



MASTER IN COGNITIVE SCIENCE AND LANGUAGE

MASTER THESIS

September 2021

The perception of accent and intonation in Italian teenagers
with Developmental Dyslexia

by Laura Gornati

under the supervision of Dr. Anna Gavarró (UAB) and Dr. Elena Pagliarini
(University of Padova)



UNIVERSITAT DE
BARCELONA



Universitat
Pompeu Fabra
Barcelona



UNIVERSITAT
ROVIRA I VIRGILI

TABLE OF CONTENTS

LIST OF FIGURES	4
LIST OF TABLES	5
ACKNOWLEDGEMENTS	6
ABSTRACT	8
1 INTRODUCTION	9
2 BACKGROUND	
2.1 Suprasegmental prosody	11
2.2 Phonological awareness and dyslexia	13
2.3 Italian studies on prosody and Developmental Dyslexia	15
2.4 Previous key studies	16
3 RESEARCH QUESTION AND EXPERIMENTAL DESIGN	
3.1 Participants	22
3.2 Procedure	23
4 STANDARDIZED TESTS: METHOD AND RESULTS	
4.1 Reading Task	24
4.2 Spoonerism	26
4.3 Non-word repetition	27
5 SAME/DIFFERENT TASKS WITH WORDS AND NON-WORDS	
5.1 Experimental design and method	31
5.2 Results	32
6 SAME/DIFFERENT TASKS WITH SENTENCES	
6.1 Experimental design and method	36
6.2 Results	39
7 DISCUSSION AND CONCLUSION	42
REFERENCES	
APPENDIX I: Participants	
APPENDIX II: Consent form	
APPENDIX III: Individual results	

LIST OF FIGURES

- Figure 1. Percentage of accuracy in same/different task from Magarotto, 2021)
- Figure 2. Mean percentage of results in the two groups by condition from Salmons, 2010)
- Figure 3. Bar chart describing reading speed
- Figure 4. Bar chart describing reading accuracy in number of errors
- Figure 5. Bar chart in number of correct answers (/30)
- Figure 6. Bar chart in number of correct answers (/40)
- Figure 7. Visual presentation of words task
- Figure 8. Visual presentation of non-words task
- Figure 9. Bar chart describing percentage of correct answers
- Figure 10. Bar chart describes the three 'same' condition taking stress into account
- Figure 11. Bar chart for the three 'different' conditions
- Figure 12. Graphic display of Psychopy
- Figure 13. Introduction slide of Psychopy software while running the experiment
- Figure 14. Results for s/d task with sentences
- Figure 15. Results of correct answers in the 'same' condition
- Figure 16. Results of correct answers in the 'different' condition in detail.
- Figure 17. Results of the same/different tasks
- Figure 18. Revised results of the same/different tasks

LIST OF TABLES

Table 1. Words list for the experiment with words taken from Magarotto (2021)

Table 2. Word list for the experiment with non-words taken from Magarotto (2021)

Table 3. List of words from CMF spoonerism with correct answers

Table 4. List of non-word used in the non-word repetition task

Table 5. Mean of correct answers

Table 6. Order of the items and their conditions in the same/different task with sentences

ACKNOWLEDGEMENTS

Without the constant help and suggestions of my two supervisors Dr. Anna Gavarró from the UAB and Dr. Elena Pagliarini from the University of Padova I would never have been able to make this work. I want to thank both of them warmly because even without knowing me very well they believed in me and sorted out all the issues I found on the way.

This present research would not have been possible without the contribution of the students of E. Vanoni school in Menaggio. For this reason I have to thank all those who cheerfully wanted to take part in this experiment and their families for having given me the possibility to join this research project.

A special thanks to the headmaster Silvio Catalini for this opportunity and for his trust and help in organizing the experiments in a time full of problems and difficulties for Italian schools such as the pandemic of Covid19. His enthusiasm and positive approach to this research went beyond all the possible difficulties and obstacles there may have been. I'm also thankful to prof. Marco Scarpi who patiently assigned me every week a room for the experiments.

To my dad, Gornati Geremia.

ABSTRACT

Dyslexia is a specific learning disorder (SLD) that affects reading, writing and spelling skills due to problems in decoding. Most of the studies on dyslexia base their analysis on deficits in detection of segmental phonology. However, recently the attention has moved to suprasegmental phonology too. The aim of this study is to define if in Italian dyslexic teenagers the perception of prosody is impaired compared to a control group. Following a series of previous studies in other languages, this research aims to explore if this impairment is present also in Italian, a syllable-timed language. To see if suprasegmentals, in particular accent and intonation, are perceived differently in teenagers with and without dyslexia, three tasks are administered testing word accent, non-word accent and sentential intonation. The first two experiments replicate those of Magarotto (2021), initially administered to primary school Italian children; the third one was designed for the purpose of this study and is based on work by Salmons (2010). To measure the participants' reading ability and phonological awareness, three standardised tests were also conducted. The results of the three experiments show that Italian adolescents with dyslexia performed slightly worse in the perception of accent compared to the age-matched adolescents. Moreover, when intonation was under exam, dyslexic participants showed more difficulties in perceiving differences in sentential intonation than the control group.

1 INTRODUCTION

One hundred and thirty years ago, when medical doctors started talking about Developmental Dyslexia (henceforth DD), it was described as ‘word-blindness’; since then lots has changed and many studies have enhanced our knowledge of this impairment in reading and learning. According to the British Dyslexia Association (BDA), 10% of the population is believed to suffer from DD. Their definition of DD follows the one stated by Rose in his report of 2009 (<https://www.bdadyslexia.org.uk/dyslexia/about-dyslexia>), where dyslexia is defined as

“a learning difficulty that primarily affects the skills involved in accurate and fluent word reading and spelling. Characteristic features of dyslexia are difficulties in phonological awareness, verbal memory and verbal processing speed. Dyslexia occurs across the range of intellectual abilities. It is best thought of as a continuum, not a distinct category, and there are no clear cut-off points.”

Although there’s no cure for dyslexia, early assessment and intervention result in the best outcome. First signs of dyslexia can be difficult to recognize before a child enters school, in fact in most cases the condition becomes apparent as a child starts learning to read, but some early signs may indicate a problem. These signs are thought to be linked to a phonological deficit in children in spite of having average intelligence and normal cognitive abilities (Lyon et al., 2003).

Among the theories proposed to account for the cause of difficulties in developmental dyslexia, the most robust is the phonological theory (Castles & Coltheart, 2004; Snowling, 1981; Snowling, 2000). According to it, dyslexics are said to have a specific impairment in the representation, holding and retrieval of speech sounds in fact, the ability to learn the correspondence between grapheme (letters) and phoneme (sounds) is affected. In support of this theory Ramus et al. (2003) tested 16 university students with dyslexia on a series of tests (psychometric, phonological, auditory, visual and cerebellar) and concluded that in 10 out of 16 participants phonological deficits are responsible alone for literacy impairments although acknowledge the presence of additional sensory and motor disorders in certain individuals.

Recently, an interest on suprasegmental phonology has emerged and studies have considered it as another aspect in children’s difficulty to read. The study of Veenendaal et al. (2016) for example examines the relation between reading and both segmental and suprasegmental phonology, with the finding that prosody is actually a key component in reading comprehension in Dutch children. The next section describes some of the work conducted on suprasegmental phonology,

above and beyond segmental phonology; this dissertation is part of this collective effort towards the understanding of dyslexia.

2 BACKGROUND

2.1 SUPRASEGMENTAL PHONOLOGY

Prosody is not a unitary construct, rather it includes a number of different components. Prosody may reflect various features of the speaker or the utterance: the emotional state of the speaker and the form of the utterance (statement, question, or command). Among the main features of prosody, stress, tone, intonation and rhythm constitute suprasegmental features of speech. Prosodic processing at the sentential level concerns the suprasegmental features of speech that help the listener recognise syntactic structure, grammatical boundaries and sentence meaning. According to their rhythm, languages differ according to which chunks of speech must have similar durations and they can be grouped accordingly into (Caccia et al., 2019):

- syllable-timed languages, where each syllable takes the same amount of time to be pronounced, as for example in Italian;
- stress-timed languages, like English, in which syllables may last different amounts of time, but the time between two stressed syllable is usually constant;
- mora-timed languages, for example Japanese, where the duration of every *mora* is the same.

Quite often accent, tones and intonation are put together and contrasted because they all have similar phonetic characteristics (duration, intensity, height), however they belong to different categories. In fact, languages differ not only because of the phonological repertoire that they use but also in the way they use suprasegmental information. Accent has a key role and a contrastive function whose aim is to discriminate a (stressed) segment from other (unstressed) one and this relation (stress vs unstress) is part of the structure of the language.

With respect to accent, languages can be phonemic – or free stress, which means that stress is predictable (like in English), or predictable – or fixed stress (like in Polish, in which accent is on the penultimate syllable). Even in languages with phonemic accent, though, there are rules, which predict the position of the stress (Hayes, 2009). In Italian, for example, words are grouped into words with accent on the first syllable (from the end) such as *caffè* ('coffee'), words with accent on the second syllable, such as *matita* ('pencil'), words with accent on the third syllable, like *telefono* ('telephone') and finally words with accent on the fourth syllable, there are not very common and they are usually verbs such as *miagolano* ('meow'). The majority of words have stress on the second (93% of Italian words according to Marotta and Vanelli, 2021), while words on the fourth are not common. Moreover, there are some pair of words which can be distinguished only thanks to

the syllable that bears the accent, e. g., *ancOra* ('more, again, yet') vs *Ancora* ('anchor'), *mEta* ('destination') vs *metÀ* ('half') (Simone, 1990). When a syllable is stressed, all its parameters (frequency, timing and amplitude) increase and the listeners usually perceive it as longer and more intense (Simone, 1990).

Tone and intonation differ on the use of pitch, tone is a property of lexical items, and intonation a property of non-lexical items, for example utterance level distinctions and phrase boundaries (Ota, 2016). Intonation is a clear example of suprasegmental pitch variation, which means that it extends beyond more than one segment. The main physical correlate of intonation is fundamental frequency (F0).

In Pierrehumbert's analysis of intonation in English language called autosegmental metrical model (Pierrehumbert, 1980), each intonational curve is described as a sequence of high (H) or low (L) tones. The intonational curve can be analysed as a sequence of different tones (starred, leading, trailing and boundary) that compose the curve. Tones are marked with different diacritics: (*) means that the syllable is prominent, and it can represent a simple (H* and L*) or complex (H+L*) tone; (-) or (%) are signs used with boundary tones to show the edge of an intonational phrase (%) or intermediate phrase (-). Utterances can be discriminated, according to the intonation used, into different types, like declaratives or interrogatives, but also they can have different pragmatic values.

According to Avesani (1995), standard Italian presents the following intonational curves:

(1)	H+L* L- L%	declaratives
	H* L- L%	declaratives with focus and imperative sentences
	%H H* L- L%	exclamation
	L*+H L- L%	doubt/ hesitation
	L* H- H%, H+L* L- H%	interrogatives
	H* L- H%, H+L* L- H%	continuation
	H* H- L%	reprimand

According to Simone (1990), infants since their first days of life are able to produce simple intonational curves, before they can produce segmental units. At 12 months, infants possess the whole range of relevant intonations of their native language (Simone, 1990).

Moreover, recent research conducted with typically and non-typically developing children showed how prosody and linguistic competence, such as being able to build syntactic complex sentences or to tell stories, are linked (Zanchi et al. 2016), opening the way to a new branch of studies based on prosody and its relevance in linguistic performance.

2.2 PHONOLOGICAL AWARENESS AND DEVELOPMENTAL DYSLEXIA

Developmental Dyslexia (DD) is a specific learning disability, characterised by difficulties with accurate and/or fluent word recognition, and by poor spelling and decoding abilities. A deficit at the phonological level and its role in reading disorders are well established, in fact many studies have been conducted to assess dyslexic phonological awareness. In comparison, little work has been carried out with acoustic, physical properties of the speech stream such as stress, rhythm and intonation at the word or sentence level. It is only recently that certain theoretical proposals have been made regarding prosody and reading (Calet et al. 2019).

Holliman et al. (2010) found out that prosody affects successful literacy development; also, in a cross-sectional study, they found that poor readers have less prosodic sensitivity compared to their chronological age-matched peers. Their results showed that chronological-age matched controls outperformed the poor readers on all measures of prosodic sensitivity, especially those relating to stress mispronunciation and stress assignment. In a 1-year longitudinal study, 69 five- to 8-year-old English-speaking children completed a speech rhythm assessment at Time 1 along with other cognitive assessments and then completed a variety of reading assessments at Time 2 (1 year later). The results showed that speech rhythm sensitivity influences reading development in children; however, in the study only stress was measured leaving out other prosodic elements, such as timing, pausing and tone, that were not assessed (Holliman et al., 2010).

The findings demonstrate a relationship between prosodic sensitivity and reading and represent a first step towards developing a more sophisticated understanding of its role in early reading development. Studies regarding dyslexic children and their ability in suprasegmental awareness have been carried out by Goswami et al. (2011); in a series of different studies they consider the perception of sounds in a dyslexic population, and they found that dyslexics have difficulties in detecting rhythmic timing. According to Goswami et al.'s temporal-sampling theory, children with dyslexia have also difficulty in detecting any low frequency sounds and this particularly affects the slower temporal rate in speech processing and syllabic segmentation (Goswami et al. 2011).

Goswami et al. (2012) administered two different stress perception tasks to children with and without dyslexia. The experimental design aimed to compare the development of sub-lexical (rhyme and phoneme awareness) and prosodic (syllable stress) aspects of phonology in the participants. An initial cohort of 104 children was recruited. In Experiment 1 (mean age 9 years), participants received a reiterative speech task (DeeDee task) and in Experiment 2 (4 years later,

mean age 13 years), they received a direct stress perception same/different task. The children with dyslexia were compared to both younger reading-level matched controls (aged 7 years initially) and to age-matched controls.

The data obtained from the first experiment suggest that the phonological deficit in dyslexia is particularly marked for prosodic sensitivity in comparison to word-level and sub-lexical phonology. In fact, while children with dyslexia were as successful at making sub-lexical phonological judgements (rhyme judgements) as the younger reading level matched children aged on average 7 years (58% and 61% correct respectively), for prosodic judgements this was not the case. The data seem to suggest that an impaired perception to prosodic structure may be a causal factor in developmental dyslexia in English (Goswami et al. 2013).

The second experiment conducted 4 years after the first one included 64 of the children who took part in the previous study. This time participants listened to a 4-syllable word pronounced twice, and made a same/different judgement about stress. The results of Experiment 2 with stress perception provided evidence that dyslexic children had problems in perceiving syllable stress. Also the longitudinal multiple regression analyses conducted for Experiment 2 demonstrated that earlier developmental levels of both auditory sensitivity and metalinguistic sensitivity shaped the developmental trajectory for stress sensitivity. The results of these unique longitudinal studies are consistent with the hypothesis about the importance of prosodic awareness, showing that children with dyslexia develop prosodic awareness but not as non-dyslexic age-matched children (Goswami, 2012).

In order to see if this dysfunction is a peculiarity of dyslexia dependent on the language acquired, it is important to investigate other languages. Lately, studies on Spanish have been published. In its writing system, Spanish is a transparent language, meaning that the relation between speech sounds and written symbols is direct. Jiménez-Fernández et al. (2015) examined stress awareness in Spanish children with dyslexia and the possible mediation of phonemic awareness on suprasegmental phonological skills. They tested 31 Spanish children with dyslexia and 31 chronological age-control children; two stress awareness tasks were administrated, one with words and another with non-words. The results showed that the children with dyslexia performed more poorly on both tasks than control children, the number of mistakes was in fact much higher. They found that when phonemic awareness was entered as a covariate, accuracy differences disappeared in the task with words while when pseudo-words were used perception of stress was statistically different between the two groups.

Calet et al. (2019) also studied Spanish dyslexic children and compared them to TD children with a series of tasks to investigate if Spanish children have a prosodic deficit in processing

information at word-level but also phrase-level. In particular, suprasegmental phonology of the 24 dyslexic Spanish children and their corresponding control group was measured in 4 different tasks: word stress awareness, where children had to indicate which was the stressed syllable of a series of 18 words; pseudowords awareness, where instead of words, non-words were used; a phrase-level suprasegmental processing task, where 8 pair of sentences with different punctuation marks were proposed and children had to choose the correct meaning for each pair of items; and a non-linguistic rhythm task, used to measure non-linguistic rhythm skills where children had to reproduce a sequence of beats heard. The results confirmed the initial hypothesis that dyslexic children exhibit a core deficit in perception of suprasegmental phonology in both linguistic and non-linguistic stimuli (Calet et al. 2019).

2.3 ITALIAN STUDIES ON PROSODY AND DEVELOPMENTAL DYSLEXIA

In recent years a contribution to prosody in dyslexia has also been made by Italian researchers. Accent perception in Italian has been investigated in the works of Paizi et al. (2010), Caccia et al. (2019).

Paizi et al. (2010) investigate the role of stress assignment in reading development in relation to stress dominance and stress neighbourhood. They carried out two experiments, one to examine the relation between words frequency and stress dominance. The participants selected for the tests were 12 dyslexic children (mean age 11.6) and 12 age-matched children typically develop for the control group. The first test was composed by a list of high frequency words and one of low frequency words that the participants had to read aloud. Accuracy and reaction time (RT) were measured but only accuracy was considered for the analysis. The results showed that while TD children assign stress like adults, dyslexic children are affected by word frequency and stress dominance indicating a greater reliance on sublexical processing in this group. In the second test four sets of 14 three- and four-syllable low frequency words (nouns and adjectives) varying on stress type (dominant/non-dominant) and stress neighbourhood were used. The words had the same orthographic final sequences and they were 6–9 letters long. Also in this case participants had to read aloud the inputs while accuracy and RT were measured. In this case the results indicated that the effect of stress neighbourhood is identical in the two groups suggesting that both skilled and dyslexic readers are able to rely successfully on the statistical properties of their language, including the visual orthographic cues for stress assignment (Paizi et al., 2010).

The other study on dyslexic Italian population is by Caccia et al. (2019) and it investigates the reliability of duration, pitch and intensity as predictors of stress perception in three-syllabic non-words. They wanted to understand if duration is a critical parameter in the determination of stress assignment, and the results were not expected to differ from children to adults, while DD children were expected to be less sensitive to changes in duration and pitch when processing stress position. A series of 81 stimuli were presented to the participants, children with dyslexia, TD group and adults, who had to discriminate the position of the stressed syllable. The results suggested that DD children showed an impairment in processing skills of acoustic parameters responsible for lexical stress assignment and therefore, their orthographic difficulties with diacritical markers should be supported and rehabilitated on the basis of strategies that are not based on acoustic analysis.

Finally, in Magarotto (2021), a DD population is examined for the first time putting in relation accent perception in words and non-words for dyslexic Italian children. This last study will be described in detail in the next section as it is the immediate antecedent to this research with Italian teenagers.

2.4 PREVIOUS KEY EXPERIMENTS

In her study, Magarotto (2021) investigated if what had been found in English dyslexic children holds in Italian. As described in the previous section, the finding for English was that the perception of accent differs between dyslexic and non-dyslexic children. Italian is a syllable-timed language. This is why the question of Magarotto's study is whether accent perception in dyslexic children may be impaired also in a language with different characteristic from English.

Magarotto's study consists in two experiments where pairs of words and non-words are presented to the 26 participants (mean age 11.4) divided in two groups, a group of dyslexic children and a control group. In each experiment the participants listen to pair of words or non-words presented through a recording and are asked to say if they are different or identical accordingly. The reason for using words and non-words is to see if knowledge of the material (in this case of words) can influence the perception making the test easier or on the contrary more difficult.

The method and the procedure of the experiments is the same either for words and non-words and the conditions are: words with accent on the third syllable (in tables 1 and 2 *T* stands for 'terzultima', as for example in *sábato* 'Saturday'), words with the accent on the second syllable (*P* stands for 'penultima', as for example in *piràta* 'pirate', and words with the accent on the first syllable (*U* stands for 'ultima', as for example in *società* 'society'). The first three items of each experiment (I-II-III) were warm up items, to ensure that the participants understood the task.

In the experiment with real words, all three conditions occurred in three identical pairs and six different pairs, with a total of 27 items. The full list appears in table 1. In contrast, in the experiment with non-words there are three pairs of identical items and three of different items for each condition, making a total of 18 items. The full relation appears in table 2. The order of presentation of both table 1 and table 2 corresponds to the one in which they were presented in the experiments.

Order	words		same or diff	conditions	
I	càlice	càlice	same	T	T
II	natùra	naturà	different	P	U
III	fùcile	fucile	different	T	P
1	pagina	pàgina	different	P	T
2	cavità	cavità	same	U	U
3	farina	fàrina	different	P	T
4	parità	parità	different	U	P
5	divàno	divàno	same	P	P
6	matità	matita	different	U	P
7	fàvola	favolà	different	T	U
8	rarità	rarità	same	U	U
9	sanità	sànIta	different	U	T
10	lùmaca	lumàca	different	T	P
11	tàvolo	tàvolo	same	T	T
12	nùvola	nuvolà	different	T	U
13	càrita	carità	different	T	U
14	mùsica	musica	different	T	P
15	gelàto	gelàto	same	P	P
16	novità	novita	different	U	P
17	rùcola	rùcola	same	T	T
18	società	società	same	U	U
19	regina	reginà	different	P	U
20	piràta	pirata	different	P	T
21	verità	verità	different	P	U

22	sàbato	sàbato	same	T	T
23	cinemà	cinema	different	U	T
24	lùnedi	lunedì	different	T	U
25	befàna	befanà	different	P	U
26	bibita	bìbita	different	P	T
27	salàme	salàme	same	P	P

Table 1. Words list for the experiment with words taken from Magarotto (2021).

ordine	non-words		same or diff	conditions	
I	rùsali	rusàli	different	T	P
II	kesùfe	kesùfe	same	P	P
III	talodì	talodì	same	U	U
1	càtira	catirà	different	T	U
2	robike	robike	same	P	P
3	pàrivu	parivu	different	T	P
4	dikùtu	dikutù	different	P	U
5	silàka	silaka	different	P	T
6	bùbeto	bùbeto	same	T	T
7	titàso	titàso	same	P	P
8	foparà	fopàra	different	U	P
9	bodesà	bodesà	same	U	U
10	tudolì	tùdoli	different	U	T
11	siteti	siteti	same	T	T
12	rifolù	rifolù	same	U	U
13	vàroca	vàroca	same	T	T
14	berikì	beriki	different	U	P
15	fireta	firetà	different	T	U
16	dupùle	dupùle	same	P	P
17	vùtibo	vutibo	different	T	P
18	feturì	feturì	same	U	U

Table 2. Word list for the experiment with non-words taken from Magarotto (2021).

All the audio inputs were recorded using Audacity and presented in a powerpoint presentation. In each slide there was a picture of two girls and the audio of the pair of words or non-words accordingly. Every participant listened carefully (in an individual session) and after each pair of items had to say aloud if the words or non-words were identical or different, while the examiner annotated the answers.

Although the percentage of correct answers were all above 90%, the results show that dyslexic children in general tend to have more difficulties in perceiving the accent both in words and non-words when compared to the control group. Also, as can be seen from the figure below, the recognition of accent in non-words is more challenging for dyslexic children (66% of correct answers) than for TD children (100% of correct answers). Most of the mistakes made by dyslexic children regarded the different condition, in particular in the condition 3 vs 1 (third vs first syllable stressed, for example in the pair of words *càrita* – *carità* or in the pair of non-words *fìreta* – *firetà*); the percentage of correct answers in primary school dyslexic children was in this case 89.74% in same/different task with words and 74.36% in the task with non-words, while in lower secondary school children the accuracy was 100% with words and 97.44% in the task with non-words, showing an improvement in the ability to perceive the difference but still the dyslexic group scored lower than the control group.

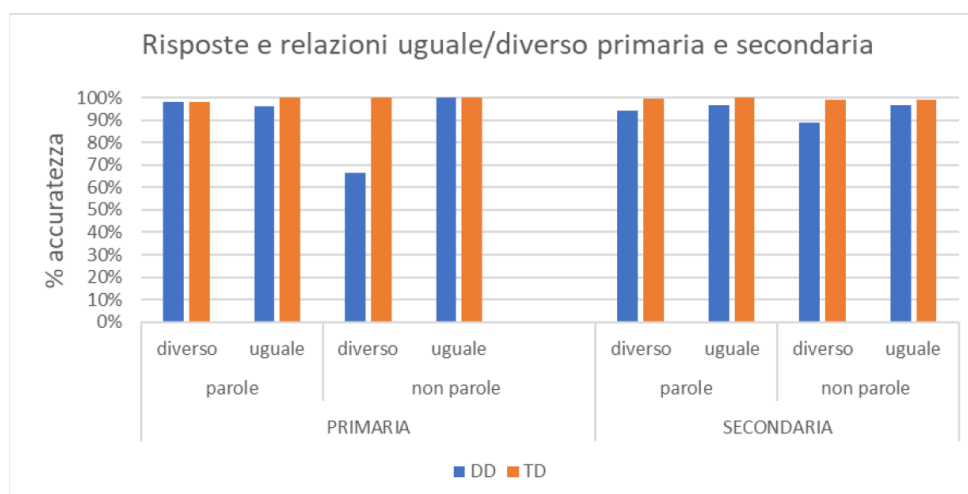


Figure 1. Percentage of accuracy in same/different task (Magarotto, 2021)

To investigate the perception of intonation, my study is an adaptation of the experiment of Salmons (2010), Gavarró and Salmons (2010) conducted with patients with Broca's aphasia. In their study patients with Broca's aphasia were tested to see if Broca's aphasia involved impairment in the patient's phonological abilities or if their agrammatic comprehension was due to impairment elsewhere in the grammar.

They selected 12 participants, six of them diagnosed with Broca's aphasia while the other were part of the control group. The experiment consisted in asking the participants to listen carefully to a stimulus consisting in a sentence repeated twice with same or different intonation and say if the two were identical or different. The participants had to press a red key if they thought the sentences were the same or a green key if they were different. The experiment was run on a laptop using *PsyScope* where both answers and reaction time were recorded. The items used for the test consisted of 32 pairs of sentences with different or identical intonational contours. There were eight pairs of 'interrogatives vs declaratives', used as control, the six different conditions, as in (2).

- (2)
- a. Interrogative vs declarative
 - b. Declarative vs declarative
 - c. Topic vs topic
 - d. Focus vs focus
 - e. Focus vs declarative
 - f. Topic vs declarative
 - g. Focus vs topic

The sentences used in the experiment were simple from the semantic and grammar point of view. The experimental design aims to avoid asking any metalinguistic question to the participants. An example of each condition appears in (3):

- (3)
- a. La mare veu el pare? (yes-no question)
det-fs mother see-3s det-ms father
'Does the mother see the father?'
 - b. La mare veu el pare. (declarative)
det-fs mother see-3s det-ms father
'The mother sees the father.'
 - c. La mare, veu el pare. (topicalisation)
det-fs mother see-3s det-ms father
'The mother, sees the father.'
 - d. LA MARE, veu el pare. (focalisation)
det-fs mother see-3s det-ms father
'It is the mother who sees the father.'

The results of Salmons' study show that aphasic patients performed well enough to be able to distinguish the four intonations. In fact, as can be seen in the bar graph below that summarizes the results of Salmons' experiment, aphasic patients obtained identical results in the three same conditions (declarative vs declarative, focus vs focus, interrogative vs interrogative) and in the control condition (declarative vs interrogative). On the other hand, aphasics' results in the different conditions were clearly worse: mean percentage of results in aphasic patients is below 80% and the risk of having a wrong answer in aphasic group was four times higher than in the control group. However, in only one condition (declarative vs topic) there was a statistical significant difference between the two groups, where the risk of errors was eleven times higher in the aphasic's results, and 70% got correct answers compared to 95% of control group.

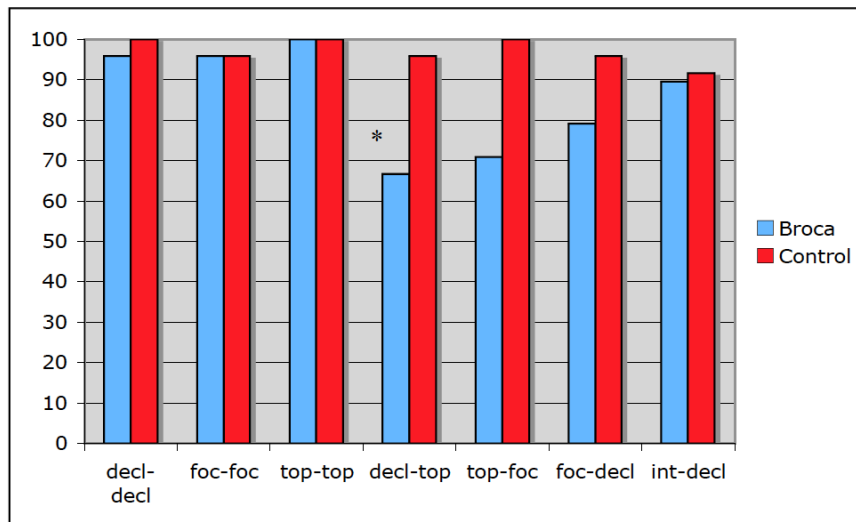


Figure 2. Mean percentage of results in the two groups by condition (Salmons, 2010)

3. RESEARCH QUESTION AND EXPERIMENTAL DESIGN

Considering the previous research reported, the present study is a follow-up study of Magarotto's (2021) study with Italian children and seeks to determine if suprasegmental phonology, in particular accent and intonation, is impaired in Italian dyslexic teenagers. To that purpose, I carried out two experiments on word stress that replicate the experiment with words and non-words of Magarotto (2021) and extended it to teenagers, and an experiment on sentential intonation inspired in the experiment by Salmons (2010). A series of standard pre-tests were also administered to secondary school students, older in age from those in Magarotto's study. I present them in turn, after giving the details of the participants in the study and of the general procedure.

3.1 PARTICIPANTS

The experiment was conducted with 27 subjects, 15 females and 12 males. 24 of the participants attended the secondary school Istituto Ezio Vanoni in Menaggio, Como, while 3 of them were external (didn't belong to the same school) students. Of these 27 teenagers, 20 were selected to be part of the study, half of them were Italian teenagers with a diagnosis of dyslexia (DD) updated within the previous three years¹, the other half was made up of ten Italian non-dyslexic teenagers used as a control group (TD). The remaining 7 participants were non-dyslexic and were excluded from the analysis for lack of an age-matched dyslexic participant. The age of the participants ranged from 14 years to 17 years (with an average age of 16.12). In order to select the control group the participants were to be at most three months older or younger than the adolescent with dyslexia. Only in one case there were 6 months of difference between the two participants. Further details of the participants are reported in Appendix I.

Before taking part in the tests all the participants received a written informed consent form, where the experiment was carefully explained, to be filled and signed by their parents, being all of them underage (see Appendix II). All the data collection respected the privacy policy and every part of the experiment has been conducted following the Covid-19 safety measures of Istituto E. Vanoni in Menaggio.

¹ In Italy an update of the diagnosis of dyslexia should be provided to schools every three years or at the end of any schooling path (after primary or lower secondary school), according to the norm "Indicazioni per la diagnosi e la certificazione dei DSA" by the State/ Regions Conference <http://archivio.statoregioni.it/dettaglioDoc73f3.html?idprov=11032&iddoc=37451&tipodoc=2&CO NF=CSR>.

3.2 PROCEDURE

In the study all participants performed 6 tests individually: 4 standardized tests, one test on the discrimination of stress with words and non-words, and a new version of intonation discrimination task of Salmons (2010). Moreover, non-verbal intelligence was measured through a Raven test, *Standard Progressive Matrices (SPM)* (Raven, 1994), which has been used as a pre-test to select participants in consideration of their ability to perform perceptual relations and analogy. The percentile results obtained in the Raven test allow (equal or above 25th percentile), and so all the participants were included. The entire test composed of the 6 tasks lasts about 50 minutes while the duration of the Raven test, administered at the end, varies in length depending on the subject. The experiment was conducted in a quiet room of the Istituto E. Vanoni in Menaggio. Each subject did the experiment following the same order and on the same day.

The order of the tests including both standardized tests and discrimination tasks is the following:

1. Discrimination tasks with words and non-words, of Magarotto (2021) was administered adapting the graphic layout to teenagers;
2. Reading task, *Prova di Velocità di lettura brani per la scuola media superiore* by Judica and De Luca (2005) to measure the speed and accuracy in reading skill;
3. Discrimination task for sentential intonation designed especially for the current study;
4. Repetition of non-words, taken from the *Batteria per la Valutazione dell'Attenzione Uditiva e della Memoria di Lavoro Fonologica nell'Età Evolutiva* (VAUMeLF) by Bertelli/Bilancia (2006), to measure phonologic memory;
5. Spoonerism task, from *Valutazione delle Competenze Metafonologiche* (CMF) by Marotta et al. (2008), to evaluate meta-phonological competence and segmental awareness;
6. *Standard Progressive Matrices (SPM)* by Raven (1994) by Giunti psychometrics edition.

In the next chapter a description of each standardized test with its results is presented.

4. STANDARDIZED TESTS

In this section I describe each pre-test and present for each its results.

4.1. Reading task

In the reading test, each participant had to read the text “Un viaggio con le mucche” taken from the *Prova di velocità di lettura brani per la scuola media superiore* by Judica and De Luca (2005). Each participant was given a printed version of the text to be read aloud while the experimenter was recording it using a sound recorder software on the mobile phone. The text used can be found in appendix IV. For each participant both reading time and accuracy were analysed. In the case that the reading speed was below 4 minutes, which happened in all the cases except one, in order to get the reading time, the number of seconds is divided by the number of syllables which in the text used are 605 (total sec/605). In the reading test longer than 4 minutes, the reading speed was obtained dividing 240 seconds by the number of syllables that were read until the time limit. On the other hand, in order to get the accuracy of reading, the number of mistakes is counted. Misread words, wrong words and words with the wrong accent are considered errors that affect accuracy.

Results – In this reading task reading speed and reading accuracy were measured. The table in Appendix III shows how fast each participant was. The data are given in seconds and they are calculated dividing the seconds taken to read the text by the total number of syllables in all the cases except EE where the result is given dividing 240 seconds by the number of syllables read. The mean of seconds per syllable in dyslexic teenagers is 0.29 while the matched-age group's mean speed is 0.24. This confirms that dyslexics are slower in reading compared to non-dyslexic participants.

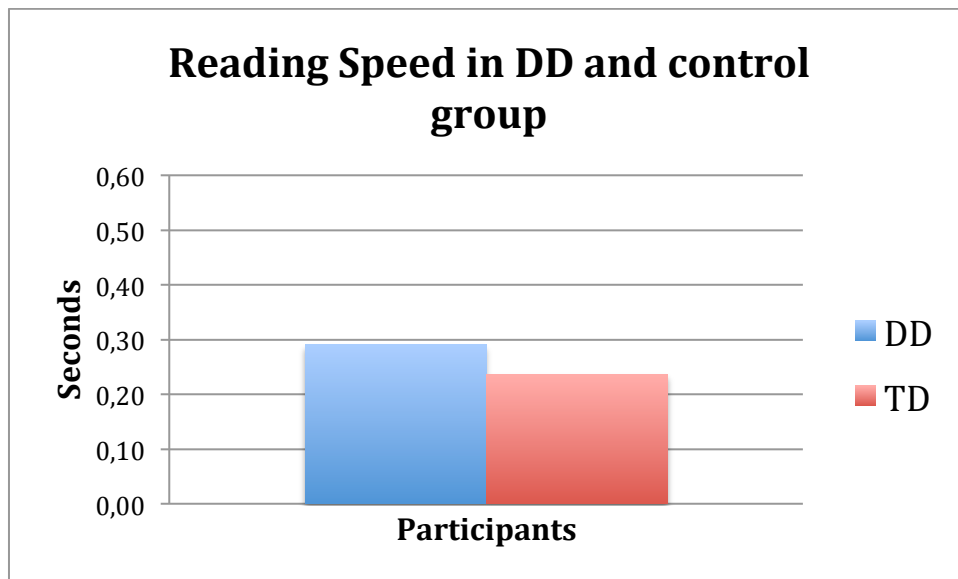


Figure 3. Bar chart describing reading speed

Reading accuracy for the two groups can be found in the table in Appendix III and it is graphically represented in Figure 4. Dyslexic teenagers not only are slower but they also make more mistakes compared to the control group. In particular the mean of reading errors is 10.4 for the experimental group and 8.3 for the control group. Again the difference here is clear and it confirms what is known about reading skills in dyslexia.

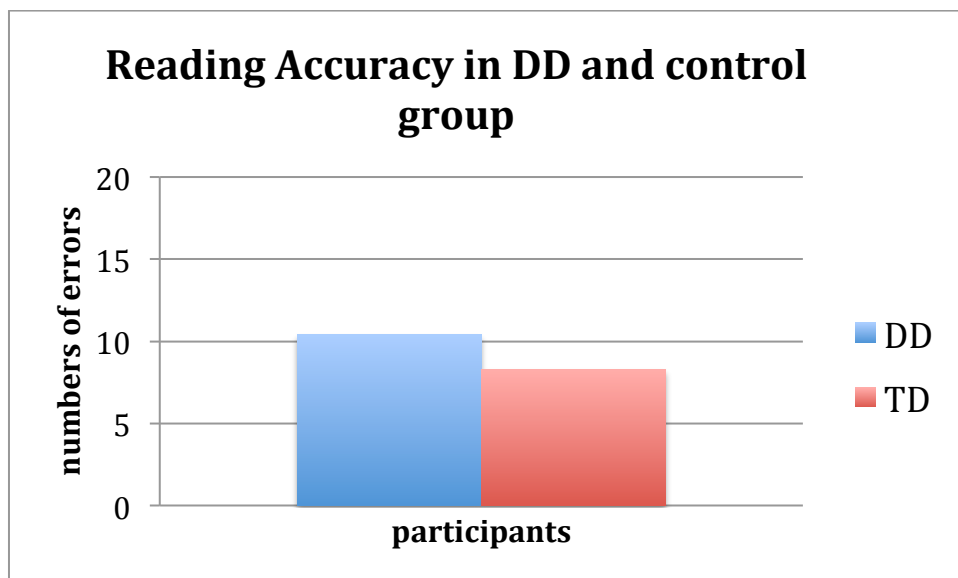


Figure 4. Bar chart describing reading accuracy in number of errors

4.2. CMF spoonerism

This is a standard test, taken from CMF *Valutazione delle Competenze Metafonologiche* by Marotta et al. (2008), which measures the meta-phonological competence of the participants. This means that the test studies their ability to perceive, recognize and analyse speech in phonological units and manipulate them. The spoonerism task requires blending as well as segmentation skills, but also involves short-term and WM (working memory) abilities, close monitoring of the phonological manipulation, and inhibitory processes (Varvara et al. 2014). This is why dyslexic people should have bigger difficulties in performing it compared to TD population (Marotta et al. 2008).

The examiner pronounces two words aloud and the participant has to swap the initial phonemes to form two new real words. The participant is asked to transpose the beginning sounds of the two words as quickly as possible. For example in the trial session the two words *pane – collo* are given, and the participant has to swap *p* with *c*, as a result the two new words obtained are *cane – pollo*. The test is composed of 15 pairs of words as reported in table 3. The score is the number of correct answers (maximum score 30): 2 points when both answers are correct, 1 point for one correct word, 0 for wrong answers. Here the list of words:

word1	word2	solution
duna	lente	luna-dente
benda	tuono	tenda-buono
pallina	gatto	gallina-patto
canto	vento	vanto-cento
vaso	ruota	raso-vuota
torre	corta	corre-torta
secchio	vandali	vecchio-sandali
tondo	mela	mondo-tela
vasta	pero	pasta- vero
ponte	fiume	fonte- piume
martello	coda	cartello- moda
sarta	canto	carta- santo
calore	marte	malore- carte
pacco	sera	sacco-pera

zucca	molla	mucca-zolla
-------	-------	-------------

Table 3. List of words from CMF spoonerism with correct answers

During the administration of the test the answers are written down and the test is recorded through sound recorder software.

Results – The number of correct answers by the dyslexic participants (DD) and in the control group (TD) appear in the table in Appendix III. Figure 5 represents the accuracy measure considering 30 the maximum score of correct responses, and it shows how the mean of correct answers is 19.7 for DD and 24.6 for the age-matched group. The percentage of accuracy is then 65.6% for the DD group compared to 82% for the control group. Given the difficulty of the task the control group also gave a low number of correct answers, however the DD teenagers performed worse in this task. This result confirms what has been found by Magarotto (2021) in primary and lower secondary school children, where the percentage of accuracy were 59.49% for the DD and 91.79% for TD children, although the difference between dyslexic and non-dyslexic is less evident in secondary school teenagers.

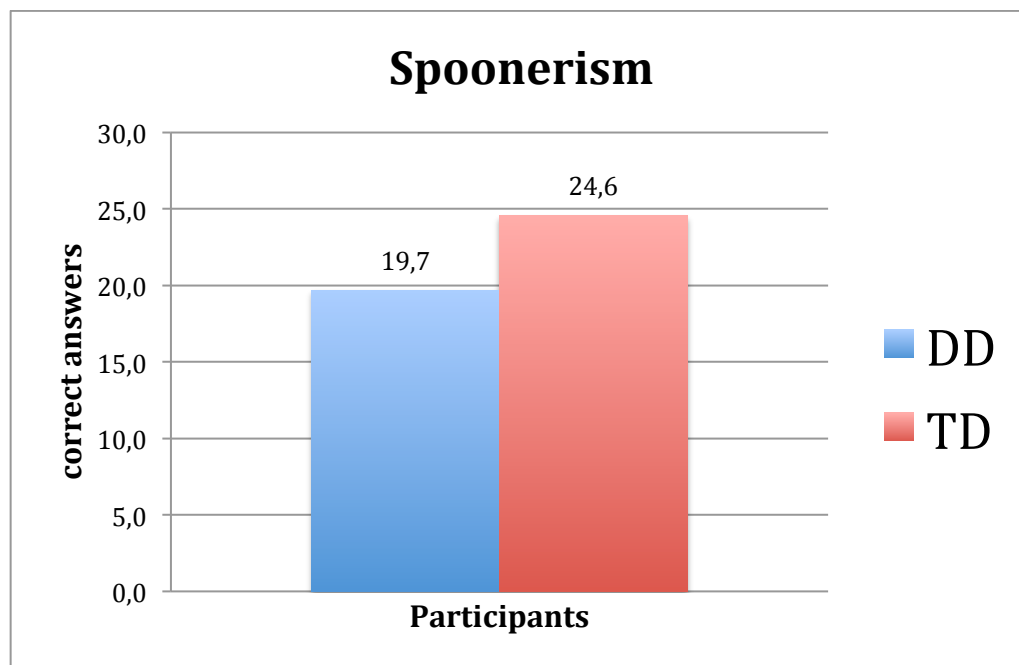


Figure 5. Bar chart in number of correct answers (/30)

4.3. Non-words repetition

In this standardized test, taken from the VAUMeLF, *Batteria per la Valutazione dell'Attenzione Uditiva e della Memoria di Lavoro Fonologica nell'Età Evolutiva* (VAUMeLF) by Bertelli and Bilancia (2006), the aim is to test the phonological memory of the participants. Considering that this kind of memory is involved in the reading process, in particular in learning of phoneme/grapheme correspondence, it is expected to be impaired in dyslexic population.

A list of 42 non-words (see table 4), different in length and sounds, performed by a female voice is played. The first two items are warm-up items. The recording is played by a computer and each participant using earphones listens to each item (one at a time only) and is asked to repeat aloud every non-word s/he hears, while the examiner takes notes of any mistakes. The performance is recorded and the total score is 40, so one point is given to every correct answer. As for the mistakes, a mispronunciation of one consonant or vowel is considered incorrect.

robuta
bitalevro
cafrimo
scrole
foblitego
cilosabe
strepa
sbralogamevi
sapegucistri
clobato
sdramive
guvidena
lusbri
fopegi
glopi
cebra
vugnedrapi
recusprogi
glatinuba

gnosfra
geplura
gnadetra
veco
flime
fisprumo
duvomascre
sgrimubofi
suricoflage
pasclumegno
fepucotari
bignascletuvo
besogaruno
fabre
vrecaludepa
nigapso
bucritocefa
femuscla
rognitrulepa
suba
fenadumiblo

Table 4. List of non-word used in the non-word repetition task

Results – For this task we found no difference in performance between the dyslexic and the control group, in fact the mean of correct pronunciation is 33.2 for the DD and 33 for the TD.

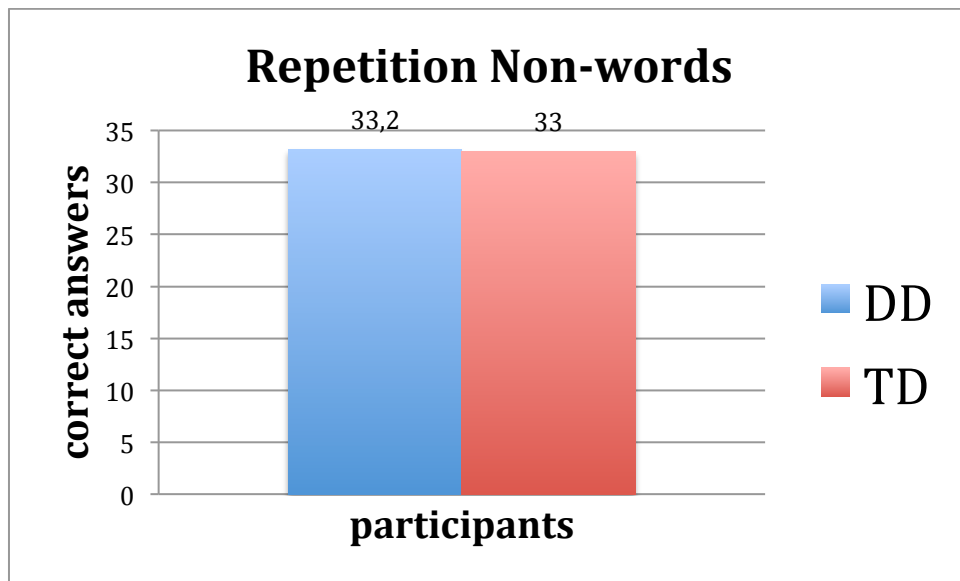


Figure 6. Bar chart in number of correct answers (/40)

5. SAME/DIFFERENT TASKS WITH WORDS AND NON-WORDS

5.1 Experimental design and method

The main part of this study is based on three same/different tasks (s/d task). This type of task requires participants to decide if two presented stimuli are the same, say AA or BB, or different, say AB or BA (Macmillan & Creelman, 2005). The procedure is simple, after presenting two inputs in a row the subject has to detect the similarity or the difference of the two. The answer can be given aloud or the participants can be asked to press a key button. The interesting aspect of this task beyond its simplicity and versatility is also that participants do not need to know how the two elements differ, or be able to verbalise, and because of this this task has been widely used in many experiments especially in the language sciences.

Two s/d tasks have been used to detect the accent of the items presented. In the first task the items are words, in the second non-words. The tests are administered in a row, first the task with words and then the task with non-words. The list of words and non-words used and the conditions are those in the experiment designed by Magarotto (2021) in her study on Italian described in the previous chapter.

In particular, both ‘same’ and ‘different’ conditions are represented as follows (take into consideration that each item consists in a trisyllabic word or non-word and that accent is counted from the end):

- third syllable stressed vs third syllable stressed (3 vs 3);
- second syllable stressed vs second syllable stressed (2 vs 2);
- first syllable stressed vs first syllable stressed (1 vs 1);

In the ‘same’ condition, for each option there are three items in both the task with words and non-words.

These are the combinations in the ‘different’ condition:

- third syllable stressed vs second syllable stressed (3 vs 2) and vice versa;
- second syllable stressed vs first syllable stressed (2 vs 1) and vice versa;
- third syllable stressed vs first syllable stressed (3 vs 1) and vice versa;

In this case, for each combination there are six items in the task with words and three items in the task with non-words.

The procedure is the same in the two tasks. The audio is played through a powerpoint presentation on a computer using earphones for a better quality of sound. Each participant checks the volume and the items can be heard only once. Figures 7 and 8 below show what appears on the

screen. The participants were instructed on how to click on the icon to listen to sound and after each input to move forward. The examiner takes notes of each answer given by the participant and check that the participants follow the correct order of slides.

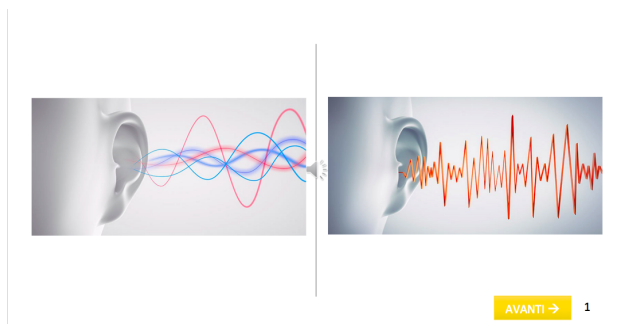


Figure 7. Visual presentation of words task

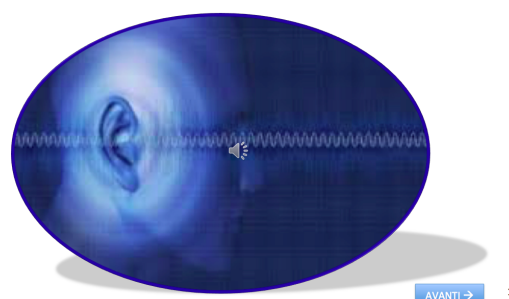


Figure 8. Visual presentation of non-words task

5.2 Results

Table 5 and Figure 9 present the results of the two tasks, with words and non-words.

	DD		TD	
	same	different	same	different
words	97.7%	93.3%	100%	99.4%
non-word	95.5%	93.3%	100%	95.5%

Table 5. Mean of correct answers

Table 5 shows the results of the two tasks in general. Even if the difference is small, it is clear that dyslexic teenagers' perception of accent is not the same as non-dyslexic ones. In fact, considering the 'same' condition, TD group does not have any difficulty in perceiving when the stress in words and in non-words is identical. In fact, non-dyslexic teenagers made no mistakes in the tasks, either with words or non-words. The dyslexic group, on the other hand, shows a slight difficulty in spotting the accent especially when the input is represented by non-words. However, the number of mistakes is low considering that the percentage is above 95%.

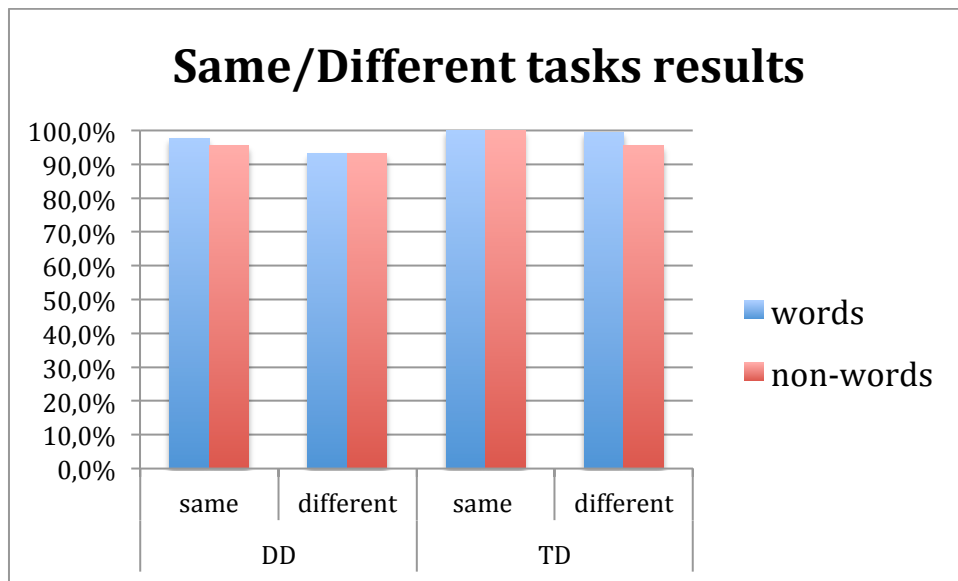


Figure 9. Bar chart describing percentage of correct answers

Regarding the ‘different’ condition, 93.3% of the time dyslexic teenagers answer correctly to the stimuli both in words and non-words. In this case it seems not to be any difference if the input presented is a real word or a non-word, which differs from what Magarotto (2021) found with children. In fact, primary school dyslexic children had a percentage of accuracy in the ‘different’ condition with non-words of 66% while when the input was composed by words the accuracy was 98%, while in lower secondary participants’ accuracy with words was 94.4% and 88.89% with non-words. In the current study, the results for the control group is 99.4% of correct answers in the task with words while 95.5% in the task with non-words, showing a little difficulty when they had to work with non-words.

Taking a look at each condition in detail these are the results. Starting from the ‘same’ condition the results show that the TD group does not have any difficulty in this task neither with words or non-words in any combinations. Regarding the dyslexic subjects when the position is on the second syllable (2 vs 2) they do not have any difficulty in perceiving the accent, in fact no mistakes are made in this condition. On the contrary, the input that seems to create more issues is non-words with the accent on the third syllable (3 vs 3). In this case, in fact, the number of mistakes is the highest and the percentage of correct answers is the lowest, 90%.

Last, in the ‘same’ condition when the accent is on the first syllable (1 vs 1) again dyslexic teenagers seem to have some problems in the perception of the stress both in words and in non-words. They got 93.3% of correct answers when the input was a word and 96.6% when the input was a non-word. In Figure 10 the lower percentage of correct responses by the DD group is evident.

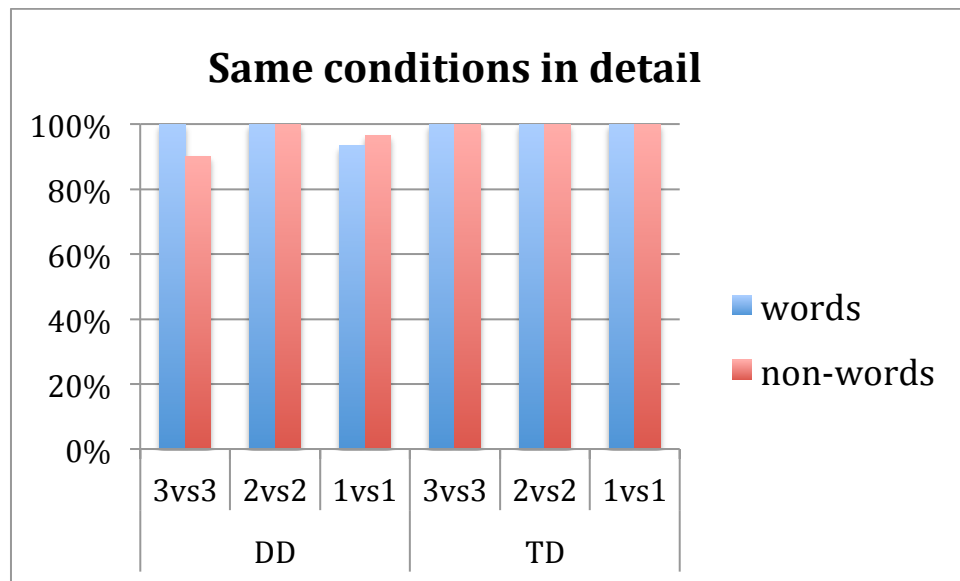


Figure 10. Bar chart describes the three ‘same’ condition taking stress into account

Figure 11 below shows the results for each combination of the ‘different’ condition. What appears is that TD teenagers do not have problems in the perception of accent neither in words nor non-words in the 3 vs 2 and 2 vs 1 combinations. In fact, there are no mistakes in these cases. In dyslexic teenagers, on the other hand, the percentage of correct answers is slightly lower in non-words while it is 92.6% with words in the combination 3 vs 2. What emerges from the data and is worth taking into consideration is the combination 3 vs 1 so when the accent is on the third syllable and on the first syllable. In this case dyslexic adolescents clearly have difficulties in perceiving the difference especially with non-words. The percentage is in fact 90.7% with words and 86.6% with non-words. On the other hand, non-dyslexic participants also seem to have trouble in spotting the accent when confronted to non-words. Also for them 86.6% is the percentage of correct answers. It seems that there is no difference in the way teenagers perceive different accents in particular in the case 3 vs 1 especially when the input is a non-word.

Clearly when the inputs consist in non-word Italian teenagers tend to have the same difficulties them being dyslexic or not in the case of the perception of the accent on the third syllable accent vs first syllable (3 vs 1).

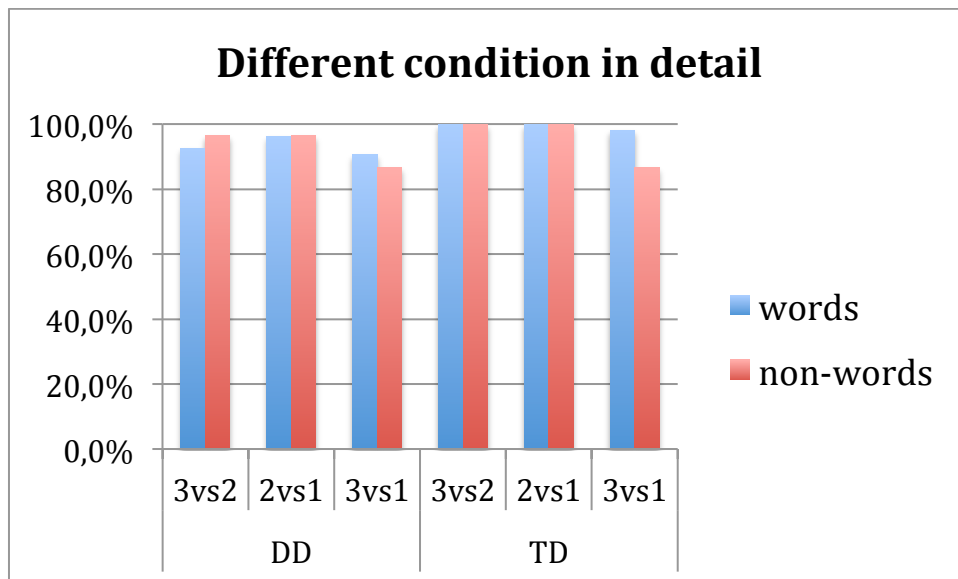


Figure 11. Bar chart for the three 'different' conditions

This last result confirms on one hand what Magarotto found with children, where the percentage of accuracy of DD for this combination (3 vs 1) was the lowest (89% with words and 74.36% with non-words). On the other hand, in Magarotto's study non-dyslexic children's result was 97% confirming that they do not have an impaired perception of this combination of accents, while in this study it seems that TD participants struggle in perceiving the difference of accent on the antepenultimate and the first syllable when the input is a non-word.

6. SAME/DIFFERENT TASK WITH SENTENCES

6.1 Experimental design and method

Considering that Italian and Catalan are languages with similar syntactic structures, it has been possible to adapt a similar study in Italian. Adapting Salmons' experiment we tested a dyslexic population to see if their ability to perceive different intonational contours is impaired.

In particular, from the original design only three intonational contours have been used in this experiment: neutral declaratives (D), yes/no interrogatives (I) and focus sentences (F, corresponding to subject focus sentences). The topic condition was eliminated to make the test shorter. Four different sentences per condition were tested and they were recorded using Audacity software in normal speaking speed and a neutral Italian accent. Each sentence was read in the three different conditions selected (D, I, F). Here there are the sentences used for the experiment (4):

- (4) a. Giorgio gioca con il gatto - Giorgio gioca con il gatto? - GIORGIO gioca con il gatto
Giorgio play-3s with det-ms cat
'Giorgio is playing with the cat – Does Giorgio play with the cat? – it is Giorgio who plays with the cat'
- b. Tua sorella studia legge - Tua sorella studia legge?- TUA SORELLA studia legge.
Your-fs sister study-3s Law
'Your sister studies Law – Does your sister study Law?- it is your sister who studies Law'
- c. I fiumi sono in secca - I fiumi sono in secca? – I FIUMI sono in secca.
Det-mp Rivers be-3p in secca
'Rivers are dry – Are rivers dry? – it is rivers which are dry'
- d. Carla suona la chitarra - Carla suona la chitarra? - CARLA suona la chitarra.
Carla play-3s the-fs guitar
'Carla is playing the guitar – Does Carla play the guitar? – it is CARLA who plays the guitar'

According to Avesani (1995) standard presentation of Italian intonational curves exposed in section 1, the intonational contours of the sentences selected can be described as follow:

- (5) DECLARATIVE: H+L* L- L%
 FOCUS: H* L- L%
 INTERROGATIVE: H+L* L- H%

Each sentence follows the same superficial word order, although the underlying structure is different, in fact, the only superficial difference between the three sentence types D, I and F is the intonation. This has been possible considering that, in fact, in Italian yes-no questions there is no movement of the auxiliary verb but only a change in the intonation of the utterances. Moreover in every sentence the verb is in the present tense and the words used are very simple and common, also phonologically. Moreover, each sentence is composed by words similarly in length to have the same number of total syllables (8 syllables).

After selecting and recording the materials, 24 pairs of items are obtained in which the same sentence was repeated with identical or different intonation. All the experimental conditions are matched forming three groups having same intonations and three whose intonation was different. Table 6 summarizes how they have been matched and presented during the experiment in a random order:

SENTENCES		CONDITIONS
GIORGIO gioca con il gatto	Giorgio gioca con il gatto	F vs D
TUA SORELLA studia legge	Tua sorella studia legge	F vs D
Tua sorella studia legge?	Tua sorella studia legge?	I vs I
Tua sorella studia legge?	Tua sorella studia legge	I vs D
I fiumi sono in secca?	I FIUMI sono in secca	I vs F
I FIUMI sono in secca	I FIUMI sono in secca	F vs F
CARLA suona la chitarra	Carla suona la chitarra	F vs D
Carla suona la chitarra?	Carla suona la chitarra	I vs D
Carla suona la chitarra?	Carla suona la chitarra?	I vs I
I fiumi sono in secca?	I fiumi sono in secca?	I vs I
Giorgio gioca con il gatto	Giorgio gioca con il gatto	D vs D
GIORGIO gioca con il gatto	Giorgio gioca con il gatto?	F vs I
Tua sorella studia legge?	TUA SORELLA studia legge	I vs F
I fiumi sono in secca	I fiumi sono in secca ?	D vs I
GIORGIO gioca con il gatto	GIORGIO gioca con il gatto	F vs F

Tua sorella studia legge	Tua sorella studia legge	D vs D
CARLA_suona la chitarra	CARLA suona la chitarra	F vs F
Carla suona la chitarra?	CARLA_suona la chitarra	I vs F
Giorgio gioca con il gatto?	Giorgio gioca con il gatto?	I vs I
Carla suona la chitarra	Carla suona la chitarra	D vs D
TUA SORELLA studia legge	TUA SORELLA studia legge	F vs F
I FIUMI sono in secca	I fiumi sono in secca	F vs D
I fiumi sono in secca	I fiumi sono in secca	D vs D
Giorgio gioca con il gatto	Giorgio gioca con il gatto?	D vs I

Table 6. Order of the items and their conditions in the s/d task with sentences (D= declarative sentence; F= focus sentence; I= interrogative sentence)

The experiment was created using the free software Psychopy (<https://www.psychopy.org/>) and it was run on a laptop (see the form of presentation in Figures 12 and 13). Earphones were used to have good sound quality. During the test the participants listened to the recordings and pressed a letter on the keyboard, ‘U’ if the utterances were identical, ‘D’ if they were different. After each item the software reproduced automatically the following pair until all the 24 combinations were reproduced and the test was over. All the answers were collected automatically in a folder on the laptop.

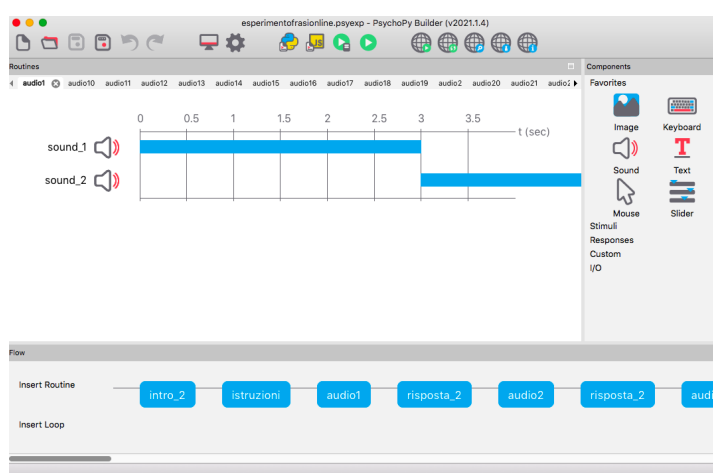


Figure 12. Graphic display of Psychopy

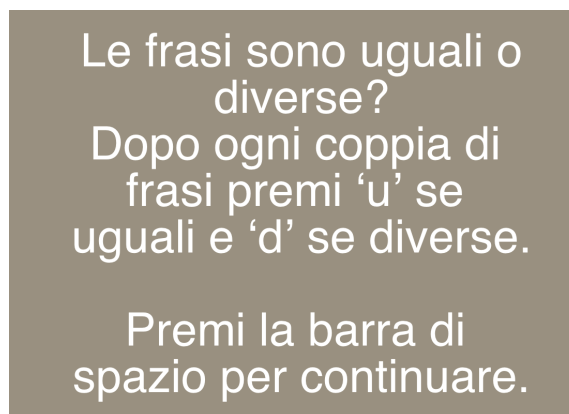


Figure 13. Introduction slide of Psychopy software while running the experiment

6.2 Results

This task consists of two conditions: same and different intonation. The table in Appendix III reports the individual percentage of accuracy in the same/different task when inputs are sentences. The TD group has no trouble in detecting when the intonation of utterances was the same, in fact, 99% of their answers were correct, while for the DD group percentage of accuracy in perceiving the intonation in the 'same' condition is 94.4%. This little variation can be observed also in Figure 14 comparing the two bars in the first condition.

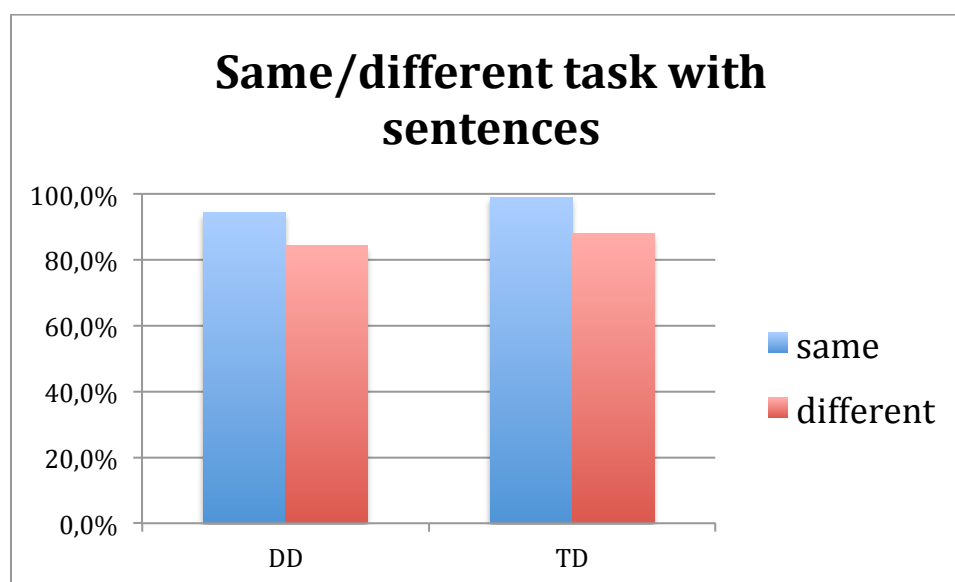


Figure 14. Results for same/different task with sentences

On the other hand, taking a look at the 'different' condition, the situation differs. In fact, the percentage of accuracy in the experimental group (DD) drops to 85% compared to the 94.4% of the 'same' condition in the control group. This value tends to confirm the hypothesis that dyslexic teenager's perception of intonation is actually impaired. However, the data of the control group is

lower than expected. Non-dyslexic participants in fact get 89% of correct answers, suggesting that this group also has difficulty in spotting the intonation of utterances when they differ one from the other.

Considering the results in general dyslexic teenagers and non-dyslexic teenagers seem to obtain similar results in both the tasks with a slight disadvantage in the DD group.

After an analysis of the results by sentence type, the results are the following. Looking at the results of the experimental group, the lowest percentage of accuracy is in the Interrogatives combination with 92.5% of correct answers. On the other two conditions, declaratives and focus, the accuracy is 95%. The participants of the control group make some mistakes in the F vs F condition getting 97.5% of accurate answers. They do not show any problems in the other two possible combinations, D vs D and I vs I. Still, in the ‘same’ condition the percentage of accuracy is above 90% for the two groups in all conditions (Figure 15).

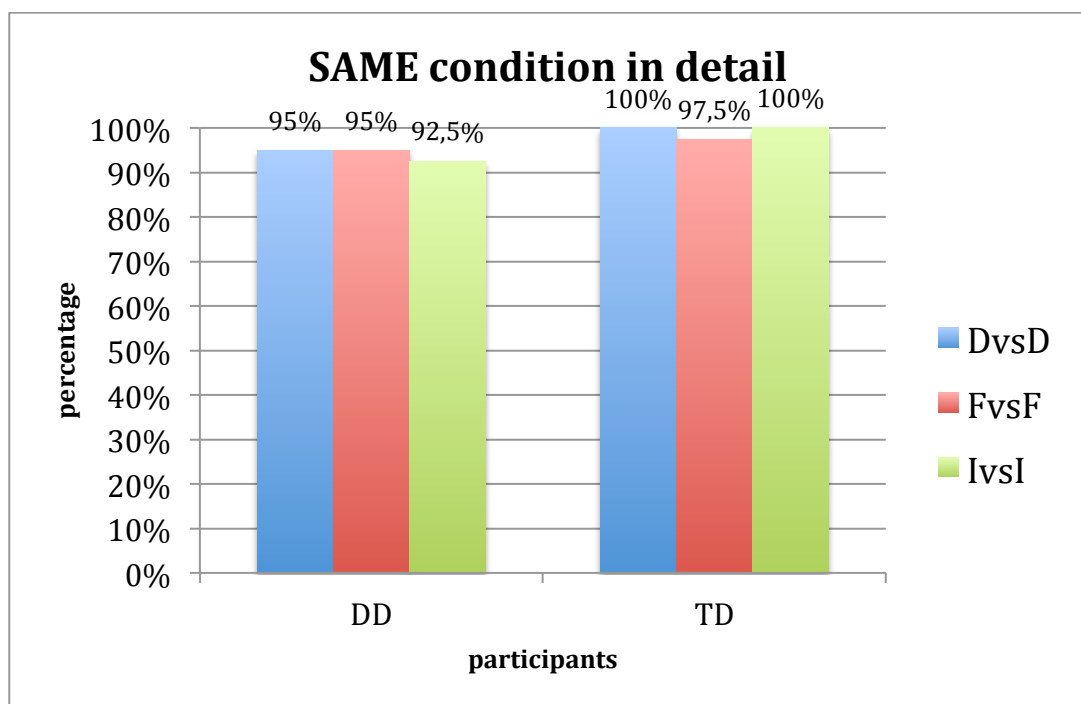


Figure 15. Results of correct answers in the ‘same’ condition

Considering the ‘different’ condition in sentences the results are lower. In fact, both in DD and TD in two conditions the percentage of accuracy is lower than 90%.

Starting from the dyslexic group, the condition with the higher percentage is the focus vs interrogative with 92.5% of correct answers. In this case the difference of the intonation seems to have been perceived better compared to the other conditions. Only 77.5% of accuracy is obtained when the intonation is focus vs declaratives. This low result was expected, being this condition the

most difficult one. Lastly, in the declarative vs interrogative combination the percentage of correct answers is 85%. This condition was supposed to be the easiest among the three, in fact in Salmons' study it was used as control. However, Italian dyslexic teenagers obtained a percentage of accuracy which is below 90%.

In the control group the situation is as follow: 90% of correct answers given in declaratives vs interrogatives, 95% in focus vs interrogative condition and 82.5% in focus vs declarative condition. Although this last result is higher than the one obtained by DD, it shows that non-dyslexic teenagers also have difficulty in spotting the F vs D intonation.

Figure 16 presents the results graphically.

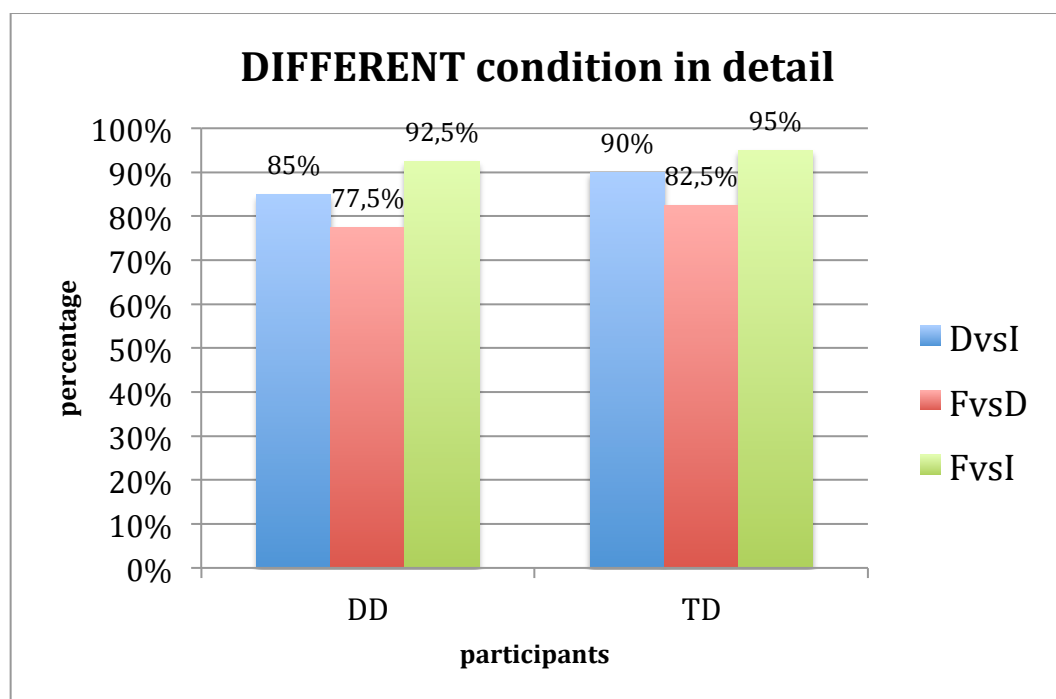


Figure 16. Results of correct answers in the 'different' condition in detail.

7. DISCUSSION AND CONCLUSION

The present study aimed to investigate phonological awareness in Italian dyslexic teenagers, in particular their perception of accent and intonation. It can be considered a follow-up research of the study by Magarotto (2021) with Italian children, considering that part of the tests administered were the same but the participants were teenagers instead of children. This was done to investigate if the slight impairment in accent perception in DD, obtained in Magarotto's experiment, remains in an older population too.

Taking a look at the results of the standardized tests presented above, the initial hypothesis, that Italian adolescents with dyslexia have difficulties in tasks where metaphonological awareness and working memory is needed, can be confirmed; in fact, their scores were lower than those of the TD group. Both in the Spoonerism (Marotta et al. 2008) and in the Reading task (Judica et al. 2005), DD participants got a worse result than the control group. On the other hand, there seems not to be much of a difference in the Italian teenagers' performance, whether dyslexic or not, as shown by the results of the Non-word repetition task (Bertelli et al., 2006) where the mean of correct answers was basically the same (33 in the control group vs 33.3 in the experimental group)

Considering the two same/ different tasks proposed the graph below offers a summary of the accuracy results.

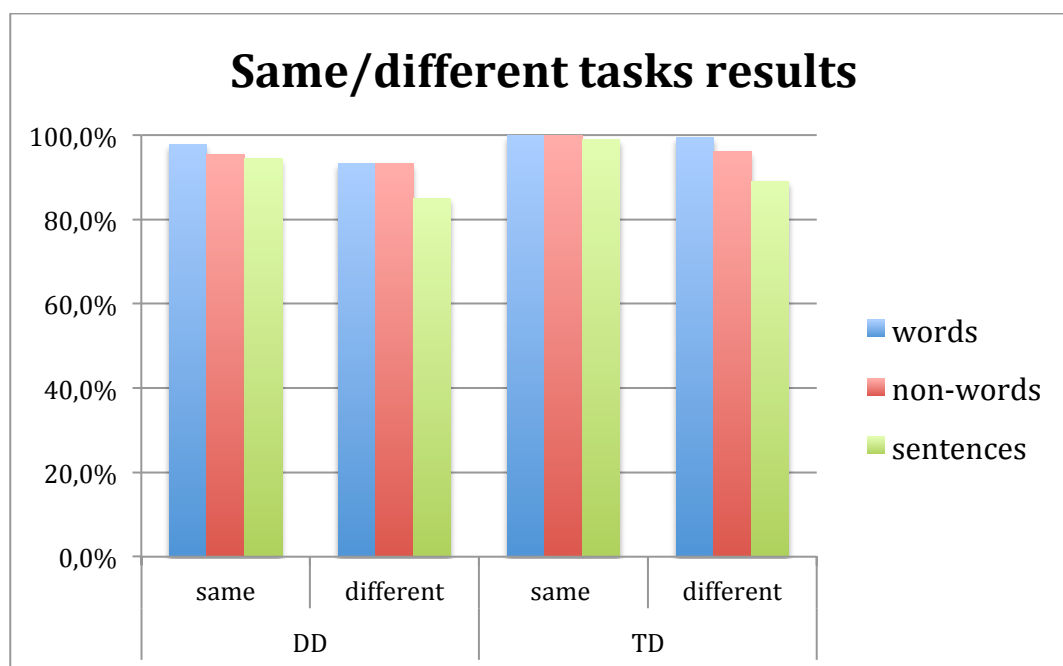


Figure 17. Results of the same/different tasks

What emerged from the word/non-word same/different tasks confirmed the results of Magarotto's study (2021), in which children with dyslexia show more difficulties in performance. Although all the results were similarly above 90%, Italian dyslexic teenagers scored lower than the TD group. In particular, when the items presented were different, dyslexic adolescents had trouble in spotting this difference. However, as can be seen in Figure 10, a detailed analysis of the 'same' condition showed that dyslexics scored lower than non-dyslexics even when the two items had the same accent. In particular, in the condition 3 vs 3 when inputs are non-words, the dyslexics' percentage of correct answers is 90% and also in the condition 1 vs 1 the experimental group seems to have trouble both in recognizing same accented words (93.3% accuracy) and non-words (96%).

In contrast to the previous study with children of Magarotto (2021), in which non-word items were more challenging for the experimental group, the teenagers' results in the 'different' condition do not seem to differ whether the stimulus is represented by words or non-words. In fact, in both situations their percentage of accuracy is 93.3%.

Further analysis of the different conditions reveals greater difficulty in the perception of the accent when it appeared on the first syllable, in particular in the combination third syllable stressed vs first syllable stressed (3 vs 1) the percentage of accuracy is 90.7%. In Magarotto's results the combination third syllable stressed vs first syllable stressed was also the one that granted the worst performance, and she suggested this might be due to the fact that the accent on the first syllable is more difficult to spot. Considering that in Italian stressed syllables are longer than unstressed ones, and open stressed syllables are longer than closed stressed syllables, it seems that stressed vowels in final position are identical in length and duration to those in closed syllables and so short in phonological and phonetic terms (Hajek et al. 2008). Also, it appears that duration is one of the main stress cues, among duration, intensity and frequency (Bertinetto, 1990), so there seems to be a dysfunction then in the perception of different length of syllables which is apparent especially in 3 vs 1 condition (Magarotto, 2021).

The analysis of the same/different task with sentences suggests again lower performance in dyslexic perception of prosodic elements, in this case intonation. Although the TD group also seems to have some difficulty in the task with different inputs, the experimental group reached only 85% of accuracy in the different conditions. A detailed analysis of each condition showed that, among the three combinations of sentences in the 'different' condition (declarative vs interrogative, focus vs declarative and focus vs interrogative), focus intonation when compared to declaratives was the most problematic in dyslexic teenagers (77.5% of accuracy). Differently from Salmons' (2010) results with Broca's aphasics, where the combination declarative vs interrogative was used as control and thus no big difficulties were found, here the DD percentage of accuracy is only 85%.

The better result was obtained when the stimuli were focus vs interrogatives, with 92.5% of correct answers.

Taking a look at the control group, the results present fewer contrasts. In fact, in all the combinations of the ‘different’ conditions they obtained a lower percentage of accuracy than expected. Besides the last condition (focus vs interrogative) where they scored 95% of correct answers, in the other two cases the percentage is lower than 90%, which suggested that there are some issues to be investigated either in the procedure of the experiment or in the participants.

This outcome might be also due to heterogeneity of the control group and in their selection and to the difference in the severity of language impairment of participants. In public schools there are many cases of masked dyslexic adolescents and also borderline subjects, who thanks to schooling and scaffolding tools built over the years, have never been diagnosed. In particular, there are three participants in the control group (MCO, MA and DM), who in the Reading task were on or below the threshold (0.25 seconds according to Judica et al. 2005) and in Spoonerism their number of correct answers was pretty low compared to the others in the TD group (see Appendix III for individual results).

If these possibly misdiagnosed participants were left out in the same/different task with sentences these would be the results (see Figure 18)

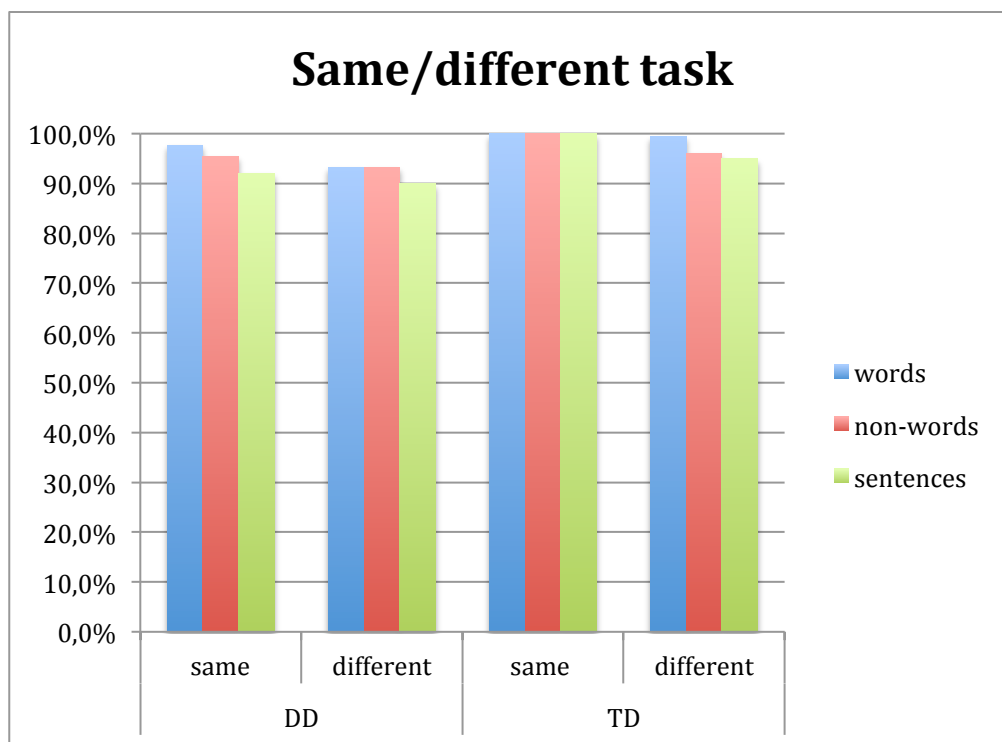


Figure 18. Revised results of the s/d tasks

In this new outcome a difference in the perception of intonation between DD and TD adolescents would emerge clearly, with 90% of correct answers for the DD group compared to 95% for the TD.

To conclude, all these results are in line with previous results on the dyslexics' suprasegmental awareness (Gowsami et al. 2013, Leong et al. 2011, Jiménez-Fernández et al. 2015) suggesting that suprasegmental features are actually involved as well as segmental awareness in language processing. The present study confirms that accent perception is still impaired in dyslexic teenagers even after years of schooling, and the intonation of sentences is not perceived. Future studies should confirm these findings.

REFERENCES

- Avesani, C. (1995). ToBit: un sistema di trascrizione per l'intonazione italiana. *Lazzari*, 1995, 85-98.
- Bertelli, B., Bilancia, G. (2006). *VAUMeLF, Batterie per la valutazione dell'attenzione uditiva e della memoria di lavoro fonologica nell'età evolutiva*. Firenze: Giunti Psychometrics.
- Bertinetto, P. M. (1980). The perception of stress by Italian speakers. *Journal of Phonetics*, 8(4), 385–395.
- Blay, A. (2018). *Intonation Production And Perception In Children With Developmental Language Impairment*. Theses and Dissertations 2171, University of North Dakota.
- Caccia, M., Presti, G., Toraldo, A., Radaelli, A., Ludovico, L. A., Ogliari, A., & Lorusso, M. L. (2019). Pitch as the main determiner of Italian lexical stress perception across the lifespan: Evidence from Typical Development and Dyslexia. *Frontiers in Psychology*, 10, 1458. <https://doi.org/10.3389/fpsyg.2019.01458>
- Calet, N., Gutiérrez-Palma, N., Defior, S. Jiménez-Fernández, G. (2019). Linguistic and non-linguistic prosodic skills in Spanish children with developmental dyslexia. *Research in Developmental Disabilities*, 90, 92–100.
- Castles, A., & Coltheart, M. (2004). Is there a causal link from phonological awareness to success in learning to read? *Cognition*, 91(1), 77–111. [http://doi.org/10.1016/S0010-0277\(03\)00164-1](http://doi.org/10.1016/S0010-0277(03)00164-1).
- Gavarró, Anna & Io Salmons (2010). The discrimination of intonational contours in Broca's aphasia. *Clinical Linguistics & Phonetics*, 2013; 27(8): 632–646. doi: 10.3109/02699206.2013.800908
- Goswami U, Thomson J, Richardson U, Stainthorp R, Hughes D, Rosen S, Scott SK. Amplitude envelope onsets and developmental dyslexia: A new hypothesis. *Proc Natl Acad Sci U S A*. 2002 Aug 6; 99(16):10911–6.
- Goswami U., Mead N., Fosker T., Huss M., Barnes L., Leong V. (2013). Impaired perception of syllable stress in children with dyslexia: a longitudinal study. *Journal of Memory and Language*, 69, 1–17.
- Goswami, U. (2011). A temporal sampling framework for developmental dyslexia. *Trends in Cognitive Sciences*, 15, 3–10.
- Hayes, B. (2009). *Introductory phonology*. Oxford: Wiley-Blackwell Publication.

- Hajek, J., Stevens, M. (2008) Vowel duration, compression and lengthening in stressed syllables in central and southern varieties of standard *Italian*. *Proc. Interspeech 2008*, 516-519
- Holliman, A. J., Wood, C., & Sheehy, K. (2010). Does speech rhythm sensitivity predict children's reading ability 1 year later? *Journal of Educational Psychology*, 102(2), 356–366.
- Holliman, A.J., Sheehy, K. and Wood, C. (2010). A cross-sectional study of prosodic sensitivity and reading difficulties. *Journal of Research in Reading*, 34 (4).
- Jiménez-Fernández, G. (2015). Impaired stress awareness in Spanish children with developmental dyslexia. *Research in Developmental Disability*, 37:152-61.
- Judica, A., De Luca, M. (2005). *Prova di velocità di lettura brani per la scuola superiore*. Roma: IRCCS fondazione Santa Lucia. Ed. 2005.
- Knoop-van Campen, C., Segers, E., & Verhoeven, L. (2018). How phonological awareness mediates the relation between working memory and word reading efficiency in children with dyslexia. *Dyslexia*, 24(2), 156–169.
- Leong, V., Hämäläinen, J., Soltész, F. & Goswami, U. (2011). Rise time perception and detection of syllable stress in adults with developmental dyslexia. *Journal of Memory and Language*, 64, 59–73.
- Lepschy, G. C. (1968) Note su accento e intonazione con riferimento all'italiano, *Word*, 24,1-3, 270-285.
- Macmillan, N. A., & Creelman, C. D. (2005). *Detection theory: a user's guide*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Magarotto, G. (2021) *La percezione dell'accento nei bambini italiani con dislessia: uno studio sperimentale*. Master thesis, Università degli Studi di Padova.
- Marotta, L., Trasciani, M., and Vicari, S. (2008). *Test CMF. Valutazione Delle Competenze Metafonologiche*. Trento: Erickson.
- Moroni, M.C (2013). La prosodia dell'italiano e del tedesco a confronto. *ITALIENISCH* 2013/2, 80-93.
- Nespor, M., Shukla, M., & Mehler, J. (2011). Stress-timed vs. syllable-timed languages. In van Oostendorp et al. (Eds.), *The Blackwell Companion to Phonology* (pp. 1147-1159). Malden, MA: Blackwell.
- Ota, M. (2016) Prosodic phenomena: Stress, tone, and intonation. *Oxford Handbook of Developmental Linguistics*. New York: Oxford University Press.

- Paizi, D., Zoccolotti, P., & Burani, C. (2011). Lexical stress assignment in Italian developmental dyslexia. *Reading and Writing: An Interdisciplinary Journal*, 24(4), 443–461.
- Ramus F, Rosen S, Dakin SC, Day BL, Castellote JM, White S, Frith U. (2003). Theories of developmental dyslexia: insights from a multiple case study of dyslexic adults. *Brain*. Apr;126 (Pt 4):841-65.
- Romano, A. (2008) *Inventari sonori delle lingue. Elementi descrittivi di sistemi e processi di variazione segmentali e sovrasegmentali*. Alessandria: Dell’Orso edizioni.
- Salmons, I. (2010). *Intonational patterns and comprehension in Broca’s aphasia*. Master Thesis, Universitat Autònoma de Barcelona.
- Simone, R. (1990) *Fondamenti di Linguistica*. Bari-Roma: Laterza edizioni.
- Snowling, M. J. (1981). Phonemic deficits in developmental dyslexia. *Psychological Research*, 43, 219–234. <http://doi.org/10.1007/BF00309831>
- Snowling, M. J. (2000). *Dyslexia* (2nd edn.). Oxford: Blackwell.
- Varvara P, Varuzza C, Sorrentino ACP, Vicari S and Menghini D (2014) Executive functions in developmental dyslexia. *Front. Hum. Neurosci.*, 8, 120.
- Veenendaal, N. J., Groen, M. A., & Verhoeven, L. (2016). The contribution of segmental and suprasegmental phonology to reading comprehension. *Reading Research Quarterly*, 51(1), 55–66.
- Zanchi, P., D’imperio, M, Zampini, L., & Fasolo, M. (2016). L’intonazione delle narrazioni di bambini ed adulti italiani: un’analisi all’interno dell’approccio autosegmentale metrico. In *Convegno Associazione Italiana Scienze della Voce (AISV)*.

WEBSITES

<https://dyslexiahistory.web.ox.ac.uk/what-dyslexia>

<https://www.bdadyslexia.org.uk/dyslexia/about-dyslexia>

APPENDIX I: Participants

Code	School	Group	Gender	Month total
JR	Vanoni	TD	M	213
MC	Vanoni	DD	F	215
MD	Vanoni	TD	F	187
SP	Esterna	DD	F	188
GM	Vanoni	TD	F	204
MB	Vanoni	DD	M	203
MCO	Vanoni	TD	M	182
MG	Vanoni	DD	M	186
MA	Vanoni	TD	F	201
CF	Vanoni	DD	M	205
MDS	Vanoni	TD	F	214
GD	Vanoni	DD	M	215
ED	Vanoni	TD	F	177
TC	Vanoni	DD	M	176
DM	Vanoni	TD	M	182
LB	Vanoni	DD	M	184
IT	Esterna	TD	F	195
IS	Vanoni	DD	F	193
EE	Esterna	TD	F	173
AD	Vanoni	DD	F	176

APPENDIX II: Consent

CONSENSO INFORMATO ALLA RICERCA CON MINORI

(da firmarsi a cura dei Genitori)

TITOLO DELLO STUDIO: La percezione dei suoni negli adolescenti con dislessia e non.

FOGLIO INFORMATIVO PER LA PARTECIPAZIONE DI MINORI

Gentili genitori, vorremmo proporvi di coinvolgere Vostra/o figlia/a in una ricerca promossa dall'Università di Barcellona e coinvolge anche il nostro istituto. È Vostro diritto essere informati circa lo scopo, le caratteristiche e le modalità di svolgimento dello studio affinché possiate decidere in modo consapevole e libero se acconsentire o meno alla partecipazione di Vostra/o figlia/o. Vi invitiamo a leggere attentamente quanto riportato di seguito, i ricercatori coinvolti in questo progetto sono a Vostra disposizione per rispondere alle Vostre domande

Responsabile dello studio: prof.ssa Gornati Laura email: lauragornati.las@gmailcom cellulare: 3387344661

Qual è lo scopo di questo studio?

La presente ricerca è parte di un lavoro di tesi per il Master in Scienze Cognitive del Linguaggio dell'Università di Barcellona. Lo scopo generale del presente studio è capire in che modo la percezione sonora di parole, non-parole e frasi con diverse prosodie possa variare nella popolazione con dislessia. La ricerca non ha né lo scopo di rilevare il livello intellettuale né quello di verificare la bravura di dei partecipanti e i dati raccolti saranno totalmente in forma anonima.

Come si svolgerà lo studio? Lo studio sarà condotto in parte online tramite piattaforme di video-conferenza e in parte in presenza utilizzando un computer per lo svolgimento dei test visivo/sonori. Ogni evento in presenza si terrà nel rispetto delle norme anti-Covid in vigore.

È obbligatorio partecipare allo studio?

La partecipazione è completamente libera. Inoltre, se in un qualsiasi momento, Voi e/o Vostra/o figlia/o dovete cambiare idea, siete liberi di ritirare il consenso alla partecipazione senza dover fornire alcuna spiegazione.

Come saranno usati i dati personali di Vostra/o figlia/o?

I dati raccolti saranno utilizzati in forma anonima ed aggregata, in modo da non poter risalire ai dati dei singoli individui, solo ed esclusivamente per il lavoro di tesi e/o di pubblicazioni scientifiche. Pertanto, i nomi dei minori che prenderanno parte alla ricerca non verranno mai utilizzati, né verranno fornite informazioni che potrebbero consentirne l'identificazione.

Quali sono i passaggi necessari per la partecipazione allo studio di Vostra/o figlia/o?

La partecipazione allo studio avviene firmando il modulo di consenso informato e speditendolo alla mail della professoressa Gornati. È importante che anche Vostra/o figlia/o siano d'accordo a partecipare. Solo dopo che avrete espresso per iscritto il consenso, Vostra/o figlia/o potrà attivamente partecipare allo studio proposto.

Cosa succederà nel caso acconsentiste alla partecipazione di Vostra/o figlia/o allo studio? Cosa Le/Gli verrà chiesto di fare?

Nel caso di adesione allo studio sarete contattati e invitati a far partecipare vostro/a figlio/a solo nel caso venga ritenuto necessario ai fini della ricerca, ovvero dopo la selezione di un cluster di studio. Al fine di studiare come la percezione sonora possa essere influenzata dalle variabili in esame, alle persone selezionate verranno somministrati dei test sonori e dei task a cui dovranno rispondere in modo autonomo e sereno. Non ci sono risposte giuste o sbagliate ma solo l'analisi dei dati raccolti che servirà ai fini della ricerca. La durata dell'esperimento sarà di circa 50 minuti e gli strumenti utilizzati saranno un computer con registrazioni audio, brani da leggere, opzioni da scegliere verbalmente. Verrà inoltre richiesto l'uso di cuffie o auricolari personali per rispettare le norme anti-Covid. Ogni altra informazione sulle prove specifiche da svolgere verrà data ad ogni partecipante prima dello svolgimento del test. Per ulteriori informazioni, domande o curiosità non esitate a contattare la prof.ssa Gornati Laura tramite i contatti forniti.

Vi ringraziamo per la Vostra disponibilità ed aiuto

ESPRESSIONE DI CONSENSO INFORMATO
(da firmare da parte di entrambi i genitori/tutori)

Nome e Cognome del minore partecipante allo studio

Data di nascita

Noi sottoscritti

- Nome: _____ Cognome _____

- Nome: _____ Cognome _____

in quanto genitori/tutori del suddetto partecipante,

-Dichiariamo di aver ricevuto spiegazioni esaurienti in merito alla richiesta di partecipazione di nostra/o figlia/o allo studio sperimentale in oggetto secondo quanto riportato nel foglio informativo in allegato.

- Dichiariamo di aver potuto discutere tali spiegazioni, di aver potuto porre tutte le domande che abbiamo ritenuto necessarie e di aver ricevuto in merito risposte soddisfacenti.

Pertanto, alla luce delle informazioni che ci sono state fornite (selezionare l'opzione prescelta):

Io sottoscritta/oin qualità di genitore/tutore legale

<input type="checkbox"/>	ACCONSENTO	<input type="checkbox"/>	NON ACCONSENTO	Alla partecipazione di Mia/o figlia/o allo studio
<input type="checkbox"/>	ACCONSENTO	<input type="checkbox"/>	NON ACCONSENTO	All'audio-video registrazione (qualora necessaria ai fini della ricerca)
<input type="checkbox"/>	VOGLIO	<input type="checkbox"/>	NON VOGLIO	Essere informata/o su eventuali risultati utili alla salute di mia/o figlia/o derivanti dallo studio stesso. Nel caso desideri essere informata, indicare un contatto telefonico:

LUOGO DATA

FIRMA DEL GENITORE

LUOGO DATA

FIRMA DEL RICERCATORE

APPENDIX III: Individual results

Standardized tests: individual results

Participants	Group	Words reading speed (sec/sill)	Words reading accuracy (n. of errors)	Rp non-words	Raven raw	Raven percentile	Spoonerism
JR	TD	0.21	3	34	49	92	29
MC	DD	0.25	10	33	41	70	24
MD	TD	0.21	8	32	39	61	24
SP	DD	0.25	3	32	50	94	26
GM	TD	0.24	9	38	51	94	28
MB	DD	0.33	20	29	50	94	23
MCO	TD	0.33	16	32	44	82	18
MG	DD	0.28	9	35	49	92	19
MA	TD	0.25	16	26	43	77	22
CF	DD	0.26	3	38	42	75	25
MDS	TD	0.19	5	35	42	75	27
GD	DD	0.25	5	39	51	94	23
ED	TD	0.22	9	39	46	86	27
TC	DD	0.37	13	37	40	59	18
DM	TD	0.31	8	39	54	98	22
LB	DD	0.30	13	30	34	42	15
IT	TD	0.22	4	32	54	98	29
IS	DD	0.23	14	32	33	48	20
EE	TD	0.18	5	23	46	86	20
AD	DD	0.40	14	27	45	87	4

Same/ different tasks individual results: number of errors for each task

Participants	Group	Words task	Non-words task	Sentences task
MC	DD	9	0	5
JR	TD	1	2	2
MD	TD	0	0	0
SP	DD	0	0	1
GM	TD	0	0	1
MB	DD	0	2	4
MCO	TD	0	0	1
MG	DD	0	0	5
MA	TD	0	1	6
CF	DD	0	1	4
MDS	TD	0	0	1
GD	DD	0	2	2

ED	TD	0	0	1
TC	DD	0	0	0
DM	TD	0	0	2
LB	DD	0	1	0
IT	TD	0	0	0
IS	DD	2	5	4
AD	DD	2	1	2
EE	TD	0	0	0