s Strengths: The Experience of Project Spectrum. Tomo I. Madrid: Ediciones Morata; 2000

[45] Gardner H, Feldman D, Krechevsky M. Project Spectrum: Preschool Assessment Handbook. Tomo III. Madrid: Ediciones Morata; 2008

[46] Ferrándiz C, Prieto MD, Ballester P, Bermejo MR. Validity and reliability of the multiple intelligences assessment instruments in the pre-school and primary school. Psicothema. 2004;**16**:7-13

[47] Gardner H. Frames of Mind. The Theory of Multiple Intelligences. Nueva York: Basic Books; 1983

[48] Bruner JS. The process of education. Cambridge: Harvard University Press; 1969

[49] Armstrong T. Multiple Intelligences in the classroom. Barcelona: Paidós; 2016

[50] Al-Onizat SH. Measurement of multiple intelligences among sample of students with autism, and intellectual disability using teacher estimation and its relationship with the variables: The type and severity of disability, gender, age, type of center. International Journal of Education. 2016;**8**(1):107-128. DOI: 10.5296/ije.v8i1.8268

[51] Andreou E, Vlachos F, Stavroussi P. Multiple intelligences of typical readers and dyslexic adolescents. International Journal of Education, Learning and Development. 2013;**1**(2):61-72

[52] Rose DH, Meyer A. Teaching every student in the digital age: Universal design for learning. Alexandria: Association for Supervision and Curriculum Development; 2002

[53] Al-Salameh EM. Multiple intelligences of the high primary stage students. International Journal of Psychological Studies. 2012;**4**:196-210

[54] Kornhaber M. Multiple intelligences: From the ivory tower to the dusty classroom-but why? Teachers College Record. 2004;**106**:67-76. DOI: 10.1111/j.1467-9620.2004.00319.x

[55] Abdulkader FA, Gundogdu K, Eissa MA. The effectiveness of a multiple intelligences-based program on improving certain reading skills in 5th-year primary learning disabled students. Revista Electrónica de Investigación Psicoeducativa Psicopedagógica. 2009;**7**(3):673-690

[56] Takahashi J. Multiple intelligence theory can help promote inclusive education for children with intellectual disabilities and developmental disorders: Historical reviews of intelligence theory, measurement methods, and suggestions for inclusive education. Creative Education. 2013;**4**(9):605-610

[57] Al-Zyoud NF, Nemrawi ZA. The efficiency of multiple intelligence theory (MIT) in developing the academic achievement and academic-self of students with mathematical learning disabilities in the areas of addition, subtraction and multiplication. American International Journal of Social Science. 2015;**4**(2):171-180

Chapter 6

Specific Learning Disabilities: Response to Intervention

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Jennifer S. Griffin

Additional information is available at the end of the chapter

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Abstract

The content included in the current chapter centers around the screening and identification of students who experience learning challenges in an educational setting in the United States of America. The specific learning challenges discussed will focus on students who may have a specific learning disability (SLD). Legislation that brought about concepts such as response to intervention (RTI) is discussed in detail. The various levels of intensity of interventions, or tiers, provided to students are explained by more than one discipline. The new regulations guiding access to special education services are based on the identification, intervention, and close monitoring of student progress. The overarching goal of RTI is to provide support to students who may be experiencing difficulty, before they experience failure by falling too far behind their peers.

Keywords: response to intervention, evidence-based intervention, instruction, monitoring, dynamic assessment, multitiered system, educational legislation

1. Introduction

This current chapter provides an overview of the historical background of specific learning disabilities (SLDs) in the United States of America. A SLD is a developmental disorder that begins by school age, although it may not be recognized until later [1]. It involves ongoing problems learning key academic skills, including reading, writing, and math. SLDs may also affect the way an individual is able to write, spell words, reason, recall, or organize information. SLDs are a lifelong condition that comes with varying levels of challenges unique to each individual. The impact that a SLD has on an individual can be minimized based upon the early detection and treatment of the condition. The treatments provided should be evidence based and selected as a result of the individual's learning needs, preferences, and background [2]. Evidence-based interventions are methods that have been scientifically confirmed with regard

to the selected treatment and proven effectiveness. In the current chapter, distinct types of SLDs will be emphasized. An overview of response to intervention (RTI), as well as an explanation of the multitiered system, will be illustrated throughout the chapter and within **Figure 1**. Progress monitoring is a key component to successful RTI implementation. This chapter will describe the assessments used to observe improvements. The benefits associated with RTI methods are discussed from multiple perspectives within this chapter. The role of speech-language pathologists (SLPs) and special educators is highlighted below.

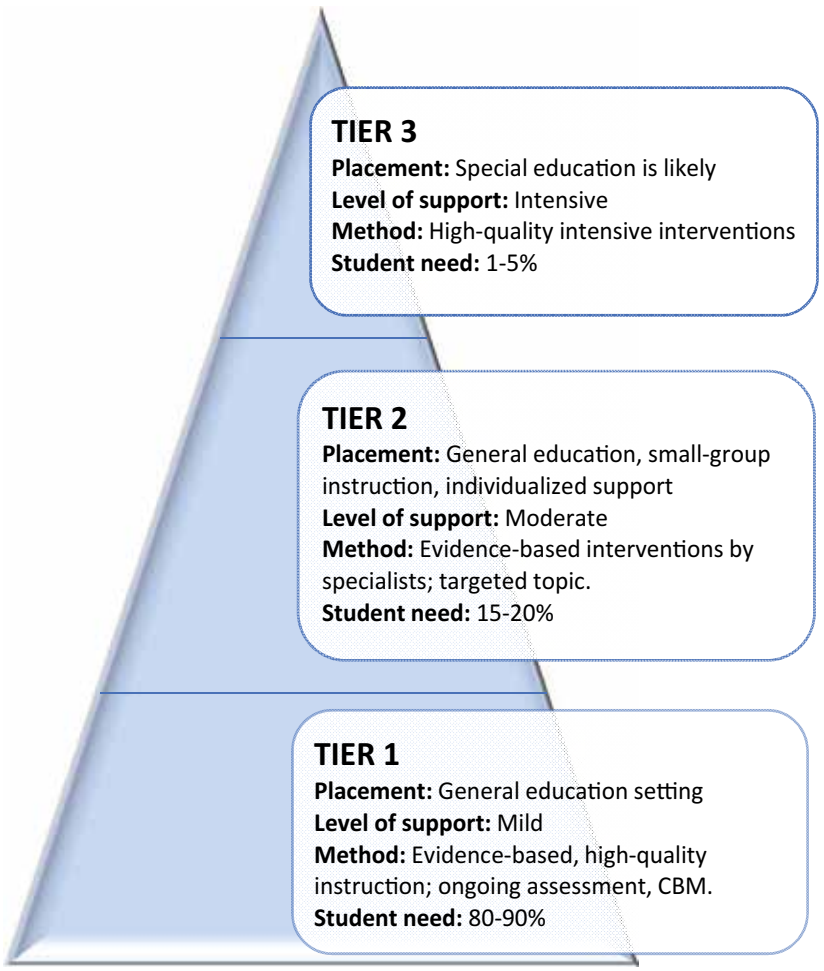

Figure 1. The figure presents each of the three levels (Tier 1, Tier 2, and Tier 3) of response to intervention (RTI). Each tier refers to the general descriptors of the strategies implemented in an increasingly intensive method [10]. Each tier presents the percentage of students requiring the specific tier's level of intervention and a description of each of the following: typical placement, level of support, method of intervention, and student need presented as a percentage of the student population requiring such interventions within each tier.

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2. History of learning disabilities

This section provides a historical presentation of learning disabilities in the United States of America. Over the past few decades, students with learning disabilities have improved their ability to contribute to society as a result of receiving better services and a clearer diagnosis in relation to their deficits [3].

In the past, learning and attention issues were not on the public radar. In 1905, the first publication by W.E. Bruner reported about childhood reading difficulties. It was not until the 1930s that the term dyslexia was coined. In the 1960s, in the United States of America, professionals first started to recognize the term learning disability (LD), which is later regarded as attention deficit hyperactivity disorder (ADHD). At this time, inclusion of students with learning disabilities and their nondisabled peers was not practiced in the United States of America [4]. Instead, students with learning disabilities were educated separately. In 1963, Samuel A. Kirk was the first psychologist to use the term learning disability at a professional conference. It was around this time that public school and the federal government started paying attention to learning disabilities.

The Association for Children with Learning Disabilities (ACLD) was created in 1963. This organization is now known as the Learning Disabilities Association of America (LDA) and is spread across the United States of America. LDA's vision is that all individuals with learning disabilities are empowered to thrive and participate fully in the society; the incidence of learning disabilities is reduced; and learning disabilities are universally understood and effectively addressed. LDA's mission is to create opportunities for success for all individuals affected by learning disabilities and to reduce the incidence of learning disabilities in future generations. LDA provides a plethora of resources to educators, individuals, families, states, and professional resources.

In 1969, the first federal law was passed to mandate services for students with learning disabilities. In 1973, an act that prohibits discrimination against people with disabilities in programs receiving public finding was passed. This act is referred to as Section 504 of the Rehabilitation Act. The US Congress passed the Education for All Handicapped Children Act (EAHCA), which popularized Free Appropriate Public Education (FAPE) for all students living in the United States of America, in 1975. The National Center for Learning Disabilities was founded in 1977, which was the former Foundation for Children with Learning Disabilities. In the 1980s and 1990s, trends continued to progress for individuals with learning disabilities. In 1985, the first dyslexia state law was enacted in Texas requiring instructional interventions to be put in place for students. In 1996, the National Institute of Mental Health completed research that identified the regions of the brain affected when a person has a diagnosis of dyslexia. The first learning disability web source, for parents and teachers, was established this decade. In the year 2000 and beyond, the awareness and research of learning disabilities continued to grow. Public laws and policies provided individuals with more rights and guidelines were established for professionals responsible for educating students with disabilities.

Brain research became fundamental in understanding learning disabilities and their causes. In 2001, legislation known as No Child Left Behind Act (NCLB) enhanced the states and district's accountability for students' progress. In 2002, research completed at Yale University looked at the differences between non-dyslexic and dyslexic brains. The researchers were able to view how the brains of those with dyslexia worked differently than non-dyslexic peers using MRI technology. Later in 2005, Yale University identified a gene associated with dyslexia. The overall public view at this time was evolving with regard to the way people perceived individuals who have a learning disability.

The reauthorization of Individuals with Disabilities Education Act (IDEA) in 2004 increased responsibility of school districts and enhanced parental rights. Another important piece to the legislation is the alignment of IDEA and NCLB. As a result, response to intervention (RTI) was introduced to assist struggling students before they are referred for special education services. In 2007, researchers at the University College London used brain imaging to identify the areas of the brain that works differently when individuals have learning disabilities such as dyscalculia.

In 2013, the *Diagnostic and Statistical Manual of Mental Disorders*-5 (DSM-5) broadened the definition of learning disability (LD) to specific learning disorder (SLD) [1]. In 2015, NCLB was repealed, and the US Congress enacted new legislation referred to as Every Student Succeeds Act (ESSA). This law provided each state within the United States of America to set their own goals for student achievement within a flexible federal framework. The ways in which students are identified as having a learning disability have changed over the years. Until recently, the most common approach to diagnose a student with a learning disability was to use a "severe discrepancy" formula. This referred to the gap, or discrepancy, between the child's intelligence or aptitude and his or her actual performance. In the 2004, reauthorization of IDEA changed how LD is determined. IDEA now requires that states adopt criteria that must not require the use of a severe discrepancy between intellectual ability and achievement in determining whether a child has a specific learning disability. In addition, states must permit local educational agencies (LEAs) to use a process based on the child's response to scientific, research-based intervention and allow the use of other alternative research-based procedures for determining whether a child has a specific learning disability.

To summarize the new practices, instead of using a severe discrepancy approach to determine a learning disability, school systems must provide the student with a research-based intervention. The student's performance must then be closely monitored related to their response to the selected interventions.

3. Types of learning disabilities

The most common types of SLDs affect the areas of math, reading, and writing [1]. Learning disabilities can be best described as having difficulties in academic achievement and related areas of learning and behavior. There is more than one cause for SLDs. Often, learning disabilities are a result of an individual's genetic makeup. The other cause may be from a stroke or traumatic brain injury that occurs later in an individual's lifetime.

This section of the chapter outlines several types of LDs. Some of the SLDs listed below are of high incidence, and others are of low incidence. It is also important to note that students who have a diagnosis of a SLD may have a comorbid diagnosis of another disability such as dyspraxia and attention deficit hyperactivity disorder (ADHD) or have patterns of weakness in executive functioning, which will impact the treatment they receive [2].

3.1. Dyslexia

Dyslexia is a learning disability categorized by deficits in learning to read or understand words, letters, and other symbols of a learner's native language. Dyslexia is caused by neurobiological dysfunctions in the brain. It may be inherited from parents or be a result of a traumatic brain injury, stroke, or dementia. A person who has a diagnosis of dyslexia may have difficulty in understanding letters, groups of letters or symbols, sentences, or paragraphs [2]. Dyslexia can be diagnosed through a battery of assessments including memory, vision, spelling, and reading tests.

3.2. Dysgraphia

Dysgraphia is a type of learning disability that impacts an individual's writing ability. Students who have dysgraphia may have difficulties that range from inability to formulate thoughts into text, illegible handwriting, inconsistent mix of print and cursive, upper and lower case, and unbalanced size, shape, and slant of letters. In addition, an individual with dysgraphia may display difficulties in copying words, may show poor spatial planning, may use inconsistent spacing between letters or words, or may not complete letters or familiar words. Dysgraphia may also impact an individual's ability to think and write at the same time; making note taking challenging [1].

3.3. Dyscalculia

Dyscalculia involves frequent difficulties with everyday arithmetic tasks, such as telling time, following directions, adhering to and creating schedules, and sequencing events [1]. Individuals with dyscalculia make mistakes with distinguishing between left and right. In addition, students with dyscalculia face challenges with consistently solving addition, subtraction, division, and multiplication problems. The knowledge of budgeting, financial planning, and estimating numbers is a daily challenge for individuals with dyscalculia.

4. Overview of response to intervention

Response to intervention's (RTI) foundation is rooted in prevention of science and evidence-based practice. This approach embraces special and general education through the use of three target areas: (a) effective curriculum that provides opportunity for the majority of students to progress at the expected rate, (b) universal screening for early identification at-risk students so that these students may be provided additional, focused, intensive instruction while their progress is monitored, and (c) intensive interventions to aid students with learning difficulty [3].

RTI emerged in the field of education based on research on specific learning disabilities (SLDs) and reading interventions. The results of SLD research influenced education laws and classroom practice [4]. In the United States of America, special education is governed by IDEA 2004. IDEA 2004 encouraged schools to use research-based interventions to differentiate between students struggling due to poor instruction or to a disability [5]. Prior to the reauthorization of IDEA 2004, a student may qualify for services under the SLD category by showing a discrepancy between achievement and aptitude on a qualified assessment. As a discrepancy model, SLD is the term used to describe a student performing at average or higher intelligence on a standardized test and performing at a significant discrepancy (usually two standard deviations) in one or more academic areas. Shortcomings of the discrepancy model led leaders in the field of SLD to propose RTI as a valid method of identifying a student with a learning disability [4]. Through the use of powerful, scientific-based procedures for decision making, RTI focuses on improving the outcomes in both general and special education [5].

RTI is more than a method of identifying students with learning disabilities; it is a way to ensure better academic outcomes for all students. RTI shifts the focus from individual intrinsic abilities and characteristics to environmental variables and instruction [6]. The shift also requires a closer look at individualizing instruction within the classroom and consistent monitoring of progress through validated, research-based techniques [5]. Further, RTI encourages educators to be proactive in identifying learning delays, ideally to prevent those delays from becoming learning disabilities. Educators can intervene as early as preschool and kindergarten. This model differs from the past practice of allowing the opportunity for students to fail in middle-elementary grades (e.g., second and third grades) before intervening with special education services [3].

RTI's proposed models involve two critical components: (a) evidence-based instruction and interventions implemented and (b) ongoing monitoring of student progress and responses throughout intervention. Valid instruction and interventions are defined as those leading to positive, reliable results for students with similar characteristics [5]. Thus, using RTI to identify students with SLD requires showing not only that a student demonstrates educational need but also an inconsistent response to high-quality general education instruction [7].

5. Explanation of a multitiered system

As mentioned in the overview, RTI is a multitiered system. Although variations of multitier instructional systems exist, this chapter discusses the use of three-tier models. Various school systems nationwide have discussed and adopted the use of the three-tier model. Barnes and Harlacher [6] describe a typical implementation of the three-tier RTI system, which includes 60 minutes of core instruction for all students (Tier 1), 30 minutes of supplemental instruction for those students requiring additional interventions (Tier 2), and additional specialized instruction for those requiring maximum additional support (Tier 3). Therefore, as a student changes tiers (Tier 1 to 2 or Tier 2 to 3), the interventions' intensity increases. This intensity is measured using several factors, including physical features of the intervention (duration, session frequency, and length) and the student-to-teacher ratio. As the student-to-teacher ratio decreases in size, interventions become more intense [8].

Though most illustrations and descriptions of multitiered systems depict a triangle or pyramid as three or more distinct levels, other models have been presented. One such visualization depicts the RTI model in a series of interconnected circles in order to emphasize the relationship and overlap of each targeted intervention. In either depiction, a pyramid or a circle, an effective three-tier model must provide instructional programming in a dynamic and fluent manner across all three levels [9].

Although the number of tiers and what interventions are provided at each tier may differ between different models, they all implement the general concepts of RTI by providing levels of increasingly intensive instruction and interventions with the same end goal: promoting positive academic outcomes. According to these models, approximately 80–90% of the students will be successful with just high-quality general education instruction, while 15–20% will need some form of targeted supplemental instruction. Only 1–5% will require intensive interventions [9].

5.1. Tier 1

In Tier 1, general education teachers rely on the core curriculum and provide students with evidence-based, high-quality instruction. Students are regularly assessed using a variety of methods, including Curriculum-Based Measurements (CBM) to ensure that the students are responding to the instruction. Students who may need additional support are identified in Tier 1 and provided with alternate methods of instruction or interventions within the classroom setting [4]. As shown in **Figure 1**, Tier 1 instruction meets the needs of about 80% of the students within the general education setting; however, approximately 20% of the students do not reach grade-level standards within the core program under Tier 1. Therefore, additional instruction and intervention should be implemented [5]. The expected outcome for Tier 1 is for students to receive quality instruction and achieve expected academic and behavioral goals within the general education setting [9]. If the expected outcome is not attained, Tier 2 instruction and interventions are implemented.

5.2. Tier 2

When a student does not respond to additional instruction and intervention within the general education classroom in Tier 1, Tier 2 interventions are implemented. Thus, the intensity of interventions is increased (**Figure 1**). Tier 2 interventions can be provided within the school day, such as support from a reading specialist or through a specific research-validated intervention. Tier 2 interventions could also occur after school, such as tutoring [10]. In addition, the supplemental instruction is targeted to the specific areas of need and directly compliments the core instruction [9]. These interventions may require small-group instruction (four to five students) or one-to-one tutoring and more regular (biweekly) progress monitoring. Often taking 20 minutes per day to implement, Tier 2 interventions are implemented for up to 20 weeks. Students can exit Tier 2 services, if they meet grade-level benchmarks. Some students may continue for the full 20 weeks in order to make sufficient progress [5]. The documentation of a student's responses is critical within Tier 2 interventions. The data collected can be used to determine whether a more formal special education assessment is necessary [6].

The expected outcome of Tier 2 is for students to receive more targeted instruction after not meeting general class expectations and exhibiting the need for supplemental support. Targeted Tier 2 instruction can take place within the general education classroom or in other settings in the school, such as pullout situations. Students' instruction and interventions should be modified and differentiated while providing more specialized equipment and technology, as needed, to target each individual student's instructional needs. Students who make insufficient progress in Tier 2 then are considered for Tier 3, intensive intervention. There should be evidence-based documentation and evaluation to support evidence of insufficient progress [9].

5.3. Tier 3

If a student does not make acceptable progress within provided supplemental instruction and intervention within Tier 2, they can then be referred to Tier 3. Tier 3 includes more intense, specifically designed instruction and/or special education services [4]. Tier 3 is a high-quality, intensive intervention that includes interventions that are individualized to meet significant needs, including various disabilities. About 2–5% of the students who did not respond as expected to Tier 1 and Tier 2 interventions are provided more intensive interventions within Tier 3. The length of time required to implement Tier 3 interventions will often replace some portion of the core curriculum, at least temporarily. Depending on the district or school policy and decision-making process, Tier 3 interventions may or may not include special education services (**Figure 1**). Through continued progress monitoring of the documentation of interventions and further evaluation, often students within Tier 3 will be referred to special education and may qualify for special education services [5]. However, to assume that Tier 3 is only for special education is a myth. In RTI, it is expected that students with learning disabilities of all kinds are represented in all tiers of intervention, including students who are not classified as special education students. This expectation depends on universal screening of the particular skill domain, behavior, and outcome of interest [3]. The expected outcome for Tier 3 is to provide students who have more significant needs with intensive, evidence-based interventions within a range of educational settings [9].

6. Progress monitoring

A key component to successful RTI implementation is a formal and organized assessment system. This component is crucial in the decision-making process when determining what tier to place students. Assessment, progress monitoring, and instruction are intricately tied together within the RTI model. Students are usually placed into their initial tier through the results of benchmark assessments, though teacher observations can be considered as well. Once students are placed in their appropriate tiers, they are progress monitored to track how well they are responding to their current instruction. If the student is not progressing at the expected rate, a change in instruction, interventions, or possibly their tier needs to be considered [11]. Ongoing progress monitoring serves two purposes: (a) the data collected is used to make decisions about instruction, interventions, and placement within tiers by evaluating the students' strengths and needs, and (b) continual progress monitoring determines whether the student is

responding to the intervention. The data collected from continual progress monitoring aids in the decision-making process whether a student needs to continue receiving intensive intervention services with Tier 2 or Tier 3 or can be exited from the tier they are currently placed [5].

It is important that students are assessed and monitored frequently and continually, in order for schools to identify and respond quickly when students are not meeting academic standards or the aligned goals for intervention [6]. With RTI, decisions regarding progress are more high stakes and less self-correcting. Failure to progress monitor and respond to students that are not meeting the targeted goals can potentially cause them to be referred for special education services, resulting in a special education label and placement. With that, a more intensive intervention is implemented and often comes with well-known special education side effects such as reduced time with nondisabled peers, stigmatization, and so forth [7].

For all students in Tier 1, benchmark assessments should be taken three to four times per year. Often, schools throughout the United States of America follow a fall, winter, and spring benchmark time frame. RTI models differ on recommended frequency of progress monitoring within each tier. Most often, it is suggested for students in Tier 3 to be monitored weekly. Some models suggest two to four times per month, which on the high end of the suggested times equates to weekly monitoring. Suggestions for Tier 2 include twice a month and one to two times per month. When choosing a progress monitoring schedule, consider the possibility of a student in Tier 2 or Tier 3 being referred for special education services. It is encouraged to have a minimum of six to eight data points that show a student's lack of response to interventions and/or instruction and need for more intensive interventions. Although schools throughout the United States of America may use different assessment systems, procedures, and progress monitoring time lines, the two purposes of RTI are met by using data from formative assessments (i.e., ongoing assessment used to monitor student progress while the instruction is occurring) in order to guide the decision-making process about instructional placements and decisions [6].

7. Benefits of response to intervention

The RTI framework as a whole is beneficial in that it evaluates the external factors that may be impacting a student's progress before determining if the struggling student has an intrinsic learning deficit or disability. Further, the RTI framework evaluates instruction and interventions, discourages giving up or labeling a child after just one intervention, and encourages schools and educators to use creative strategies to meet individual student needs while moving toward more intense interventions, as needed [4]. Though there are many benefits of RTI, this chapter will focus on three primary benefits of the framework: (a) reduction of inappropriate special education referrals, (b) student benefits, and (c) benefits to schools and teachers.

7.1. Reduction of inappropriate special education referrals

The number of students who are referred and who qualify for special education services is reduced when RTI is implemented effectively, as found in several studies [5]. If effective interventions are implemented within Tier 1 and Tier 2, inappropriate special education referrals

and the need for extensive Tier 3 instruction are reduced [6]. Numerous studies have shown the utility of RTI programs. One study showed consistent decreases in special education placements. In particular, that study showed a 39% decrease in special education placements in kindergarten, a 32% decrease in special education placements in the first grade, a 21% decrease in special education placements in the second grade, and a 19% decrease in special education placements in the third grade. Another study reported that engagement in Tier 1 interventions reduced the percentage of students going to special education by 12%. Participation in all three tiers reduced the rate of students placed in special education by 8% [12]. Because RTI helps ensure that all students receive quality instruction and proper supports, it lessens the likelihood that a student will be misdiagnosed with a disability and placed in special education [4].

7.2. Student benefits

One study on the barriers and benefits of RTI sought feedback from special education teachers about the benefits that students experience from RTI [13]. A majority of responses from the surveyed teachers showed that students were receiving better instruction that more quickly identified and addressed problems so that students did not fall further behind waiting for necessary assistance. Other responses indicated that teachers found the RTI process to help correctly identify students with learning disabilities during the special education referral process so that students without special needs are not improperly shuffled into special education programs. However, the study noted that many teachers found the benefits of RTI to extend beyond special education programming, for teachers noted that the one-to-one intervention strategies of RTI assisted students across the learning spectrum [13].

7.3. Benefits to schools and teachers

RTI has also been found to lead to other benefits for schools and teachers, including better data collection on student growth and achievement [13]. Furthermore, teachers have disclosed that the individualized nature of RTI has helped general education teachers and educational teams more precisely and accurately identify individual skill areas or behaviors in which a student is struggling. Finally, many educators have noted that RTI has increased collaboration between teachers and parents [13].

8. Speech pathology and RTI

The American Speech-Language-Hearing Association (ASHA) defines RTI as an increasingly intense, multitiered system to providing services and interventions to struggling students and encourages speech-language pathologists (SLPs) to assist in identification. As mentioned before, this approach incorporates increasingly intensive levels of intervention, meeting the student where they currently are, in terms of academic success. Universal speech screenings, frequent progress monitoring, high-quality and evidence-based interventions, and response data are the core foundations of RTI that are utilized, in an attempt to identify students early and provide them with the support to be successful.

8.1. Identifying students at risk

Speech-language pathologists play a vital role in identification of students with needs, both those with speech-language impairments and those students presenting with specific learning disabilities. Prior to the introduction of RTI, students were found eligible for special education services based on discrepancies between performances on standardized tests and performance in the classroom. In hearings related to the reauthorization of IDEA, the US Congress found that using these measures was insufficient to identify learning disabilities, as the IQ-achievement discrepancy formulas that had previously been utilized cannot be applied in a reliable and valid manner. In addition, students living in poverty or students from culturally and linguistically diverse backgrounds may be mistakenly viewed as having intrinsic intellectual limitations, although their differences on such tests are really reflective of a lack of experience or educational opportunity.

With RTI in place, students are able to access these services based on their personal performance or response to increasingly intense interventions provided to them in their area of deficit. Speech-language pathologists can be integral to successful RTI initiatives in a school [14]. In Tier 1, they should be providing consultation services regarding possible disorders and impairments within their scope of practice and dissemination of information regarding speech-language disabilities and how they interplay with curriculum, assessment, and instruction.

8.2. SLPs and their role in the school

According to ASHA, there are many ways in which speech-language pathologists can make unique contributions to RTI in their school. They can explain the role that language plays in curriculum, assessment, and instruction, as a basis for appropriate program design, as well as explain the interconnection between spoken and written language. They can identify and analyze existing literature on scientifically based literacy assessment and intervention approaches and make recommendations on their implementation in the school. Speech-language pathologists can also assist in the selection of screening measures and plan for and conduct professional development on the language basis of literacy and learning [15].

Trainings that include information regarding typical articulation/phonological errors and the ages when they should no longer occur could be appropriate trainings for a school-based speech-language pathologist to provide to his/her colleagues. By informing classroom teachers of these developmental norms, it is likely that more students will be properly identified through screenings and assessments and that interventions will be implemented for the students who need it most. Furthermore, evidence supports the use of dynamic assessment for reducing overidentification and identifying students for small-group language intervention [16].

Speech-language pathologists should be presenting information on a variety of speech-language disorders including but not limited to language impairments, speech disorders, phonological impairments, dysfluency (stuttering), and voice production problems/vocal abuse. Another important component of Tier 1 is the instructional information that speech-language pathologists can provide to their colleagues including special education teachers, teachers,

and other support staff in the school, who may be making referrals [17]. Providing other professionals with strategies to address general speech-language difficulties can increase the effectiveness of general teaching procedures and assist all students in the classroom.

8.3. SLP implementation of RTI

Many techniques can be implemented quickly in the classroom and can support improved student performance. For example, students demonstrating difficulty learning-related vocabulary may benefit from direct and explicit strategies, such as teaching the vocabulary in context, using word webs, pre-teaching key words and concepts, and using visuals (gestures/pictures) to teach meaning. Other strategies that are effective across subjects and grade levels include stating the objectives; providing direct instructions; utilizing multiple modalities; engaging students in group activities; using feedback, reinforcement, and recognition; highlighting similarities and differences; and utilizing advanced visual organizers [18].

8.4. SLPs and Tier 1

As previously mentioned, RTI also provides schools with an opportunity to take preventative steps by providing evidence-based practices to groups of students that are at risk. Reading is a fundamental skill for academic success, and it is closely linked to phonemic awareness. Phonemic awareness is the ability to understand that words are composed of individual sounds (phonemes) and manipulate those sounds, sound sequences, and sound structures in a syllable or word. It may be difficult to develop for many groups of students, including those with phonological impairment, speech impairment, students learning English as a second language and those from low-income households [19]. Strong phonemic awareness has been found to be a predictor for reading skills, and in its absence, students will struggle with reading [20]. The curriculum for upper grades relies heavily on independent reading skills, and students who have struggled to build a solid foundation in the early grades will begin to demonstrate difficulties in all academic areas based on their reading difficulties. Speech-language pathologists can assist by providing classroom teachers with evidence-based strategies for teaching phonemic awareness. For example, students struggling with literacy skills have been found to benefit from structured teaching activities such as name writing, alphabet recognition, and phonological awareness activities. If incorporating these supports into the curriculum class-wide does not prove to be intense enough, and the student continues to perform below curriculum-based measures and/or benchmarks, he/she will be referred for Tier 2 of RTI to be provided with need-based learning in intensive small groups.

8.5. SLPs and Tier 2

Tier 2 intervention typically is provided in collaboration with the general education teachers. It usually consists of small groups of students being provided with high-quality, but specific and explicit, short-term instruction in the area of difficulty. This Tier is the most important in terms of using clinical expertise and data from performance during Tier 1 to identify students that need these groups. Dynamic assessment can take place over a relatively brief period, and his/her response to intervention can be an indicator of their ability to progress academically throughout the school year [21].

Intervention at this stage will vary greatly depending on the nature of the difficulty that the student is having. For example, if the student is struggling in the area of articulation (the actual production of sounds based on place, manner, and voicing) and is stopping his/her /s/ sounds (replacing the /s/ sound with a sound like /d/ or /t/), the speech-language pathologist may provide the classroom teacher and parents with specific strategies for practicing and producing the correct /s/ sound. Articulation strategies can include word lists with the target sound, modeling, and descriptive instruction for production and embedding "traditional" articulation therapy techniques, such as sound discrimination and correcting productions until the sound can be produced in all contexts and speaking situations [22]. If progress is not made and/or the misarticulated sounds further impact the student's academic and/or social/emotional functioning in the classroom, a referral to Tier 3 may be warranted.

Students experiencing dysfluencies (stuttering) may also require Tier 2 if their dysfluency is impacting their academic progress or their social/emotional functioning in the classroom, but it is unclear whether there is an obvious disorder. The speech-language pathologist should identify one to three possible strategies that the classroom teacher can implement such as modeling, providing think-time (for the student before providing a verbal response), refraining from interrupting [23], and decreasing stress in the classroom. If dysfluent behaviors become pervasive across environments, the student may need to be referred to Tier 3 and/or require therapy provided by a speech-language pathologist with expertise in treating stuttering [24].

Speech-language pathologists may also receive referrals to Tier 2 for students experiencing voice difficulties, such as hoarse voice, problems with nasality, or decreased volume. Recommendations for the classroom may include reviewing good vocal hygiene such as the importance of hydration and appropriate volume/loudness but may also implement self-monitoring strategies for the student, such as charting appropriate vocal productions throughout the school day.

8.6. SLPs and Tier 3

Tier 3 provides the most support prior to a referral to special education. Where oftentimes the small groups in Tier 2 may meet two times a week for 30 minutes, the students identified as needing Tier 3 may receive up to double the amount of time previously allotted in Tier 2. Tier 3 instruction is characterized by more explicit, individualized, and systematic instruction to support students' speech-language skills in addition to indirect activities that may include helping to select research-based interventions, completing student observations, assisting with frequent progress monitoring, and helping the team make decisions regarding referral for special education evaluation.

Speech-language pathologists may need to complete a detailed and individualized language/literacy battery of formal, informal, and curriculum-based assessments, including assessment of receptive and expressive vocabulary and language, articulation, phonology, pragmatics, reading, and written language, as well as the speech components of voice, fluency, and resonance. Interpretation of these assessment results will further assist in determining if the student has special education needs, and if indicated, the basis for the Individualized Education Plan (IEP) goals [25].

Many school-based speech-language pathologists often have heavy caseloads, overflowing with mandated individual and group sessions and making the task of being involved in RTI a seemingly impossible one, but as an integral part of the multidisciplinary educational team, their therapeutic interventions are critical to student success. Prevention of speech, language, and communication disorders is one of the key roles and responsibilities of school-based speech-language pathologists and as such can complement and augment RTI services..

9. Conclusion

In summary, RTI has changed the way educators and clinicians identify and support students who may be experiencing difficulty, in an educational setting. The intention of intervening early on with a treatment-oriented diagnosis process is to prevent students from falling too far behind their peers, requiring special education services. The reauthorization of IDEA (04) has changed the landscape for educators and SLPs, alike. RTI is a multitiered approach that allows students to receive support at a level that is optimal and individualized for their specific learning needs or deficits. In Tier 1, students receive instruction within the general education setting [9]. In Tier 2, interventions can be provided from a specialist during the school day or from a tutor [4]. In Tier 3, intensive instruction and/or special education services are individualized to meet significant needs of a student [4]. **Figure 1** provides an illustration of RTI and an overview of each tier. The emphasis on evidence-based interventions, constant monitoring, and systematic support remains the primary focus of RTI methods.

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References

[1] Cortiella C, Horowitz S. The State of Learning Disabilities: Facts, Trends and Emerging Issues. 3rd ed. 2014. p. 2-45

[2] Howarth RA. Examining the Neurocognitive Profile of Dysnomia: A Comparison of School-aged Children with and without Dyslexia Across the Domains of Expressive Language, Attention/Memory, and Academic Achievement. Ann Arbor: The University of Iowa; 2010

[3] Coleman M, Roth F, West T. Roadmap to pre-K RTI: Applying Response to Intervention in Preschool Settings. National Center for Learning Disabilities. 2009;(1):2-24

[4] Samson JS. Evidence-based Reading Practices for Response to Intervention: A Practical Guide for Every Teacher. Harvard Educational Review. 2009 Spring;**79**(1):148-159

[5] Richards C, Pavri S, Golez F, Canges R, Murphy J. Response to Intervention: Building the Capacity of Teachers To Serve Students with Learning Difficulties. Issues in Teacher Education. 2007 Fall;**16**(2):55-64

[6] Barnes AC, Harlacher JE. Clearing the confusion: Response-to-intervention as a set of principles. Education & Treatment of Children. 2008 Aug;**31**(3):417-431

[7] Shinn MR. Identifying students at risk, monitoring performance, and determining eligibility within response to intervention: Research on educational need and benefit from academic intervention. School Psychology Review. 2007 Dec;**36**(4):601-617

[8] Legere EJ, Conca LM. Response to intervention by a child with a severe reading disability: A case study. Teaching Exceptional Children. 2010 Sep;**43**(1):32-39

[9] Hoover JJ, Patton JR. The role of special educators in a multitiered instructional system. Intervention in School and Clinic. 2008 Mar;**43**(4):195-202

[10] Morrison D, Hessler T. Teaching the teachers: Eliminating gaps to better serve children with dyslexia. Perspectives on Language and Literacy. 2016 Fall;**42**(4):7-8 13

[11] Gore N, Hastings R, Brady S. Early intervention for children with learning disabilities: Making use of what we know. Tizard Learning Disability Review. 2014;**19**(4):181

[12] Marston D. Tiers of intervention in responsiveness to intervention: Prevention outcomes and learning disabilities identification patterns. Journal of Learning Disabilities. 2005 Nov;**38**(6):539-544

[13] Werts MG, Carpenter ES, Fewell C. Barriers and benefits to response to intervention: Perceptions of special education teachers. Rural Special Education Quarterly. 2014 Summer;**33**(2):3-11

[14] Justice LM. Evidence-based practice, response to intervention, and the prevention of reading difficulties. Language, Speech, and Hearing Services in Schools. 2006;**34**:284-297

[15] Ehren B, Montgomery J, Rudebusch J, Whitmire K. Responsiveness to Intervention: New Roles for Speech-language pathologists [Internet]. 2017. Asha.org. Available from: http://www.asha.org/SLP/schools/prof-consult/NewRolesSLP/ [Accessed: April 7, 2017]

[16] Spencer T, Petersen D, Adams J. Tier 2 language intervention for diverse reschoolers: An early-stage randomized control group study following an analysis of response to intervention. American Journal of Speech-Language Pathology. 2015;**24**(4):619

[17] American Speech-Language-Hearing Association, ASHA. Response to Intervention (RTI) [Internet]; Available from: http://www.asha.org/slp/schools/prof-consult/RtoI/ [Accessed August 21, 2017]

[18] Special Education Guide. Response to Intervention Strategies | A Guide for Teachers [Internet]. Available from: http://www.specialeducationguide.com/pre-k-12/response-to-intervention/effective-rti-strategies-for-teachers/ [Accessed April 20, 2017]

[19] Koutsoftas A, Harmon M, Gray S. The effect of Tier 2 intervention for phonemic awareness in a response-to-intervention model in low-income preschool classrooms. Language Speech and Hearing Services in Schools. 2009;**40**(2):116

[20] Catts H, Fey M, Zhang X, Tomblin J. Estimating the risk of future reading difficulties in kindergarten children. Language Speech and Hearing Services in Schools. 2001;**32**(1):38

[21] Gottwald S, Reeves N. Response to intervention: How do fluency disorders fit in? Perspectives on Fluency and Fluency Disorders. 2011;**21**(1):6

[22] Van Riper C. Speech Correction. 1st ed. Englewood Cliffs, NJ: Prentice-Hall; 1978

[23] Kelly E, Conture E. Speaking rates, response time latencies, and interrupting behaviors of young stutterers, nonstutterers, and their mothers. Journal of Speech Language and Hearing Research. 1992;**35**(6):1256

[24] Petersen D, Allen M, Spencer T. Predicting reading difficulty in first grade using dynamic assessment of decoding in early kindergarten: A large-scale longitudinal study. Journal of Learning Disabilities. 2014;**49**(2):200-215

[25] Long E. Integrating dynamic assessment and response-to-intervention in reading instruction. The ASHA Leader. 2012;**17**(4):27-43

Section 3

Research in Learning Disabilities

Chapter 7

Developing Automaticity in Children with Learning Disabilities: A Functional Perspective Part One: Theory and Assessment

Charles Potter

Additional information is available at the end of the chapter

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Abstract

The current chapter is the first of two chapters in this book to describe an instructional programme based on Luria's theories, which can be used to develop basic skills and automaticity in reading, as well as basic skills and automaticity in writing and spelling. This chapter focuses on the theory behind the programme and then describes how assessment is used to develop an individual programme relating to both basic skill and fluency needs in reading, writing and spelling. The process is illustrated with one detailed case study, in which instructional needs identified in the assessment process are linked to particular areas of the programme. The results of this child and other case studies are then presented in the second chapter, *Developing Automaticity in Children with Learning Disabilities: A Functional Perspective. Part Two: Programme Methods and Materials*, in which the results of children exposed to the programme are analysed to identify key implementation variables affecting the development of reading, writing and spelling fluency.

Keywords: reading difficulties, dyslexia, reading fluency, writing and spelling fluency, automaticity, rate of work, analytical phonics, large print, repeated reading, visual tracking, sequential spelling

1. Introduction

This is the first of two linked chapters, both published in this book, which describes a framework for working to develop automaticity in reading, writing and spelling, based on the work of Luria [1–3]. In this chapter, Luria's theories are outlined in relation to the broader literature on automaticity. This is followed by a case study of a child (Child 1) with difficulties in automaticity in reading, writing and spelling, which outlines the procedures used for assessment and development of his individual programme.

In the second chapter, this child's results are then presented, together with the results of 13 other children with learning difficulties, with whom similar methods and materials have been applied. Six contrast case studies are also presented, where divergence in materials and methods has occurred. At the end of the second chapter, conclusions are drawn, and the reader is referred to a resource of low cost materials for developing automaticity in reading, writing and spelling, which is available for use by others. This is currently being used by a network of parents, therapists and teachers in Southern Africa, as well as more widely internationally.

The two chapters presented in this book are intended to be read together. The aim is to provide the reader with access to a resource, which is both theoretical and practical, based on the theory, assessment procedures, methods and materials used in implementing a fluency-based programme.

2. The development of functional systems in the brain

Based on the theories of Sechenov [4] and Pavlov [5], Luria [1] conceptualises higher mental processes as complex reflex activities, responsible for reflecting and working with the outside world. Following Vygotsky [6, 7], Luria suggests that these reflex processes are social in origin, mediate in structure and voluntary in mode of function [8].

In this dynamic view of neurological development and functioning, the natural reflexes of the child become radically organised as a result of the handling of objects. New motor patterns, for example, are formed so that the child's movements are able to match the properties of the objects with which he or she interacts. Similar principles apply in the development of human perception, which would be formed under the direct influence of the objective world of things, the majority of which have a social origin [9].

As the brain and the nervous system form the basis for human adaptation to the social and physical demands of the environment, the social and interactive conditions in human development would lead to the formation of highly complex systems of reflex connections. To be capable of reflecting, the external world requires the combined working of many receptors in the formation of new functional systems [10]. In this ongoing process of organisation and reorganisation, the development of higher mental functions would be based on the creation of new, intermediate structures of mental processes and the development of new interfunctional relationships directed towards the performance of new tasks, as well as the performance of previous tasks by new methods.

Luria suggests [1, 2] that the performance of increasingly complex tasks would require the development of increasingly complex mediate structures in the brain. A mediate structure would thus be a characteristic feature of all mental processes. Speech would also play a decisive role in the mediation of mental processes [11]. The higher mental functions would be based on mediate structures and would be neurolinguistic in character [3], as they would be both formed and mediated, with the intimate participation of speech.

Luria's theories have had direct influence into the literature on the neurological basis of speech, language and developmental learning disabilities, both directly through his writings and through the neurological principles he advocated [12–22]. Luria's theories have formed the basis for the development of assessment procedures such as the Luria-Nebraska Neuropsychological Battery [23, 24] and NEPSY [25] and have also had a strong influence on the Cognitive Assessment System developed by Das and Naglieri [26, 27], as well as into assessment procedures more generally [28–31].

While Luria did not refer to learning disabilities directly, others have seen the relevance of Luria's theories to procedures for diagnosis and remediation [27, 32–37]. Luria's work has influenced the work of a number of theorists and practitioners who approach learning disabilities from a neuropsychological standpoint (for example, see [38–45]), and his influence can also be traced into instructional approaches based on fluency and automaticity in language, reading, writing and spelling [46–61], such as the fluency-based programme described in this chapter.

3. Automaticity as a cognitive process

Luria [1] suggests that if the higher mental functions are complex, organised functional systems which are social in origin, any attempt to localise them in circumscribed areas of the brain would not be justifiable. Rather, the system of reflexes and connections underpinning the higher mental functions would be likely to have a wide, dynamic representation throughout the cerebral cortex. Developmentally, the involvement of speech connections as necessary components of the higher mental processes would make the cerebral organisation of higher mental functioning increasingly complex.

For this reason, Luria follows Pavlov [5] in suggesting that the higher mental functions would be accommodated in the brain in functional combination centres. These functional systems would not be ready-made at birth, but would be formed in the process of social contact as well as the activities undertaken by the child in his interactions with the external world. Increasingly complex connections and interactions between these functional systems would become necessary for the development of speech and language and the language processes involved in reading and writing.

Based on the theories of Leontiev [62–64] and Vygotsky [6, 7, 65], Luria [66] suggests that the development of higher mental functions takes place in stages. In the early stages, the higher mental functions would depend on the use of external evocative signs, within a pattern of a series of unfolding operations [67]. Only when the capacity to undertake operations at a basic level is complete would these operations gradually consolidate, enabling the whole process to be converted into a concise action, based initially on external and then on internal speech. The consolidation process would involve increasing automaticity, in which a complex cycle of unconnected acts would become a highly automatised skill.

4. Automaticity in reading

In terms of Luria's conceptualisation of the development of higher mental processes, the development of automaticity in reading would be essential for its use in the hierarchical processing of information by the working brain. Following Luria [68], automaticity would be developed in reading when there has been sufficient practice to enable this complex functional act to become fluent enough to form the basis for higher mental processing.

LaBerge and Samuels [46] were the first researchers to focus on automaticity in reading, conceptualising reading fluency as a function of information processing in reading. In their model, visual information would be transformed through a series of processing stages involving visual, phonological and episodic memory systems, until it was finally comprehended in the semantic system. LaBerge and Samuels further proposed that the processing occurring at each processing stage was learned, while the degree of learning could be assessed with respect to two criteria: *accuracy* and *automaticity*. At the accuracy level of performance, attention would be necessary for processing. At the automatic level, it would not.

Samuels [69] suggested that automaticity in reading could be trained through procedures involving repeated reading, commenting that repeated reading was not a method for teaching all reading skills, but should rather be used as supplemental to a developmental reading program. Samuels further suggested that while repeated reading was particularly suitable for students with learning problems, it was also useful for all children [69]

Support for LaBerge and Samuels' work was provided by Chomsky [70] at Harvard University. Chomsky concluded that the repeated reading procedure she had used with students had been facilitating for both slow and halting readers, "increasing fluency rapidly and with apparent ease." Other researchers such as Carbo [71], Morgan and Lyon [72] and Ashby-Davis [73] also conducted studies using different repeated reading methods to model and develop automaticity through repetition. Each of these studies focused on the development of reading fluency, which Allington [74] pointed out was a characteristic of poor readers, but was seldom treated.

The notions of reading fluency and automaticity have then recurred in subsequent literature. Adams [75], for example, suggested that the most salient characteristic of skilful reading was the speed with which text was reproduced into spoken language, whereas Ehri and McCormick [76] suggested that automaticity in word reading developed in phases, with each phase being characterised by children's working knowledge of the alphabetic system.

On the applied level, repeated reading was implemented over the 1980s and 1990s in a variety of ways and was shown to be effective in developing reading fluency in a number of contexts, being successfully implemented by teachers [77–79], parents [79, 80], as well as peer tutors [81–85]. Repeated reading was successfully conducted by parents at home [80], in schools and classrooms [83, 86], as well as in sessional programmes [87, 88]. The evidence from these various types of implementation was positive, effects were often rapidly obtained and variations in implementation procedures often produced similar positive effects (for example, see [77, 78, 85, 89–94]).

Based on review and meta-analysis of the literature, the National Reading Panel [95] concluded that there was:

"a persuasive case that repeated reading and other procedures that have students reading passages orally multiple times while receiving guidance or feedback from peers, parents or teachers are effective in improving a variety of reading skills. It is also clear that these procedures are not particularly difficult to use or do they require lots of special equipment or materials, although it is uncertain how widely used they are at this time. These procedures help improve students' reading ability, at least through Grade 5, and they help improve the reading of students with learning problems much later than this." [96].

Based on these indications, the U.S. Congress [97] supported the inclusion of fluency as an important component of reading ability, defining the essential components of reading instruction as involving explicit and systematic instruction in:[1]

- Phonemic awareness
- Phonics
- Vocabulary development
- Reading fluency, including oral reading skills
- Reading comprehension strategies.

The literature indicates that these components are stage-related and linked [99]. There is convergent evidence that phonological awareness, phonemic awareness and phonic skills are associated with learning to read [100–104]. Fluency is associated with the development of both oral reading ability and comprehension [84, 105, 106]. Fuchs et al. [107] have defined oral reading fluency as the oral translation of text with speed and accuracy. On the basis of the review of theoretical arguments and several studies substantiating this phenomenon, Fuchs et al. concluded that oral reading fluency is an indicator of overall reading competence and may also reflect overall reading competence.

Rasinski [108] has stressed that fluency needs to be an integral component of both assessment and reading instruction. Given evidence that reading fluency improves through a variety of different types of interventions involving teacher, parent or peer-tutored reading (for example, see [80, 89, 92–94]), both in children with learning disabilities [88, 109–112] and in children without learning disabilities [82, 87, 88], a major issue is whether reading fluency can be addressed solely through fluency-focused reading strategies (for example, see [79, 113]) or whether it also needs to be addressed through building connections between the processes involved in reading, writing and spelling, as well as focus on language and reading comprehension [99, 114, 115].

Wolf and Katzir-Cohen [116] have argued that there are a number of levels of subskills and components in reading fluency instruction, suggesting the need for curricular strategies for dealing with fluency-based issues. They also suggest that increased exploration of the subskills

[1]U.S. Congress. [98] (SEC. 1208. DEFINITIONS).

and components of, and issues surrounding, fluency and comprehension, will contribute to understanding of both reading development, and dyslexia subtypes. There would thus be justification on a theoretical level for incorporating assessment of oral reading fluency as one aspect of psychometric measurement of reading, together with other indicators of automaticity, (for example, see [117–120]).

At the same time, Moors and De Houwer [121] caution that there is wide usage of terms associated with automaticity as a concept, but no agreed definition as to what automaticity actually means. The author of this chapter follows Logan [50] in defining automaticity as relating to learned automatic processes, to which, following Luria [18, 19], fluency in speech and language, as well as fluency in reading, writing and spelling, would be related.

5. Automaticity in writing and spelling

Luria [67, 122] suggests that writing follows other mental processes in being a process which changes on a functional level through use and that changes on a functional level reflect greater functional integration in the brain. In the initial stages, writing depends on memorisation of the graphic form of each letter. With practice, the performance on each individual element becomes altered as writing develops into a single "kinetic melody," in which the structures underpinning the process of writing individual letters become automatised and integrated. Similar changes also take place in other higher mental processes to which the writing process is linked.

In the course of this development, it is not only the functional structure of the process which changes but also its cerebral organisation, as the activities of writing and spelling start to depend on different systems of concertedly working zones [123]. Following Vygotsky [7], this process of organisation would be based on new, intermediate structures of mental processes and new interfunctional relationships which would enable the performance of increasingly complex tasks by new methods. Automaticity would be central to the development of writing and spelling, as processes which enable their development into a single "kinetic melody" [67] capable of supporting the use of writing and spelling in higher mental activity.

Following Luria, assessment of writing and spelling would need to be linked to the assessment of reading ability. Luria [124] suggests that the investigation of writing should be conducted with a series of tests designed to analyse the state of the various elementary components and levels in writing. As writing is intimately connected with spelling, its assessment should also be linked to the investigation of phonetic analysis and synthesis of words and begin with the writing of individual letter, syllables and words. It should end with investigation of complex forms of written speech. In the course of these tests, the investigator would not only observe the quality of writing from dictation but also note the distinguishing features of the actual writing process.

On the level of instruction, Luria's theories would suggest that it would be important to develop both automaticity in reading and automaticity in writing and spelling, if these processes are not fluent. The work of the Spaldings [125–127] is based on the assumption

that both writing and reading are stage-related and linked and that the rapid recognition of phonograms forms the basis through which writing is linked to the development of reading ability. Frith [128] has also suggested that the processes relating to the development of reading and the development of writing and spelling are stage-related and linked, as the following diagram suggests.

The terms used in **Table 1** reflect Frith's contention that initially, pre-readers use logographic strategies, which involve the use of non-linguistic contextual cues, as well as the use of visual cues related to the whole shape of the word or to letter configurations within the word. This stage is primarily based on a visual route to learning, in that words are learned by rote memory through association of visual cues with the graphic representation of the word. The second alphabetic stage relies on a phonological route to learning which is more analytical. During this stage, both phonemes and graphemes become associated as children learn to sound out words [129].

Phonological processing then forms the basis for the establishment of an orthographic lexicon, in which alphabetic representations become precise enough to enable transfer from reading to spelling. The orthographic stage then develops after acquisition of phoneme-grapheme conversion knowledge, based on the application of phonological processing to spelling. At this stage, readers have learned to analyse words, and both letter groupings and word structure become important for increasingly fluid reading [129–131].

Frith suggests that there is initial dissociation between the strategies used in reading and writing in Stage 1 of each phase, whereas one and the same strategy is used in Stage 2 of each phase as children proceed from stage to stage in learning to read and spell [132]. Ehri [99] also suggests that spelling links closely with reading, but contends that beginning readers/spellers progress through phases of proficiency as opposed to stages. These phases are termed pre-alphabetic, partial alphabetic, full alphabetic and consolidated alphabetic and are related to the child's developing alphabetic and phonological knowledge. Ehri suggests that orthographic learning comes about through experience with printed language, in the process

Step	Reading		Writing
1a	Logographic		(Symbolic)
1b	Logographic		Logographic
2a	Logographic		Alphabetic
2b	Alphabetic		Alphabetic
3a	Orthographic		Alphabetic
3b	Orthographic		Orthographic

Note that Frith's model assumes interplay between the evolving processes of reading and writing, which develop through logographic, alphabetic and orthographic stages. The numbers in the table indicate different stages in reading and writing development, whereas the arrows indicate how different stages in reading and writing development are linked. The small letters a and b indicate how the processes of reading and writing evolve in the different stages, become synchronised and ultimately become fluent.

Table 1. The six-step model of skills in reading and writing acquisition [128].

of which longer and longer letter strings become stored in memory. Children in the final consolidated alphabetic phase are able to read fluently as well as spell accurately, by relying upon these stored orthographic representations.

Besides requiring integration between the processes of instruction used to develop reading, writing and spelling [133], it would also be important to conceptualise the development of fluency in writing and spelling as a long-term process. Both Frith [132, 134] and Ehri [133, 135] are in agreement that considerable practice at reading by means of an alphabetic procedure is necessary to enable the reader to establish internal representations of word forms, as the basis for developing the ability to spell accurately and fluently.

Kellogg [136] suggests that mastering the mechanics of writing forms the foundations for a 10-year process of achieving fluency in the acquisition of knowledge, as well as written and spoken production in the telling of knowledge. This would then be followed by a second decade post school to advance from knowledge-telling to knowledge-transforming. As Kellogg observes, this is similar to the process of development involved in becoming an outstanding performer in music, chess, typewriting and other domains, in which deliberate practice needs to continue for a minimum of a decade for an individual to acquire expert standing [137, 138].

6. Fluency-based materials and methods used in the author's practice

Given evidence of the importance of fluency in the development of reading, writing and spelling and the need to integrate instruction in both reading and spelling, the author has developed a set of fluency-based materials and methods for developing automaticity in reading, writing and spelling. These are based on Luria's [139] conception of the nervous system as a complex constellation of connections that in the performance of an adaptive task may be changed, whereas the task itself remains unchanged. They are also based on Schlaggar and McCandliss' [140] contention that neural networks are in a continual process of both functional and structural change during the development of fluency, Shaywitz and Shaywitz's [103] observation that neural malleability can be influenced by systematic and targeted remedial instruction and Perfetti and McCutchen's conception of reading and writing as both connected through the phonological basis of language, as well as schooled [141–145].

Following Luria [2, 3, 11], the author conceptualises the processes of reading, writing and spelling as hierarchical and linked, whereas the procedures used for developing automaticity in reading, writing and spelling are conceptualised as functional, activity-based and repetitive, based on teaching which is phonologically, visually and kinesthetically based. The materials used in the author's practice are phonically based, and the methods for using these are based on the suggestions made by Ehri [133] that the processes of teaching reading and spelling should be linked and closely articulated, using common knowledge sources and processes and that acquiring knowledge of the alphabetic system should lie within the province of teaching spelling.

The database of materials in the author's practice has been developed and added to over a 20-year period [146]. At this stage, it includes a phonically based large-print reading series, a foundation level series of readers with linked activity books, as well as manuals developed to enable the use of these materials by parents, teachers and therapists. Being phonically based, the materials can not only be used for developing reading fluency but can also be used for analysis, learning and testing of spelling and sequential spelling, linked to indications from the literature [147–150] that spelling practice has been found to result in superior orthographic learning relative to print exposure through reading alone.

The reading fluency methods involve repetitive paired reading, involving a procedure through which paragraphs are divided into groups of three and then read by the child and a partner in varied order. This is done in 20-minute sessions which involve parents or reading partners in working the child four or five times a week. The writing and spelling fluency methods initially involve the use of the same phonically based, large-print material in activities involving copying, phonic analysis and learning words singly and in sequence. The procedures are then broadened to include more difficult graded material, which is used in activities involving handwriting, typing, analysis and revisualisation, as the basis for orthographic learning.

At the level of input, a five vowel and then a seven vowel phonic analysis procedure is introduced, which aims to make English orthography transparent to the child through activities involving colour coding.[2] The seven vowel analytical procedure is then applied repetitively in a cycle of activities involving copying, phonic analysis, use of working memory and coding of words learned into spoken, typed and written output.[3]

Target words are identified through analysis of the vowel situation within words [155], with the aim of making the alphabetic relationships between vowel sounds and letters evident. Once children have grasped and are proficient at the process involved in colour coding of vowels within phonically graded text, these phonic analysis skills are then applied in analysing more complex written material for reasons relating to the links between automaticity and semantics [156–160]. Text is used which the child has recently read and with which the child is familiar. Single words and then sequences of words are analysed, learned and tested through spelling of single words as well as dictation of sentences and paragraphs. In the process, focus is placed on developing working memory for words and sequences of words [99, 133, 152, 161–163] as well as underlying sequentialisation abilities,[4] through linking spoken to written output [166–169].

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[2]Based on indications from the literature that fundamental linguistic differences in syllabic complexity and orthographic depth affect reading [151] and that orthographic learning varies in young children relative to the transparency of the particular written language involved [152].

[3]Emphasis on use of both handwriting and typing in the process of learning spelling and sequential spelling would follow indications from Ouellette and Tims [153] of different types of interactions between handwriting skills, typing skills, practice and success in learning new words. Both writing and typing are used in the learning phase, whereas writing is used in the testing phase, following indications from Ouellette and Tims [153] as well as Cunningham and Stanovich [154].

[4]Based on indications from two longitudinal case studies involving children with severe learning disabilities [164, 165]. Both children had difficulties with coding, as indicated by low scores on the coding subtest of the WISC-R. Coding abilities in both children improved after work on writing and spelling fluency using the Seven Vowel Analysis System and the Targeted Revisualisation and Sequential Spelling Programme.

As with the repetitive methods used for developing fluency in reading, the procedures used by the author for developing automaticity in writing and spelling are based on Luria's assumption [2, 3, 11] that language mediates reading, writing and spelling and that repetition and practice increases automaticity at each level of input and integration and fluency at each level of output. The methods used in the author's practice are multisensory, repetitive and integrative, following Nicolson and Fawcett's [118] and Nicolson's [170] contention that automaticity can relate to a variety of different reading, writing and spelling skills and that therapeutic techniques need to be capable of addressing a variety of areas of deficit in children with reading, writing and spelling difficulties.[5]

It is important to stress that these types of fluency-based activities are not undertaken in isolation, but as an integral part of an individual programme directed at a range of difficulties identified through assessment. How this is done will be outlined in the following sections.

7. Assessment of reading, writing and spelling difficulties in the author's practice

Country contexts differ. Much of the literature reviewed has been based on work with North American children and to lesser extent British children. This chapter focuses on the fluency processes applying to children in South Africa, and for this reason this section focuses on the format used to assess reading, writing and spelling in the author's practice, which is based in the northern suburbs of Johannesburg.[6] This reflects similar procedures used by other educational psychologists in South Africa to provide evidence which can be used not only for diagnostic purposes against what are termed the ICD DSM IV criteria by South African medical

[5]As indicated by the range of deficits found empirically in children with reading difficulties. These would not only indicate associated language-based and phonological deficits as proposed by Snowling et al. [171], Snowling [172], Stanovich [173, 174] and Vellutino [175, 176], but also a range of additional deficits as indicated by Rudel [177], Eden and Zeffiro [178], Wolf and Bowers [179], Nicolson and Fawcett [118, 119, 180–182], Nicolson et al. [183], Tallal et al. [184, 185], Stein and Walsh [186], Swan and Goswami [187], Stein [188], Nicolson et al. [189], Goswami et al. [190], Facoetti et al. [191], Bosse et al. [192] and Nicolson et al. [193].

[6]Affluence of parents may have affected the results of the sample of children referred to in this chapter. Parents in the northern suburbs of Johannesburg have traditionally been from higher socio-economic brackets than parents in other residential areas, or the reason that as the city evolved, the eastern, western and southern suburbs were closer to the dust, pollution as well as the physical danger of underground blasting in the gold mines. As commercial gold mining has been phased out as the underlying gold-bearing reef has been exhausted, wealth distinctions affecting residential areas have become more blurred. The majority of the children in the author's practice come from affluent households in a wide catchment area, with many parents traveling from the eastern, southern and western suburbs, and some parents travelling as much as 600 km from out of town on a weekend to bring their children for assessment or for educational therapy sessions. Similarly the referral and schooling network in the practice covers a wide geographical area. This is possible with the advent of email and cellphones, and this has been enabled by the fact that our reading, writing and spelling fluency materials and manuals are electronic and can be delivered by email.

aid societies,[7] but also as background for the development of programmes which can be used for working with children with deficits on a functional level.

Four screening tests are used at the outset of the assessment process in the author's practice. These are designed to yield information about reading single words and reading words in sequence and writing and spelling single words and words in sequence. The results on these tests are then reported using reading, spelling and dictation ages, for the reason that the South African ICD DSM IV criteria are based on age-related expectancies, which are then used by the medical aid societies for the management of claims and benefits.[8]

Besides following the guidelines of the DSM IV criteria in focusing on basic skills in reading and written expression and in reporting age levels for test results, the assessment procedures followed in the author's practice are also based on the procedures suggested by Luria [1] for clinical assessment of reading and writing. Qualitative analysis of an initial interview is combined with analysis of drawings, pragmatic writing-based tasks and observation in an initial ice-breaking session with the child, followed by a second initial session with the child during which the four screening tests are used to establish levels of basic skills in reading, writing and spelling. This information is then combined with additional evidence from a biographical inventory, parental interview and more formal psychometric testing.

The author also follows Luria's suggestion [201] that assessment should start with a preliminary conversation and then include a careful history, detailed observation of behaviour,

[7]The ICD-10 (International Statistical Classification of Diseases and Related Health Problems – 10th Revision) is a diagnostic coding standard owned and maintained by the World Health Organisation (WHO) [194]. The coding standard has been adopted by the National Health Information System of South Africa (NHISSA) and forms part of the health information strategy of the South African National Department of Health (NDoH). The standard serves as the diagnostic coding standard of choice in both the public and private healthcare sectors in South Africa for morbidity coding under Regulation 5(f) of the Medical Schemes Act 131 of 1998 [195, 196].
In psychology in South Africa, due to the similarity between the DSM IV and ICD classification systems, the DSM IV criteria have been used since August 2005 for the purpose of deriving ICD-10 codes by all psychology healthcare providers except pharmacists, clinical support and allied healthcare providers. The mandatory submission of ICD-10 codes by these groups was postponed until 1 January 2006. With effect from this date, the criteria have been referred to as the ICD DSM IV criteria, and ICD-10 coding using these criteria has been mandatory for all psychology health providers (including pharmacists and clinical support and allied healthcare providers) under government regulation in South Africa.

[8]There have been differences between the ICD and the DSM criteria historically, for the reason that the ICD is produced by a global health agency (The World Health Organisation) with a constitutional public health mission, while the DSM is produced by a national professional association (The American Psychiatric Association). Since 2005, South African medical aid societies have used both sets of criteria interchangeably in providing benefits for psychological work, for the reason that while the DSM and ICD have over time become very similar, due to collaboration between the two organizations. The coding system utilized by the DSM-IV [197] is designed to correspond with codes from the International Classification of Diseases, Ninth Revision, Clinical Modification, commonly referred to as the ICD-9-CM [198]. The coding system for the later revised DSM-IV TR [199] is designed to correspond with codes from the International Classification of Diseases, Tenth Revision, commonly referred to as ICD-10 [194]. Government regulation has been based on a national task team set up in South Africa involving representatives of the medical aid societies and of the Department of Health [200]. Based on the recommendations of the national task team, what are termed the ICD DSM-IV criteria have been adopted by all medical aid societies to cover the services provided by psychologists and other allied health workers registered with the South African Board of Healthcare Providers. This board, in turn, provides practice numbers to South African psychology and allied healthcare providers registered with the Health Professions Council of South Africa.

analysis of neurological symptoms and a series of additional objective tests. Luria suggests that the examination needs to be relatively short and involves methods of experimental psychological investigation applied to clinical practice.

The methods of examination used in the initial sessions spent working with the child also include pragmatic assessment of repetitive and spontaneous speech, writing, reading, comprehension of texts and the solution of problems, in order to establish how reading, writing and spelling are used by the child as a functional system. This informal evidence is then combined with more formal testing of reading, writing and spelling skills and interpreted, as Luria suggests, against a framework of knowledge of the types of difficulties normally associated with the functional system under investigation, based on current literature (for example [104, 170]).

Assessment leads to a functional description of deficits sufficient for diagnosis of learning disability to meet medical aid requirements,[9] as opposed to an attempt to link this to possible labelling of the child as dyslexic. The standpoint adopted by the author would accord with the suggestions made by Elliott and Grigorenko [204] and Elliott [205], namely that adding a label adds little of clarity to a functional description of deficits in reading, writing and spelling for purposes of intervention. Similarly, the pattern of scores on subtests of an IQ test is used functionally to indicate areas of cognitive and language strength and weakness, as well as areas in sequencing and working memory which may need to be worked with in therapy.

8. From assessment to statement of areas of deficit

The majority of children referred into the author's practice have had developmental difficulties at school, manifesting in problems with language, reading, writing and spelling, as well as associated difficulties with focus, attention and working memory. A number of the children have had previous assessments or have been referred by either their teachers or medical professionals. These difficulties form the focus of discussion in the preliminary interview with the child's parents, as well as preliminary conversation conducted during an initial session with the child.

Following Luria [1], the aim is to move from assessment to statement of areas of deficit and from this to specific suggestions for programmatic intervention. During the initial session with the child, evidence is collected on how the child uses a pencil for drawing and copying, how the child uses language in conversation and in writing and how the child works with integrated picture-based tasks involving comprehension and interpretation. Evidence collected during the second initial session includes indicators of one word reading ability, sentence reading ability, one word spelling ability and sequential spelling ability as tapped by two short tests of dictation.

Besides assessment of basic skills in reading, writing and spelling, the evidence collected in the two initial sessions also enables assessment to be made concerning handedness, eye movements and visual tracking, as well as the potential influences of focus, attention and fatigue on rate of work. This evidence is then interpreted against a framework of additional

[9]At time of writing, the ICD DSM IV criteria are being phased out by South African medical aid societies and replaced by the ICD DSM V criteria. This may affect the codings used in the author's practice [202, 203] in the future, but has not affected the codings used with the children whose results are reported in this and the next chapter.

evidence from a biographical questionnaire completed by the parents, analysis of the child's school books, a reading fluency rating form completed with parents and evidence from previous assessments conducted with the child.

The aim of the initial sessions is thus to develop a preliminary base of observational and test data, which can then be used as a basis for a diagnosis for medical aid purposes, recommendations concerning the need for additional more in-depth testing (e.g. cognitive testing, speech and language and/or visual assessment, more in-depth analysis of phonological and phonic skills) or for more in-depth neurological or paediatric investigation,[10] as well as to recommend specific types of programmatic activities which can be used to address the areas of deficit.

Being based on the DSM IV criteria,[11] the diagnosis then enables parents to be able to claim benefits from their medical aid societies. At the same time, the recommendations then enable work to commence on more in-depth testing in areas where there is evidence of language deficits, reading and writing skills deficits or evidence concerning lack of automaticity in reading, writing and spelling.

9. Development of a programme directed at areas of language weakness, basic skills deficits and areas of lack of automaticity

It will be evident from the above that the conceptual framework suggested by Luria [206] not only underpins the functional nature of the assessment process used in the author's practice but also guides how indications from assessment are operationalised into specific activities to address areas of language weakness, areas of basic skill deficit as well as areas in which automaticity still needs to develop. How a child's needs are related to different areas and components within a programme of intervention will be evident from the following case study.

9.1. Child 1: A Grade 3 child in a South African Government School

9.1.1. Problems highlighted in initial interview (February 2014)

Auditory processing difficulties.

Delayed milestones affecting speech and walking.

Has had occupational therapy.

Phonological weaknesses.

[10]The author has worked with children under the care of a number of paediatricians and neurologists, but particularly closely with Dr W.G. Maxwell, neurologist, of Sandton Clinic. The stabilisation of focus and attentional difficulties as well as attendant attentional lapses and symptoms of cortical irritability has been an essential feature of the fluency-based interventions provided in the author's practice. Behavioural, emotional, parental as well as chemical interventions are likely to have contributed to the gains made by the children whose results are reported in this chapter.

[11]The DSM V criteria were published in May 2013, with both ICD-9-CM and ICD-10-CM codes assigned to each of the DSM V diagnoses. South African medical aids have continued to use DSM IV criteria up to this point in time. At time of writing, the shift to use of the DSM V criteria is in process of taking place. All children referred to in this and the next chapter were assessed against the ICD DSM IV criteria [194, 199].

b/d Reversals; n/m confusion.

High anxiety levels.

Familial difficulty (dad also had learning difficulties as child).

9.1.2. Strengths highlighted in initial interview

Social abilities and friendships at school.

Good visualisation abilities.

Interest in lego and computers.

Spatially competent child.

9.1.3. Results from initial sessions of observation of performance on tests of basic skills combined with analysis of performance on pragmatic language tasks

The following tests were administered in the initial sessions with Child 1:

Buck's House Tree Person Test, the Bender Gestalt Test, the Peabody Picture-Language Vocabulary Test, the Schonell One Word Spelling Test, the Holborn Reading Scale, the Daniels and Diack Sentence Reading Test (as performance on the Holborn was low), the Schonell One Word Spelling Test and the Schonell Graded Dictation Tests (Tests A and B). The test-based evidence was supplemented by pragmatic language tasks involving (a) analysis of a spontaneous writing sample, (b) analysis of school books and (c) analysis and comprehension of a picture story.

Child 1 presented with one word reading difficulties, sentence reading difficulties, one word spelling difficulties, sequential spelling difficulties and problems with sound/letter associations indicating difficulties with phonics. There were a number of reversals in writing (b/d) as well as confusion of n/m. Observation indicated that Child 1 had attentional and focus difficulties and was very active. Emotional indicators were also present both in Child 1's drawings and in the Bender Gestalt test.

As there were a number of indicators of potential learning disability in the case history as well as in the evidence from the two initial sessions conducted with Child 1, a diagnosis of learning disability with attendant difficulties in reading, writing and spelling was made. As there was evidence of fluency-based difficulties affecting accuracy and rate of reading, as well as evidence of difficulties with rate and spelling of written work, recommendations were made for more in-depth testing to establish Child 1's cognitive profile, ongoing assessment by the family's neurologist,[12] as well as testing using the phonic inventories [207–209] to establish Child 1's pattern of phonic errors.

These results are reported below.

[12]Child 1 had symptoms of focus and attentional difficulties due to immaturity in the myelinisation process, as well as accompanying attentional lapses and cortical irritability. He was treated for each of these symptoms by Dr W.G. Maxwell, neurologist, of Sandton Clinic, who assessed Child 1 on a six monthly basis throughout the period the fluency-based intervention programme was implemented.

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10. Child 1's profile on the WISC IV (UK)

Child 1's performance on the different subtests of the WISC IV (UK) [210] is summarised in **Table 2**, which presents the profile of standard scores obtained in the verbal comprehension, perceptual reasoning, working memory and processing speed areas of the test.

Child 1's performance in all areas of the test was in the normal range. However, there was evidence of scatter in level of performance both within and across different areas of the test. The verbal comprehension profile indicated that Child 1 had well developed vocabulary, a good level of general knowledge and well developed verbal reasoning abilities, but had difficulties with verbal classification and comprehension. The high scores on the perceptual reasoning side of the test indicated well developed perceptual and spatial abilities, with weakness in non-verbal reasoning, whereas the scores on both the working memory and the processing speed areas of the test indicated good sequencing abilities.

As scatter is indicative of strengths and weaknesses in particular types of cognitive and language processing, this confirmed the diagnosis of learning disability. The indications were that Child 1 was a spatially competent child with particular strengths in sequencing and working memory, which could be used as the basis for interventions to improve his functioning in writing and spelling. The conclusion was that the tests of basic reading, writing and spelling skills already conducted fell well below would be expected in terms of age level as well as overall level of cognitive performance, enabling diagnosis of a reading disorder under DSM-IV code 315.00[13] and a disorder of written expression in terms of the diagnostic criteria for DSM-IV code 315.2.[14]

There were also emotional, as well as focus and attentional indicators in the profile. Child 1's attentional difficulties were corroborated by reports from his parents and also from school,

[13]In terms of ICD DSM IV diagnosis, assessment of reading difficulties would normally be conducted on Axis IV, which would aim to identify psychosocial stressors, as well as psychosocial and environmental problems affecting reading ability on a functional level. Reading difficulties would then be classified under reading disorders, corresponding to ICD-10 code F81.0 and DSM-IV code 315.00, as follows:

A. Reading achievement, as measured by individually administered standardized tests of reading accuracy or comprehension, is substantially below that expected given the person's chronological age, measured intelligence and age-appropriate education.

B. The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living that require reading skills.

C. If a sensory deficit is present, the reading difficulties are in excess of those usually associated with it.

If a general medical (e.g., neurological) condition or sensory deficit is present, Axis III on the ICD DSM IV would also be used for classification purposes. This axis aims to identify underlying medical or neurological conditions which may influence reading ability (e.g. attentional or concentration difficulties, especially those associated with cortical immaturity or slow myelinisation associated with poor connectivity) [199, 211, 212].

[14]The diagnostic criteria corresponding to ICD-10 code F81.2 and DSM-IV code 315.2 for diagnosis of a disorder of written expression are as follows:

A. Writing skills, as measured by individually administered standardized tests (or functional assessments of writing skills), are substantially below those expected given the person's chronological age, measured intelligence and ageappropriate education.

B. The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living that require the composition of written texts (e.g. writing grammatically correct sentences and organized paragraphs).

C. If a sensory deficit is present, the difficulties in writing skills are in excess of those usually associated with it. As with Code 315.00, if a general medical (e.g. neurological) condition or sensory deficit is present, the condition would then be coded on Axis III [213, 214].

Subtest	What subtest measures	Standard score	Subtest	What subtest measures	Standard score
Verbal comprehension			**Perceptual reasoning**		
Similarities	Verbal abstract reasoning and word finding ability	7	Block design	Abstract non-verbal reasoning, spatial perception and organisation	13
Vocabulary	Ability to explain the meaning of words	12	Picture concepts	Abstract ability to analyse and classify pictorial information	15
Comprehension	Social understanding and judgement	8	Matrix reasoning	Non-verbal abstract reasoning and concept formation	7
Information	Social information, general knowledge	11	Picture completion	Ability to analyse a picture to identify missing parts	16
Word reasoning	Word finding skills based on a list of verbal clues	15			
Working memory			**Processing speed**		
Digit span	Short-term auditory memory	10	Coding	Ability to work at speed in applying a simple code accurately and in sequence	10
Letter-number sequencing	Ability to manipulate letters and numbers sequentially by holding them in short-term and working memory	13	Symbol search	Ability to work at speed in establishing whether particular symbols are present or absent	13
Arithmetic	Ability to use auditory memory for numerical reasoning	6	Cancellation	Ability to work at speed in identifying relevant pictures	8

Note that in the above table, a standard score is a scaled score relative to a normal curve, where the average score would be a score of 10. Scores higher than 12 indicate above average performance relative to age level, indicating potential areas of cognitive strength. Scores lower than 8 indicate below average performance relative to age level, indicating potential areas of cognitive weakness. This type of profile interpretation needs to be conducted cautiously and substantiated against other information, as any scaled score is subject to measurement error.

Table 2. Profile of Child 1 on WISC IV (UK).

where Child 1's teacher had flagged his attentional difficulties in the classroom, and was indicating that he was likely to fail Grade 3. The emotional lability was confirmed by reports from Child 1's parents, which indicated that he was frustrated by his difficulties at school and was subject to mood swings as well as emotional outbursts at home.

11. Child 1's profile on the phonic inventories

Two of the three levels of the phonic inventories were administered, and error analysis was conducted. Child 1's profile indicated that short vowel sounds were established, but there were high error scores on:

- Ending consonant blends.
- Medial vowel digraphs.

Overall, Child 1's pattern of errors on the phonic inventories provided evidence of both phonological and phonic difficulties. A high incidence of errors on ending consonant blends on this instrument [208, 215–218] is associated with learning disabilities. Number of medial vowel digraph errors is also an indicator of learning disability both in primary school age children [219–221] and high school children [222].

The profile of errors on the instrument was thus used as corroborating evidence of the presence of a learning disability. The profile was also analysed to identify specific phonic errors and error types which could be targeted for instruction [223, 224].

12. Statement of areas of strength and weakness

Based on the indications from the case history and the instruments used in the assessment, more in-depth diagnosis was possible. Child 1 was diagnosed as a child with developmental auditory processing difficulties affecting phonics, reading and the writing/spelling processes. Reading fluency and comprehension, spelling and writing fluency were particular areas of weakness. Scatter was evident both within and across the cognitive profile of the WISC IV, indicating that areas of strength and weakness also likely to be affecting performance at school. Focus and attentional factors and emotional indicators were present, which had been pervasive as well as occurring over time, as confirmed by Child 1's mother and the family's neurologist[15].

Child 1's high scores on verbal reasoning and on the perceptual reasoning side indicated that he was a child with a high level of spatial competence, which could be used for purposes of instruction. Based on the indications from assessment, the following areas of difficulty were identified, and the following programme implemented in therapy, with carry-over at home.

13. Development of an individual programme

As there was evidence of difficulty in a number of areas, the individual programme developed for Child 1 consisted of a number of specific interventions, which are summarised in **Table 3**.

[15]There was also erratic behaviour, temper outbursts and mood swings suggestive of cortical irritability, for which medication was prescribed.

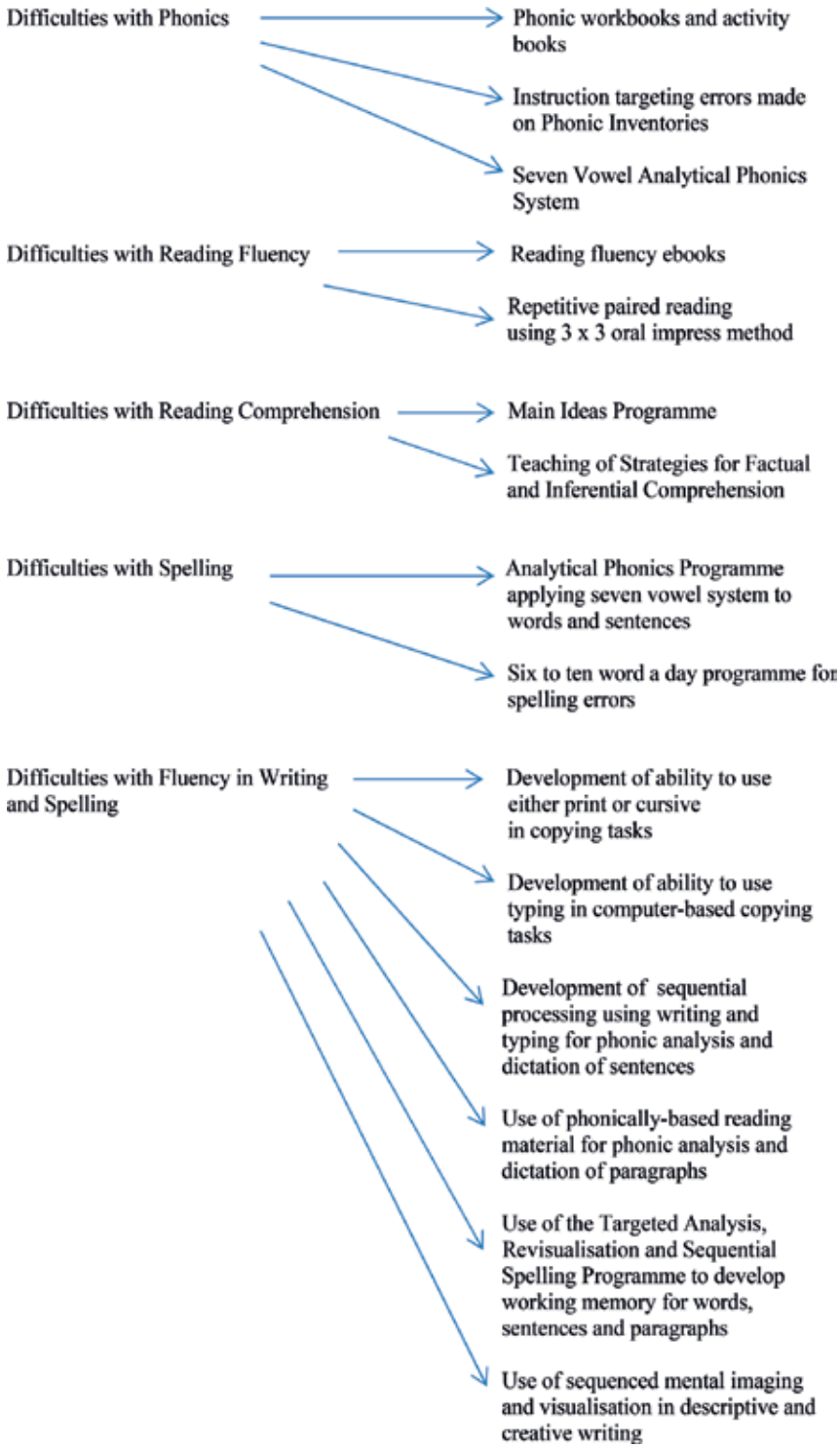

Table 3. Child 1's individual programme.

It will be evident from **Table 3** that there were a number of areas of intervention in Child 1's programme, reflecting different needs on a functional level. These included interventions aimed at establishing basic phonological and phonic skills, as well as skills in both synthetic and analytical phonics. There were also interventions designed to improve skills in word reading, as well as to establish fluency in the use of sequential reading skills and reading comprehension, as the basis for coping with the type of language and reading comprehension tasks Child 1 was being given in the classroom.

In addition, there were interventions aimed at establishing basic skills in spelling and writing and by teaching Child 1 how to analyse the structure of the words he was being asked to learn for his spelling tests at school. This was done by focusing on the vowels occurring in these words using a seven vowel analytical system, with the aim of making the vowel system used in English orthography transparent.

There were also interventions directed at establishing fluency in sequential writing and spelling. This was done through word, sentence and paragraph dictation. There was also a family-based counselling intervention. Work ethic and motivation were maintained through a reward system based on hundred squares and points.[16]

Child 1's individual programme thus provided a framework of areas of difficulty, linked on the one hand to his assessment and on the other to specific areas of intervention. This provided a basis for implementation in weekly sessions conducted with Child 1 and reinforced by Child 1's parents at home. This was done using the resources described in the next chapter.

14. Summary and evaluation

There has been increasing interest in automaticity as a necessary component in working with children with reading, writing and spelling difficulties. In this chapter, Luria's theories [1–3] of automaticity have first been outlined in relation to the broader literature. This has then been followed by a case study of a child (Child 1) presenting with difficulties in automaticity in reading, writing and spelling, and the procedures used for assessment and development of his individual programme.

In the following chapter, this child's results are presented, together with the results of 13 other children with learning difficulties with whom similar methods and materials have been applied. Six contrast case studies are also presented, where divergence in materials and methods has occurred.

At the end of the second chapter, conclusions are drawn, and the reader is referred to a resource of low cost materials for developing automaticity in reading, writing and spelling, which is available for use by others. This is currently being used by a network of parents, therapists and teachers in Southern Africa, as well as more widely internationally.

The two chapters are presented side by side in this book, so that the reader can first focus in this chapter on theory and how this translates into assessment, and then on the practical. The

[16]Influenced by comments concerning the value of points-based reward systems made by Alex Bannatyne to the author in 1978. The emphasis on teaching hundreds, tens and units through repetitive use of an ongoing reward system is the author's own.

reason for this is that procedures for assessment form the link between the areas of difficulty found in children with reading and learning disabilities and the methods and materials which can be used on a functional level for implementing fluency-based programmes in practice. The fluency-based methods used by the author are described and then evaluated in the next chapter. Key implementation variables affecting the development of reading, writing and spelling fluency are also identified, based on evidence of gains made by particular children.

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References

[1] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966

[2] Luria AR. The Working Brain: An Introduction to Neurospychology. Harmondsworth: Penguin Education; 1973

[3] Luria AR. Basic Problems of Neurolinguistics. Vol. 73. Berlin: Walter de Gruyter; 1976

[4] Sechenov IM. Refleksy golovnogo mozgo (Reflexes of the brain). Meditsinskii Vestnik (Medical Herald). 1863;**47**:461-481 and Vol. 48: pp. 493-512. English edition In: Sechenov I. Selected Physiological and Psychological Works. Moscow: Foreign Languages Publishing House; 1957 and In: "Reflexes of the Brain: An attempt to establish the physiological basis for psychological processes," Translated from Russian by Belsky S, The Massachusetts Institute of Technology (M.I.T.) Press, 1965

[5] Pavlov IP. Complete Collected Works. Moscow: Izd. AU SSSR; 1949

[6] Vygotsky LS. Selected psychological Investigations. Moscow: Izdstel'sto Pedagogical Academy; 1956

[7] Vygotsky LS. Razvitie vysshikh psikhicheskikh funktsii [Development of the higher mental functions]. Moscow: Publishing House of the R.S.F.S.R. Academy of Pedagogical Sciences; 1960. p. 13-223

[8] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. p. 32

[9] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. p. 33

[10] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. p. 33-34

[11] Luria AR. The Working Brain: An Introduction to Neurospychology. Harmondsworth: Penguin Education; 1973. p. 30

[12] Luria AR. Brain disorders and language analysis. Language and Speech. 1958;**1**(1):14-34

[13] Luria AR. The directive function of speech in development and dissolution. Word. 1959;**15**(2):341-352

[14] Luria AR. The directive function of speech in development and dissolution: Part II: Dissolution of the regulative function of speech in pathological states of the brain. Word. 1959;**15**(3):453-464

[15] Luria AR. Disorders of "ldquo; simultaneous perception" in a case of bilateral occipito-parietal brain injury. Brain. 1959;**82**(3):437-449

[16] Luria AR. Experimental study of the higher nervous activity of the abnormal child. Journal of Intellectual Disability Research. 1959;**3**(1):1-22

[17] Luria AR, Vinogradova OS. An objective investigation of the dynamics of semantic systems. British Journal of Psychology. 1959;**50**(2):89-105

[18] Luria AR, Yudovich FI. Speech and the Development of Mental Processes in the Child. Harmondsworth: Penguin Books; 1971. (Kovasc O, Simon J, Trans.)

[19] Luria AR. Language and brain: Towards the basic problems of neurolinguistics. Brain and Language. 1974;**1**(1):1-14

[20] Luria AR. On quasi-aphasic speech disturbances in lesions of the deep structures of the brain. Brain and Language. 1977;**4**(3):432-459

[21] Luria AR, Hutton JT. A modern assessment of the basic forms of aphasia. Brain and Language. 1977;**4**(2):129-151

[22] Luria AR. The Role of Speech in the Regulation of Normal and Abnormal Behavior. Amsterdam: Elsevier; 2014

[23] Golden C. The Luria-Nebraska Children's Battery: Theory and Formulation. New York: Grune and Stratton; 1981

[24] Golden CJ, Freshwater SM. Luria-Nebraska neuropsychological battery. In: Dorfman WI, Hersen M, editors. Understanding Psychological Assessment. New York: Springer; 2001. p. 59-75

[25] Korkman M. NEPSY – An adaptation of Luria's investigation for young children. The Clinical Neuropsychologist. 1988;**2**(4):375-392

[26] Naglieri JA, Das JP. Planning-arousal-simultaneous-successive (PASS): A model for assessment. Journal of School Psychology. 1988;**26**(1):35-48

[27] Das JP. A neo-Lurian approach to assessment and remediation. Neuropsychology Review. 1999;**9**(2):107-116

[28] Hynd GW, Obrzut JE, editors. Neuropsychological Assessment and the School-age Child: Issues and Procedures. New York: Grune and Stratton; 1981

[29] Mittenberg W, Kasprisin A, Farage C. Localization and diagnosis in aphasia with the Luria-Nebraska Neuropsychological Battery. Journal of Consulting and Clinical Psychology. 1985;**53**(3):386

[30] Tupper DE. Introduction: Neuropsychological assessment apres Luria. Neuropsychology Review. 1999;**9**(2):57-61

[31] Ardila A. Spanish applications of Luria's assessment methods. Neuropsychology Review. 1999;**9**(2):63-69

[32] Dykman RA, Walls RC, Suzuki T, Ackerman PT, Peters JE. Children with learning disabilities: Conditioning, differentiation, and the effect of distraction. American Journal of Orthopsychiatry. 1970;**40**(5):766

[33] de Quirds JB. Diagnosis of vestibular disorders in the learning disabled. Journal of Learning Disabilities. 1976;**9**(1):39-47

[34] Denckla MB, Rudel RG. Naming of object-drawings by dyslexic and other learning disabled children. Brain and Language. 1976;**3**(1):1-15

[35] Lyon R, Watson B. Empirically derived subgroups of learning disabled readers: Diagnostic characteristics. Journal of Learning Disabilities. 1981;**14**(5):256-261

[36] Lyon R, Reitta S, Watson B, Porch B, Rhodes J. Selected linguistic and perceptual abilities of empirically derived subgroups of learning disabled readers. Journal of School Psychology. 1981;**19**(2):152-166

[37] Semrud-Clikeman M, Hynd GW. Right hemisphere dysfunction in nonverbal learning disabilities: Social, academic, and adaptive functioning in adults and children. Psychological Bulletin. 1990;**107**(2):196

[38] Passler MA, Isaac W, Hynd GW. Neuropsychological development of behavior attributed to frontal lobe functioning in children. Developmental Neuropsychology. 1985;**1**(4):349-370

[39] Coplin JW, Morgan SB. Learning disabilities: A multidimensional perspective. Journal of Learning Disabilities. 1988;**21**(10):614-622

[40] Goodgold-Edwards SA, Cermak SA. Integrating motor control and motor learning concepts with neuropsychological perspectives on apraxia and developmental dyspraxia. American Journal of Occupational Therapy. 1990;**44**(5):431-439

[41] Rourke BP. Neuropsychological Validation of Learning Disability Subtypes. New York: Guilford Press; 1991

[42] Rourke BP, Del Dotto JE. Learning Disabilities: A Neuropsychological Perspective. Thousand Oaks, CA: Sage; 1994

[43] Akhutina TV. The remediation of executive functions in children with cognitive disorders: The Vygotsky-Luria neuropsychological approach. Journal of Intellectual Disability Research. 1997;**41**(2):144-151

[44] Hooper SR, Willis WG. Learning Disability Subtyping: Neuropsychological Foundations, Conceptual Models, and Issues in Clinical Differentiation. Berlin: Springer Science and Business Media; 2013

[45] Gaddes WH. Learning disabilities and brain function: A neuropsychological approach. Berlin: Springer Science and Business Media; 2013

[46] LaBerge D, Samuels SJ. Toward a theory of automatic information processing in reading. Cognitive Psychology. 1974;**6**(2):293-323

[47] Siegel LS. Psycholinguistic aspects of reading disabilities. In: Siegel L, Morrison F, editors. Cognitive Development in Atypical Children. New York: Springer-Verlag; 1985. p. 45-65

[48] Graham S, Harris KR, MacArthur CA, Schwartz S. Writing and writing instruction for students with learning disabilities: Review of a research program. Learning Disability Quarterly. 1991;**14**(2):89-114

[49] Samuels SJ, Schermer N, Reinking D. Reading fluency: Techniques for making decoding automatic. What Research has to Say about Reading Instruction. 1992;**2**:124-144

[50] Logan GD. Attention and preattention in theories of automaticity. American Journal of Psychology. 1992;**105**:317-339

[51] Mathes PG, Fuchs D, Fuchs LS, Henley AM. Increasing strategic reading practice with Peabody Classwide Peer Tutoring. Learning Disabilities Research & Practice. 1994;**9**(1):44-48

[52] Dougherty KM, Johnston JM. Overlearning, fluency, and automaticity. The Behavior Analyst. 1996;**19**(2):289

[53] Stone CA. The metaphor of scaffolding: Its utility for the field of learning disabilities. Journal of Learning Disabilities. 1998;**31**(4):344-364

[54] Wolf M, Bowers PG, Biddle K. Naming-speed processes, timing, and reading: A conceptual review. Journal of Learning Disabilities. 2000;**33**(4):387-407

[55] Wolf M, Miller L, Donnelly K. Retrieval, automaticity, vocabulary elaboration, orthography (RAVE-O) a comprehensive, fluency-based reading intervention program. Journal of Learning Disabilities. 2000;**33**(4):375-386

[56] Berninger VW. Effects of phonological, morphological, and orthographic treatment on brain activation. In: Paper presented at the International Dyslexia Association conference. San Diego, CA; November 2003

[57] Shaywitz SE. Overcoming Dyslexia: A New and Complete Science-based Program for Reading Problems at Any Level. New York: Knopf-Doubleday; 2003

[58] Samuels SJ. Toward a theory of automatic information processing in reading, revisited. In: Ruddell RB, Unrau NJ, editors. Theoretical Models and Processes. Newark, DE: International Reading Association; 2004. p. 1127-1148

[59] Samuels SJ. Reading fluency: Its past, present, and future. In: Rasinski T, Blachowicz C, Lems K, editors. Fluency Instruction: Research-based Best Practices. New York: Guilford; 2006. p. 7-20

[60] Rasinski T. Reading fluency instruction: Moving beyond accuracy, automaticity, and prosody. The Reading Teacher. 2006;**59**(7):704-706

[61] Kuhn MR, Schwanenflugel PJ, Meisinger EB. Aligning theory and assessment of reading fluency: Automaticity, prosody, and definitions of fluency. Reading Research Quarterly. 2010;**45**(2):230-251

[62] Leontiev AN. Razvitie Pamyati [Development of Memory]. Uchpedgiz: Moskva-Leningrad; 1931. p. 27-198

[63] Leontiev AN. Problems in Mental Development. Moscow: Izdstel'sto Pedagogical Academy; 1959

[64] Leontiev AN. Principles of child mental development and the problem of intellectual backwardness, In B. Simon and J. Simon (Eds.), Educational Psychology in the U.S.S.R. London: Routledge and Kegan Paul, 1963. pp. 68-82

[65] Vygotsky L. Thought and Language. Cambridge, MA: MIT Press; 1934. (Hanfmann E, Vakar G, Trans.)

[66] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. p. 35-36

[67] Luria AR. The working brain: An introduction to neurospychology. Harmondsworth: Penguin Education; 1973. p. 32-33

[68] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. p. 423-431

[69] Samuels SJ. The method of repeated readings. The Reading Teacher. 1979;**32**(4):403-408

[70] Chomsky C. After decoding: What? Language Arts. 1976;**53**(3):288-296

[71] Carbo M. Teaching reading with talking books. The Reading Teacher. 1978;**32**(3):267-273

[72] Morgan R, Lyon E. Paired reading – A preliminary report on a technique for parental tuition of reading retarded children. Journal of Child Psychology and Psychiatry. 1979;**20**(2):151-160

[73] Ashby-Davis C. A review of three techniques for use with remedial readers. The Reading Teacher. 1981;**34**(5):534-538

[74] Allington RL. Fluency: The neglected reading goal. The Reading Teacher. 1983;**36**(6): 556-561

[75] Adams MJ. Beginning to Read: Thinking and Learning About Print. Cambridge, MA: MIT Press; 1990

[76] Ehri LC, McCormick S. Phases of word learning: Implications for instruction with delayed and disabled readers. Reading & Writing Quarterly: Overcoming Learning Difficulties. 1998;**14**(2):135-163

[77] Dowhower SL. Effects of repeated reading on second-grade transitional readers' fluency and comprehension. Reading Research Quarterly. 1987:389-406

[78] O'Shea LJ, Sindelar PT, O'Shea DJ. The effects of repeated readings and attentional cues on the reading fluency and comprehension of learning disabled readers. Learning Disabilities Research. 1987;**2**(2):103-109

[79] Topping K. Paired, Reading, Spelling and Writing: The Handbook for Teachers and Parents. London: Cassell; 1995

[80] Topping K. Paired reading: A powerful technique for parent use. The Reading Teacher. 1987;**40**(7):608-614

[81] Miller AD, Barbetta PM, Heron TE. START tutoring: Designing, training, implementing, adapting, and evaluating tutoring programs for school and home settings. In: Gardner R, Cooper JO, Sainato DM, editors. Behavior Analysis in Education: Focus on Measurably Superior Instruction. Pacific Grove, CA: Brooks/Cole; 1994. p. 265-282

[82] Rasinski TV, Padak N, Linek W, Sturtevant E. Effects of fluency development on urban second-grade readers. The Journal of Educational Research. 1994;**87**(3):158-165

[83] Simmons DC, Fuchs LS, Fuchs D, Mathes P, Hodge JP. Effects of explicit teaching and peer tutoring on the reading achievement of learning-disabled and low-performing students in regular classrooms. The Elementary School Journal. 1995;**95**(5):387-408

[84] Stoddard K, Valcante G, Sindelar P, O'Shea L, Algozzine B. Increasing reading rate and comprehension: The effects of repeated readings, sentence segmentation, and intonation training. Literacy Research and Instruction. 1993;**32**(4):53-65

[85] Topping K. Peer tutoring and paired reading: Combining two powerful techniques. The Reading Teacher. 1989;**42**(7):488-494

[86] Homan SP, Klesius JP, Hite C. Effects of repeated readings and nonrepetitive strategies on students' fluency and comprehension. The Journal of Educational Research. 1993;**87**(2):94-99

[87] O'Shea LJ, Sindelar PT, O'Shea DJ. The effects of repeated readings and attentional cues on reading fluency and comprehension. Journal of Reading Behavior. 1985;**17**(2):129-142

[88] Sindelar PT, Monda LE, O'Shea LJ. Effects of repeated readings on instructional-and mastery-level readers. The Journal of Educational Research. 1990;**83**(4):220-226

[89] Dowhower SL. Repeated reading revisited: Research into practice. Reading and Writing Quarterly: Overcoming Learning Difficulties. 1994;**10**(4):343-358

[90] Gilbert LM, Williams RL, McLaughlin TF. Use of assisted reading to increase correct reading rates and decrease error rates of students with learning disabilities. Journal of Applied Behavior Analysis. 1996;**29**(2):255-257

[91] Rasinski TV. Effects of repeated reading and listening-while-reading on reading fluency. The Journal of Educational Research. 1990;**83**(3):147-151

[92] Topping K. Peer tutored paired reading: Outcome data from ten projects. Educational Psychology: An International Journal of Experimental Educational Psychology. 1987;**7**(2):133-145

[93] Topping KJ, Lindsay GA. Paired reading: A review of the literature. Research Papers in Education. 1992;**7**(3):199-246

[94] Topping K, Wolfendale S, editors. Parental Involvement in Children's Reading. New York: Nichols; 1985

[95] National Reading Panel (US), National Institute of Child Health, & Human Development (US). Report of the National Reading Panel: Teaching Children to Read: An Evidence-based Assessment of the Scientific Research Literature on Reading and its Implications for Reading Instruction: Reports of the Subgroups. National Institute of Child Health and Human Development, National Institutes of Health; Rockville, MD; 2000

[96] National Reading Panel (US), National Institute of Child Health, & Human Development (US). Report of the National Reading Panel: Teaching Children to Read: An Evidence-based Assessment of the Scientific Research Literature on Reading and its Implications for Reading Instruction: Reports of the Subgroups. National Institute of Child Health and Human Development, National Institutes of Health. Chapter 3; 2000. p. 20

[97] U.S. Congress. No Child Left Behind Act: Reauthorization of the Elementary and Secondary Education Act (PL 107-110). 2001. Available from: www.ed.gov/offices/oese/esea/

[98] U.S. Congress. [333] No Child Left Behind Act: Reauthorization of the Elementary and Secondary Education Act (PL 107-110). 2001. Available from: www.ed.gov/offices/oese/esea/

[99] Ehri LC. Learning to read words: Theory, findings and issues. Scientific Studies of Reading. 2005;**9**:167-188

[100] Chall JS, Read LT. The Great Debate. New York: McGraw-Hill; 1967

[101] Chall JS, Popp HM. Teaching and Assessing Phonics: Why, What, When, How: A Guide for Teachers. Cambridge MA: Educators Publishing Service; 1997

[102] Elliott J, Nicolson R, editors. Dyslexia: Developing the Debate. London: Bloomsbury; 2016

[103] Shaywitz SE, Shaywitz BA. Dyslexia (specific reading disability). Biological Psychiatry. 2005;**57**(11):1301-1309

[104] Thompson PA, Hulme C, Nash HM, Gooch D, Hayiou-Thomas E, Snowling MJ. Developmental dyslexia: Predicting individual risk. Journal of Child Psychology and Psychiatry. 2015;**56**(9):976-987

[105] Levy BA, Nicholls A, Kohen D. Repeated readings: Process benefits for good and poor readers. Journal of Experimental Child Psychology. 1993;**56**(3):303-327

[106] Therrien WJ. Fluency and comprehension gains as a result of repeated reading: A meta-analysis. Remedial and Special Education. 2004;**25**(4):252-261

[107] Fuchs LS, Fuchs D, Hosp MK, Jenkins JR. Oral reading fluency as an indicator of reading competence: A theoretical, empirical, and historical analysis. Scientific Studies of Reading. 2001;**5**(3):239-256

[108] Rasinski TV. The Fluent Reader: Oral Reading Strategies for Building Word Recognition, Fluency, and Comprehension. New York: Scholastic; 2003

[109] Freeland JT, Skinner CH, Jackson B, McDaniel CE, Smith S. Measuring and increasing silent reading comprehension rates: Empirically validating a repeated readings intervention. Psychology in the Schools. 2000;**37**(5):415-429

[110] Mercer CD, Campbell KU, Miller MD, Mercer KD, Lane HB. Effects of a reading fluency intervention for middle schoolers with specific learning disabilities. Learning Disabilities Research and Practice. 2000;**15**(4):179-189

[111] Rashotte CA, Torgesen JK, Repeated reading and reading fluency in learning disabled children. Reading Research Quarterly. January 1985;**20**(2):80-188

[112] Vaughn S, Chard DJ, Bryant DP, Coleman M, Tyler BJ, Linan-Thompson S, Kouzekanani K. Fluency and comprehension interventions for third-grade students. Remedial and Special Education. 2000;**21**(6):325-333

[113] Therrien WJ, Kubina RM Jr. Developing reading fluency with repeated reading. Intervention in School and Clinic. 2006;**41**(3):156-160

[114] Berninger VW, Abbott RD, Abbott SP, Graham S, Richards T. Writing and reading: Connections between language by hand and language by eye. Journal of Learning Disabilities. 2002;**35**(1):39-56

[115] Wolf M, Katzir-Cohen T. Reading fluency and its intervention. Scientific Studies of Reading. 2001;**5**(3):211-239

[116] Wolf M, Katzir-Cohen T. Reading fluency and its intervention. Scientific Studies of Reading. 2001;**5**(3):211-239 at pp. 219-222

[117] Fawcett AJ, Nicolson RI. Naming speed in children with dyslexia. Journal of Learning Disabilities. 1994;**27**(10):641-646

[118] Nicolson RI, Fawcett AJ. Automaticity: A new framework for dyslexia research? Cognition. 1990;**35**(2):159-182

[119] Nicolson RI, Fawcett AJ. Dyslexia is more than a phonological disability. Dyslexia-Chichester. 1995;**1**:19-36

[120] Norton ES, Wolf M. Rapid Automatized Naming (RAN) and reading fluency: Implications for understanding and treatment of reading disabilities. Annual Review of Psychology. 2012;**63**:427-452

[121] Moors A, De Houwer J. Automaticity: A theoretical and conceptual analysis. Psycholo gical Bulletin. 2006;**132**(2):297

[122] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. p. 36-37

[123] Luria AR, Simernitskaya EG, Tubylevich B. The structure of psychological processes in relation to cerebral organization. Neuropsychologia. 1970;**8**(1):13-19

[124] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. p. 417-418

[125] Spalding RB. The Writing Road to Reading: A Modern Method of Phonics for Teaching Children to Read. New York: Whiteside and Morrow; 1962

[126] Spalding RB, DesRoches JR. The Writing Road to Reading. New York: William Morrow; 1986

[127] Spalding RB, Spalding WT. The Writing Road to Reading: The Spalding Method of Phonics for Teaching Speech, Writing, and Reading. Beaverton, OR: Riggs Institute; 1990

[128] Frith U. Beneath the surface of developmental dyslexia. Surface Dyslexia. 1985;**32**:301-330

[129] Ratz C, Lenhard W. Reading skills among students with intellectual disabilities. Research in Developmental Disabilities. 2013;**34**(5):1740-1748

[130] Sprenger-Charolles L, Bonnet P. New doubts on the importance of the logographic stage. Cahiers de Psychologie Cognitive-Current Psychology of Cognition. 1996;**15**:173-208

[131] Martinet C, Valdois S, Fayol M. Lexical orthographic knowledge develops from the beginning of literacy acquisition. Cognition. 2004;**91**(2):B11-B22

[132] Frith U. A developmental framework for developmental dyslexia. Annals of Dyslexia. 1986;**36**(1):67-81

[133] Ehri LC. Learning to read and learning to spell are one and the same, almost. In: Perfetti CA, Rieben L, Fayol M, editors. Learning to Spell: Research, Theory, and Practice Across Languages. Hillsdale, NJ: Erlbaum; 1997. p. 237-269

[134] Frith U. Unexpected spelling problems. In: Frith U, editor. Cognitive Processes in Spelling. London: Academic Press; 1980. p. 495-517

[135] Ehri LC. Sources of difficulty in learning to spell and read. In: Wolraich ML, Routh D, editors. Advances in Developmental and Behavioral Pediatrics. Greenwich, CT: JAI Press; 1986. p. 121-195

[136] Kellogg RT. Training writing skills: A cognitive developmental perspective. Journal of Writing Research. 2008;**1**(1):1-26

[137] Ericsson KA, Lehmann AC. Expert and exceptional performance: Evidence of maximal adaptation to task constraints. Annual Review of Psychology. 1996;**47**(1):273-305

[138] Lehmann AC, Ericsson KA. Performance without preparation: Structure and acquisition of expert sight-reading and accompanying performance. Psychomusicology: A Journal of Research in Music Cognition. 1996;**15**:1-29

[139] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. p. 24

[140] Schlaggar BL, McCandliss BD. Development of neural systems for reading. Annual Review of Neuroscience. 2007;**30**:475-503

[141] Perfetti CA, McCutchen D. Speech processes in reading. Speech and language: Advances in Basic Research and Practice. 1982;**7**:237-269

[142] McCutchen D, Perfetti CA. The visual tongue-twister effect: Phonological activation in silent reading. Journal of Verbal Learning and Verbal Behavior. 1982;**21**(6):672-687

[143] Perfetti CA, McCutchen D. Schooled language competence: Linguistic abilities in reading and writing. Advances in Applied Psycholinguistics. 1987;**2**:105-141

[144] McCutchen D. "Functional automaticity" in children's writing: A problem of metacognitive control. Written Communication. 1988;**5**(3):306-324

[145] Perfetti CA, Zhang S, Berent I. Reading in English and Chinese: Evidence for a "universal" phonological principle. Advances in Psychology. 1992;**94**:227-248

[146] Potter CS. Using phonically based e-books to develop reading fluency. In: Gradinarova B, editor. E-Learning – Instructional Design, Organizational Strategy and Management. InTech: Rijeka; 2015. DOI: 10.5772/61607 Available from: http://www.intechopen.com/books/e-learning-instructional-design-organizational-strategy-and-management/using-phonically-based-e-books-to-develop-reading-fluency

[147] Castles A, Nation K. How does orthographic learning happen? In: Andrews S, editor. From Inkmarks to Ideas: Current Issues in Lexical Processing. Hove: Psychology Press; 2006. p. 151-179

[148] Conrad NJ. From reading to spelling and spelling to reading: Transfer goes both ways. Journal of Educational Psychology. 2008;**100**(4):869-878

[149] Ouellette G. Orthographic learning in learning to spell: The roles of semantics and type of practice. Journal of Experimental Child Psychology. 2010;**107**(1):50-58

[150] Shahar-Yames D, Share DL. Spelling as a self-teaching mechanism in orthographic learning. Journal of Research in Reading. 2008;**31**(1):22-39

[151] Seymour P, Aro M, Erskine J. Foundation literacy acquisition in European orthographies. British Journal of Psychology. 2003;**94**(2):143-174

[152] Share DL. Orthographic learning at a glance: On the time course and developmental onset of self-teaching. Journal of Experimental Child Psychology. 2004;**87**(4):267-298

[153] Ouellette G, Tims T. The write way to spell: Printing vs. typing effects on orthographic learning. Frontiers in Psychology. 2014;**5**:117

[154] Cunningham AE, Stanovich KE. Early spelling acquisition: Writing beats the computer. Journal of Educational Psychology. 1990;**82**(1):159-162

[155] Oaks RE. A study of the vowel situation in a primary vocabulary. Spelling Progress Bulletin. 1981;**72**(9):604-617

[156] Fisk AD, Schneider W. Category and word search: Generalizing search principles to complex processing. Journal of Experimental Psychology: Learning, Memory, and Cognition. 1983;**9**(2):177

[157] Schneider W, Fisk AD. Attention theory and mechanisms for skilled performance. Advances in Psychology. 1983;**12**:119-143

[158] Snowling MJ. Language and literacy skills: Who is at risk and why. In: Bishop DVM, Leonard LB, editors. Speech and Language Impairments in Children: Causes, Characteristics, Intervention and Outcome. Hove: Psychology Press; 2000. p. 245-259

[159] Ouellette G, Fraser JR. What exactly is a yait anyway: The role of semantics in orthographic learning. Journal of Experimental Child Psychology. 2009;**104**(2):239-251

[160] Cohen RA. The Neuropsychology of Attention. New York: Springer; 2013

[161] Share DL. Phonological recoding and self-teaching: Sine qua non of reading acquisition. Cognition. 1995;**55**(2):151-218

[162] Share DL. Phonological recoding and orthographic learning: A direct test of the self-teaching hypothesis. Journal of Experimental Child Psychology. 1999;**72**(2):95-129

[163] Smith-Spark JH, Fisk JE. Working memory functioning in developmental dyslexia. Memory. 2007;**15**(1):34-56

[164] Sfetsios N. The use of mental imagery in the treatment of a child with severe learning disabilities. Honours research report. Johannesburg: University of the Witwatersrand, Department of Psychology; 2002

[165] Potter CS. Targeted Revisualisation Programme: Results Initial Case Studies 1995-2001. Johannesburg: University of the Witwatersrand, Department of Psychology (mimeo); 2004

[166] Altmann G, Steedman M. Interaction with context during human sentence processing. Cognition. 1988;**30**(3):191-238

[167] Houghton G. The problem of serial order: A neural network model of sequence learning and recall. In: Dale RE, Mellish CS, editors. Current Research in Natural Language Generation. Cambridge, MA: Academic Press Professional; 1990. p. 287-319

[168] Eikmeyer H-J, Schade U. Sequentialization in connectionist language-production models. Cognitive Systems. 1991;**3-2**:128-138

[169] Dell GS, Burger LK, Svec WR. Language production and serial order: A functional analysis and a model. Psychological Review. 1997;**104**(1):123

[170] Nicolson R. Developmental dyslexia: The bigger picture. In: Elliott J, Nicolson R, editors. Dyslexia: Developing the Debate. London: Bloomsbury; 2016. p. 5-72

[171] Snowling MJ, Goulandris N, Bowlby M, Howell P. Segmentation and speech perception in relation to reading skill: A developmental analysis. Journal of Experimental Child Psychology. 1986;**41**:487-507

[172] Snowling M. Dyslexia: A Cognitive Developmental Perspective. Oxford: Blackwell; 1987

[173] Stanovich KE. The right and wrong places to look for the cognitive locus of reading disability. Annals of Dyslexia. 1988;**38**(1):154-177

[174] Stanovich KE. Explaining the differences between the dyslexic and the garden variety poor reader: The phonological-core variable-difference model. Journal of Learning Disabilities. 1988;**21**(10):590-612

[175] Vellutino FR, Scanlon D. Early intervention can reduce the number of children diagnosed as "reading disabled". New England Reading Association Journal. 1999;**35**(3):3

[176] Vellutino FR, Fletcher JM, Snowling MJ, Scanlon DM. Specific reading disability (dyslexia): What have we learned in the past four decades? Journal of Child Psychology and Psychiatry. 2004;**45**(1):2-40

[177] Rudel RG. The definition of dyslexia: Language and motor deficits. In: Duffy FH, Geschwind N, editors. Dyslexia: A Neuroscientific Approach to Clinical Evaluation. Boston, MA: Little Brown; 1985. p. 33-53

[178] Eden GF, Zeffiro TA. Neural systems affected in developmental dyslexia revealed by functional neuroimaging. Neuron. 1998;**21**(2):279-282

[179] Wolf M, Bowers PG. The double-deficit hypothesis for the developmental dyslexias. Journal of Educational Psychology. 1999;**91**(3):415-438

[180] Nicolson RI, Fawcett AJ. Children with dyslexia automatize temporal skills more slowly. Annals-New York Academy of Sciences. 1993;**682**:390-390

[181] Nicolson RI, Fawcett AJ. Comparison of deficits in cognitive and motor skills among children with dyslexia. Annals of Dyslexia. 1994:147-164

[182] Nicolson RI, Fawcett AJ. Procedural learning difficulties: Reuniting the developmental disorders? Trends in Neurosciences. 2007;**30**(4):135-141

[183] Nicolson RI, Fawcett AJ, Baddeley AD. Working Memory and Dyslexia. Sheffield, UK: University of Sheffield, Department of Psychology, Report LRG; 1992. p. 3/91

[184] Tallal P, Miller S, Fitch RH. Neurobiological basis of speech: A case for the preeminence of temporal processing. Annals of the New York Academy of Sciences. 1993;**682**(1):27-47

[185] Tallal P, Miller SL, Jenkins WM, Merzenich MM. The role of temporal processing in developmental language-based learning disorders: Research and clinical implications. In: Blachman BA, editor. Foundations of Reading Acquisition and Dyslexia: Implications for Early Intervention. Mahwah, NJ: Erlbaum; 1997. p. 49-66

[186] Stein J, Walsh V. To see but not to read; the magnocellular theory of dyslexia. Trends in Neurosciences. 1997;**20**(4):147-152

[187] Swan D, Goswami U. Picture naming deficits in developmental dyslexia: The phonological representations hypothesis. Brain and Language. 1997;**56**(3):334-353

[188] Stein J. The magnocellular theory of developmental dyslexia. Dyslexia. 2001;**7**(1):12-36

[189] Nicolson RI, Fawcett AJ, Dean P. Developmental dyslexia: The cerebellar deficit hypothesis. Trends in neurosciences. 2001;**24**(9):508-511

[190] Goswami U, Thomson J, Richardson U, Stainthorp R, Hughes D, Rosen S, Scott SK. Amplitude envelope onsets and developmental dyslexia: A new hypothesis. Proceedings of the National Academy of Sciences. 2002;**99**(16):10911-10916

[191] Facoetti A, Lorusso ML, Paganoni P, Umilta C, Mascetti GG. The role of visuospatial attention in developmental dyslexia: Evidence from a rehabilitation study. Cognitive Brain Research. 2003;**15**(2):154-164

[192] Bosse ML, Tainturier MJ, Valdois S. Developmental dyslexia: The visual attention span deficit hypothesis. Cognition. 2007;**104**(2):198-230

[193] Nicolson RI, Fawcett AJ, Brookes RL, Needle J. Procedural learning and dyslexia. Dyslexia. 2010;**16**(3):194-212

[194] World Health Organization. International Statistical Classification of Diseases and Related Health Problems. Vol. 1. World Health Organization. Geneva, Switzerland; 2004

[195] Department Health Republic of South Africa South African ICD-10 Technical User Guide: Technical User Guide Compiled by the Ministerial ICD-10 Task Team to Define Standards and Guidelines for ICD-10 Coding Implementation. June 2014 of Version 2.00. 2004. Available from: http://www.health.gov.za

[196] Ministerial ICD-10 Task Team. South African ICD-10 Technical User Guide to Define Standards and Guidelines for ICD-10 Coding Implementation. June 2014 of Version 2.00. 2014. Available from: http://www.health.gov.za

[197] American Psychiatric Association. DSM-IV: Diagnostic and Statistical Manual of Mental Disorders. Washington DC: American Psychiatric Association; 1994

[198] World Health Organization, and Practice Management Information Corporation. ICD-9-CM: International Classification of Diseases, 9th revision: Clinical Modification. Vol. 1. PMIC (Practice Management Information Corporation), Downers Grove. IL Geneva, Switzerland; 1998

[199] American Psychiatric Association. Diagnostic criteria from DSM-IV-TR. Washington DC: American Psychiatric Association; 2000 Available from: http://behavenet.com/node/21477

[200] Council for Medical Schemes and Department of Health Republic of South Africa. South African ICD-10 Coding Standards Developed to Assist the Clinical Coder in the South African Environment. The South African ICD-10 Coding Standards, Version 3 (as at March 2009) Compiled by the National Task Team for the Implementation of ICD-10. 2009. Available from: https://www.medicalschemes.com

[201] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. p. 299-308

[202] American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-5®). Washington DC: American Psychiatric Association; 2013. Available from: http://www.icd10data.com/ICD10CM/Codes/F01-F99/F80-F89/F81-/F81.0

[203] American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-5®). Washington DC: American Psychiatric Association; 2013. Available from: http://www.icd10data.com/ICD10CM/Codes/F01-F99/F80-F89/F81-/F81.81

[204] Elliott JG, Grigorenko EL. The Dyslexia Debate. Vol. 14. New York: Cambridge University Press; 2014

[205] Elliott J. Response to Rod Nicolson. In: Elliott J, Nicolson R, editors. Dyslexia: Developing the Debate. London: Bloomsbury; 2016. p. 135-149

[206] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. p. 408-431

[207] Potter CS. The Phonic Inventories: An Instrument for Establishing the Patterns of Error Made by Children. Johannesburg: Norwood Remedial School. (mimeo); 1979

[208] Potter CS. Using the Phonic Inventories for establishing the patterns of error made by children with learning disabilities. In: Paper presented at International Conference on Learning Disabilities. SAALED and the Centre for Continuing Medical Education. Johannesburg. University of the Witwatersrand; July 1979

[209] Grasko D. The phonic inventories. [unpublished Master's thesis]. Johannesburg: University of the Witwatersrand; 2005

[210] Wechsler D. Wechsler Intelligence Scale for Children – Fourth. UK ed. London: Harcourt Assessment; 2004

[211] Available from: http://www.psychtreatment.com/mental_health_diagnosis_reading_disorder.htm

[212] Available from: http://www.icd10data.com/ICD10CM/Codes/F01-F99/F80-F89/F81-/F81.0

[213] Available from: http://www.psychtreatment.com/mental_health_diagnosis_written_disorder.htm

[214] Available from: http://www.icd10data.com/ICD10CM/Codes/F01-F99/F80-F89/F81-/F81.81

[215] Potter CS. The Phonic Inventories: An Ipsative Instrument for Analysing the Error Patterns of Children. Johannesburg: University of the Witwatersrand, Department of Psychology (mimeo); 1996

[216] Pereira C. An analysis of the short and long-term validity of the Phonic Inventories. [unpublished Masters thesis]. Johannesburg: University of the Witwatersrand; 2008

[217] Potter CS, Grasko D, Pereira C. Using spelling errors to identify children with learning disabilities. In: Paper presented at SAALED International Conference "Reading for All". Nelspruit; September 2008

[218] Ravenscroft G, Potter CS, Fridjhon P. Using Information and Communication Technology (ICT) to identify error patterns amongst children and guide their remedial intervention. In: Barcelona, Proceedings International Conference ICERI. IATED Academy, Valencia, Spain. 2009, pdf 1294, November. 2009

[219] Callander A. Using phonic inventories to identify children with learning disorders or barriers to learning. B.Ed Honours research report. Johannesburg: University of the Witwatersrand, Department of Psychology; 2007

[220] Mazansky K. Using phonic inventories to identify children with learning disorders/ barriers to learning with specified spelling difficulties in a mainstream Grade 6 classroom in South Africa. B.Ed Honours research report. Johannesburg: University of the Witwatersrand, Department of Psychology; 2007

[221] Potter CS, Fridjhon P, Grasko D, Pereira C, Ravenscroft G. Identifying patterns of phonic errors in children with learning disabilities. In: Salt Lake City, UT: Research poster presented as part of Research on Learning Disabilities session. 46th International Conference of the Learning Disabilities Association of America. Castle Shannon, Pennsylvania February. 2009

[222] Kruger M. A comparison of reading and spelling test scores and frequency of phonic errors in a remedial and a mainstream high school. Honours research report. Johannesburg: University of Witwatersrand, Department of Psychology; 2011

[223] Potter C, Fridjhon P, Ravenscroft G. Evaluating a test's conceptual propertis and utilisation potential: Linking results from validation and applied research as a basis for implementation. In: Proceedings of 3rd International Conference on Education and New Learning Technologies, 1929 pdf, EDULEARN, Barcelona IATED Academy, Valencia, Spain, July. 2011

[224] Potter CS, Fridjhon P, Ravenscroft G. Using test results as a basis for identifying instructional needs and monitoring progress of children in schools and classrooms. In: Paper presented at the Conference of the South African Monitoring and Evaluation Association, M&E 4 outcomes: Answering the 'So what?' question. September. 2011

Chapter 8

Developing Automaticity in Children with Learning Disabilities: A Functional Perspective Part Two: Programme Methods and Materials

Charles Potter

Additional information is available at the end of the chapter

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Abstract

This chapter is the second of two chapters in this book to describe an instructional programme based on Luria's theories, which can be used to develop basic skills and automaticity in reading, writing, and spelling. The first chapter focused on the programme's theory, and then described how assessment is used to develop an individual programme relating to both basic skill and fluency needs in reading, writing, and spelling. The process was illustrated with one detailed case study. The results of this case study (Child 1) are presented in the current chapter, together with the results of 13 children exposed to similar fluency-based interventions. The results of six children exposed to one or more systematic variations in programme implementation are then discussed. Case contrast analysis is used to highlight three variables affecting successful programme implementation, namely: consistent and regular exposure to phonological and phonic instruction to provide a foundation of basic skills on which the fluency interventions in the programme can be built; consistent implementation of methods designed to improve both reading fluency, and writing and spelling fluency, to produce the greatest likelihood of positive effects; and consistent support from parents in programme implementation to produce the greatest likelihood of positive effects.

Keywords: reading difficulties, dyslexia, reading fluency, writing and spelling fluency, automaticity, rate of work, analytical phonics, large print, repeated reading, visual tracking, sequential spelling

1. Introduction

The current chapter is the second of two linked chapters that describe a framework for working to develop automaticity in reading, writing, and spelling, based on the work of Luria

[1–3]. The two chapters are presented sequentially in this text, and are intended to be read in successive order.

In the initial chapter, Luria's theories were outlined in relation to the broader literature on automaticity. The initial description was then followed by a case study of an 8-year-old child presenting with difficulties in automaticity in reading, writing, and spelling, in addition to the procedures used for assessment and development of his individual programme.

The current chapter focuses on the methods and materials used to work with Child 1, and how the programme was implemented. Child 1's results are then presented, together with the results of 13 other children with learning difficulties for whom similar methods and materials were applied. Following this, six contrast case studies are discussed, for which there was a unique arrangement of materials and methods used.

At the end of the current chapter, conclusions are drawn and the reader is referred to a resource of low-cost materials for developing automaticity in reading, writing, and spelling. The materials are currently being used by a network of parents, therapists, and teachers in Southern Africa, as well as internationally.

The aim is to highlight key implementation variables in developing automaticity in reading, writing, and spelling, and to provide the reader with access to a teaching resource that is evidence-based, as well as to the theory, types of assessment procedures, methods, and materials linked to particular areas of a fluency-based programme.

2. Resources

Based on the areas of difficulty identified in the previous chapter,[1] the following resources were used to implement the different areas of intervention with Child 1:

Child 1's phonic skills were developed through use of targeted phonic instruction, use of phonically regular reading material, reading skill activity books, and phonic workbooks, and in particular:

- Instruction targeting the particular types of phonic errors identified in Child 1's profile on the Phonic Inventories [4, 5];
- The reading fluency ebook series published through the author's practice [6];
- The foundation level phonic activity books accompanying this series [7]; and
- A series of phonic workbooks published by Modern Curriculum Press [8].

[1]Child 1 was an 8-year old boy diagnosed as having a learning disability affecting reading, writing and spelling. His case profile and the assessment procedures used have been described in the previous chapter, to which the reader is referred for detail.

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Reading fluency was developed through:

- Regular engagement with the large-print, phonically regular ebooks referred to above; and.
- A repetitive paired reading procedure called the 3 × 3 Oral Impress System [9].

Spelling ability was developed though:

- Identification of long and short vowel sounds as used in words and word families based on the errors made by Child 1 in the Phonic Inventories [10, 11];
- Week by week analysis of Child 1's school books to identify the words he would be required to know for classroom usage (e.g. in spelling tests); and
- A methodology for analysing vowel situations in words called the Seven Vowel Phonic Analysis System [12].

Writing and spelling fluency was developed through:

- Colour coding of long and short vowel sounds used in the text of the large-print, phonically regular ebooks referred to above, using the Seven Vowel Phonic Analysis System;
- Copying of sentences and paragraphs, using the colour-coded material drawn from the ebooks;
- Sentence and paragraph dictation, using the colour-coded material drawn from the ebooks;
- Use of computer-based colour coding of vowels and vowel combinations in single syllable and polysyllabic words using a methodology for developing sequential working memory skills called the Targeted Analysis, Revisualisation, and Sequential Spelling Programme [13–16];
- Application of this methodology in a series of graded dictation paragraphs developed by Schonell [17]; and
- Use of sequenced mental imaging and visualisation in descriptive and creative writing [18, 19].

Application of the above phonic analysis and fluency-based procedures was undertaken side by side with the types of activities suggested by Johnson and Myklebust [20] for remediation of disorders of written language, Harris and Smith [21], Harris and Sipay [22], and Spache [23] for developing skills in reading comprehension, and Moffett [24, 25] for using discourse as the basis for developing student-centred language arts curricula at Grade 3 and Grade 4 levels at school.

In summary, Child 1's programme involved a number of different functional activities within a fluency-based model (refer **Table 1** following) in which there were three main areas of intervention, namely (a) language and reading comprehension; (b) reading fluency; and (c) writing and spelling fluency. In each of these areas of intervention there were a number of different components. The programme as a whole was activity-based, and conducted with the aim of developing basic perceptual, language, phonological and phonic skills, as well as automaticity in reading, writing, and spelling.

Foundation Level Readers and Activity Books		
Foundational Speech and Language Skills		
↕		
Auditory and Visual Perceptual + Processing Abilities		
↕		
Phonological and Phonic Skills		
↕		
Basic Letter Formation, Writing and Typing Skills		
↕		
	Core Series Readers	
Language and Reading Comprehension	**Reading Fluency**	**Writing and Spelling Fluency**
Understanding Words and Sentences	Higher level foundational readers + initial core readers	Sequenced Writing and Copying Skills
↕	↕	↕
Main Ideas in Paragraphs	3 x 3 Oral Impress Method	Seven Vowel Phonic Analysis System
↕	↕	↕
Prompts for Comprehension in Reading Passages	Silent Reading and Higher Level Fluency Readers	Targeted Analysis, Revisualisation and Sequential Spelling Programme
↕	↕	↕
Hierarchical Oral Questioning (Passages)	Rate of Oral and Silent Reading	Rate of Coying and Writing
↕	↕	↕
Hierarchical Written Questioning (Passages)	Extension Reading	Descriptive and Creative Writing
↕	↕	↕
Summaries and Reviews	Oral and Written Summary + Precis	10 word a day Spelling Programme

Table 1. Model of areas of intervention and components in the fluency-based programme.

Implicit in the model presented in **Table 1** is the assumption that the processes of reading, writing, and spelling need to be linked to processes of phonological and perceptual development, language development, and comprehension. At least one fluency-based activity involving repetition was undertaken in each therapy session as a means of developing automaticity in these functional areas, as well as the linkages between the brain areas used in reading, writing, and spelling, on which automaticity is based.

3. Programme implementation

Child 1's programme was implemented in hourly sessions, with two components (e.g. an activity based on a language and comprehension area component followed by a writing and

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spelling fluency activity; or a reading fluency activity followed by a writing and spelling fluency activity) being covered within the hour. As indicated earlier in this chapter, the reading fluency material was drawn from a resource of 80 graded, large-print, phonically based ebooks written by the author[2]. These were used both as material for developing reading fluency [26], as well as for activities designed to develop writing and spelling fluency [27, 28], with phonic analysis forming an essential component in both these areas of the programme. The reading fluency as well as the writing and spelling fluency activities and methods were then reinforced by being implemented at home[3].

As English is a relatively complex written language system, both reading fluency and writing and spelling fluency, were developed through two linked strategies. On the one hand, fluency-based methods were used which aimed to develop automaticity through repetition, while at the same time phonic analysis was undertaken as the basis for developing alphabetic and word attack skills. This was done using a seven vowel phonic analysis system designed to simplify the phonic rules, while at the same time lessening the orthographic constraints applying in English text. The use of seven as opposed to five vowels was based on indications from Perfetti and McCutchen's work [29–32] and Perfetti et al.'s research in China [33] of a universal phonic principle which is applied across both shallow and more opaque as well as pictographically based orthographies, as soon as the phonological basis of a particular written language system is mastered by the child.

As English orthography is complex, opaque, and takes longer to grasp than more transparent orthographies [34], the author's aim was to make English orthography transparent through consistent use of a phonic analysis system which was consistent, easy to explain, and easy for Child 1 to master and then apply. Use of seven vowels removed many of the inconsistencies and constraints implicit in the tasks of learning to read, copy, write, and spell using the English language, with which Child 1 was experiencing difficulty. As the large-print reading materials in the practice's database had been written based on phonic principles, they could be used as the basis for both the reading fluency as well as the writing and spelling areas of intervention. The ebooks were thus used both in therapy, and were also made available by email to Child 1's parents so that sufficient repetition could be provided on a daily basis for automaticity to develop.

Theoretically, these areas of intervention and components in Child 1's programme reflected the previous contributions of Orton and Gillingham [35–37], Fernald [38], and the Spaldings [39–41], as well as the particular contributions of Sister Mary Caroline on the vowel combinations useful in phonic analysis [42]. The emphasis on linking the development of reading and

[2]There are currently more than 80 ebooks in the data base of the author's practice The resource is being added to steadily, and the material is made available at low cost to others who wish to use it. Manuals for the reading, writing and spelling methods used with these materials are also made available by email to parents, teachers and therapists in the network of programme users. See http://www.charlespotter.org

[3]The author sent 11 ebooks to Child 1's mother by email over the period between March 2014 and June 2016. These materials were used on a regular basis for both reading fluency work conducted four times a week as well as for writing and spelling fluency activities conducted by the author as an integral part of therapy sessions. The Seven Vowel Phonic Analysis System was also used by Child 1 to learn for his weekly spelling tests at school.

orthography shared commonalities with the models proposed by Frith [43, 44], Ehri [45], and Wolf and her colleagues [46, 47]. The emphasis on developing automaticity through paired reading was based on similar assumptions to the work of Heckelman [48–50] and Laberge and Samuels [51], as well as the approaches described by Topping [52–55].

The techniques used for developing automaticity through combined use of repetitive paired reading and visual tracking in the 3 × 3 Oral Impress Method, the emphasis on developing writing and spelling automaticity through repetitive phonic analysis using the Seven Vowel Phonic Analysis System, and the emphasis on the development of sequentialisation and working memory skills through use of graded sentence and paragraph dictation passages in the Targeted Analysis, Revisualisation, and Sequential Spelling Programme reflected the author's own contributions. Each of these would appear from the literature to be unique.

It is important to stress that in addition to fluency-based activities, work was also undertaken during therapy sessions with Child 1 in areas of language and comprehension, drawing on the types of exercises suggested by Johnson and Myklebust [56], Harris and Smith [57], Spache [58], Harris and Sipay [59], as well as Moffett [60, 61]. The programme as a whole can thus be described as both fluency-based as well as language and comprehension-based. The two fluency-based areas of intervention (reading, and writing and spelling fluency) were conceptualised as activity-based and hierarchical, while the language and comprehension area was conceptualised as more eclectic, with skills requiring intervention determined both by initial assessment, as well as by clinical teaching. Each area of intervention in therapy was undertaken using simple, low-cost material [62]. In addition, phonically based reading material from the practice's database was made available by email to Child 1's mother to support her reinforcement of the fluency-based activities implemented as an integral part of each therapy session.

4. Additional children who have used the same materials and methods

Children's problems vary, and no one size fits all. There is, however, sufficient breadth of graded, phonically based material in the database of the author's practice to develop fluency-based programmes for children of different ages and with different pre-test levels of reading, writing, spelling, and sequential spelling skill. These materials have thus also been used by the parents of other children in the author's practice diagnosed as having learning disabilities manifesting in difficulties with reading, writing, and spelling, as well as fluency-based difficulties.

As a number of additional children have used the same database of materials, as well as similar methods for developing reading, writing, and spelling fluency, an opportunity sample of 19 other children was selected from the files of children with whom similar fluency-based programmes had been implemented during the years 2014, 2015, and 2016. The selection of the sample was purposive. Criteria for inclusion were that each child had been diagnosed with a learning disability affecting reading, writing, and spelling, had fluency-based difficulties, and would be exposed to work in all three areas of intervention of the fluency-based programme presented in **Table 1**.

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As the programmes developed for all of these children had similar aims and were based on the same assumptions as Child 1's individual programme, Child 1 was also included in the sample, bringing the total sample size to 20. The pre- and post-test results of all 20 children were then extracted from the practice's records, and tabulated for purposes of analysis.

5. Design of the analysis

The design of the analysis was to first establish a sample of children based on similarity in areas of difficulty and similarity in the principles applied in developing the fluency-based areas of their individual programmes [63, 64]. This sample was then grouped in terms of similarities and differences in programme inputs [65], in terms what was actually done in the therapy setting with each child [66].

The children's physical and computer files were first examined on a case by case basis. Difference in programme inputs was then used as a categorisation variable. This enabled certain case studies to be aggregated in terms of similarities in programme interventions received by the children, and certain case studies to be contrasted [67–69] on the basis of differences in programme interventions received by the children.

For purposes of analysis, the results of the initial sample of 20 children were thus partitioned into two groups. Included in the first group were 14 children who had consistent programme implementation involving all 3 areas of intervention in the programme, with regular reinforcement of programme activities from their parents at home. Based on these similarities, the results of these children were then inspected for common trends, and conclusions drawn based on triangulation across case studies.

In the second group were six children on whom one or other systematic variation in programme implementation had taken place. These data were analysed by cross-case analysis, using interpretive ex post facto analysis [70–72].

Overall, it should be noted that both groupings of data were purposive opportunity samples based on evidence drawn from clinical work. This limits generalisability [73, 74]. The analysis was also based on inspection and categorisation of the data as opposed to statistical analysis [75–77], owing to the small numbers of children involved, as well as differences in ages, physical and neurological maturation, date of intake into the practice, number of therapy sessions between pre- and post-testing, and gender within the sample.

There were also differences in initial levels of reading, writing, and spelling ability in the children, as well as variation in demographic variables such as the geographical areas in which the children lived, the schools they attended and how far they had to travel to the author's practice. In addition, there were differences in socio-economic variables such as the types of houses, townhouses, or apartment accommodation in which the children's families lived, whether one or both of their parents worked, and how the families spent their leisure time and holidays. These indicated the need for case study, as opposed to statistical treatment of the data.

However, despite age, maturation, demographic, socio-economic, and gender differences, there was a pervasive commonality across the sample as a whole, in that each child has been diagnosed as having a learning disability with difficulties affecting reading, writing, and spelling, as well as fluency-based difficulties. In addition, the individual programmes for each child were based on sufficiently similar principles and used sufficiently similar materials and methods to form the basis for aggregation and case contrast of results.

6. Results

The pre- and post-test results of the two groups are presented in **Tables 2** and **3**. **Table 2** contains the results of Child 1 and of 13 other children who had been exposed to programme inputs involving focus on language and comprehension, phonological and phonic instruction, reading fluency work, as well as writing and spelling fluency work (i.e. all of the different areas of intervention and components in the fluency-based programme). **Table 3** then presents

Child 1				
Pre-test date: March 2014	Pre-test age scores			
Grade at School: 3 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 8 yrs. 4 mths	**7 yrs. 0 mth**	**7 yrs. 7 mth**	**7 yrs. 5 mth**	**7 yrs. 0 mth**
Post-test date: June 2016	Post-test age scores			
Grade at School	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 10 yrs. 8 mths	**10 yrs. 1 mth**	**9 yrs. 10 mth**	**9 yrs. 7 mth**	**8 yrs. 10 mth**
Number of therapy sessions: 84				
Number of reading fluency books covered: 11				
Number of writing/spelling fluency paragraphs covered: 18				
Child 2				
Pre-test date: July 2015	Pre-test age scores			
Grade at School: 4 Gender female	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test 9 yrs. 9 mths	**9 yrs. 2 mth**	**9 yrs. 10 mth**	**9 yrs. 8 mth**	**7 yrs. 0 mth**
Post-test date	Post-test age scores			
Grade at School	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test 10 yrs. 2 mths	**10 yrs. 10 mth**	**11 yrs. 10 mth**	**9 yrs. 9 mth**	**13 yrs. 1 mth**
Number of therapy sessions: 22				
Number of reading fluency books covered: 5				
Number of writing/spelling fluency paragraphs covered: 10				

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Child 3

Pre-test date: November 2014	Pre-test age scores			
Grade at School: 3 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 7 yrs. 7 mth	**7 yrs. 4 mth**	**7 yrs. 3 mth**	**7 yrs. 0 mth**	**< 6 yrs. 0 mth**
Post-test date: November 2016	Post-test age scores			
Grade at School	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 9 yrs. 7 mth	**10 yrs. 8 mth**	**9 yrs. 10 mth**	**9 yrs. 4 mths**	**9 yrs. 6 mth**

Number of therapy sessions: 73

Number of reading fluency books covered: 8

Number of writing/spelling fluency paragraphs covered: 10

Child 4

Pre-test date: November 2015	Pre-test age scores			
Grade at School: 5 Gender female	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 11 yrs. 5 mth	**10 yrs. 8 mth**	**9 yrs. 5 mth**	**10 yrs. 9 mth**	**9 yrs. 6 mth**
Post-test date: July 2016	Post-test age scores			
Grade at School: 6	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test 12 yrs. 1 mth	**12 yrs. 9 mth**	**12 yrs. 1 mth**	**11 yrs. 1 mth**	**10 yrs. 9 mth**

Number of therapy sessions: 30

Number of reading fluency books covered: 6

Number of writing/spelling fluency paragraphs covered: 11

Child 5

Pre-test date: April 2014	Pre-test age scores			
Grade at School: 7 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 14 yrs. 0 mth	**8 yrs. 2 mth**	**8 yrs. 6 mth**	**6 yrs. 8 mth**	**6 yrs. 9 mth**
Post-test date: November 2016	Post-test age scores			
Grade at School: 9	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 16 yrs. 7 mth	**12 yrs. 4 mth**	**11 yrs. 0 mth**	**8 yrs. 8 mth**	**8 yrs. 8 mth**

Number of therapy sessions: 121

Number of reading fluency books covered: 9

Number of writing/spelling fluency paragraphs covered: 31

Child 6

Pre-test date: November 2015	Pre-test age scores			
Grade at School: 3 Gender female	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 9 yrs. 7 mth	**7 yrs. 9 mth**	**8 yrs. 3 mth**	**8 yrs. 4 mth**	**7 yrs. 0 mth**

Post-test date: November 2016	Post-test age scores			
Grade at School: 4	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 10 yrs. 7 mth	**10 yrs. 9 mth**	**9 yrs. 5 mth**	**8 yrs. 7 mth**	**8 yrs. 0 mth**

Number of therapy sessions: 42

Number of reading fluency books covered: 5

Number of writing/spelling fluency paragraphs covered: 15

Child 7

Pre-test date October 2015	Pre-test age scores			
Grade at School: 2 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 8 yrs. 11 mth	**7 yrs. 7 mth**	**8 yrs. 3 mth**	**7 yrs. 3 mth**	**7 yrs. 3 mth**
Post-test date: August 2016	Post-test age scores			
Grade at School: 3	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 9 yrs. 6 mths	**9 yrs. 5 mth**	**9 yrs. 10 mth**	**8 yrs. 8 mth**	**8 yrs. 6 mth**

Number of therapy sessions: 34

Number of reading fluency books covered: 2

Number of writing/spelling fluency paragraphs covered: 4

Child 8

Pre-test date: June 2014	Pre-test age scores			
Grade at School: 3 Gender female	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 9 yrs. 1 mth	**6 yr. 10 mth**	**7 yrs. 2 mth**	**5 yrs. 6 mth**	**< 6 yrs. 0 mth**
Post-test date: November 2016	Post-test age scores			
Grade at School: 5	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 11 yrs. 7 mth	**8 yrs. 11 mth**	**8 yrs. 0 mth**	**7 yrs. 7 mth**	**7 yrs. 11 mth**

Number of therapy sessions: 78

Number of reading fluency books covered: 9

Number of fluency paragraphs covered: 11

Child 9

Pre-test date: March 2016	Pre-test age scores			
Grade at School: 4 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test" 10 yrs. 6 mth	**7 yrs. 10 mth**	**8 yrs. 6 mth**	**7 yrs. 4 mth**	**6 yrs. 9 mth**
Post-test date: November 2016	Post-test age scores			
Grade at School: 4	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 11 yrs. 3 mth	**10 yrs. 0 mth**	**8 yrs. 11 mth**	**8 yrs. 2 mth**	**7 yrs. 11 mth**

Number of therapy sessions: 27

Number of reading fluency books covered: 6

Number of fluency paragraphs covered: 8

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Child 10

Pre-test date: August 2016	Pre-test age scores			
Grade at School: 2 Gender female	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 8 yrs. 10 mth	**8 yrs. 5 mth**	**7 yrs. 7 mth**	**7 yrs. 6 mth**	**< 6 yrs. 0 mth**
Post-test date: November 2016	Post-test age scores			
Grade at School: 2	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 9 yrs. 1 mth	**9 yrs. 3 mth**	**9 yrs. 2 mth**	**8 yrs. 1 mth**	**8 yrs. 6 mth**

Number of therapy sessions: 17

Number of reading fluency books covered: 3

Number of fluency paragraphs covered: 6

Child 11

Pre-test date: October 2015	Pre-test age scores			
Grade at School: 1 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 7 yrs. 4 mth	**6 yrs. 10 mth**	**7 yrs. 5 mth**	**6 yrs. 6 mth**	**< 6 yrs. 0 mth**
Post-test date: November 2016	Post-test age scores			
Grade at School: 2	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 8 yrs. 4 mth	**8 yrs. 4 mth**	**8 yrs. 8 mth**	**7 yrs. 9 mth**	**8 yrs. 4 mth**

Number of therapy sessions: 29

Number of reading fluency books covered: 4

Number of fluency paragraphs covered: 12

Child 12

Pre-test date: June 2016	Pre-test age scores			
Grade at School: 5 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 10 yrs. 8 mth	**8 yrs. 5 mth**	**8 yrs. 3 mth**	**6 yrs. 9 mth**	**< 6 yrs. 0 mth**
Post-test date: November 2016	Post-test age scores			
Grade at School: 5	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 11 yrs. 4 mth	**10 yrs. 1 mth**	**9 yrs. 10 mth**	**9 yrs. 6 mth**	**8 yrs. 10 mth**

Number of therapy sessions: 25

Number of reading fluency books covered: 4

Number of writing/spelling fluency paragraphs covered: 2

Child 13

Pre-test date: April 2016	Pre-test age scores			
Grade at School: 5 Gender female	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 8 yrs. 10 mth	**8 yrs. 6 mth**	**8 yrs. 0 mth**	**6 yrs. 6 mth**	**6 yrs. 0 mth**
Post-test date: November 2016	Post-test age scores			

Grade at School: 5	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 9 yrs. 1mth	**9 yrs. 1 mth**	**9 yrs. 5 mth**	**7 yrs. 6 mth**	**7 yrs. 0 mth**
Number of therapy sessions: 26				
Number of reading fluency books covered: 9				
Number of fluency paragraphs covered: 7				

Child 14

Pre-test date: October 2015	Pre-test age scores			
Grade at School: 1 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 7 yrs. 4 mth	**6 yrs. 6 mth**	**6 yrs. 9 mth**	**6 yrs. 8 mth**	**< 6 yrs. 0 mth**
Post-test date: November 2016	Post-test age scores			
Grade at School: 2	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 8 yrs. 4 mth	**8 yrs. 7 mth**	**9 yrs. 2 mth**	**9 yrs. 7 mth**	**8 yrs. 6 mth**
Number of therapy sessions: 29				
Number of reading fluency books covered: 4				
Number of fluency paragraphs covered: 17				

Note that in **Table 2**, the pre- and post-test scores for each child have been highlighted and also accentuated in larger font size to enable case by case visual inspection of the data for each type of assessment test used, as well as profile interpretation across different areas of the assessment.

Table 2. Pre- and post-test results of children who have worked on phonological and phonic skills, reading fluency, as well as writing and spelling fluency.

Child A: worked in only one of the fluency areas of the programme (reading fluency) owing to need to focus on phonological and phonic difficulties

Pre-test date: June 2016	Pre-test age scores			
Grade at School: 1 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 6 yrs. 8 mth	**6 yrs. 4 mth**	**5 yrs. 6 mth**	**6 yrs. 1 mth**	**< 6 yrs. 0 mth**
Post-test date: November 2016	Post-test age scores			
Grade at School: 1	One word reading	Sentence reading	One word spelling	Sequential Spelling
Age at post-test: 7 yrs. 2 mth	**8 yrs. 2 mth**	**8 yrs. 3 mth**	**7 yrs. 9 mth**	**< 6 yrs. 0 mth**
Number of therapy sessions: 24				
Number of reading fluency books covered: 10				
Number of writing/spelling fluency paragraphs covered: 0				

Child B: worked in only one of the fluency areas of the programme (reading fluency) owing to need to focus on phonological and phonic difficulties, as well as persistent letter reversals in writing

Pre-test date: December 2015	Pre-test age scores			
Grade at School: 2 Gender male	One word reading	Sentence reading	One word spelling	Sequential Spelling
Age at pre-test: 7 yrs. 6 mth	**7 yrs. 4 mth**	**7 yrs. 2 mth**	**5 yrs. 5 mth**	**< 6 yrs. 0 mth**

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Post-test date: November 2016	Post-test age scores			
Grade at School: 2	One word reading	Sentence reading	One word spelling	Sequential Spelling
Age at post-test: 8 yrs. 2 mth	**8 yrs. 6 mth**	**8 yrs. 11 mth**	**7 yrs. 9 mth**	**< 6 yrs. 0 mth**

Number of therapy sessions: 41
Number of reading fluency books covered: 3
Number of writing/spelling fluency paragraphs covered: 0

Child C: worked only during therapy sessions as parent was unwilling to work on fluency materials with child at home

Pre-test date: April 2015	Pre-test age scores			
Grade at School: 4 Gender male	One word reading	Sentence reading	One word spelling	Sequential Spelling
Age at pre-test: 10 yrs. 7 mth	**8 yrs. 2 mth**	**7 yrs. 7mth**	**7 yrs. 9 mth**	**7 yrs. 2 mth**
Post-test date: December 2016	Post-test age scores			
Grade at School: 5	One word reading	Sentence reading	One word spelling	Sequential Spelling
Age at post-test: 12 yrs. 2 mth	**8 yrs. 6 mth**	**8 yrs. 0 mth**	**8 yrs. 1 mth**	**8 yrs. I mth**

Number of therapy sessions: 45
Number of reading fluency books covered: 3 (working with therapist only)
Number of writing/spelling fluency paragraphs covered: 20

Child D: slow learning child who has worked well during therapy sessions but inconsistently on reading fluency materials, due to divorce in family, and mother's unwillingness to support the programme with work on reading fluency materials at home

Pre-test date: August 2014	Pre-test age scores			
Grade at School: 4 Gender male	One word reading	Sentence reading	One word spelling	Sequential Spelling
Age at pre-test: 14 yrs. 8 mth	**9 yrs. 8 mth**	**9 yrs. 1mth**	**9 yrs. 6 mth**	**9 yrs. 0 mth**
Post-test date: December 2016	Post-test age scores			
Grade at School: 6	One word reading	Sentence reading	One word spelling	Sequential Spelling
Age at post-test: 16 yrs. 0 mth	**11 yrs. 8 mth**	**10 yrs. 1 mth**	**10 yrs. 7 mth**	**11 yrs. 0 mth**

Number of therapy sessions: 74
Number of reading fluency books covered: 3 (working with therapist only)
Number of writing/spelling fluency paragraphs covered: 68

Child E: worked in both of the fluency areas of the programme (reading fluency, and writing/spelling fluency using analytical phonics linked to sequential spelling), but not on basic phonic skills and phonic workbooks

Pre-test date: April 2015	Pre-test age scores			
Grade at School: 7 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 8 yrs. 10 mth	**9 yrs. 7 mth**	**8 yrs. 6 mth**	**8 yrs. 0 mth**	**7 yrs. 6 mth**
Post-test date: December 2015	Post-test age scores			
Grade at School: 7	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 9 yrs. 1mth	**11 yrs. 4 mth**	**11 yrs. 4 mth**	**7 yrs. 9 mth**	**8 yrs. 6 mth**

Number of therapy sessions: 29
Number of reading fluency books covered: 9
Number of fluency paragraphs covered: 14

Child F: slow learning child who has worked on reading fluency but has not yet had consistent intervention in the writing/sequential spelling area of the programme, owing to the need to focus on developing phonological, phonic and language skills

Pre-test date: November 2013	Pre-test age scores			
Grade at School: 2 Gender male	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at pre-test: 10 yrs. 0 mth	**7 yrs. 7 mth**	**8 yrs. 6 mth**	**7 yrs. 8 mth**	**6 yrs. 0 mth**
Post-test date: December 2016	Post-test age scores			
Grade at School: 5	One word reading	Sentence reading	One word spelling	Sequential spelling
Age at post-test: 13 yrs. 0 mth	**11 yrs. 8 mth**	**10 yrs. 1 mth**	**9 yrs. 7 mth**	**7 yrs. 8 mth**

Number of therapy sessions: 97
Number of reading fluency books covered: 7
Number of fluency paragraphs covered: 6

Note that in **Table 3**, the pre- and post-test scores for each child have been highlighted and also accentuated in larger font size to enable case by case visual inspection of the data for each type of assessment test used, as well as profile interpretation across different areas of the assessment.

Table 3. Case contrasts (pre- and post-test results of children where systematic variations in implementation of the fluency-based programme have occurred).

six case contrasts (the results of six children on whom systematic variation in one or more area of programme implementation has occurred over the past 3 years).

The results presented in **Table 2** indicate a number of common trends indicating improvements made by these children in all areas pre- and post-tested. The results presented in **Table 3**, in contrast, indicate improvements in certain areas of functioning but not in others.

These trends and counter-trends in the data will be discussed in the section following, by linking particular groupings of results to particular intervention areas in the fluency-based programme. The discussion will be structured by first focusing on common trends in the results of the main body of case studies (i.e. the 14 children for whom convergent implementation of our programme has taken place). Divergences will then be highlighted, by focusing on the counter-trends evident in the six case contrasts (i.e. the six children where divergent implementation of the programme has occurred).

7. Discussion

There are limitations in interpretive analysis of case studies, as well as ex post facto analysis of evidence. Claims made on the basis of these types of evidence are limited, and essentially descriptive and exploratory.

Nevertheless, despite the cautions applying to both opportunity sampling and generalisability, a number of trends in the main body of case studies can be highlighted.

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7.1. The main body of case studies

It will be evident from **Table 2** that each of the 14 children exposed to all areas of intervention in the programme has made gains in each of the 4 areas tested. However, some of the children have made greater and quicker progress than others. Some children have also required more input in terms of therapy sessions than others, indicating that in many cases, the gains made have been hard to achieve.

For this reason, gains made by these children relative to programme input variables as well as number of therapy sessions are summarised in **Table 4**.

As programme inputs have been similar for all these children, progress made relative to number of therapy sessions has been used to further partition the data, so as to highlight trends in response to the programme.

7.1.1. Children responding rapidly to treatment

A number of the children have responded rapidly to intervention in the reading fluency area of the programme (Child 1, Child 4, Child 7, Child 10, Child 11, Child 12, and Child 14) indicated by number of therapy sessions conducted and number of reading fluency books covered. These children all commenced the programme with deficits in one word reading and sentence reading, and have all achieved reading scores within 6 months of chronological age at time of post-testing. The evaluation reports from the children's parents indicate that there have been observable differences in reading fluency, and improvement in the following problems with problems with reading accuracy and fluency which were evident prior to commencement of the programme, in the following areas:

- Word-by-word reading;
- Inaccurate reading of words;
- Incorrect reading of phrases;
- Incorrect phrasing;
- Slow rate of reading;
- Hesitant reading;
- Unconfident reading; and
- Poor reading fluency.

Child 2, Child 11, and Child 14 have also responded to the writing and spelling fluency methods used in the programme rapidly, achieving spelling, and sequential spelling scores either above or at level of within 6 months of chronological age at time of post-testing. Each of these children has also done well in their written work presented at school, as indicated by analysis of their school books and their school reports.

	Programme inputs					Programme outputs				
	Phonic workbooks	**Reading fluency**	**Writing and spelling fluency**	**Language and comprehension**	**Parent support at home**	**Word reading gains**	**Sentence reading gains**	**Word spelling gains**	**Sequential spelling gains**	**Parent fluency rating gains**
Child 1	◊	◊	◊	◊	11 bks in 27 mths	37 mths in 27 mths	27 mths in 27 mths	26 mths in 27 mths	22 mths in 27 mths	♦
Child 2	◊	◊	◊	◊	5 bks in 5 mths	20 mths in 5 mths	24 mths in 5 mths	1 mth in 5 mths	73 mths in 5 mths	♦
Child 3	◊	◊	◊	◊	8 bks in 24 mths	40 mths in 24 mths	31 mths in 24 mths	28 mths in 24 mths	42 mths in 24 mths	♦
Child 4	◊	◊	◊	◊	6 bks in 8 mths	25 mths in 8 mths	32 mths in 8 mths	4 mths in 8 mths	15 mths in 8 mths	♦
Child 5	◊	◊	◊	◊	9 bks in 31 mths	50 mths in 31 mths	30 mths in 31 mths	24 mths in 31 mths	23 mths in 31 mths	♦
Child 6	◊	◊	◊	◊	5 bks in 12 mths	36 mths in 12 mths	14 mths in 12 mths	3 mths in 12 mths	12 mths in 12 mths	♦
Child 7	◊	◊	◊	◊	2 bks in 10 mths	22 mths in 10 mths	19 mths in 10 mths	17 mths in 10 mths	15 mths in 10 mths	♦
Child 8	◊	◊	◊	◊	9 bks in 29 mths	25 mths in 29 mths	10 mths in 29 mths	25 mths in 29 mths	23 mths in 15 mths	♦
Child 9	◊	◊	◊	◊	6 bks in 8 mths	26 mths in 8 mths	5 mths In 8 mths	8 mths in 8 mths	14 mths in 8 mths	♦
Child 10	◊	◊	◊	◊	3 bks in 4 mths	8 mths in 4 mths	19 mths in 4 mths	5 mths in 4 mths	30 mths in 4 mths	♦
Child 11	◊	◊	◊	◊	4 bks in 13 mths	18 mths in 13 mths	15 mths in 13 mths	15 mths in 13 mths	28 mths in 13 mths	♦
Child 12	◊	◊	◊	◊	4 bks in 5 mths	20 mths in 5 mths	19 mths in 5 mths	33 mths in 5 mths	34 mths in 5 mths	♦
Child 13	◊	◊	◊	◊	9 bks in 7 mths	7 mths in 7 mths	17 mths in 7 mths	12 mths in 7 mths	12 mths in 7 mths	♦
Child 14	◊	◊	◊	◊	4 bks in 13 mths	25 mths in 13 mths	29 mths in 13 mths	35 mths in 13 mths	39 mths in 13 mths	♦

Note that programme inputs in **Table 4** refer to the different areas of the fluency-based programme implemented with each child. Programme outputs are quantified in terms of gains made by the child in each area of assessment (expressed as gain scores in months relative to the period of time in months spent in therapy between pre- and post-testing). Parents' rating of improvements in fluency is an additional indicator of gains made by each child. Number of months spent in therapy is an indicator of the severity of each child's learning disability.

Table 4. Analysis of programme inputs and outputs (main body of case studies).

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Child 4, Child 7, Child 10, and Child 12, in contrast, have responded well to the reading fluency area of intervention in the programme, but require additional time on task and additional work in writing and spelling areas of the programme. These needs are corroborated by analysis of their school books as well as their school reports.

7.1.2. Children responding less rapidly to treatment

Child 1, Child 3, Child 5, Child 6, and Child 8 have all been involved in working with all areas of the programme for some time, as indicated by the number of therapy sessions and the number of reading fluency books on which they have worked. These children have all made progress, but require further work.

Child 1 left the programme in June 2016 as it was felt that his parents were at that point able to address his continuing difficulties with writing and spelling themselves. Child 3, Child 5, Child 6, and Child 8 will be continuing with the programme in 2017.

7.1.3. Gains made in response to teaching both basic skills and fluency

Where focus has been placed in the programme on teaching both basic skills and training fluency, gains have been made in one word reading, sentence reading, one word spelling, and sequential spelling as measured by tests of dictation. While certain children have responded more rapidly to treatment than others, gains have been made by all children, indicating that both basic skills and fluency are trainable, in both reading and in writing and spelling.

The gains made on psychometric tests have been corroborated by qualitative evidence from parent evaluation questionnaires as well as the children's school reports. All children in the main body of case studies have made progress at school, and their parents have also evaluated the programme positively. Child 1, for example, passed the year well, 8 months after entering the programme. His mother's progress evaluation form also indicated many areas of gain, relative to his fluency skills when he commenced the programme. This is presented as Appendix 1 at the end of this chapter, together with a copy of the evaluation form itself as Appendix 2, should others wish to use it.

7.1.4. Conclusions

Overall, analysis of the main body of case studies would suggest that consistent involvement in fluency-based work is associated with gains in psychometric test scores as well as positive changes in performance at school in all 14 cases presented. On the basis of observable improvement, the parents of all 14 children have evaluated their progress positively.

It is important to stress that all 14 children in the main body of case studies have not only been involved in all areas of intervention in the fluency-based programme, but have also had consistent input both from the therapist and from the child's parents in support of particular components within the programme at home. Fluency in reading has been addressed both in therapy sessions and at home by repetitive paired reading methods, in which paragraphs read are repeated with the order of the person reading being rotated. It has also been addressed

through simultaneous focus on visual tracking. This type of intervention has led to observable effects which have sometimes been achieved quickly, but in the majority of cases have required considerable focus and application. To provide the necessary time on task, the involvement of both therapist and parent has been essential.

Fluency in writing and spelling has been addressed through a variety of methods involving not only training in phonics and basic skills in writing and copying, but also by teaching the child how to analyse words based on phonic analysis of how words work, and then using these skills as the basis for training of working memory for words in sequence. This type of intervention has led to effects which have sometimes been achieved quickly, but in the majority of cases have required considerable time on task.

In developing individual programmes for each of the 14 children, the processes of reading, writing, spelling, and comprehension have been conceptualised as linked on a functional level, with basic phonological and phonic skills initially being taught as a foundation for use in the processes of reading, writing, spelling, and comprehension. The use of repetitive paired reading has then formed the basis for developing reading fluency, while at the same time a seven vowel phonic analysis system has been introduced to provide a metacognitive basis for developing fluency in writing and spelling.

In each case where this type of linked intervention across areas and components has taken place, there has been steady and even progress. There has also been evidence of a backwash effect from application of the methods used in teaching phonic analysis into both proficiency in one word reading ability as well as fluency in reading sequentially, as well as reciprocal effects from use of reading fluency methods into competencies in writing and spelling (and vice versa). The indications would thus be that there is commonality of influence across the different areas of the fluency-based intervention programme described in this chapter.

Following Luria [78–80], the reason for commonality of influence across the different areas and components in the programme would be that the various language, reading, writing, and spelling interventions are dependent on the mediation of speech processes. They would thus be dependent on the development of both phonological and phonic abilities, which would need to be the core skills taught in the language and reading comprehension, the reading fluency, as well as the writing and spelling fluency areas of intervention in the programme, as well as across different components within each of these areas, on a functional level.

In terms of more recent literature, commonality of influence could also be cited as evidence of a common linguistic awareness manifesting in phonological, orthographic, and morphological awareness as suggested by Berninger et al. [81], and of a universal phonic principle manifesting across different orthographies as suggested by Perfetti et al. [82]. Difficulties in developing linguistic awareness and the universal phonic principle would have been assisted, as suggested by McCutchen [83], by introducing metacognitive strategies such as the Seven Vowel Phonic

http://dx.doi.org/10.5772/intechopen.72052

Analysis System in each of the 14 children's individual programmes. Greater metacognitive control, as opposed to simply increasing encapsulated automaticity, would then have accounted for the backwash effects as well as the steady progress across different areas of the fluency-based programme observed in therapy.

7.2. Case contrast analysis

In addition to the 14 children in the main body of case studies, 6 case studies have been presented in **Table 3** for purposes of case contrast. These are children for whom there has been one or other systematic variation in programme implementation (differences in programme inputs in terms of areas of the programme covered, or differences in parental support at home).

To enable case contrast, gains made by these children relative to programme input variables and number of therapy sessions are summarised in **Table 5**.

It will be evident from **Table 5** that there are differences in terms of programme input indicating that differences in the areas of intervention in the programmes implemented with each child. There has also been uneven progress in terms of the output variables, indicating that each of the six children has not made steady and even progress in terms of gains made on the four assessment tests used to monitor progress made in response to therapy. This would also indicate that that the following variables affected successful implementation of the fluency-based intervention programme with these children.

7.2.1. Parental support

Whereas each of the 14 children in the main body of case studies has been exposed to regular parental support involving exposure to repetitive paired reading on the reading fluency ebooks, and have also produced evidence of gains in reading fluency, both Child C and Child D in the contrast group have not had consistent input from their parents at home.

Gains have been made by both children, but their case files indicate that less ground has been covered and that gains would have been greater, had parental support been more consistent.

7.2.2. Exposure to all three areas of intervention in the programme

Whereas each of the 14 children in the main body of case studies has been exposed to all areas of intervention in the fluency-based programme, and have produced evidence of gains in all four sides of the assessment, both Child A and Child B have had difficulties at the phonological and phonic level which have required particular attention. They have thus been exposed to work on language and comprehension, auditory processing, phonological awareness and

	Programme inputs					Programme outputs				
	Phonic workbooks	**Reading fluency**	**Writing and spelling Fluency**	**Language and comprehension**	**Parent reinforcement at home**	**Word reading gains**	**Sentence reading gains**	**Word spelling gains**	**Sequential spelling gains**	**Parent fluency rating gains**
Child A	◊	◊		◊	10 bks in 5 mths	20 mths in 5 mths	33 mths in 5 mths	20 mths in 5 mths	0 mths in 5 mths	◆
Child B	◊	◊		◊	3 bks in 11 mths	14 mths in 11 mths	21 mths in 11 mths	26 mths in 11 mths	0 mths in 11 mths	◆
Child C	◊	◊	◊	◊	3 bks in 20 mths	4 mths in 20 mths	5 mths in 20 mths	4 mths in 20 mths	9 mths in 20 mths	Working with therapist only
Child D	◊	◊	◊	◊	3 bks in 28 mths	24 mths in 28 mths	12 mths in 28 mths	13 mths in 28 mths	24 mths in 28 mths	Working with therapist only
Child E		◊	◊	◊	9 bksin 8 mths	21 mths in 8 mths	24 mths in 8 mths	- 3 mths in 8 mths	12 mths in 8 mths	◆
Child F	◊	◊		◊	7 bks in 37 mths	37 mths in 37 mths	17 mths in 37 mths	23 mths in 37 mths	20 mths in 37 mths	◆

Note that programme inputs in **Table 5** refer to the different areas of the fluency-based programme implemented with each child. Programme outputs are quantified in terms of gains made by the child in each area of assessment (expressed as gain scores in months relative to the period of time in months spent in therapy between pre- and post-testing). Parents' rating of improvements in fluency is an additional indicator of gains made by each child. Number of months spent in therapy is an indicator of the severity of each child's learning disability.

Table 5. Analysis of programme inputs and outputs (case contrasts).

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phonics as well as consistent work on reading fluency ebooks, and have also had work on basic skills in writing and spelling.

However, neither Child A nor Child B has yet worked on the writing and spelling fluency area of the programme. The assessment data on both children also indicates that neither Child A or Child B has made gains in sequential spelling skills, suggesting that gains in sequential writing and dictation skills are associated with exposure to the writing and spelling fluency area of the programme.

This may seem a trivial and self-evident conclusion. It is an important one, nevertheless, for the reason that all children in the author's practice have been diagnosed as learning disabled against the DSM IV criteria. Certain children can also be described as resistant to treatment, as they have had previous interventions which have not been effective. As both Child A and Child B have had multiple difficulties and can also be described as treatment resistant children, evidence of improvement as well as lack of evidence of improvement would be important indicators.

7.2.3. Consistent exposure to basic phonological and phonic instruction

Whereas all of the 14 children in the main body of case studies have been exposed to all 3 areas of intervention in the fluency-based programme and have produced evidence of gains in all 4 tests used in assessment, Child E was exposed to the language and reading fluency areas and the writing and spelling fluency area of the programme. However, he was not exposed to consistent basic phonological and phonic instruction, as provided by instruction targeting the particular types of errors made on the Phonic Inventories, as well as exposure to reading skill activity books and phonic workbooks.

Child E has not made gains in spelling skills, suggesting that gains in spelling are associated with exposure to basic phonic instruction. The gains made in sequential spelling, in contrast, would appear to be associated with involvement with the sequencing, and the working memory skills taught in the writing and spelling fluency area of the programme.

It is thus important to stress that phonological and phonic abilities would appear to be the core and foundational skills essential to progress in both the reading fluency and the writing and spelling intervention areas of the programme. The evidence from analysis of Child E's results would indicate that phonological and phonic abilities should remain the focus of intervention, even where children are older, or where there are time constraints affecting programme implementation.

7.2.4. Use of the programme with slow learning children

Both Child D and Child F are slow learning children. Each child has made progress on all four sides of the assessment, but each child has required a large number of therapy sessions to support the gains made, suggesting that slow learning children can benefit from exposure to the language, reading fluency, and writing fluency areas of the programme, but require greater support to do so.

Lerner[4] has suggested that it is important to bear in mind that slow learning children learn, but that this is at a slower rate than many other children. This observation would be corroborated by the author's experience, as well as the experience of other teachers and therapists who have worked with the materials and methods used in the programme.

It has also been the author's observation that certain of the children who have been treated in the practice make gains and can "bank" the skills learned and integrities developed. In other children, deterioration takes place in the absence of repetition, indicating difficulties in long-term memory processes and needs for ongoing work to maintain and consolidate gains made.

8. Summary and evaluation

Vygotsky suggests [84] that higher mental functions such as speech, reading and writing exist as a result of interaction between highly differentiated brain structures. These structures make their own individual specific contributions to the dynamic whole. Luria [85] thus conceptualises brain structures as being dynamic and changing, as lower level functioning evolves to provide a basis for higher level functioning. The structure of mental functions does not remain constant, but is dynamic and systemic, developing the capacity for greater integration through a process of automaticity, in which previously unconnected acts become highly automatized skills.

The fluency-based programme described in this chapter is based on these assumptions. It represents an attempt to operationalise Luria's theories, and to create a resource of low-cost material which can be used to develop basic skills and automaticity in reading, and basic skills and automaticity in writing and spelling. There are a number of different areas and components in the programme, as well as four sides to the assessment process used to establish basic skill and fluency needs, and to monitor the implementation of the programme in practice.

An attempt has been made in this chapter to indicate through one detailed case study how results from assessment can be used to develop an individual programme relating to both basic skill and fluency needs both in reading and in writing and spelling, and to link these needs to a variety of programmatic activities on a functional level. The results of 14 children who have been exposed to all three areas of intervention in the programme have then been presented in tabular format. The evidence presented indicates that each of the children in the main body of case studies has made observable improvement in each of the four sides of the

[4]Comment on slow learning children made by Janet Lerner to the author in 1977.

http://dx.doi.org/10.5772/intechopen.72052

assessment used to monitor the implementation of the programme. Each of the children has also made observable improvements at school.

The results of six other children have then been presented in similar format as a case contrast group. This evidence has been drawn from the files of children in the practice for whom there has been one or other systematic variation in the way in which the programme has been implemented. Case contrast analysis has then been used to highlight three implementation variables likely to affect the successful implementation of the programme. These variables are:

- Consistent and regular exposure to phonological and phonic instruction to provide a foundation of basic skills on which the fluency interventions in the programme can be built;
- Consistent implementation of methods designed to improve both reading fluency and writing and spelling fluency to produce the greatest likelihood of positive effects; and
- Consistent support from parents in programme implementation to produce the greatest likelihood of positive effects.

There have also been unanticipated outcomes which are of interest. It was never anticipated that the reading fluency materials used in the fluency-based areas of the programme would be acceptable to children of different ages and cultural backgrounds in South Africa, for the reason that the animal characters and settings used in the ebooks were originally developed for use overseas with a child in Holland. As this child had severe learning disabilities which required long-term intervention, it was necessary to write a series of graded reading books which could lead to learning gains, while at the same time maintaining involvement, motivation, and interest [86]. The development of the first series of books then occurred over a 5 year period in the 1990s, with the content of the books being designed to match the interests and humour of this particular child as she got older.

Over the last 5 years since 2012, a large number of additional graded reading books have been written about the same set of animal characters. These reflect a variety of settings, and have been workshopped and used with South African children of different ages, and from different cultural backgrounds, whose parents report that they find them enjoyable. They are also being used by children in England, as well as in other countries adjacent to South Africa, whose parents are reporting that their children are learning to read more fluently, and at the same time enjoying the stories.

Similarly, the writing and spelling methods used in the programme have been developed over a considerable period of time, have been implemented clinically for a number of years, and have over the past 5 years been implemented with an increasing number of children of different ages, and cultural backgrounds. There is an emerging body of research evidence

indicating that other therapists working with children diagnosed as having learning disabilities have used these methods successfully, (for example, see [87–89]). There is also evidence from the network of parents, teachers, therapists, and schools using the materials, that others are able to use these methods successfully at home, in their practices, as well as in the classroom.

There are limitations in both the data and in the aggregative case study analysis presented in this chapter. The author is a clinician running a busy practice, and referrals into the practice are made from other clinicians as well as on the basis of word of mouth. The composition of the sample is thus not only highly selected on the basis of a referral network, but the evidence presented in this chapter has been based on the results of an opportunity sample consisting of those children who have worked on fluency-based individual programmes, using materials drawn from the practice's database.

Nevertheless, despite limitations in sampling as well as limitations applying to conclusions based on ex post facto case analysis and aggregation, the evidence occurring across the different case studies is recurring. Progress made by 14 children working in all three areas of intervention in the fluency-based programme would suggest that the practice's database of materials is at a point in its development where it has been successfully used with children of a variety of ages and backgrounds in South Africa. There is also additional case by case evidence that it can be used successfully with children in other countries[5].

This conclusion is based on evidence that in addition to gains in reading, spelling and dictation ages, the parents of young children, as well as adolescents report that there have been observable differences in both reading fluency, and writing and spelling fluency, linked to use of the programme's materials and methods. At the same time, their children have also made progress in relation to their learning difficulties at school, as evidenced by increase in marks and improvement in teacher comments and ratings.

The case studies presented in this chapter indicate gains in basic skills as well as gains in fluency associated with consistent use of the programme's materials and its methods,

[5] Children in South Africa, Botswana, Namibia, Mauritius as well as the United Kingdom are currently using the programme's materials and methods.

linking with positive evidence from parent evaluations, analysis of school books, and reports from school. The evidence from contrast case studies would also suggest broad-based difficulties with automaticity in the children with whom the author has worked, with gains made in areas where the programme has been implemented, and lack of gains in areas where there has been inconsistent or erratic implementation, or lack of implementation.

It has not been possible in this chapter to describe the methods used in working with the children in detail, but interested readers are referred to the author's website at http://www.charlespotter.org for more information on the fluency-based areas of the programmes used with the children whose results are reported in this chapter, its methodologies, as well as how to access the resource of materials. The interested reader is also referred to a chapter on the theory underpinning the reading fluency area of intervention in the programme, which can be downloaded free of charge by clicking on the following link: http://www.intechopen.com/articles/show/title/using-phonically-based-e-books-to-develop-reading-fluency

On the theoretical level, the results presented in this chapter would provide support for the theoretical framework developed by Luria [90–92], who has suggested that automaticity provides the necessary link between basic and more complex mental operations, and between the basic skills involved in reading, writing, and spelling and the integration required for their more complex use. The evidence of commonality of influence across different areas of the programme would also provide support for the notions of a common linguistic awareness suggested by Berninger et al. [93], and of a universal phonic principle suggested by the work of Perfetti et al. [94] and Perfetti and McCutchen [95].

It is tempting to go beyond functional descriptions of the data into clinical evidence from particular case studies which would indicate support for the various hypotheses developed in the literature to account for the phonological, visual, rate of work, procedural learning, and working memory deficits observed by others. This is beyond the scope of the two chapters presented in this book.

Overall, evidence of improvement through exposure to the programme would indicate, in line with the research of others, (for example, see [96–98]), that focused therapy not only produces changes in behaviour, but is also likely to produce changes on a central level. This, in turn, is likely to contribute to improved performance at school. This is not only a phenomenon observed internationally, but also applies in Southern Africa.

A. Appendix 1

READING FLUENCY MATERIALS: EVALUATION FORM

Date of Birth 12.10.2005 Grade at School 3

Date commenced reading fluency programme

Problems with reading accuracy and fluency prior to commencement of programme (tick each of the following if these apply)

a. Word by word reading ✓
b. Inaccurate reading of words ✓
c. Incorrect reading of phrases ✓
d. Incorrect phrasing ✓
e. Slow rate of reading ✓
f. Hesitant reading ✓
g. Unconfident reading ✓
h. Poor reading fluency ✓
i. Poor reading comprehension owing to poor reading fluency. ✓
j. Poor reading comprehension due to difficulties with language. Not sure

How many months has your child been using the reading fluency materials?
6 Months

How many of the reading fluency ebooks has your child read?
~~5~~
We are busy with Tom the Cat's Secret.

Jud the Rat and Tom the Cat
~~Jud the Rat's House~~
Jud the Cat tries to trick Jud the Rat
Tom the Cat's Secret

What type of changes have you noticed since your child started using the reading fluency materials?

J said to me today
"Mom I can now read
Jud the Rat has really helped me, maybe I'll even get a 6/7 for reading on my report."
He is much more confident
His phonics has improved and so has spelling
His anxiety levels have decrease
Overall I have a much happier child.

Any other comments?

Thank you for your help and your quiet calm approach it really has worked with J
Kumon has also shown remarkable improvement
I'm looking forward to his report at the end of the year

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B. Appendix 2

Name of Child.

Date of Birth Grade at School

Date commenced reading fluency programme.

Problems with reading accuracy and fluency prior to commencement of programme (tick each of the following if these apply)

a. Word by word reading

b. Inaccurate reading of words

c. Incorrect reading of phrases

d. Incorrect phrasing

e. Slow rate of reading

f. Hesitant reading

g. Unconfident reading

h. Poor reading fluency

i. Poor reading comprehension owing to poor reading fluency

j. Poor reading comprehension due to difficulties with language.

Number of weeks so far on reading fluency programme.

Child's response so far to reading fluency programme (please comment)

1. Has your child enjoyed the programme content? YES NO

2. Have you noted improvement in reading accuracy since starting the progamme? (please specify what you have seen)

3. Have you noted improvement in reading fluency since starting the progamme? (please specify what you have seen)

4. Have you noted improvement in reading hesitancy and/or confidence since starting the progamme? (please specify what you have seen)

5. Have you noted improvement in reading comprehension since starting the progamme? (please specify what you have seen.

6. Any other comments:

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References

[1] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966

[2] Luria AR. The Working Brain: An Introduction to Neurospychology. Harmondsworth: Penguin Education; 1973

[3] Luria AR. Basic Problems of Neurolinguistics. Vol. 73. Berlin: Walter de Gruyter; 1976

[4] Potter CS. The Phonic Inventories: An Instrument for Establishing the Patterns of Error Made by Children. Johannesburg: Norwood Remedial School. (mimeo); 1979

[5] Potter CS. Using the Phonic Inventories for Establishing the Patterns of Error Made by Children with Learning Disabilities. Paper Presented at International Conference on Learning Disabilities. SAALED and the Centre for Continuing Medical Education. Johannesburg; University of the Witwatersrand, July. 1979

[6] Potter CS. Using phonically based E-books to develop reading fluency. In: Gradinarova B, editor. E-Learning–Instructional Design, Organizational Strategy and Management. Rijeka: InTech; 2015. DOI: 10.5772/61607. Available from: http://www.intechopen.com/books/e-learning-instructional-design-organizational-strategy-and-mmanagement/using-phonically-based-e-books-to-develop-reading-fluency

[7] Potter CS. Using phonically based E-books to develop reading fluency. In: Gradinarova B, editor. E-Learning - Instructional Design, Organizational Strategy and Management. Rijeka: InTech; 2015. DOI: 10.5772/61607. Available from: http://www.intechopen.com/books/e-learning-instructional-design-organizational-strategy-and-management/using-phonically-based-e-books-to-develop-reading-fluency

[8] Pearson Curriculum Group. Modern Curriculum Press Phonic Workbooks Levels A, B and C. Saddle River, NJ: Pearsons; 2011

[9] Potter CS. The 3 x 3 Oral Impress System: A Manual. Electronic copy available from my practice by emailing me at: pottercs@gmail.com; 2012

[10] Potter CS. The Phonic Inventories: An Instrument for Establishing the Patterns of Error Made by Children. Johannesburg: Norwood Remedial School (mimeo); 1979

[11] Potter CS. The Phonic Inventories: An Ipsative Instrument for Analysing the Error Patterns of Children. Johannesburg: University of the Witwatersrand, Department of Psychology (mimeo); 1996

[12] Potter CS. The Seven Vowel Phonic Analysis System: A Manual. Electronic copy available from my practice by emailing me at pottercs@gmail.com; 2014

[13] Potter CS. The use of the Targeted Revisualisation Programme in the Development of Spelling Capacity. Johannesburg: University of the Witwatersrand: Department of Psychology (mimeo); 2000

[14] Potter CS. Model of the Sequence of Instruction Followed in the Targeted Spelling, Imagery, Reading and Revisualisation Programme. Johannesburg: University of Witwatersrand; Department of Psychology (mimeo); 2001

[15] Potter CS. The Targeted Analysis, Revisualisation and Sequential Spelling Programme: A Manual. Electronic copy available from my practice by emailing me at: pottercs@gmail.com; 2016

[16] Ravenscroft G. Remedial instructional techniques: Assessing the effectiveness of high imagery teaching techniques in the remedial environment. Unpublished Masters Thesis. Johannesburg: University of the Witwatersrand; 2008

[17] Schonell FJ. Essentials in Teaching and Testing Spelling. London: MacMillan; 1974

[18] Potter CS. The Use of Targeted Recall Imagery in the Development of Reading Writing and Spelling Ability. Johannesburg: University of Witwatersrand; Department of Psychology (mimeo); 2003

[19] Potter CS. A Longitudinal Analysis of a Child Taught Using High Imagery Teaching Techniques (A Case Study Report). Johannesburg: University of the Witwatersrand; Department of Psychology (mimeo); 2004

[20] Johnson DJ, Myklebust HR. Learning Disabilities; Educational Principles and Practices. New York: Grune and Stratton; 1967

[21] Harris LA, Smith CB. Reading Instruction through Diagnostic Teaching. New York: Holt, Rinehart and Winston; 1972

[22] Harris AJ, Sipay SR. How to Improve Reading Ability. White Plains, NY: Longman; 1990

[23] Spache GD. Diagnosing and Correcting Reading Disabilities. Boston, MA: Allyn and Bacon; 1976

[24] Moffett J. Teaching the Universe of Discourse. Boston, MA: Houghton Mifflin; 1968

[25] Moffett J. A Student-Centred Language Arts Curriculum Grades K-13. Boston, MA: Houghton Mifflin; 1973

[26] Potter CS. The 3 x 3 Oral Impress System: A Manual. Electronic copy available from my practice by emailing me at pottercs@gmail.com; 2012

[27] Potter CS. The Seven Vowel Phonic Analysis System: A Manual. Electronic copy available from my practice by emailing me at pottercs@gmail.com; 2014

[28] Potter CS. The Targeted Analysis, Revisualisation and Sequential Spelling Programme: A Manual. Electronic copy available from my practice by emailing me at pottercs@gmail.com; 2016

[29] Perfetti CA, McCutchen D. Speech Processes in Reading. Speech and Language: Advances in Basic Research and Practice. Academic Press, New York. Vol. 71982. pp. 237-269

[30] McCutchen D, Perfetti CA. The visual tongue-twister effect: Phonological activation in silent reading. Journal of Verbal Learning and Verbal Behavior. 1982;**21**(6):672-687

[31] Perfetti CA, McCutchen D. Schooled language competence: Linguistic abilities in reading and writing. Advances in Applied PsychoLinguistics. 1987;**2**:105-141

[32] McCutchen D. "Functional automaticity" in children's writing: A problem of metacognitive control. Written Communication. 1988;**5**(3):306-324

[33] Perfetti CA, Zhang S, Berent I. Reading in English and Chinese: Evidence for a "universal" phonological principle. Advances in Psychology. 1992;**94**:227-248

[34] Seymour PH, Aro M, Erskine JM. Foundation literacy acquisition in European orthographies. British Journal of Psychology. 2003;**94**(2):143-174

[35] Orton ST. Reading, Writing and Speech Problems in Children. Psyclit database, PsycINFO Database Record (c) 2016 APA; 1937

[36] Gillingham A, Stillman BW. Remedial Training for Children with Specific Disability in Reading, Spelling and Penmanship. The authors; 1946

[37] Gillingham A, Stillman BW. The Gillingham Manual. Cambridge, MA: Educators; 1997

[38] Fernald GM. Remedial Techniques in Basic School Subjects. New York and London: McGraw-Hill Book Company; 1943

[39] Spalding RB. The Writing Road to Reading: A Modern Method of Phonics for Teaching Children to Read. New York: Whiteside and Morrow; 1962

[40] Spalding RB, DesRoches JR. The Writing Road to Reading. New York: William Morrow; 1986

[41] Spalding RB, Spalding WT. The Writing Road to Reading: The Spalding Method of Phonics for Teaching Speech, Writing, and Reading. 4185 SW 102nd Avenue, Beaverton, OR 97005: Riggs Institute; 1990

[42] Caroline SM. Breaking the Sound Barrier: A Phonics Handbook. New York: Macmillan; 1960

[43] Frith U. Beneath the surface of developmental dyslexia. Surface Dyslexia. 1985;**32**:301-330

[44] Frith U. A developmental framework for developmental dyslexia. Annals of Dyslexia. 1986;**36**(1):67-81

[45] Ehri LC. Learning to read words: Theory, findings and issues. Scientific Studies of Reading. 2005;**9**:167-188

[46] Wolf M, Miller L, Donnelly K. Retrieval, automaticity, vocabulary elaboration, orthography (RAVE-O) a comprehensive, fluency-based reading intervention program. Journal of Learning Disabilities. 2000;**33**(4):375-386

[47] Wolf M, Barzillai M, Gottwald S, Miller L, Spencer K, Norton E, Morris R. The RAVE-O intervention: Connecting neuroscience to the classroom. Mind, Brain, and Education. 2009;**3**(2):84-93

[48] Heckelman RG. A neurological impress method of reading instruction. Merced, CA: Merced County Schools Office; 1962

[49] Heckelman RG. A neurological-impress method of remedial-reading instruction. Academic Therapy. 1969;**4**(4):277-282

[50] Heckelman RG. N.I.M. Revisited. Academic Therapy. 1986;**21**(4):411-420

[51] Laberge D, Samuels JS. Toward a theory of automatic information processing in reading. Cognitive Psychology. 1974;**6**(2):293-323

[52] Topping K. Paired reading: A powerful technique for parent use. The Reading Teacher. 1987;**40**(7):608-614

[53] Topping K. (b). Peer tutored paired reading: Outcome data from ten projects. Educational Psychology: An International Journal of Experimental Educational Psychology. 1987;**7**(2):133-145

[54] Topping K. Peer tutoring and paired reading: Combining two powerful techniques. The Reading Teacher. 1989;**42**(7):488-494

[55] Topping K. Paired Reading, Spelling and Writing: The Handbook for Teachers and Parents. London: Cassell; 1995

[56] Johnson DJ, Myklebust HR. Learning Disabilities; Educational Principles and Practices. New York: Grune and Stratton; 1967

[57] Harris LA, Smith CB. Reading Instruction through Diagnostic Teaching. New York: Holt, Rinehart and Winston; 1972

[58] Spache GD. Diagnosing and Correcting Reading Disabilities. Boston, MA: Allyn and Bacon; 1976

[59] Harris AJ, Sipay SR. How to Improve Reading Ability. White Plains, NY: Longman; 1990

[60] Moffett J. Teaching the Universe of Discourse. Boston, MA: Houghton Mifflin; 1968

[61] Moffett J. A Student-Centred Language Arts Curriculum Grades K-13. Boston, MA: Houghton Mifflin; 1973

[62] Potter CS. Using phonically based e-books to develop reading fluency. In: Gradinarova B, editor. E-Learning–Instructional Design, Organizational Strategy and Management. Rijekae: InTech; 2015. DOI: 10.5772/61607 Available from: http://www.intechopen.com/books/e-learning-instructional-design-organizational-strategy-and-management/-using-phonically-based-e-books-to-develop-reading-fluency

[63] Cohen L, Manion L. Research Methods in Education. 3rd ed. London: Croom Helm; 1989

[64] Denzin NK. The Research Act: A Theoretical Introduction to Sociological Methods. Chicago: Aldine; 1970

[65] Stufflebeam DL. The CIPP model for program evaluation. In: Guba EG, Lincoln YS, editors. Effective Evaluation: Improving the Usefulness of Evaluation Results through Responsive and Naturalistic Approaches. San Francisco, CA: Jossey-Bass; 1981. pp. 117-142. Refer also Wikipedia, Program Evaluation

[66] Denzin NK. The logic of naturalistic inquiry. In: Denzin NK, editor. Sociological Methods: A Sourcebook. New York: McGraw-Hill; 1978. pp. 54-73

[67] Lucas W. The Case-Survey Method: Aggregating Case Experience. Santa Monica, CA: Rand Corporation; 1974

[68] Lucas W. The Case-Survey and Alternative Methods for Research Aggregation. Santa Monica, CA: Rand Corporation; 1974

[69] Seawright J, Gerring J. Case selection techniques in case study research: A menu of qualitative and quantitative options. Political Research Quarterly. 2008;**61**(2):294-308

[70] Guba EG, Lincoln YS. Epistemological and methodological bases of naturalistic inquiry. In: Madaus GE, Scriven M, Stufflebeam DL, editors. Evaluation Models: Viewpoints on Educational and Human Services Evaluation. Kluwer-Nijhoff: Boston, MA; 1983. pp. 311-334

[71] Neuman WL. Social Science Methods: Qualitative and Quantitative Methods. Boston, MA: Allyn and Bacon; 1997

[72] Potter CS. Programme evaluation. In: Terre Blanche M, Durrheim K, Painter D, editors. Research in Practice: Applied Methods for the Social Sciences. 2nd ed. Cape Town: University of Cape Town Press; 2006. pp. 409-428

[73] Kerlinger FN, Lee HB. Foundations of Behavioral Research. New York: Holt, Rinehart and Winston; 1999

[74] Babbie E. The Practice of Social Research. 9th ed. New York: Wadsworth; 2001

[75] Stake RE. The case study method in social inquiry. In: Madaus GF, Scriven MS, Stufflebeam DL, editors. Evaluation Models: Viewpoints on Educational and Human Services Evaluation. Kluwer-Nijhoff: Boston, MA; 1983. pp. 279-286

[76] Wilson SL. Single case experimental designs. In: Breakwell GM, Hammond S, Fife-Shaw C, editors. Research Methods in Psychology. Thousand Oaks, CA: Sage; 1995. pp. 69-84

[77] Rosenthal R, Rosnow RL. Essentials of Behavioral Research: Methods and Data Analysis. 2nd ed. New York: McGraw-Hill; 1991

[78] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966

[79] Luria AR. The Working Brain: An Introduction to Neurospychology. Harmondsworth: Penguin Education; 1973. p. 30

[80] Luria AR. Basic Problems of Neurolinguistics. Vol. 73. Berlin: Walter de Gruyter; 1976

[81] Berninger VW, Abbott RD, Nagy W, Carlisle J. Growth in phonological, orthographic, and morphological awareness in grades 1 to 6. Journal of Psycholinguistic Research. 2010;**39**(2):141-163

[82] Perfetti CA, Zhang S, Berent I. Reading in English and Chinese: Evidence for a "universal" phonological principle. Advances in Psychology. 1992;**94**:227-248

[83] McCutchen D. "Functional automaticity" in children's writing: A problem of metacognitive control. Written Communication. 1988;**5**(3):306-324

[84] Vygotsky LS. Razvitie vysshikh psikhicheskikh funktsii [Development of the Higher Mental Functions]. Moscow: Publishing House of the R.S.F.S.R. Academy of Pedagogical Sciences; 1960. pp. 384-393

[85] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966. pp. 36-37

[86] Sfetsios N. The use of Mental Imagery in the Treatment of a Child with Severe Learning Disabilities. Honours Research Report. Johannesburg: University of the Witwatersrand, Department of Psychology; 2002

[87] Els K. The use of Mental Imagery in Improving the English Spelling, Reading and Writing abilities of Grade IV Learners with Learning Disabilities. Honours Research Report. Johannesburg: University of the Witwatersrand, Department of Psychology; 2003

[88] Els K. The use of mental imagery in improving the simultaneous and successive processing abilities of grade V learners with learning disorders of reading and written expression. Unpublished Masters Thesis. Johannesburg: University of the Witwatersrand; 2005

[89] Ravenscroft G. Remedial instructional techniques: Assessing the effectiveness of high imagery teaching techniques in the remedial environment. Unpublished Masters Thesis. Johannesburg: University of the Witwatersrand; 2008

[90] Luria AR. Higher Cortical Functions in Man. London: Tavistock Publications; 1966

[91] Luria AR. The Working Brain: An Introduction to Neurospychology. Harmondsworth: Penguin Education; 1973. p. 30

[92] Luria AR. Basic Problems of Neurolinguistics. Vol. 73. Berlin: Walter de Gruyter; 1976

[93] Berninger VW, Abbott RD, Nagy W, Carlisle J. Growth in phonological, orthographic, and morphological awareness in grades 1 to 6. Journal of Psycholinguistic Research. 2010;**39**(2):141-163

[94] Perfetti CA, Zhang S, Berent I. Reading in English and Chinese: Evidence for a "universal" phonological principle. Advances in Psychology. 1992;**94**:227-248

[95] Perfetti CA, McCutchen D. Schooled language competence: Linguistic abilities in reading and writing. Advances in. Applied PsychoLinguistics. 1987;**2**:105-141

[96] Simos PG, Fletcher JM, Bergman E, Breier JJ, Foorman BR, Castillo EM, Davis RN, Fitzgerald M, Papanicolaou AC. Dyslexia-specific brain activation profile becomes normal following successful remedial training. Neurology. 2002;**58**(8):1203-1213

[97] Shaywitz BA, Shaywitz SE, Blachman BA, Pugh KR, Fulbright RK, Skudlarski P, Mencl WE, Constable RT, Holahan JM, Marchione KE, Fletcher JM, Lyon GR, Gore JC. Development of left occipitotemporal systems for skilled reading in children after a phonologically-based intervention. Biological Psychiatry. 2004;**55**(9):926-933

[98] Maurer U, Brem S, Kranz F, Bucher K, Benz R, Halder P, Steinhausen H, Brandeis D. Coarse neural tuning for print peaks when children learn to read. NeuroImage. 2006;**33** (2):749-758

Chapter 9

Exploring Community Attitudes to People with Learning Disabilities: Using a Micro-Neighbourhood Design

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Additional information is available at the end of the chapter

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Abstract

People with learning disabilities living in the community strive for meaningful social inclusion and integration. The attitudes of society to such individuals living in communities continues to be the catalyst that will enable them to achieve genuine social inclusion and integration. Identified barriers to social inclusion are a lack of change in societal attitudes towards people with learning disabilities. People with learning disabilities should live in a socially, not just functionally, integrated manner in community settings. Hence, attitudes of the community are extremely influential in achieving social integration and inclusion. It is important therefore to plan how best to capture attitudes in fact. An exemplar of a completed comparative study in Ireland, which used a micro-neighbourhood design combined with a random survey, illustrates how attitudes can be researched effectively. Study findings show that while attitudes were generally positive towards people with learning disabilities, there was no evidence of social integration, only functional integration. These findings reflect the challenges of achieving authentic social inclusion and integration and warrant further exploration by government agencies and service providers for people with learning disabilities. The study design outlined can contribute to gaining a true insight of societal attitudes.

Keywords: attitudes, community, learning disabilities, social inclusion, micro-neighbourhood

1. Introduction

Today, people with learning disabilities live in the community and strive for meaningful social inclusion [1]. The attitudes of society to such individuals living in communities continue to be the catalyst that will enable them to achieve genuine social inclusion

and integration [2]. Debenham [3] identified a barrier to social inclusion as the slow or complete lack of change in attitude from people in society towards people with learning disabilities. This paradigm of care, which focuses on community living and social integration, is however influenced by the attitudes of the general public [3]. In attitude research, expressed opinions may not be the views in fact held by respondents, but views in principle only [4]. Presence without participation can be more isolating than no presence at all [5]. Over the last number of years, there have been significant advances in the growth and development of services in the community for people with learning disabilities worldwide. Contemporary evidence-based practice has focused on the philosophy of social inclusion for people with learning disabilities living in the community [6, 7]. This philosophy is based on the proposition that the quality of life of a person with a disability increases as access to culturally typical activities and settings increases.

The chapter will firstly provide a brief discussion on the move from institutional to community care for people with learning disabilities. It then explores attitudes and the possible influences of these attitudes towards people with learning disabilities. This will then be followed by an exploration of researching attitudes. An exemplar of a completed study in Ireland, which utilized a randomized survey combined with a micro-neighbourhood design, will then be discussed.

2. Attitudes towards the care of people with learning disabilities

Over the years, perceptions towards disability have varied significantly from one community to another and traditional approaches to the care of people with learning disabilities have a rather tarnished history [6]. In this chapter, learning disability is categorized according to the international classification of diseases (ICD) [10] where it is classified as a condition of arrested or incomplete development of the mind, which is characterized by impairment of skills, and manifested during the developmental period, which contributes to the overall level of intelligence, i.e. cognitive, language, motor and social abilities [8].

When children who were labelled 'feeble minded' grew into adults, those who could no longer be taken care of in their own homes were put into asylums or workhouses [9]. Goffman [10] spoke of such institutional care as the tendency towards the absolute control of every aspect of a person's life and which led him to coin the term 'total institution'. This was a situation where people were totally cut off from the wider society for an appreciable period and all aspects of life were conducted in the same place in the immediate company of others and all within the same hierarchic and bureaucratic framework [10]. Similarly, King et al. [11] wrote on institutional care and described how it included block treatment, rigidity of routine, social distance and depersonalization. Goffman referred to living in such institutions as being stripped of one's identify kit [10].

For people with a learning disability, the situation was even worse because their experiences may only have been of institutional life and their '*identify kit*' may solely have consisted of

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institutional life and practices. It is very evident that these institutions failed to provide normal experiences for those with a learning disability.

3. The move to community care

In many countries, the 1970s brought about major changes in where those with a learning disability were housed and cared for. Normalization as a philosophy of care originated in Scandinavia at the end of the 1950s as a reaction to the shortcomings of institutional care for those with a learning disability. It was based on the premise that the quality of life of a person increases as access to culturally typical activities and settings increased in the person's life. The principle of normalization rested on the premise that people with learning disabilities should enjoy, as far possible, the services available to ordinary people. This philosophy offered a powerful stimulus to the replacement of institutional care [12].

Bank–Mikkelsen [13] defined normalization in terms of enabling people with learning disabilities to live similar lives to people without disabilities. Wolfensberger [14] defined normalization as the utilization of means that are as culturally normative as possible with the avoidance of special segregated services. He later suggested [15] that the term normalization should be changed to social role valorization as he felt that this emphasized the true goal of normalization—that is the development of valued social roles for all people who are at risk of social devaluation.

4. Social inclusion

Over the past 30 years, people with learning disabilities have increasingly been living in community settings rather than in segregated facilities and this pattern is reflected internationally [16–17]. People living in the community are assumed to be more likely to use community resources and to have more opportunities to experience roles and relationships that are inherent to being part of a community, thus achieving social inclusion [18].

Social inclusion can be described as not only being present in a community, but also having meaningful social connections and participating in fulfilling social activities [19]. Clifford-Simplican et al. [2] further define social inclusion as the interaction between two major life domains: interpersonal relationships and community participation and developed an ecological model of social inclusion that includes individual, interpersonal, organizational, community and socio-political factors.

It is widely acknowledged that this community participation remains an important element of well-being for people with learning disabilities [18] and a key component of the United Nations Convention on the Rights of Persons with Disabilities [19]. People with learning disabilities, however, continue to experience high rates of social isolation [18, 20–24], and their social networks are composed mainly of family members and professionals [25]. The pattern

of service provision perceived by Ritchie [25] in 1999 was one of the segregation and could still be said to be the same.

The aim therefore of service providers who wish to improve the lives of people with learning disabilities should be to reduce segregation and promote social inclusion. It seems that people with learning disabilities living in community settings participate more than people living in segregated setting; however, the level of participation is still much lower than in other marginalized groups [17, 26–27]. For social inclusion to occur, consideration must be taken of the attitudes of those in communities towards people with learning disabilities.

5. Attitudes

Belief systems, values and attitudes impact on how a person responds to others, those with or without a learning disability, either at an individual, group or societal level [25]. McConkey [27] defines attitude as peoples' expressed opinion and their anticipated reactions towards specific events within their personal experience.

Attitudes can also be defined in terms of mood, thought processes, behavioural tendencies and evaluation [28, 29]. Evaluations including cognition, affect and behaviour are fundamental to the notion of attitudes. Cognitive evaluations refer to thoughts people have about the object. Affective evaluations refer to feelings or emotions people have and behavioural evaluations refer to people's ensuing actions. Attitudes are generally accepted as stable qualities in a person or society and empirical evidence would suggest that attitudes are cognitively and behaviourally learned rather than native [29].

In relation to learning disability, Gellman [30] proposed that positive or negative societal attitudes to people with learning disabilities are learned in early childhood and are dictated by socially accepted norms whereby society creates attitudes towards the people who are categorized as different.

Thomas [31] suggests that societal perceptions and treatments of persons with disabilities within all cultural settings vary from acceptance or tolerance to hatred or indeed awe or revulsion. The affective attitudes held by society as identified by Wright [32] included pity, fear, uneasiness, guilt, genuine, sympathy and respect. These attributes are clearly divided into positive and negative categories and are likely to impact the relationship between persons with disabilities and society. Negative attitudes can and do stigmatize people with disabilities, thereby, denying them equal opportunities for personal and professional development, living options and demoting them to second-class citizens, who should be pitied [33].

In many instances, the initial response when dealing with people with learning disabilities is to place the individual in a predetermined category based on what is assumed to be his or her attributes and status based on exterior appearance. Such attitudes produce stigma and isolation. Wright [32] describes the phenomenon of stigma extension as taking place when a person with a disability is viewed as disabled not only with respect to the specific area of disability but also to other characteristics.

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Societal attitudes are significant since they largely determine the extent to which the personal, social, educational and psychological needs of people with learning disabilities will be met [34–35]. From every standpoint, whether that of human rights or social desirability, people with learning disabilities should be treated equally with all others. Those labelled 'disabled' are often treated differently by society, which may emphasize the disability of the individual instead of their ability. Ritchie [25] identified that adults with a learning disability are much less likely than other people in society to have their own home, to have a paid job, to be included in their local school, to have a network of social contacts or to have a bank account.

Bert Massie, Chairperson of the UK Disability Rights Commission, highlighted that attitudes to disability are the major barrier to peoples' full participation, integration and acceptance by societies [35]. While such negative attitudes persist, the full rights of people with learning disabilities will not be justly realized [37]. Researchers no longer question if attitudes predict behaviours, but under what circumstances do attitudes predict behaviours [38]. Behaviour is related to attitudes in complex ways and many factors do influence the attitudes of society.

Attitudes are directly influenced by personal experience of events or people and resultant positive or negative reinforcement outcomes [39–40]. Attitudes are indirectly swayed by social learning and observation or by learning through association [39–40]. A clear relationship exists between attitudes and personal experience of disability and this truism has been identified in many research projects worldwide [41–43].

The role of direct experience may be particularly important in attitude formation. Positive effects of contact have been demonstrated in many arenas including attitudes towards the elderly, psychiatric patients and children with disability [44–47]. Attitudes formed through direct experience may be better predictors of later behaviour than attitudes formed through indirect experience.

Hewstone [46] attempted to answer how direct contact between groups work in changing attitudes and diminishing or banishing prejudices. Pettigrew and Tropp [45] proposed four major potential mechanisms: learning about the other group, the '*out group*'; behaviour-driven attitude change, e.g. forming more positive attitudes after cooperating in a learning task; '*in-group*' reappraisal and; generating affective ties. It is engendering affective links, including the creation of close friendships that seems to be the most effective strategy in reducing negative stereotypes and misinformed preconceptions about disability.

Deal [47] found that the contact hypothesis was not supported by his research on attitudes of people with disabilities to other people with disabilities and diverse functional impairments. He suggests, however, that whether the contact between people with disabilities is voluntary or involuntary may be a significant variable. Allport [48] in his classic volume, The Nature of Prejudice, expounded the contact hypothesis for future generations of policy makers and social psychologists.

Hewstone [46] demonstrated through research that contact works to improve attitudes, how it works and when it works. Antonak [49] showed that the most influential factor in the attitudinal scores in his study was the intensity of contact with people with disabilities and centred on the impact of contact, however this contact must be on at least equal terms [49].

Wai et al. [40] found, in common with other studies including Gelber [41] and Elmaleh [42], that contact and knowledge factors influence the development of positive attitudes towards people with disabilities.

5.1. Researching attitudes

Experts in attitude research generally divide methods to measure attitudes into direct and indirect approaches [50]. Direct methods involve the respondents being aware that they are participating in attitude measurement and typically involves self-report surveys. Due consideration should be given to the use of more subtle or indirect methods of assessing attitudes. People may often hold subtle forms of prejudice towards disability that may not be detected when using more direct methods that allow respondents to respond in ways they consider more socially appropriate [51] and therefore while it is now more socially appropriate for the public to espouse positive global attitudes towards disability than negative, specific attitudes, if investigated, may be found to be more negative [4]. This social desirability phenomenon, where it becomes more appropriate socially to express certain sentiments and attitudes, may not necessarily be reflected in behaviour.

Ichheiser [4] was a social psychologist of the Austrian phenomenological tradition wrote in depth about attribution biases long before other theorists. He theorized that people have two aspects of personality, their visible outside that is exposed to pressure and control from others and an invisible inside. In other words, society misshapes the image of the other person by describing certain characteristics to their personality. He argued that attitudes and opinions are often based on the assumption people do have definite attitudes and opinions, however most people have confused ambiguous indefinite opinions and attitudes about many things, and their attitudes and sentiments are often still more confused [4].

Therefore, Ichheiser [4] maintained that the findings in attitude research seriously missed the point. The reason for this was that people expressed to use '*views in principle*' and '*views in fact*'. He suggested that views in principle are how people think they would act or how they think they should act when confronted by issues are events that are important. *Views in fact* determined a person's actions and reactions when exposed to certain events or issues. He posited that both views were genuine. This theory assists in explaining how members of society, for example, who live in areas where there were no community-homes express no reservations about having people with learning disabilities as neighbours [views in principle]; whereas views in fact surface when a community based home for people with learning disabilities is next door to their home. This latter attitude is referred to as not in my backyard (NIMBY)'effect.

Ichheiser [4] theorized that to prevent distance confounding attitude results, immediate neighbours should be targeted in attitude research. Therefore, in researching attitudes, a micro-neighbourhood has utility and applicability.

Decisions on choice of instrumentation to measure attitude are always a compromise between the ideal and the practical. It is advisable, however, to use a previously developed validated instrument that has been used in similar attitude [27] research, as showcased in the exemplar, Methodology section. Other widely used instruments to examine attitudes towards people with learning disabilities include the *Attitudes towards Disabled Persons Scale* [ATDP, 52] and the *Scale of Attitudes towards Disabled Persons* [SADP, 53]. Both these tools assess attitudes from a

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social as opposed to a personal perspective with questions centring how persons are, or should be, treated at the societal level [54]. The latter instrument however poses concerns, specifically relating to socially desirable responses (views in principle) and false positive scores. A more contemporary instrument, commonly used, is the *Attitudes towards Intellectual Disability Questionnaire* [ATTID, 55]. This instrument was developed according to a multi-dimensional model [56] addressing affective, cognitive and behavioural components of attitudes. The ATTID is based on several previously validated instruments such as the *Mental Retardation Attitude Inventory—Revised* [57], the *Behavioural Intention Scale* [58], the *Community Living Attitudes Scale-Mental Retardation* [59], the *Pictographic Scale* [36] and the interview questionnaire from the *Multinational Attitude Study Survey* [60]. Cronbach's alpha coefficients for the ATTID range from 0.59 to 0.89 showing good internal consistency for the five factors and 0.92 for the overall questionnaire; test-retest reliability generated correlations ranging from 0.62 to 0.83 for the five factors [56]. Morin et al. [55] suggest that the ATTID *can* be used to measure attitudes among different populations and allows comparisons over time within the same population.

The ATTID questionnaire has much practical and research utility in attitude research where the researcher is endeavouring to ascertain the general population attitude in relation to people with learning disabilities.

Much of the research on attitude has suggested however that increasing personal contact with people with learning disabilities by supporting them to access education, employment and social activities on an equal footing with everyone else may prove to be the most important and equitable of interventions. Abbott and McConkey [61] argue that positive attitudes follow on from increased social contact, thus a priority should be to provide opportunities for people with disabilities to engage in social contact. Clifford-Simplican et al. [2] recommended further research in the community. They highlight that communities face different challenges in fostering social inclusion depending on their characteristics, e.g. rural versus urban communities, or heterogeneous versus homogenous communities. Different forms of community organizations will likely have different attitudes towards people with learning disabilities that affect social inclusion and hence ascertaining these attitudes is very important, bearing in mind the need to separate attitudes in fact to attitudes in principle.

A research case study exemplar utilizing McConkey et al.'s [62, Appendix 1] *Attitude Questionnaire* and micro-neighbourhood combined with a comparative survey design will be outlined hereunder, which will compare views/attitudes in principle versus views/attitudes in fact. More specifically, the research examined if differences existed in attitudes to people with learning disabilities in the immediate vicinity of a community-home for people with learning disabilities, when compared with those living in a neighbourhood with no such community-homes.

6. Methodology

6.1. Aim

The aim of the current attitude research was to identify community attitudes to people with learning disabilities living in the community in Southern Ireland.

6.2. Research design

The current study utilized a comparative descriptive design, combining a random survey and a micro-neighbourhood sample. There are many research designs in attitude research and one of the authors would recommend to showcase an exemplar of attitude research is a comparative descriptive design when ascertaining attitudes to people with learning disabilities living in the community. This design has utility and practical application when endeavouring to compare the attitudes of two groups within the population under study. In line with the importance of researching attitude, the rationale behind using a micro-neighbourhood design and a simple random survey design was to ascertain true attitudes (views in fact as opposed to views in principle), as evidenced in the literature review.

This comparative descriptive design incorporates a micro-neighbourhood design [63; **Figure 1**] and a simple random survey design. A micro-neighbourhood is defined as surveying the houses surrounding a target house(s), that is, community-home for people with learning disabilities. The researcher using this design is required to survey two houses on either side of the target house on the same side of the street; the five closest houses across the street and the three closest houses behind the target house (n = 12). If the target house deviates from this definition in one respect or another, e.g. if houses did not exist behind the target house, the sampling frame should be reduced rather than extended.

6.3. Research sample

A 5% margin of error (the error in estimating a proportion with 95% confidence) is the one most commonly used in research, more especially if, a priori, no such research had been previously carried out. One method of calculating the sample size (n) required for a given some population (N) is to substitute the values in this equation [64, 65]. Five percent margin of error = 1.96 (√2500 / N) × (1−n / N); however, statistical calculation using statistical software produces a faster and more accurate calculation. The population in the chosen electoral areas was (29,490) therefore 400 was estimated as a representative sample and allowed for a 5% margin of error. A simple random selection was used to proportionally select the sample from each of the electoral areas in the city, using the electoral register

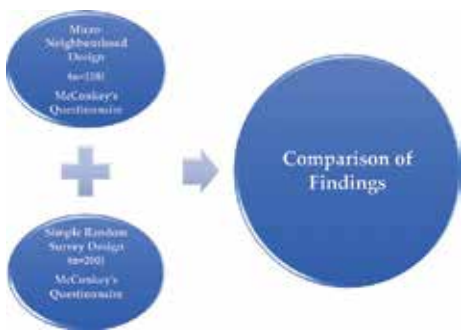

Figure 1. Comparative descriptive design.

(Area 1 = 8191 ; Area 2 = 10,453; Area 3 = 10,846) total (n = 200) (N = 29,490). The target micro-neighbourhood houses (n = 158) were excluded from the random selection. Therefore, the total sample consisted of 358 houses.

6.4. Recruiting and retaining sample

It has been noted that very few people refuse to take part in social research [65]. Therefore, there is a need for extra care when seeking access for research purposes to ensure fully informed consent obtained and full disclosure is made regarding the operationalization of the research process. A letter was sent to prospective respondents prior to the survey, explaining the rationale, aims and objectives of the research. The research information sheet explained how the final report would benefit services in the planning of future of services in the community for people with learning disabilities. The respondents were informed that the findings of the research would be made available to them if such a request was made.

6.5. Ethical approval

Ethical approval was sought from the university where the research was supervised and from main service provider for people with learning disabilities in a city in the South East of Ireland.

6.5.1. Anonymity and confidentiality

Assurances of confidentiality were conveyed in writing both in the research information sheet that was left with respondents and in the letter that was sent to participants prior to the survey being carried out. Participants were reassured that information would be analysed as group data so that individuals could not be identified by their responses and questionnaires were assigned number codes for statistical purposes only.

7. Instrument

The current research utilized a structured questionnaire developed by McConkey [62] with validated psychometric properties. The principal components analysis of all measures of attitude to people with learning disabilities was used in this questionnaire [27]. The questionnaire uses a mix of closed (Likert scales) and open questions to ascertain participants' attitude to people with learning disabilities living in the community. Four main factors or groupings of attitude measurement were used, e.g. contact with people with learning disabilities; interest in having more information about people with learning disabilities; knowledge of learning disabilities and the final factor consisted of questions to do with reactions to meeting people with learning disabilities. McConkey [62, 27] theorized that the data generated from these four aspects of attitude are relatively independent of each other, and consequently, if researchers require a composite picture of attitude, questions from each category are a requisite. Furthermore, Oppenheim [66] theorized that in attitude

research, the more specific and personal questions were to respondents, the more likely they were to give consistent and comprehensive replies.

8. Data collection

A standardized formal interview using a structured questionnaire was used in this research, as interviews tend to have a high response rate and offer the opportunity to correct misunderstanding with regard to questions. The questionnaire enabled the interviewer to carry out ratings while controlling for incompleteness. Interviews are more successful with respondents who have a reading or language difficulty and thereby can aid response rate [67].

8.1. Recruitment and response rate

It is important that the sample is representative of the population, and if a large percentage do not respond, the sample may become biased. The accepted cut-off response rate for surveys is 65% [67, 68]. In this research, an advance participation invite notification was sent to respondents. The letter included an explanation about the research; how respondents were chosen; confidentiality and anonymity; and the time that it would take to complete the questionnaire. Other strategies implied to deal with response rate were careful pilot work in order to ensure that the design of the questionnaire was delivering similar answers from respondents. Additionally, a cover letter was sent to all respondents and an incentive such as a copy of the results of the survey, if so requested, was assured by the administrators of the questionnaire. In the case of non-response, where people refused, or had moved away or were on holidays, a substitute with matching characteristics was used. The administrators also endeavoured to find out whether the reasons for non-response were somehow connected with the topic of the research. Both research administrators were afforded interview skills training as interview skills were considered an important part of the interview response rate. This training enabled the administrators together with the researcher to check responses and related problems by monitoring the completed questionnaires by comparing the results obtained by various interviews for patterned differences.

9. Data analysis

The completed questionnaires were collated and coded using a statistical package for the social sciences [69]. In phase 1 of the data analysis, frequencies of responses and cross tabulation of individual questionnaire items were calculated for the purpose of specific demographic information and the results were displayed using tables. In phase 2 of the data analysis, observations from the micro-neighbourhood and the random selection were compared. The chi-square inferential statistical method was used to examine the potential association between categorical variables, that is, between the micro-neighbourhood sample and the random sample, in each of the following categories: demographic details; social networks and activities;

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contact; problems or difficulties for a neighbourhood; benefits for neighbourhood; knowledge of local centres for people with learning disabilities; type of people who attended these centres; knowledge of community-homes for people with learning disabilities; community care policy; weekend schemes and general comments. These tests were conducted to identify associations that existed between samples and each of the individual factors in the outlined categories. Where are cell sizes were too small in '2 × 2', tables, that is, when the expected cell count was found to be less than five, Fishers exact probability test was applied. For all two by two tables, Yates [70] continuity correction was used in order to accommodate for the use of a continuous probability distribution as an approximation to the discrete probability distribution [71]. The qualitative data from the verbatim comments made by respondents were not content analysed due to time constraints, but verbatim comments were included in the results and appendices. Where percentages did not add to 100%, this was due to rounding, multiple answers and exclusions of the 'don't knows'. Only the main findings will be discussed in the current chapter.

10. Results

10.1. Demographic attributes of both samples

Across both samples, 470 interviews were attempted and 358 completed. This was made up of 158 respondents in the micro-neighbourhood and 200 respondents in the no-community-home sample. Of the respondents, 148 were males, 210 females and this included other combinations of persons, e.g. wife, mother and widow. Age, marital status, education, work patterns, number of children under 16 years and type of living accommodation were also obtained (**Table 1**).

Chi-square tests were applied to both samples, and each demographic characteristics, to see if significant associations existed. The average interviewee was between 20 and 59, and there was a significant association between the two areas and age ($p \leq 0.05$). The majority of those near a community-based residence were aged 20–29 years, followed by 49–59 age band, whereas the age range of those living in the contrast area was 49–59 years. A higher proportion of those living in the no-community-home sample were aged 60 years or over. There was no significant difference between the proportion of females versus males in both samples, indicating an equal distribution of gender ($p > 0.05$). The majority of respondents 58% (116) in the no-community-home sample left school at 15 years of age. A significant association ($p < 0.001$) between the community-home sample and education was found. There was a significant difference ($p = 0.001$) between samples with regard to marital status, a higher percentage (30%) single in the community-home location as opposed to 3% in the contrast sample. No significant associations between samples were obtained on either, length of time people resided in the neighbourhood ($p > 0.05$) and respondents' occupation ($p > 0.05$). There was significant differences between the micro-neighbourhood and the random samples with respect to having children under 16 years. A higher percentage of respondents in the community-home sample had children under 16 ($p < 0.01$). Type of accommodation differed between samples

Description	Community-home (n = 158)		No-Community-home (n = 200)		Chi square	P value
	n	%	n	%		
Age						
<20	4	2.6	8	4		
20–39	65	41.7	55	27.8	8.441	.038
49–59	58	37.2	82	41.4		
60+	29	18.6	53	26.8		
Gender						
Male	62	39.2	86	43.0	.371	.542
Female	96	60.8	114	57.0		
School (Leave school at)						
15	47	29.9	116	58.0	28.164	<.001
Go to higher level	79	50.3	63	31.5		
Go to college/university	31	19.7	21	10.5		
Marital status						
Single	20	2.7	60	30.0		
Married	124	78.5	23	61.5	15.646	.001
Widowed	12	7.6	14	7.0		
Separated	2	1.3	3	1.5		
Living in						
Neighbourhood < 1 year	10	6.3	6	3.0		
1–2 years	8	5.1	11	5.5	3.17	.365
3–5 years	9	5.7	17	8.5		
Over 5 years	131	82.9	166	83.0		
Occupation						
Working full-time	65	41.1	61	30.5		
Part time	22	13.9	34	17.0		
Full-time student	3	1.9	6	3.0	9.696	.084
Unemployed	3	1.9	13	6.5		
Housewife	43	27.2	48	24.0		
Retired	22	13.9	38	19.0		
No. of children <16						
Yes	80	51.3	114	66.3	7.377	.007
No	76	48.7	57	33.1		

Description	Community-home (n = 158)		No-Community-home (n = 200)		Chi square	P value
	n	%	n	%		
Accommodation (Type)						
Rented	15	9.7	43	22.6		
Owned/bought by you	139	90.3	147	77.4	9.185	.002
Private	137	89.5	130	78.3		
Council	16	10.5	36	21.7		

Table 1. Characteristics of community-home and no-community-home samples.

($p < 0.01$), with a higher percentage in the community-home sample owning or having owned their house, whereas in the no-community-home sample, a higher percentage rented and/or lived in council housing.

10.2. Contact with people with learning disabilities

In the questionnaire, all respondents (random and micro-neighbourhood) were asked if they had contact with people with learning disabilities living in the community (**Table 2**).

A significant association between samples and amount of contact emerged ($p < 0.001$). In the micro-neighbourhood sample, 41% (65) of respondents reported seeing people with learning disabilities in their community, this compared with 13% (25) in the no-community-home sample, but regular contact was low in both samples. Respondents were then asked if these people had a learning disability (**Table 3**).

In **Table 3**, the analysis of the data yielded statistically significant differences between the proportion of the two samples who had contact with people with learning disabilities ($p < 0.001$). In the micro-neighbourhood sample, 96% (108) maintained they had contact, but only 64% (48) of the other sample had such contact.

The type and quality of contact with people with learning disabilities from neighbours was not strongly evidenced, 52% (82) in the community-home area and 64% (128) in the corresponding sample stated they had no real contact (**Table 4**). The amount of regular contact in both areas is similar, contradicting what had been apparent in **Table 3**, in which respondents maintained that they had contact with people with learning disabilities 96% (108) in the micro-neighbourhood home and 64% (48) in the no-community-home sample.

In the micro-neighbourhood, that is, respondents living next door or in the vicinity of community-home findings from the data (**Table 5**) on contacts revealed the amount of contact they had with people with learning disabilities over a week, a month and year. Ninety-three percent (31) of the respondents stated they had seen people with learning disabilities around the neighbourhood; 77% (109) of respondents who replied to this question maintained that they had seen them in the last week and 56% (79) stated they had talked to them outside of the community-home. Respondents were then asked such contact was made and the results are presented in **Table 5**.

Contact…	Community-home (n = 158)		No-Community-home (n = 200)		Chi-square	P value
	n	%	n	%		
No contact with people with disabilities	46	29.1	124	62.0		
Seen people with disabilities people around the area	65	41.1	25	12.5	50.815	<.001
Occasional meetings people with disabilities	20	12.7	16	8.0		
Regular contact with people with disabilities	27	17.1	35	17.5		

Table 2. Percentage of respondents reporting contact with people with disabilities.

Are they people with learning disabilities?	Community-Home (n = 158)		No-Community-Home (n = 200)		Chi-square	P Value
	n	%	n	%		
Yes	108	95.6	48	64.0	31.853	<.001
No	4	3.5	25	36.0		

Table 3. Percentage of respondents reporting they had contact with people with learning disabilities.

Contact…	Community-home (n = 158)		No-Community-home (n = 200)		Chi-square	P value
	n	%	n	%		
No real contact with people with learning disabilities	82	51.9	128	64.0		
Just seen people with learning disabilities in the community	21	13.3	16	8.0	6.354	.096
Met and talked with people with learning disabilities	23	14.6	21	10.5		

Table 4. How contact was made with people with learning disabilities.

Of the 62 respondents (**Table 6**) who answered this question, 29% (18) people stated that people with learning disabilities approached them. Other than this, contact was made at other social outlets like, at mass, at the shops and social outings. The findings show no dramatic increase in meaningful contact.

Contact		Yes		NO		PW		PM		PY	
		n	%	n	%	n	%	n	%	n	%
Seen people with learning disabilities in the area	(n = 141)	131	92.9	10	7.1	109	77.3	12	8.5	8	5.7
Talked to people with learning disabilities in the community	(n = 141)	79	56.0	62	44.0	61	43.3	9	6.4	10	7.1
Visited community-home of people with learning disabilities	(n = 141)	27	19.1	114	80.9	3	2.1	2	1.4	21	14.9
Have people with learning disabilities visited your house	(n = 141)	20	14.2	121	85.8	1	0.7	4	2.8	14	9.9
Have you had any other contact with people with learning disabilities	(n = 138)	27	19.6	111	80.4	10	7.2	4	2.9	2	1.4

PW = Per Week; **PM** = Per Month; **PY**= Per Year

Table 5. Micro-neighbourhood sample and contact with people with learning disabilities.

How was contact made (n = 62)	N	%
People with learning disabilities approached you	18	29.0
You approached people with learning disabilities	15	24.2
You were introduced to people with learning disabilities by staff from a community-home	2	3.2
Other type of contact		
Mass	10	16.1
Shops	6	9.7
How was contact made …		
Mutual contact	4	6.5
Social outing	3	4.8
Bus stop	2	3.2
Mass/shops	1	1.6
Taxi	1	1.6

Table 6. Micro-neighbourhood and how contact with people with learning disabilities was made.

11. Summary of main findings

The main findings do highlight some important variations between samples. These domains include the following variables and are illustrated in **Table 7**.

There were significant differences between the two samples, with regard to the following variables. There were more people over the age of 60, more single people, more rented and

Demographic attributes of both samples	**X**	**XXX**	**XXX**	**XX**	**XX**
	Age	**School**	**Marital Status**	**Children**	**Accommodation**
Social Networks and activities	XXX				
	Public Houses				
People reporting contact with people with learning disabilities	XXX				
	Seen them around				
Are they people with learning disabilities	XXX				
	Yes				
Problems or difficulties for a neighbourhood	XXX				
	Yes, it would				
Problems that respondents suggested	XX	XXX	XXX	XXX	
	Isolated	Teased	Victimised/ picked on	Danger to children	
	XX	XXX	XXX	XXX	
	Not Adequate Care/Supervisor	Noisy/ created disturbance	Property value	Violent/irresponsible	
Benefits	X		XXX		
	General Awareness		Children would become more aware		
Centres for people with learning disabilities	XX		X		X
	Lady Lane		Brothers of Charity		Rehab
People who attended these centres	X				
	People with Learning Disabilities				
Knowledge of community-homes for people with learning disabilities	XXX				
	Yes, there is				
Reason why community care policy is good or not	XX				
	They are good neighbours				
Types of activities	XX		XXX		XXX
	Visit		Visit your home		Help with outings

Demographic attributes of both samples	X	XXX	XXX	XX	XX
	Age	**School**	**Marital Status**	**Children**	**Accommodation**
General Comments	X	X	XX	X	XX
	More information	No comment	People get to know them	Fears generally	Good neighbours

X = P < 0.05; XX = P < 0.01; XXX = P < 0.001

Table 7. Community-home and no-community-home. Significant observed differences between community-home and no-community-home samples.

council living accommodation and a higher percentage left school at 15 years of age in the no-community-home sample. A higher percentage of respondents in the community-home sample had more children under 16 years; the majority owned their accommodation and went on to pursue a higher level of education. The community-home sample reported seeing people who were '*disabled*' [with a learning disability] in their community, more often than did the contrast sample. With regard to view that a community-home opening would pose problems or difficulties, 13% of respondents in the no-community-home sample reported that this could result, whereas only 1% related negativity to this question in the community-home sample.

More people in the no-community-home sample registered concern with regard to the following variables: isolation, being teased and made fun of, being victimized, posing a danger to children, not having adequate care, being noisy, and creating a disturbance, would have an adverse effect on property values and could be violent or irresponsible. Under 50% of the community-home sample registered general awareness as a major positive for people with learning disabilities. They further alluded to the fact that children would become more aware and knowledgeable about people with learning disabilities.

Interestingly, more people in the no-community-home sample were able to identify a local service provider than in the community-home sample. Nonetheless, respondents in the community-home sample knew that people with learning disabilities attended special centres and were able to identify the name and location of a community-home in their neighbourhood, whereas a significantly less people knew of community-home in the no-community-home sample. A higher proportion of people in the community-home sample stated that people with learning disabilities were good neighbours. In the no-community-home sample, more people were interested in helping out with activities such as visiting people with learning disabilities in their homes, inviting them to their home and helping out with social outings.

12. Discussion

As evidenced by research studies including the Irish study exemplar in this chapter, true social integration has not been fully achieved for people with learning disabilities. It has been suggested that contact, personal goal setting, relationships with the staff for people with learning

disabilities and the wider community may be the key to changing attitudes and thus enhancing genuine integration [61, 72]. Thus, the micro-neighbourhood design combined with the random survey allowed the views of those who may have been expected to have contact with people with learning disabilities as living in the direct neighbourhood of a community-home to be compared with the general population.

It seems that significant contact with community-homes is very limited, which is supported by Abbott and McConkey [61, 72, 73]. While respondents maintained that they had contact with people with learning disabilities, with 96% reporting contact in the micro-neighbourhood and 64% in the no-community-home sample, this was not reflected in the type and quality of contact. Only 48% of the community-home sample and 36% of the no-community-home sample stated they had 'real contact', implying that significant contact is lacking.

The foregoing highlights the point that proximity to a group home does not necessarily imply neighbourly contact. The evolution of community living options for people with learning disabilities has therefore to be accompanied by an awareness of the prevailing social attitudes and the amount of contact people with learning disabilities have with neighbours and the wider community.

When one considers that those in the general population were more likely to report interest in becoming involved with people with learning disabilities in community-homes, this suggests that this expressed wish is an abstract statement that does not occur in reality for those living in the micro-neighbourhood in closer proximity to people with learning disabilities. The contact is superficial and reflects a major deficit in the level of relationships. Therefore, when compared with the positive attitudes expressed, it seems there is evidence of a discrepancy between attitudes in principle and attitudes in fact. Ichheiser's [4] theory serves to explain how people living in areas where there were no-community-homes express no reservations about having people with learning disabilities as neighbours ('*views in principle'*); whereas '*view in fact'* surface when a community-based home for people with learning disabilities is next door; not in my backyard or the NIMBY effect.

While the findings show significant differences between the two samples, the research cannot control or elucidate the various possible factors that may have contributed to these differences. In general, it is apparent that the results provide some evidence of the level of awareness and attitudes that exist and are illuminating in that it leaves many questions yet to be answered. These include questions relating to the determinants of social inclusiveness and more importantly quality of life issues for people with learning disabilities living a normal life in the community. It begs one to question the normality and the adequacy of such services in seeking to achieve a normal life in such community settings. The value of building relationships within communities is pivotal, creating a sense of community and changing perceptions relating to disability. Ichheiser [4] suggested that:

> *The only reasonable thing we can do about illusions and misinterpretations which are deeply rooted in the nature of our human existence is to neutralise their too disturbing effects by increasing awareness within our social perception* [p. 35].

The hope still rests on the endeavours of learning disability service providers and government agencies in promoting neighbourhood relationships and social inclusiveness. As people

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with learning disabilities are now living in communities, it is essential that social integration policy continues to be challenged and requires ongoing engagement with a broader economic and political rhetoric [74].

The lack of evidence-based research relating to natural supports and independent living is a significant obstacle to the development of policy and services in this area. Additional studies and data collection are required to address this deficit. Service providers and how they deliver services can also present barriers to network formation and social inclusion for people with learning disabilities. These barriers could arise from staffing issues, staff practices and the priority given to care over community participation. To achieve true social integration, however, the onus rests with service providers and government agencies to identify these barriers and address them. Accurate, update knowledge on the attitudes of the community towards people with learning disabilities must be elucidated before such attitudes can be improved.

13. Limitations

The research may have over-simplified public attitudes, but future research in this area could be directed at the development of a more sensitive and flexible methodology capable of assessing a wider range of attitudes, using an instrument with 5, 6 or 7 point Likert scales.

It is important to highlight that the study distinguishes between areas with and without community-homes for people with learning disabilities; this in fact was not the case as in the random sample community-homes for people with learning disabilities could have existed in the surrounding districts.

Due to time constraints, it was not possible to perform additional statistical tests to ascertain whether positive attitudes were a function of or were mediated by social class or educational record and to what degree age influenced attitude. This would have involved performing further multi-variate analysis on such variables. Future studies could also address the idea of performing content analysis using ethnography on the qualitative data from this research. The research focused on social contact, but assessment of the quality of the relationships involved was beyond the scope of the present study. Assessment in this regard could look at using discriminant analysis in order to detect root differences between samples.

14. Conclusion

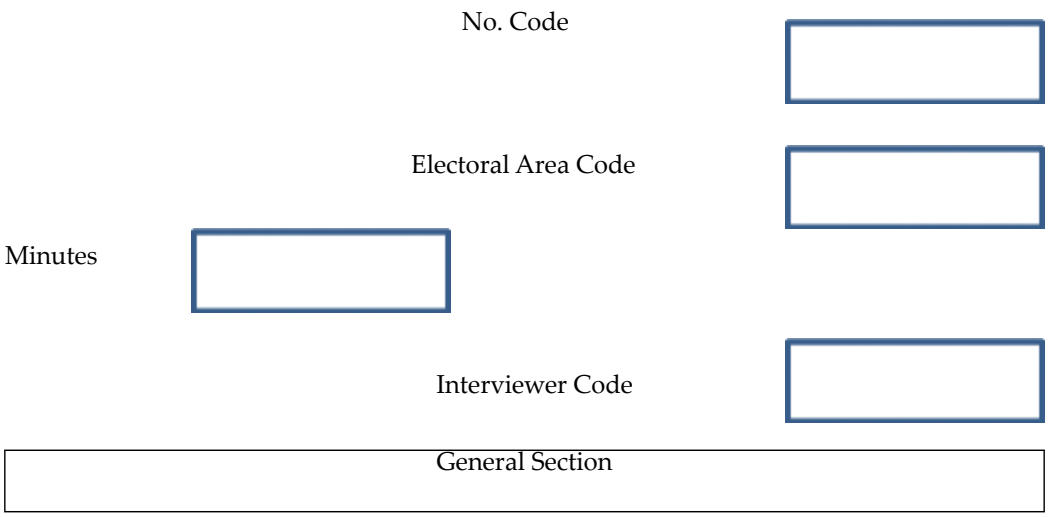
For people with disabilities to have equal opportunities to participate and to contribute as equal citizens, society needs to accept that munificence extends to all members of society and that difference is recognized and valued [74].

It was identified that people with learning disabilities were functionally, but not socially integrated in communities. Attitudes were very positive towards people with learning

disabilities, with only a minority expressing 'stereotypical' concerns. However, clear differences were identified in the attitudes of those in the random sample as opposed to those in the micro-neighbourhood survey. Those who lived near community-homes had more positive attitudes, whereas those in the random sample, while expressing positive attitudes, did not want community-homes in their locality.

It was evident from this study that attitudinal research that combines a micro-neighbourhood and a random survey gives a true picture of attitudes in fact as opposed to attitudes in principle. Hence, a more sensitive and flexible methodology capable of measuring a wider range of attitudes using the design recommended in this chapter has practical utility as a methodological approach. Attitudes cannot be expected to remain static and on-going research is required to monitor and re-evaluate such changes, which will contribute to more informed discussions and more effective planning of services and meaningful socially inclusive and self-determined lifestyles for people with learning disabilities.

Appendix 1. Attitude questionnaire



On behalf of … We are carrying out a survey about people with learning disabilities living in this neighbourhood. Can I have about 15 minutes of your time to answer some simple questions?

1. How long have you been living in this neighbourhood?

a) Less than 1 year

b) 1–2 years

c) 3–5 years

d) Over 5 years

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2. How many families would you know by name within 15 minutes walking distance of your house?

a) None

b) 1 or 2

c) 3 to 5

d) 6 to 15

e) 16+

3. How many of these families are related to you?

a) None

b) 1 or 2

c) 3 to 5

d) 6 to 15

e) 16+

4. Would you say that, in general, you have:

a) Only occasional contact with your neighbours

b) Some contact now and again with your neighbours

c) Frequent and regular contact with your neighbours

5. What activities are you regularly involved in present within this area, that is, you could walk to them within 15 minutes. Do you go to:

	Yes	**No**
a) Any sports in this area		
b) Any pubs in this area		
c) Bingo are dances		
d) Any churches in the area		
e) Any meetings at school		
f) Residents' association our neighbourhood watch		
g) Any other activities please specify		

6. Is there a centre for people with learning disabilities in your city.

a) No, there is not

b) Don't know

c) Yes, there is

A whereabouts is it?

PROBE are there any other centres? (For example)

What sort of people attend (use their all wording for the centre)

7. Can I ask what contact you will have had with people with learning disabilities in your neighbourhood?

a) No contact

b) Seen them around

c) Occasional meetings

d) Regular contact

7b. Are they people with learning disabilities? Yes or no.

8. Thinking of people with learning disabilities in general, Can I ask what contact you have had with people with learning disabilities?

a) Children

b) Adults

c) No real contact just seen them around

d) Met and talked with them

e) Regular contact

9. There is now a national policy of having people with learning disabilities living wherever possible within the local community. Do you think that?

a) On the hall, this is a good policy

b) Not so good policy

c) You have no opinion one way or the other (go to question 10)

If the person answer is 1or 2; then ask why is this?

10. Is there a house that is occupied by a group of people with learning disabilities, physical disabilities or mental health problems in this neighbourhood?

a) Yes, there is

b) I don't know

c) No, there is not

Go to section 2 is interviewing areas with a group home

Then section 4

http://dx.doi.org/10.5772/intechopen.69388

or

Go to section 3 is interviewing areas with no group home,

Then go to section 4

SECTION 2 AREAS WITH A GROUP HOME

11. Whereabouts is it?

a) If not the house ask (are there people with learning disabilities)?

b) Are you aware of any other houses for people with learning disabilities in this neighbourhood?

c) How many of the people would you know by name?

d) How many of the staff would you know by name?

12. What contact have you had with people with learning disabilities from the home?

					Past		
		No	**Yes**	**no**	**Week**	**Month**	**Year**
a	Have you seen them around the neighbourhood?	1	2	3			
b	Have you talked to them outside?	1	2	3			
c	Have you been into their home?	1	2	3			
d	Have any being into your house?	1	2	3			
e	Have you had any other contact?	1	2	3			

13. How was the contact made?

a) You approach the person with a learning disability

b) They approached you

c) Introduced by staff

d) Other/Can't recall

14. What contact have you had with the staff who work in the home?

					Past		
		No	**Yes**	**no**	**Week**	**Month**	**Year**
a	Have you seen them around the neighbourhood	1	2	3			
b	Have you talked to them outside	1	2	3			
c	Have you been into their home	1	2	3			
d	Have any being into your house	1	2	3			
e	Have you had any other contact	1	2	3			

15. How was the contact made?

a) You will approach the staff person

b) They approached you

c) Introduced by person with a learning disability

d) Other/Can't recall

15b. Has anyone else in your household had contact with people from the group home?

a) yes

b) No

If yes, who?

What contact have they had?

16. Do you think that there have been any problems or difficulties in the neighbourhood resulting from people with learning disabilities occupying that house?

a) yes

b) No

Probe: And others?

17. Can I just check some (other) problems that other people have suggested in previous surveys? I'd like to know if you have found any of these things to be at problem with regard to the home for people with learning disabilities in your neighbourhood.

a) Yes that has been a bit of a problem

b) No problem that I am aware of

c) Can't decide

A	People with learning disabilities being teased, made fun of or jeered at	1	2	3
B	People with learning disabilities and not receiving adequate professional care and supervision	1	2	3
C	They have been isolated and just kept to themselves	1	2	3
D	They have been victimized, picked on or taken advantage of	1	2	3
E	They have been danger or threat to children or others	1	2	3

F	They have made people embarrassed. People haven't known what to say to them or how to react to them	1	2	3
G	People with learning disabilities have been noisy and created disturbances	1	2	3
H	The property value of neighbourhood houses has dropped or	1	2	3
I	People with learning disabilities have been violent or irresponsible	1	2	3

18. Do you think there have been any benefits for the neighbourhood in having these people living in your area?

a) None that you can think of

b) Yes, there have been. Can you say what these are?

19. There is talk of a scheme in which people are paid to have a person with learning disabilities stay at their house for a weekend, would you:

a) Be interested in having a person staying with you

b) Be interested but would want to know more about the scheme first

c) Be interested but it's not possible at present

a) Not interested

Go to Section 4

Section 3: Areas with No Group Home

20. If a house for three or four people with learning disabilities with one or two care staff started up in your neighbourhood, for example, at that house over there/down the road/round the corner, which is vacant, do you think that this would give rise to any problems in the neighbourhood?

a) No, it wouldn't

b) Yes, it would

What might these problems be?

21. Can I just check some (other) problems that other people have suggested in previous surveys. I'd like to know if you think there would be a risk of that problem arising in your neighbourhood.

a) That could be a risk in this neighbourhood

b) No risk that you can think of

c) Can't decide

A	People with learning disabilities being teased, made fun of or jeered at	1	2	3
B	People with learning disabilities and not receiving adequate professional care and supervision	1	2	3
C	They have been isolated and just kept to themselves	1	2	3
D	They have been victimized, picked on or taken advantage of	1	2	3
E	They have been danger or threat to children or others	1	2	3
F	They have made people embarrassed. People haven't known what to say to them or how to react to them	1	2	3
G	People with learning disabilities have been noisy and created disturbances	1	2	3
H	The property value of neighbourhood houses has dropped or	1	2	3
I	People with learning disabilities have been violent or irresponsible	1	2	3

22. Do you think there could be any benefits for the neighbourhood if a group of people with learning disabilities moved into the area?

a) None that you can think of

b) Yes there might. Can you say what these might be?

23. There is talk of a scheme in which people are paid to have a person with learning disabilities stay at their house for a weekend, would you?

a) Be interested in having a person staying with you

b) Be interested but would want to know more about the scheme first

c) Be interested but it's not possible at present

d) Not interested

Section 4

Areas with a group home

As you know people with learning disabilities can do with some extra help, if you were asked, would you be interested in:

24. Areas with a group home: As you know, people with learning disabilities can do with some extra help. If a group home for people with learning disabilities were to move into your area and the staff living with them asked you to help, would you be interested in:

a)	Taking a person with a learning disability from the home along with you on an outing once in a while for example to charge, shopping etc.
b)	Goals we ~home to visit them
c)	Helping out staff in an emergency.
d)	Having a person with a learning disability come to your home on a visit are for a cup of tea
e)	Go along to an open day or a coffee evening in the house
f)	Make a point of taking to the person if you saw them around the neighbourhood are went shopping etc.

Finally, can I ask some questions about yourself?

25. Are you aged:

a) <20

b) 20 to 39

c) 40 to 59

d) 60+

26. Did you leave school at:

a) 15 years

b) Go onto a higher level (leaving certificate)

c) Go to College, University

27. Are you:

a) Working full-time

b) Part time

c) Full-time student

d) Unemployed

e) Housewife

f) Retired

28. Are you:

	Yes	No
1. Single		
2. Married		
3. Have you a children under 16 years		

29. Is your house/accommodation

a) Rented

b) Owned or bought out by you

Is it

a) Private

b) Council

30. Have you ever been involved in any form of voluntary work?

a) No

b) Yes, in the past

c) Yes, at present

31. Any further comments you would like to make about people with learning disabilities living in the community.

NB Hand-over 'Research Information Sheet' and 'Thank You Sheet' to Participant(s)

Professor Roy McConkey (1983) © Permission given to use and/or adapt instrument

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References

[1] Lemay RA, Deinstitutionalization of people with developmental disabilities: A review of the literature. Canadian Journal of Community Mental Health. 2009;**28**(1):181-194

[2] Clifford Simplican S, Leader G, Kosciulek J. Defining social inclusion of people with intellectual and developmental disabilities: An ecological model of social networks and community participation. Research in Developmental Disabilities. 2015;**38**:18-29

[3] Debenham L. Social Inclusion and Learning Disabilities [Internet]. 2016. Available from. http://www.aboutlearningdisabilities.co.uk/social-inclusion-learning-disabilities.html [Accessed: 20-December-2016]

[4] Ichheiser G. Appearances and Realities. San Francisco: Jossey-Bass; 1949

[5] Quass M, Fraser K. Beyond the Ramp: A National Approach to Education and Training in the Adult and Community Education Sector for Adults with Disabilities. Australia: Australian Association of Adult and Community Education. AAACE/CSOAE Disability Project; 1993

[6] European Commission. Progress Report on the Implementation of the European Disability Strategy (2010-2020) European Commission Brussels [Internet]. 2017. Available from: http://ec.europa.eu/social/main.jsp?catId=1137 [Accessed: 2017-10-2017]

[7] Clarke ABB, Clarke AM. Cognitive changes in the feeble minded. British Journal of Psychology. 1954;**45**:173-199

[8] International Classification of Diseases (ICD) World Health Organisation. Geneva; 2010, retrieved 4 April 2017

[9] Morris J. Pride against Prejudice. London: The Women's Press; 1991

[10] Goffman E. Asylums: Essays on the Social Situation of Mental Patients and other Inmates. Harmondsworth: Penguin; 1961

[11] King RD, Raynes NV, Tizard J. Patterns of Residential Care: Sociological Studies in Institutions for Handicapped Children. London: Routledge, Kegan Paul; 1971

[12] Grunerwald K. The Intellectually Handicapped in Sweden- New Legislation in a Bid for Normality. Current Sweden. 1968;**345**:1-10

[13] Bank Mikkelsen NE. A Metropolitan area in Denmark: Copenhagen. In: Kugel R, Wolfensberger W, editors. Changing Patterns in Residential Services for the Mentally Retarded. Washington: Presidents Committee on Mental Retardation; 1969. 227-254

[14] Wolfensberger N. The Principle of Normalisation in Human Services. Toronto: National Institute of Mental Retardation; 1972. Worldwide Process of Disability Reform. Available at: http://www.unhchr.ch/

[15] Wolfensberger W, Thomas S. PASSING (Program Analysis of Service Systems' Implementation of Normalization Goals): Normalization Criteria and Ratings Manual. 2nd ed. Toronto: National Institute on Mental Retardation; 1983

[16] National Disability Authority. A National Survey of Public Attitudes to Disability in Ireland. Dublin: National Disability Authority; 2011

[17] Verdonschot MML de Witte LP, Reichrath E, Buntingx,WHE, Curfs LMG. Community participation of people with an intellectual disability: A review of empirical findings. Journal of Intellectual Disability Research. 2009;**53**(5):303-331

[18] Forrester-Jones R, Carpenter J, Coolen-Schrijner P, Cambridge P, Tate A, Beecham J,Overmars-Marx T, Thomese F, Verdonschot M, Meininger H. Advancing social inclusion in the neighbourhood for people with an intellectual disability: An exploration of the literature. Disability & Society. 2013;**29**:255-274

[19] Quinn G, Doyle S. Getting a life–living independently and being included in the community: A legal study of the current use and future potential of the EU Structural Funds to contribute to the achievement of Article 19 of the United Nations Convention on the Rights of Persons with Disabilities. Report to the Office of the United Nations High Commissioner for Human Rights, Regional Office for Europe; 2012

[20] Perry J, Allen DG,Pimm C, Meek A, Lowe K, Groves S, et al. Adults with intellectual disabilities and challenging behaviour: The costs and outcomes of in- and out-of-area placements. Journal of Intellectual Disability Research. 2013;**57**:139-152

[21] Bigby C. Known well by no-one: Trends in the informal social networks of middle-aged and older people with intellectual disability five years after moving to the community. Journal of Intellectual and Developmental Disability. 2008;**33**(2):148-157

[22] Milner P, Kelly B. Community participation and inclusion: People with disabilities defining their place. Disability and Society. 2009;**24**(1):47-62

[23] Robertson J, Emerson E, Gregory N, Hatton C, Kessissoglou S, Hallam A, Linehan C. Social networks of people with mental retardation in residential settings. Mental Retardation. 2001;**39**:201-214

[24] Lippold T, Burns J. Social support and intellectual disabilities: A comparison between social networks of adults with intellectual disability and those with physical disability. Journal of Intellectual Disability Research. 2009;**53**(5):463-473

[25] Ritchie P. Public Attitudes to People with a Learning Disability, and How to Influence Them [Internet]. 1999. Available from: http://www.gov.scot/Resource/Doc/1095/0001679.pdf [Accessed 10-January-2017]

[26] Meyers F, Ager A, Kerr P, Myles S. Outside Looking In? Studies of the community integration of people with learning disabilities and society. Disability & Society. 1998;**13**(3):389-413.

[27] McConkey R. Who Cares? Community Involvement with Handicapped People. London: Souvenir Press; 1987

[28] Hernandez B, Keys C, Balcazar F. Employer attitudes toward workers with disabilities and their ADA employment rights: A literature review. Journal of Rehabilitation. 2000;**66**(4):4-16

[29] Zimbardo P, Ebbessen EB. Influencing attitudes and hanging behaviour. Reading, MA: Addison-Wesley; 1969

[30] Gellman W. Roots of prejudice against the handicapped. Journal of Rehabilitation. 1959:254-256

[31] Thomas MG. The Royal National Institute for the Blind 1868-1956. London: Royal National Institute for the Blind; 1957

[32] Wright BA. Physical Disability: A Psychological Approach. New York: Harper; 1960

[33] Jaffe J. Attitudes of adolescents toward persons with disabilities [thesis]. Columbia University: Teachers College; 1965

[34] Park CW, Lutz RJ. Decision plans and consumer choice dynamics. Journal of Marketing Research. 1982;**19**(1):108-115

[35] Massie B. Participation – have we got an Attitude Problem?' In: Proceedings of the NDA 5th Annual Conference Civic, Cultural and Social Participation: Building an Inclusive Society (NDA'06) Dublin; 16 November 2006; Ireland. (paper available at www.nda.ie)

[36] Nowicki EA. A cross-sectional multivariate analysis of children's attitudes towards disability. Journal of Intellectual Disability Research. 2006;**50**:335-348

[37] Cialdini RB, Petty, RE, Cacioppo JT. Attitude and attitude change. Annual Review of Psychology. 1981;**32**:357-404

[38] Fossey E. Young children and alcohol. A theory of attitude development. Alcohol and Alcoholism. 1993;**28**:485-498

[39] Sdorow L. Psychology. Dubuque, IA: W.C. Brown Publishers; 1990

[40] Wai A, King M, David WK. Attitudes toward people with disabilities: A comparison between health care professionals and students. International Journal of Rehabilitation Research. 2006;**29**:155-160

[41] Gelber DM. Changing attitudes toward physically disabled persons: Effect of contact knowledge of disability and information exchange. Ann Arbor, 1993 MI; 1993 UMI

[42] Elmaleh GY. A study of attitudes toward employees with disabilities Ann Arbor: UMI ProQuest Digital Dissertations database. [UMI No. 9973138]

[43] Hewstone M. Contact and categorization: Social psychological interventions to change inter-group relations. In: Macrae CN, Stangor C, Hewstone M, editors. Stereotypes and Stereotyping. New York: Guilford Press; 1996. pp. 323-368

[44] Pettigrew TF. Intergroup contact theory. Annual Review of Psychology. 1998;**49**:65-85

[45] Pettigrew TF, Tropp LR. Does intergroup contact reduce prejudice? Recent meta-analytic findings. In: Oskamp S, editor. Reducing Prejudice and Discrimination 'The Claremont Symposium on Applied Social Psychology. 2000. pp. 93-114

[46] Hewstone M. Inter-group contact: Panacea for prejudice? The Psychologist. 2003;**12**(7): 352-355

[47] Deal M. Aversive disablism: Subtle prejudice toward disabled people. Disability and Society. 2007:**22**:93-107

[48] Allport GW. The Nature of Prejudice. Garden City: Anchor Books; 1954

[49] Antonak RF. Prediction of attitudes towards disabled persons: A multivariate analysis. The Journal of General Psychology. 1981. pp 789-884

[50] Lemon N. Attitudes and their Measurement. New York: Wiley; 1973

[51] National Disability Authority. Literature Review of International Evidence on Attitudes to Disability [Internet]. 2007. Available from: http://nda.ie/Publications/Attitudes/Literature-Review-of-International-Evidence-on-Attitudes-to-Disability [Accessed: October 2016]

[52] Yuker HE, Block JR, Campbell WL. A Scale to Measure Attitudes Towards Disabled Persons Albertson. New York: Human Resources Foundation; 1960

[53] Antonak RF. Development and psychometric analysis of the scale of attitudes toward disabled persons. The Journal of Applied Rehabilitation Counseling. 1982;**13**:22-29

[54] White MJ, Jackson V, Gordon PJ. Implicit and explicit attitudes toward athletes with disabilities. Journal of Rehabilitation. 2006;**72**(3):33-40

[55] Morin D, Rivard M, Crocker A, Boursier C, Caron J. Public attitudes towards intellectual disability: A multidimensional perspective. Journal of Intellectual Disability Research [serial online]. 2013;**57**(3):279-292. Available from: [Accessed: 1 April 2017]

[56] Findler L, Vilchinsky N, Werner S. The multidimensional attitudes scale toward persons with disabilities (MAS): Construction and validation. Rehabilitation Counselling Bulletin. 2007;**50**:166-176

[57] Antonak RF, Harth R. Psychometric analysis and revision of the mental retardation attitude inventory. Mental Retardation. 1994;**32**:272-280

[58] Roberts CM, Lindsell JS. Children's attitudes and behavioural intentions toward peers with disabilities. International Journal of Disability, Development and Education. 1997;**44**:133-145

[59] Henry D, Keys C, Jopp D, Balcazar F. The community living attitudes scale mental retardation form: Development and psychometric properties. Mental Retardation. 1996;**34**:149-158

[60] Burge P, Ouellette-Kuntz H, Lysaght R. Public views on employment of people with intellectual disabilities. Journal of Vocational Rehabilitation. 2007;**26**(PT):29-37

[61] Abbott S, McConkey R. The barriers to social inclusion as perceived by people with intellectual disabilities. Journal of Intellectual Disabilities. 2006;**10(**3):175-187

[62] McConkey R, McCormack B, Naughton M. A national survey of young people's perceptions of mental handicap. Journal of Intellectual Disability Research. 1983;**27**:171-183

[63] Hamilton DL, Carpenter s, Bishop GD. Desegregation of suburban neighbourhood. In: Miller N, Brewer MB, editors. Groups in Contact: The Psychology of Desegregation. New York: Academic press; 1984

[64] Mosteller F, Rourke ERK, Thomas GB. Probability with Statistical Application. Reading MA: Addison-Wesley; 1961

[65] LoBiondo-Wood G, Haber J. Nursing research. 8th ed: Methods and Critical Appraisal for Evidence-Based Practice. London: Mosby; 2013; eBook ISBN: 9780323293655

[66] Oppenheim AM. Questionnaire Design, Interviewing and Attitude Measurement. London: Pinter Publishers; 1994

[67] Ong Ad. The Practice of Health Services Research. London: Chapman and Hall; 1993

[68] Ong AD, Weiss DJ. The impact of anonymity on responses to sensitive questions. Journal of Applied Social Psychology. 2000;**30**:1691-1708

[69] SPSS Inc. Released 1999. SPSS for Windows, Version 10.0, Chicago, SPSS Inc

[70] Yates F. Contingency tables involving small numbers and the chi-squared test. Journal of the Royal Society Supplement. 1934;**1**:217-235

[71] Everitt BS. The Analyses of Contingency Tables. 2nd ed. London: Chapman and Hall; 1992

[72] McConkey R, Collins S. Using personal goal setting to promote the social inclusion of people with intellectual disability living in supported accommodation. Journal of Intellectual Disability Research. 2010b;**54**(2):135-143

[73] McConkey R, Collins S. The role of support staff in promoting the social inclusion of persons with an intellectual disability. Journal of Intellectual Disability Research. 2010ba;**54**(8):691-700

[74] Morris J. Citizenship and Disabled People. UK: DRC; 2005

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Learning disabilities are conditions that are associated with difficulties in knowledge and skill acquisition to the level expected of same-age peers. The current book is an international examination of assessment methods, preventative measures, intervention, and research with those individuals with learning disabilities obtained from authors in the United States of America, Europe, Asia, and Africa.

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