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Phonological Awareness and Visual Perceptual Processing Skills of Maltese Children with Down Syndrome. How is Reading Intervention Affected?

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Abstract: The association between Phonological Awareness (PA) and reading in Down Syndrome (DS) has been questioned throughout the years. Studies have shown that PA does develop. However, several impairments have been identified. Conversely, Visual Perceptual Processing Skills (VPPS) in children with DS has been recognised as being a strength. Children with DS have been described as being visual learners and in consequence children with DS have been exposed primarily to visual methods of reading instruction. This study investigates the development of PA and VPPS in ten Maltese-speaking students with DS, with the aim of identifying the development of these skills in the Maltese language. Ten students with DS were compared to reading age matched typically developing (TD) students. Results showed that there was no overall significant difference between the results of TD students and students with DS in PA. In contrast, the group of students with DS obtained very low scores in VPPS tasks. The results suggest that the visual method of reading instruction should not be used as the only method of reading training with students with DS. Students with DS should be exposed to both a phonological method and a visual method of tuition to develop their reading abilities.

Keywords: Down Syndrome, Phonological Awareness, Visual Perceptual Processing, Reading

Introduction

Down Syndrome (DS) is a chromosomal condition with a prevalence of 8 births per year in the Maltese islands (Department of Health, Information and Research, 2015). Most children with DS typically have difficulty in acquiring and developing language skills (Snowling and Gombert, 2002; Verucci, Menghini and Vicari, 2006; Goetz, Hulme, Brigstocke, Carroll, Nasir, Snowling, 2008). This often contributes to the building of the biggest barrier

to independence and success in different areas in life (Abbeduto, Warren and Conners, 2007).

Linguistic abilities develop differently in the DS population. Language expression is often described as being limited and of telegraphic nature due to difficulties in morphology (Snowling and Gombert, 2002), whereas language comprehension is highly dependent on the level of cognitive functioning and is less impaired than expression (Verucci et. al. 2006). Both linguistic and non-linguistic limitations, such as cognitive abilities and memory, often hinder further development of other areas of language such as reading skills. Nevertheless, it has been established that many students with DS can now acquire reading skills at simple levels such as reading single words or simple books (Laws, Byrne and Buckley, 2000). Other studies show that some students manage to excel in their reading (Cardoso-Martins, Peterson, Olson, Pennington, 2009).

Individuals with DS are described as having a significant strength in word recognition. Yet, difficulty arises when phonological decoding is needed such as in non-word reading tasks and also poor comprehension skills (Cossu, Rossini and Marshal 1993; Laws and Gunn, 2002; Verucci et al. 2006**;** Abbeduto et. al, 2007; Roch and Levorato, 2009). The past twenty years have unveiled literature which confirms that reading in DS is surely possible (Laws and Gunn, 2002). This increase in literate individuals with DS can be associated with the increased importance of inclusion of children with disabilities in mainstream schools (Buckley, 2001).

Children with DS, like other children with learning difficulties, are generally introduced to the world of reading through the use of flashcards (Goetz et. al, 2008). The 'look and say' method prevails in the initial stages of reading instruction. This method of teaching has been reinforced by the theoretical backup stating that children with DS are mainly logographic readers (Buckley, 2001; Cardoso-Martins et al., 2008). This method of teaching is commonly used in Malta with children with learning difficulties. Nevertheless it is hardly used with TD children. In fact, phonological decoding skills are introduced in the first years of schooling in TD children. Unfortunately to date no local studies are available about the methods of literacy teaching in students with disabilities. The 'look and say' method is predominantly used with children with disabilities and children with poor expressive skills such as dyspraxia (Buckley, 2001; Goetz, et. al. 2008). The weakness in auditory memory skills of children with DS has also contributed to the use of this method of teaching (Goetz et al. 2008). Unfortunately, through the 'look and say' method children are not empowered with sufficient tools to decode words which are unknown to them, therefore, although it accommodates the visual memory, this method does not offer the skills for reading unfamiliar words.

A phonological method of instruction is considered to be ideal to help children to acquire reading abilities. Such a method focuses on the sound structures of words and the relation to their written correspondents (Gillon, 2004). Hence, children are taught all skills which help in the manipulation of phonemes and their association with the written graphemes (Cardoso-Martins and Frith, 2001). As a result, PA is considered to be fundamental to successful reading.

Theory

Phonological Awareness in Down Syndrome

PA is the ability to think about and control the sound structures of a language, especially in alphabetic languages such as English and Maltese (Farrar, Ashwell and Maag, 2005). While PA in DS has been thoroughly studied throughout these past ten to twenty years, contradicting results are still emerging. Some researchers maintain that reading in DS can occur in the absence of PA (Cossu, et al. 1993), while others believe that these skills are equally important to the DS population as they are to TD children and that increase proficiency in PA increases the levels of reading abilities (Cupples and Iacono 2000). Yet, the majority of the studies confirm that PA in DS does not develop as in TD peers, where a delay in the development is often noted (Kumar Mishra, 2007).

The difficulty for children with DS to master such skills has been thought to be a cause for reading disability (Cossu, et al. 1993; Laws and Gunn, 2002; Verucci et al. 2006**;** Abbeduto et. al, 2007; Roch and Levorato, 2009). However not all researchers agree that PA is fundamental to the DS population (Cossu et al. 1993). A study by Cossu et al. (1993) investigated how ten children with DS were able to acquire basic literacy skills without using PA. Results showed that PA is superfluous to children with DS as they can still acquire reading in the absence of skills such as phoneme segmentation, syllabification and rhyme. Yet, this study failed to investigate the reading of phrases and short sentences, which would have rendered the reading process more difficult. Most probably children with a dearth of phonological decoding skills would have found it difficult to read a number of unfamiliar words. The poor performance of the participants in the study by Cossu et al. (1993) can also be associated with the cognitive demands in each test (Bertelson, 1993; Cardoso-Martins and Frith, 2001). Hence, a mere difference in the method of instruction about the tasks could have accommodated the DS participants to understand the tasks and maybe perform better (Bertelson, 1993; Cardoso-Martins and Frith, 2001). On the other hand, other studies reveal contrasting results.

Cardoso-Martins and Frith, (2001) studied ninety-three children with DS in two different studies. They investigated their level of PA and how this impinged on their reading. In the first study it was concluded that the performance of the participants mirrored the results proposed by Cossu et al. (1993) as explained above. However, their second study went further than that offered by Cossu et al. (1993). The study accommodated for memory and less cognitively demanding (Cardoso-Martins and Frith, 2001). In contrast with the first test, the second showed improved performance.

In an extensive review, Lemons and Fuchs (2010) reveal that when participants with DS were compared to reading age matched peers, TD participants performed better than DS participants. Yet initial phoneme identification, rhyme judgements, letter naming and letter sound knowledge tasks did not indicate a statistically significant difference between the groups (Cardoso-Martins and Frith, 2001). Steele, Scerif, Cornish and Karmiloff-Smith (2013) found that when compared to reading age matched peers, 26 students with DS showed suggestively poorer results on rhyme and phoneme matching, yet stronger letter knowledge skills could be identified. This shows that results in this area are still sparse both at an international level and even more locally, since only a handful of studies are available.

Visual Perceptual Processing Skills in Down Syndrome

Visual perceptual processing skills (VPPS) allow an individual to retrieve visual information from the surroundings and make sense of this acquired information (Kurtz, 2006). Impairment in the development of these abilities can lead to difficulties in several areas of academic realization such as mathematical progress, reading development and handwriting abilities (Clutten, 2009). Moreover, children who have appropriate development of physical visual skills, but have a delayed development such as delayed motor skills, a learning disability or neurological difficulties, often struggle to develop VPPS (Kurtz, 2006).

In DS, ophthalmic disorders are of a higher prevalence when compared to the typically developing population and are more prone to pathological ocular conditions (Mon-Willaims, Jobling and Wann, 2000, Sheiman, 2002). Mon-Williams et al. (2000), claim that the visual refinement that occurs in typically developing children does not occur in children with DS. These anatomical deficiencies also impact the functional development of VPPS. Nevertheless, some studies have shown that children with DS do develop functional VPPS (Jarrold & Baddeley, 1997, Hodapp and Ly, 2004 and Visu-Petra, Benga, Incas and Miclea, 2007). Visuo-spatial processing is considered to be a strength for children with DS (Visu-Petra, et al. 2007). This skill enables the child to differentiate the orientation of objects and symbols and helps in distinguishing between left and right (Kurtz, 2006). Researchers suggest that

children with DS use these stronger abilities to acquire skills such as reading (Hodapp and Ly, 2004, Fidler, Most and Guiberson, 2005).

Visual memory has also been portrayed as being predominantly strong in this population, and this enabled the strong development of word identification skills, which involves the ability to read real words without decoding the letters (Kay-Raining Bird, Cleave and McConnell, 2000; Boudreau, 2002; Fidler et al., 2005). This could be attributed to intrinsic characteristics of this population and further reinforced by the form of educational training to which children with DS are generally exposed, that is the 'look and say' method (Kay-Raining Bird et al., 2000; Fidler et al., 2005).

Miranda and Fantz (1973, 1974) evaluated the visual discrimination and visual memory abilities of children with DS. Results in both studies indicated a delay in visual discrimination and visual memory when compared to the TD children. Nonetheless, the apparent presence of a delay in visual processing, the same pattern of development was noted.

VPPS have been considered in general as a relative strength in children and individuals with DS. Yet, it is debatable whether this is actually an area of strength or whether this area is stronger when compared to other skills such as, for example, weak verbal abilities (Yang, Conners and Merill, 2014). Yang et al. (2014) carried out a review of the literature where visual processing was evaluated in the population of DS. Their review included 49 studies where participants with DS were compared to TD peers on measures of cognitive age. In general it could be observed that performance of visual processing in DS is varied. Differences lie across different aspects of the visual processing continuum. Clearly, further research is needed in this area so as to evaluate further these skills.

The present study

The purpose of this study was to take a beginning step towards answering questions about the development of PA and VPPS in students with DS who are Maltese-speaking. Ten students with DS have been compared to ten reading age matched TD children. Both groups have been assessed for PA and VPPS. This has helped in the identification of similarities and differences between the two groups of children, thus tentatively providing a guideline to other professionals on how to tackle training of literacy with children with DS. This form of matching by reading age was used so as to mirror other studies of reading in DS (Cossu et al., 1993; Byrne et al., 2002; Kumar Mishra, 2007; Roch and Jarrold, 2008; Roch and Levorato, 2009), and thus allowing for comparison with other populations.

The following research questions were asked:

1: How do PA skills develop in Maltese-speaking students with DS when compared to reading age matched TD students?

2: How do VPPS develop in Maltese-speaking students with DS when compared to reading age matched TD students?

Methodology

Participants

The participants included ten students with DS (2M and 8F), ranging in age from 9;11 years to 12;10 years, and ten TD children (3M and 8F), ranging in age from 6;02 years to 9;02 years. Students were matched on reading age and were divided into two groups. Group 1 consisted of ten students (5 DS and f5 TD) with a reading age ranging from 6 years to 6;09 years (M = 6.01 years). Group 2 consisted of ten (5 DS and 5 TD) with a reading age ranging from 8;09 years to 9;11years (M= 9;06 years).

Criteria for Inclusion in the study included the following;

- A level of language comprehension of 3 Information Carrying Words on The Informal Comprehension Assessment.
- Used Maltese as their native and primary spoken language.
- Had a Primary Level of Education.
- Had a Reading Age of mean 6yrs for Group A and mean 9yrs for Group B.

Criteria for Exclusion from the study

- Had severe hearing difficulties as reported from the medical history in the last 6 months.
- Had severe visual difficulties as reported from the medical history.
- Had a comorbid diagnosis, e.g. On the Autistic Spectrum.

Seventeen potential candidates with DS were proposed by the managers of the organization. Only eleven were eligible for the study, one was 'excluded" so that two groups of five students could be formed. The 'exclusion' was based on the fact that his reading age was outside the six years or the nine years group.

All students attended a mainstream school and all were provided with the help of a Learning Support Assistant. Additionally it was determined that the TD students did not have a history of speech and/or language difficulties which could have impinged on the results of the study.

Procedure and measures
Assessment of Language Comprehension

An Informal Comprehension Assessment provided information about the students' level of verbal comprehension in view of the notion of Information Carrying Words (ICW) (Knowles and Maidslover, 1982). This tool was used as a screening measure. No other assessments of language comprehension standardized on the local population were available at the time of assessment.

Assessment of Reading

The Maltese Word Reading Test (Bartolo, 1988) was administered to gain the reading age of the participants. Students were required to read sixty words of increasing difficulty.

Assessment of Phonological Awareness

The Maltese Metalinguistic Screening Test (MuST) (Speech-Language Department Malta, no date) was utilized to collect information about the students' level of PA skills. This screening assessment was compiled by a group of Speech-Language Pathologists within the Speech-Language Department of Malta. The MuST has not been formally standardized, however it has been used by local Speech-Language Pathologists for years to identify difficulties related to PA. It has five subtests, namely; Automatic Sequences, Auditory Sequential Memory, Phonemic Level, Syllabic Level and Word Level.

Assessment of Visual Perceptual Processing Skills

The Test of Visual-Perceptual Skills (non-motor) (TVPS) (Gardner, 1982) is an assessment used to evaluate a student's visual perceptual abilities. Visual Discrimination, Visual Memory, Visual-Spatial Relations, Form Constancy, Visual Sequential Memory, Visual Figure-Ground and Visual Closure are the specific skills assessed.

Results

The students were compared in the following manner;

Group A: Typically developing students with a mean reading age of six years

COMPARED TO

Students with DS with a mean reading age of 6 years

Group B: Typically developing students with a mean reading age of 9 years

COMPARED TO

Students with DS with a mean reading age of 9 years

Results of Phonological Awareness

The results of each PA task were analysed so that the correct responses for each child on every PA task were determined. The mean percentage scores of each group; Group A and Group B were calculated and compared accordingly. Table I illustrates these results of Group A.

Group A

TD students performed at the 100th percentile in activities at the Phonemic level, such as Initial Phoneme Identification, Final Phoneme Identification and Generating Alternative Words. The lowest results were obtained in activities were memorization of a sequence of words was needed.

In the DS group the highest scores were achieved in tasks at the Phonemic Level, whilst the lowest scores were attained in Auditory Sequential Memory Tasks, in particular in the memorization of Word Lists. These results are characteristically similar in pattern to the ones obtained by the TD students. Figure 1 below illustrates the pattern of achievement of both TD students and students with DS.

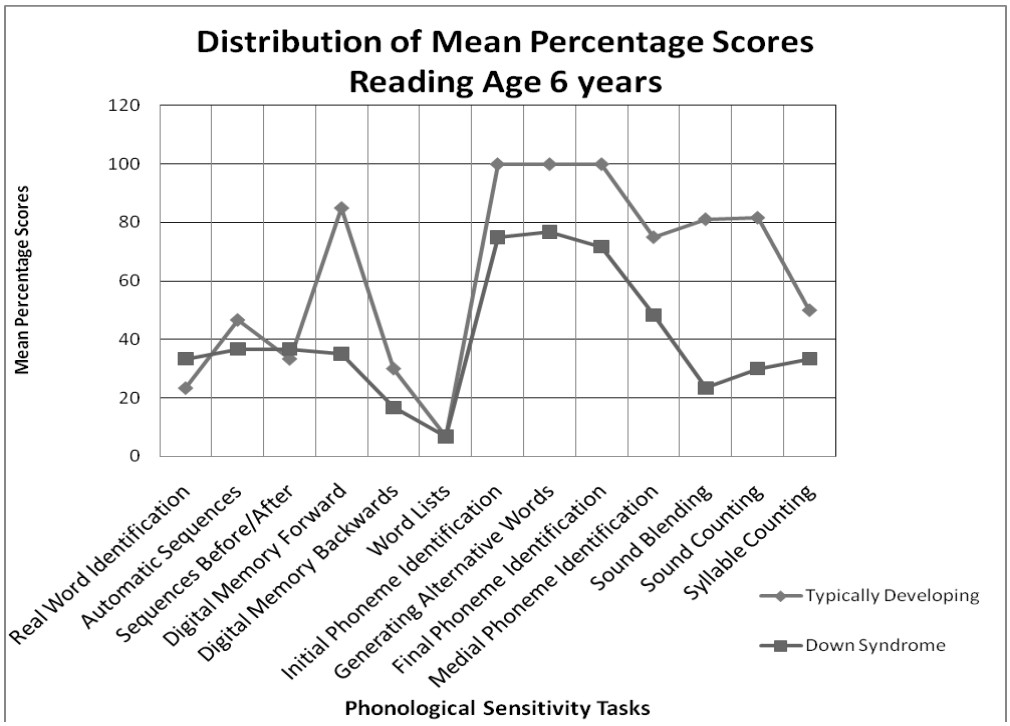

Figure 1: The Distribution of Mean Percentage Scores obtained by TD students and students with DS in Group A.

The line chart above indicates that the groups maintained a similar pattern of performance across tasks. However, students with DS performed at a lower

level on the majority of the tasks, with the exception of Reading of Real Words, Sequences Before/After and memorisation of Word Lists.

Group B

TD students with a mean reading age of 9 years fully mastered PA skills, where the majority of the scores met the 100th percentile. The three memory tasks; Digit Memory Forward, Digit memory Backward and Word lists, were considered to be the most difficult, wherein a drop in the mean scores can be observed. The memorization of Word Lists was the task with the lowest scores. Refer to Table II below.

Students with DS with a mean reading age of nine years developed high levels of PA skills. Not all the tasks meet the 100th percentile however the majority are over the 80th percentile scores. The lowest scores were registered in the memory tasks; Digit Memory Forward, Digit memory Backward and Word lists. This mirrors the pattern of development of TD students.

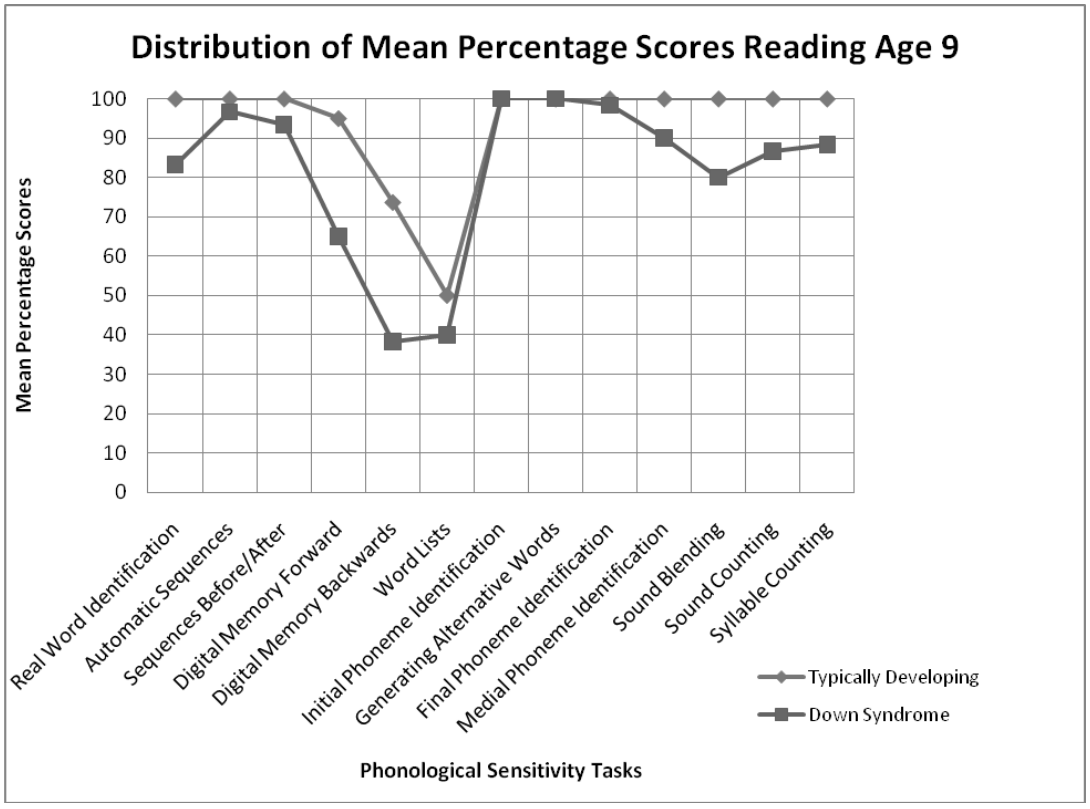

Figure 2: The Distribution of Mean Percentage Scores obtained by DS and TD students in Group B.

Figure 2 shows that in Group B students maintained a similar pattern of development of PA. Both groups Group B performed best in activities at the Phonemic Level, followed by Automatic Sequences and Syllabic level and finally Word level and Auditory Sequential Memory tasks.

Analysis of Significant Difference in Phonological Sensitivity Tasks

A one-way Analysis of Variance (ANOVA) was used to test whether there is a significant difference in performance between TD and DS students across all activities. The means and p-values (probability value) for each PA task were collated. The p-value shows the level of significance between the scores of the two groups.

Table I: Mean Scores and p-value of TD and DS students in Group A in PA Tasks.

TASKS	MEAN TYPICALLY DEVELOPING	MEAN DOWN SYNDROME	P-VALUE
Real Word Identification	23.33	33.33	0.347
Automatic Sequences	46.66	36.66	0.387
Sequences before/after	33.33	36.66	0.694
Digit Memory Forward	85.00	35.00	0.001
Digit Memory Backward	30.00	16.66	0.192
Word Lists	6.66	6.66	1.00
Initial Phoneme Identification	100	75.00	0.142
Generating alternative Words	100	76.66	0.175
Final Phoneme Identification	100	71.66	0.058
Medial Phoneme Identification	75.00	48.33	0.011
Sound Blending	81.15	23.33	0.003
Sound Counting	81.66	30.00	0.000
Syllable Counting	50.00	33.33	0.281

According to this sample, there is no statistical significant difference between TD students and students with DS. Out of 13 PA tasks, 3 tasks only scored lower than 0.05 therefore showing as significant difference. This shows that the variable of DS has not impinged on the performance of the students. The DS group obtained lower results, however these results are not significantly low enough to state that there was a difference between DS and TD

Table II: Mean scores and p-value of TD and DS students in Group B in PA Tasks.

TASKS	MEAN TYPICALLY DEVELOPING	MEAN DOWN SYNDROME	P-VALUE
Real Word Identification	100.00	83.33	0.105
Automatic Sequences	100.00	96.66	0.347
Sequences before/after	100.00	93.33	0.347
Digit Memory Forward	95.00	65.00	0.028
Digit Memory Backward	73.66	38.33	0.039

Word Lists	50.00	40.00	1.00
Initial Phoneme Identification	100.00	100.00	1.00
Generating alternative Words	100.00	100.00	1.00
Final Phoneme Identification	100.00	98.33	0.347
Medial Phoneme Identification	100.00	90.00	0.172
Sound Blending	100.00	79.99	0.065
Sound Counting	100.00	86.66	0.207
Syllable Counting	100.00	88.33	0.191

The p-values of Group B indicate that a significant difference between TD students and students with DS only lies in two PA tasks; Digit Memory Forward and Digit Memory Backward. This shows that when auditory memory of digits was expected, the factor of DS was considered to play a significant role. However throughout the other eleven tasks no significant difference could be identified since all p-values were greater than 0.05. These results reveal that students with DS showed appropriate development in the majority of PA skills when compared to reading age matched TD peers.

Results of Visual Perceptual Processing Skills

The results of the seven subtests of The Test of Visual-Perceptual Skills (non-motor) were analysed so as to ascertain the correct response from each participant. The mean percentage scores of each group; Group A and Group B were consequently calculated and evaluated. All students with DS took less time to finish the assessment. When compared to TD children, students with DS spent less time analysing the answers. This could have contributed to the discrepancy in scores between the two groups

Group A

All TD students attained age equivalent or higher mean perceptual (visual) ages when compared to both their reading age and their chronological age. Table III shows the age equivalences of TD group A. This indicates that this group of TD students showed a correlation in reading age and perceptual age.

Table III: Age equivalence of Group A TD.

STUDENTS	CHRONOLOGICAL AGE	READING AGE	PERCEPTUAL AGE
1	6;02	6;02	6;06
2	6;03	6	6;10
3	6;03	6;02	6;03
4	6;04	6	6;05
5	6;02	6;06	6;02

Group A DS students performed at a significantly lower level than their reading age matched peers throughout all the VPPS Tasks. In fact, the perceptual (visual) ages of the group of students with DS were considerably low when compared to their chronological age, but most importantly when compared to their reading age.

Table IV: Age equivalence of Group A DS

STUDENTS	CHRONOLOGICAL AGE	READING AGE	PERCEPTUAL AGE
6	12;10	6;09	5;10
7	12;06	6;03	4;08
8	12;04	6	4;02
9	12;01	6	4;10
10	11	6	4;06

The discrepancy between the perceptual age and reading age is apparent. All five students achieved a lower age equivalent across all VPPS whilst having a reading age equivalent to their TD peers. The line chart below illustrates more evidently the divergence in VPPS between the TD and DS students in Group A.

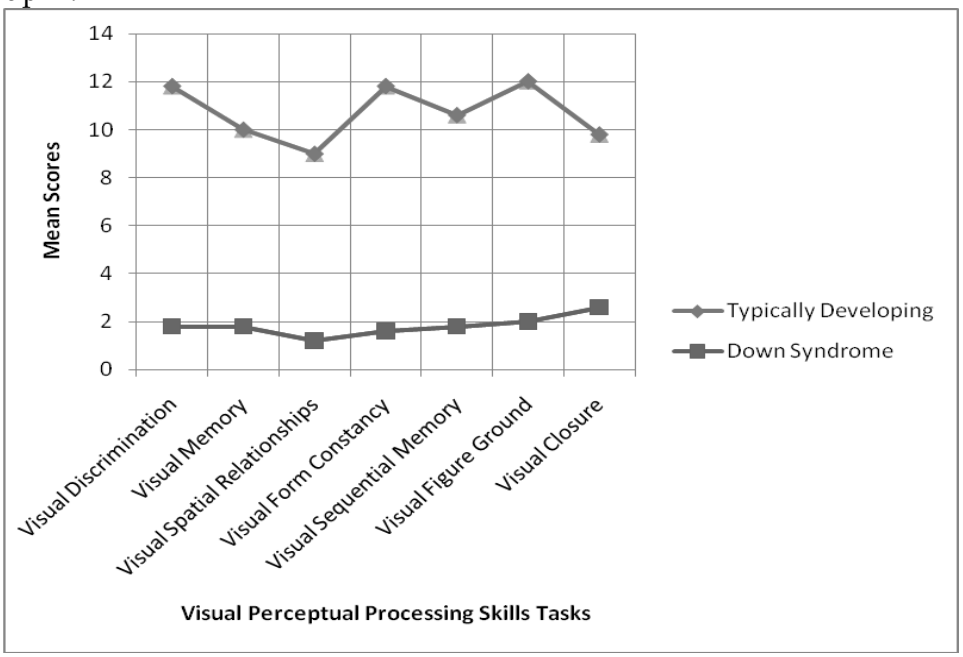

Figure 3: The Distribution of Mean Scores obtained by students with DS and TD students in Group A.

Group B

In Group B no correlation was registered between the perceptual ages and reading ages of TD students. Perceptual ages are widely elevated when compared to both reading age and chronological ages. Only student 15 showed reading age and perceptual age equivalences.

Table V: Age equivalence of Group B: TD students.

STUDENTS	CHRONOLOGICAL AGE	READING AGE	PERCEPTUAL AGE
11	9;02	9;11yrs	12;11
12	8;06	9	12.11
13	9;01	9;11	12;08
14	9	9;11	-12.11
15	8;09	9;11	9;08

Table VI shows that there is no correlation between the Reading Age of DS students and their Perceptual Age. The Perceptual ages are significantly lower than the Reading Age match TD group. This might indicate that the development of reading skills was not highly dependent on the development of VPPS.

Table VI: Age equivalences of students with DS in Group B.

STUDENTS	CHRONOLOGICAL AGE	READING AGE	PERCEPTUAL AGE
16	12;09	8;09	5;11
17	11;01	9;06	5;01
18	9;11	9;03	6;05
19	11;01	9;11	6;01
20	11;06	9;11	5;10

The performance of the students in Group B has been compared and presented in Figure 4. This chart indicates undoubtedly the discrepancy that lies between the two groups. This chart also shows that the two groups do not follow the same pattern of performance across the tasks. TD students achieved the highest scores in Visual Figure Ground and lowest scores in Visual Sequential Memory, whilst the DS group performed best in Visual Discrimination and achieved lowest results in Visual Spatial Relationships.

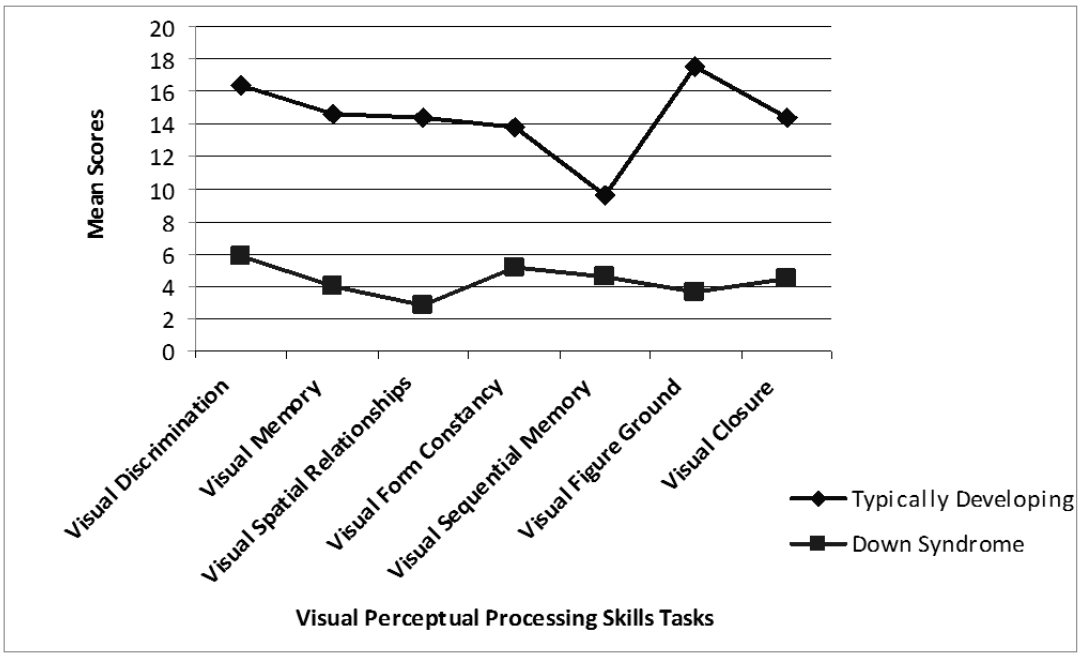

Figure 4: The Distribution of Mean Scores obtained by DS and TD students in Group B.

Analysis of Significant Difference in Visual Perceptual Processing Tasks

It can be identified that there is a significant difference between the results obtained by TD and DS students. This shows that there is no correlation in the development of Group A (Table VII) and Group B (Table VIII).

Table VII: Mean Scores and p-value of TD and DS students in Group A in VPPS Tasks.

TASKS	MEAN TYPICALLY DEVELOPING	MEAN DOWN SYNDROME	P-VALUE
Visual Discrimination	11.8	1.8	.000
Visual Memory	10	1.8	.000
Visual Spatial Relationships	9	1.2	.000
Visual Form Constancy	11.8	1.6	.000
Visual Sequential Memory	10.6	1.8	.000
Visual Figure Ground	12	2	.000
Visual Closure	9.8	2.6	.000

Table VIII: Mean Scores and p-value of TD and DS students in Group B in VPPS Tasks.

TASKS	MEAN TYPICALLY DEVELOPING	MEAN DOWN SYNDROME	P-VALUE
Visual Discrimination	16.4	5.8	.001
Visual Memory	14.6	4	.000
Visual Spatial Relationships	14.4	2.8	.000
Visual Form Constancy	13.8	5.2	.004
Visual Sequential Memory	9.6	4.6	.021
Visual Figure Ground	17.6	3.6	.000
Visual Closure	14.4	4.4	.000

Discussion

Phonological Awareness

Students with DS were mostly successful in the tasks at the Phonemic Level. However only in tasks which posed fewer cognitive demands such as identification of initial phonemes and final phonemes. The students with DS in Group A, who had an average reading age of 6 years, obtained results above the 70th percentile in Initial Phoneme Identification, Generation of Alternative Words and Final Phoneme Identification. When compared to the TD group, there was no overall significant difference in these tasks. Medial Phoneme Identification was the only task out of the Identification tasks which showed a statistical significant difference between the TD and DS groups in Group A ($p= 0.011$). This explains that this skill is still developing at this reading age in DS. In addition, a significant difference between TD and DS ($p=0.003$ and $p= 0.0$ respectively) was present in Sound Counting and Sound Blending. This dearth of successful results suggests that in students with DS phonological representations do develop but not effectively throughout all tasks. In tasks such as sound counting and sound blending, the participants are required to further manipulate the phonemes where not only identification is needed but also counting and memory skills are essential. Hence this imposes higher cognitive and memory demands on the students with DS (Gombert, 2002; Snowling et. al., 2002).

Then again, in Group B, where the participants had a mean reading age of 9 years, both TD and DS students scored at the same levels on all tasks at the Phonemic level, with no significant difference in any of the tasks. This observation indicates that students with better cognitive and language skills can handle better the cognitive demands of the activities and perform better (Snowling et. al., 2002). This result contradicts studies proposed by Cossu and Marshall (1990) and Cossu et al. (1993), where from a study of ten participants

with DS it was concluded that reading could be acquired in the absence of phoneme segmentation, syllabification and rhyme.

Automatic Sequences were the next set of skills to develop. These activities include the ability to access phonological information, which is stored in the long-term memory (Torgesen and Burgess, 1998). Positive results in these tasks indicate that a child has the ability to rapidly access, store and analyse strings of phonemes during alphabetic reading (Torgesen and Burgess, 1998). Groen, Laws, Nation and Bishop (2006) confirm that Automatic Sequences indicate the accuracy of retrieval of phonological codes of words from the long-term memory. In both Group A and Group B, students with DS scored slightly below the TD group. Nevertheless, no statistical significance difference was registered between TD and DS in all the tasks as shown in the results below.

Tasks at the Syllabic level and Word level illustrated analogous results. In both skills and across all the groups, the results were very similar, with no statistical significance between TD and DS. Hence, suggesting that both TD and students with DS follow the same pattern of development. Herein, as shown in previous results, a higher reading age correlates to higher scores, additionally supporting the two-way relationship between PA and reading, where exposure to reading can enhance PA, and an increase in PA can increment the success in reading (Boudreau, 2002; Cupples and Iacono, 2000; Goetz et. al. 2008).

With the knowledge that phonological memory difficulty is a well-known characteristic of DS (Laws & Gunn, 2004), the expectations of the researcher were confirmed by the results of the Auditory Sequential Memory tasks. Results from this study compliment results from Byrne, Buckley, MacDonald and Bird (1995). In both studies participants performed poorly on auditory memory tasks when compared to reading age matched peers. Notwithstanding, the difference between the DS groups and TD groups was not ample. In Group A the following results were obtained on the three tasks of Auditory Sequential Memory: Digital Memory Forward, Digital Memory Backwards and Word Lists.

A significant difference between TD and DS was identified in Digit Memory Forward, as this is the single task with a p-value lower than 0.05, whereas, TD students and students with DS obtained similar scores on the Word Lists task. Thus, while a difference exists between the two groups, the difference is not spectacular. A similar situation was obtained in Group B. The following results were obtained.

Group B showed a significant difference between DS and TD on two tasks: Digital Memory Forward and Digital Memory Backwards. A very high,

favourable result was achieved in naming Word lists. Ellis and Large (1988), suggested that in TD children, auditory memory and reading develop together before the age of 6 years. However, after the age of 6, it is reading practice that helps the development of auditory memory. A similar pattern of development was consequently proposed by Laws, Buckley, Bird, MacDonald, and Broadley (1995), and Buckley, Bird, and Byrne, (1996) in children with DS. These two longitudinal studies showed the relationship between reading and memory in groups of readers and non-readers due to reading difficulties. Results demonstrated higher scores by the group of readers. In this study this could be confirmed by the increase in scores between Group A and Group B. The levels of Auditory Memory improved significantly with the increase in reading age.

Answering the research questions

Question 1: How does PS develop in Maltese-speaking students with DS when compared to the reading age matched typically developing Maltese-speaking students?

This small scale study revealed that PA in students with DS develops in a similar pattern as in TD students. However, students with DS obtained lower scores. Hence, although reading ages are equivalent, students with DS present a delay in PA, yet this could be considered as a mild delay as no statistical difference between the groups was found in the majority of the tasks. When the aspect of Maltese as a language is considered, Maltese contrasts sharply with other so-called shallow orthographies such as Oriya (Kumar Misrah, 2007). In Oriya, children with DS develop rhyme first, followed by phonemic awareness and syllable awareness. Conversely, in Maltese phonemic awareness is the first to develop. In addition, Kumar Misrah, (2007), concludes that although Oriya has a shallow orthography, children with DS still do not depend on PA to develop reading. Once again in contradiction to the latter study, it has been shown here that the Maltese-speaking students with DS develop PA skills and these predict their reading levels, as an increase in PA correlates with an increase in reading age. Unfortunately the data collected from this research is very small. Further studies concerning the linguistic structures of the Maltese language are indicated so as to attain more significant results.

Visual Perceptual Processing Skills

In the DS population, VPPS have been described as being strong and that children with DS rely upon these particular skills such as Visual Memory to develop reading abilities (Jarrold and Baddeley, 1997, Hodapp and Ly, 2004, Fidler et al. 2005 and Visu-Petra, et al. 2007). However, results from this

study do not indicate the same strength in VPPS as mentioned in the above literature.

All students with DS, obtained a lower perceptual age when compared to their reading age. They also spent a significantly longer time to complete the assessment. As observed in table 7, when reading age is close to chronological age, such as in Participant 19, the perceptual age is still lower (Chronological Age: 11;01; Reading Age: 9;11; Perceptual Age: 6;01). When compared to TD participants, the performance of the students with DS was significantly lower across all VPPS, where the p-value never reached .05 of significance. All ten students with DS performed significantly lower than the TD peers, however the same pattern of development was achieved, thus reflecting results from Miranda & Fants (1974).

Conversely, the TD group obtained very high results. All participants in Group B achieved a noteworthy higher perceptual age when compared to their reading age and chronological age.

Further studies on Maltese TD children are needed. These can lead to a standardization of the TVPS as an assessment tool for the Maltese population and consequently results would be more reliable both for research and in the clinical practice.

Question 2: How do VPPS develop in Maltese-speaking students with DS when compared to the reading age matched typically developing Maltese-speaking students?

Results showed that the Maltese-speaking students with DS obtained statistically significant lower results when compared to TD students. Hence implying that students with DS might rely more on the phonological aspect in literacy development and as results PS skills were significantly stronger. This can also be associated with the depth of the Maltese orthography. Since the phonological representations in the Maltese-language are easier to access, therefore word recognition depends more on this phonological route and not a visual route of processing (Frost & Katz, 1992). Then again, the TD group obtained very high results in the VPPS tasks, hence showing that poor VPPS can be attributed more to a characteristic intrinsic to the group of students with DS rather than to Maltese as a language.

Limitations of the research studies and suggestions for further research

The first limitation of this study was the actual sample size. A bigger research population would have surely contributed to more statistically significant results and the implications of the study would have surely been stronger. A second limitation is that more information about the

developmental levels of the participants should have been obtained. Cognitive age, hearing acuity tests on the day of assessment and visual tests would have contributed to a better investigation of the research questions. The third limitation is specific to the assessment tools used for data collection. The Maltese Metalinguistic Screening Test and the Informal Comprehension Test are assessments which have been designed for the Maltese population. However, no normative data and age equivalences were available. No other assessment tools were available on the date of the study. Standardized assessments are needed as such tools would have contributed to more relevant results. The TVPS is an assessment which has not been standardized on the Maltese population, thus age equivalences might not be accurate.

Conclusion and Recommendations

The purpose of this study was to make a preliminary move into answering questions about the development of PA and VPPS in Maltese-speaking students with Down Syndrome. This aim has been reached with important implications for the training of reading in DS. While many questions about reading in this population still remain unanswered, this study served as a stepping stone to ascertain the developmental process in the complex task of reading. It is recommended that this study is replicated on a bigger sample of participants. It is also recommended that updated and validated assessments should be utilized.

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