
Semantic processing in children with Down Syndrome

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Abstract

This research focuses on language processing, and more specifically on semantic processing, in children with Down Syndrome (DS). It has repeatedly been documented that children with DS display severe deficits in all language domains, semantics among others, and especially in their expressive language. Therefore, our purpose was to detect possible differences between receptive and expressive language in the semantic domain in DS and to compare semantic processing, both receptive and expressive, of children with DS with that of children with typical development. For this purpose we examined two groups of children, a group of children with Down Syndrome (DS) and a group of children with typical development (TD), aged 4-7.11 years old. Our findings proved that children with DS scored lower than typically developing children in all semantic tasks, whether receptive or expressive and that their performance was lower in the expressive language tasks than the receptive ones.

Keywords: Down Syndrome, semantics, expressive language, receptive language

1. Introduction

Down syndrome (DS) is a genetic disorder with its most common cause being a chromosomal defect, trisomy 21. Its estimated prevalence is 13.65 per 10,000 live births (Centers for Disease Control and Prevention, 2006) or according to other sources 1 in 800 live births (Parker et al. 2010). DS is the leading genetic cause of intellectual disability accounting for 25%-30% of people with mental retardation (Nadel 1999). The degree of intellectual disability varies widely from close to normal intelligence to severe mental retardation, with 80% of individuals showing moderate retardation (Roizen 2002). Despite considerable variability, individuals with DS have been described as having phenotypically distinct behavioral patterns in language and cognition, following a consistent profile in their linguistic and cognitive development (Chapman & Hesketh 2001; Martin et al. 2009).

2. Language in Down Syndrome (DS)

Language is among the most impaired domains of functioning in DS and language development follows a characteristic profile, with DS individuals generally displaying lower expressive than receptive language skills and also lower auditory short-term memory skills (Abbeduto, Warren & Connors 2007; Andreou et al. 2002; Martin et al. 2009; Roberts, Price & Malkin 2007). Deficits in grammar (Fowler 1990) have been identified, as opposed to receptive vocabulary and comprehension, which are relatively preserved (Miller 1991). Errors in grammatical morphemes and especially the omission of tense-related grammatical morphemes have repeatedly been documented in individuals with DS (Eadie et al. 2002; Laws & Bishop 2003).

Semantics is also a domain of deficit in DS. Despite considerable individual variability, the onset of the first spoken word is often delayed, and early expressive vocabulary growth is slow for children with Down Syndrome (Berglund, Eriksson & Johansson 2001; Mervis & Robinson 2000).

3. Semantics in Down Syndrome (DS)

Children with DS exhibit speech, vocabulary, syntax, and pragmatic difficulties (Chapman et al. 1998; Fowler, Gelman & Gleitman 1994). Moreover, it has been repeatedly documented that children with DS exhibit an unusual disparity between expressive and receptive language, compared to what would be expected based on their mental age (Chapman 1997). This delay in expressive performance is evident from infancy, even prior to the development of formal vocal speech.

Receptive language or comprehension has been repeatedly studied in relation to expressive vocabulary (e.g., Chapman, Schwartz & Kay-Raining Bird 1991) and comprehension skills have been found more advanced than expressive production during all age periods up to adolescence (Chapman 2006; Chapman et al. 1991; Facon, Facon-Bollengier & Grubar 2002).

However, there is evidence that language comprehension may decline with age as individuals with DS enter adulthood (Chapman, Hesketh & Kistler 2002). This may be related to whether, in the task that assesses comprehension, auditory short-term memory is involved, which is known to be affected in individuals with DS, or long-term memory. In either way, memory seems to be enhanced when visually or auditory information is being used and so does language comprehension (Toms, Morris & Foley 1994).

Similar to the pattern of expressive vocabulary development in typically developing children, some children with Down Syndrome experience a vocabulary spurt (Miller 1999; Berglund et al. 2001), though this spurt appears to occur at more advanced mental ages for children with Down Syndrome than for typically developing children (Miller 1999).

Research findings have shown that expressive vocabulary levels may be higher than nonverbal cognitive levels in adolescents and young adults with Down Syndrome (Glenn & Cunningham 2005), but lower or commensurate with nonverbal cognitive levels in children with DS (Laws & Bishop 2003).

When vocabulary production is assessed using language samples from real life communication situations, perhaps a more challenging context than standardized tests, expressive vocabulary levels of preschoolers, elementary age children, and adolescents with DS were found to be delayed compared to their nonverbal cognitive levels (Miller 1988; Chapman et al. 1991, 1998).

In addition, more recent findings in the semantics domain in DS, using the fast mapping technique, which is described as a cognitive strategy that allows children to produce as many words as they can from a certain grammatical category, have shown that children with DS exhibit difficulties in producing many words in all categories and especially in verbs (Nash & Snowling 2008).

In view of the above, the aim of the present study was a) to investigate semantic processing in children with DS and compare it with that of Typically Developing (TD) b) to compare expressive and receptive semantic skills within the group of children with DS.

4. Methodology

The participants of the study were 15 children with DS and 15 children with TD, aged from 4 to 7.11 years old. All children with Down Syndrome had typical trisomy 21 and mild mental retardation. The mental age of the participants with DS was based on the results of the WISC Test that was given to them prior to the participation in the study, at Public Diagnostic Centers (KEEDY). Their mental age varied from 42 months to 77 months.

Four tasks, that measure semantic processing, which were subscales of a test (Tzouriadou et al. 2008) standardized for children from 4 to 7.11 years old, were given to all children in order to examine.

- a) receptive vocabulary b) relating vocabulary c) matching images to words d) oral vocabulary.

The receptive vocabulary task consists of 12 items and examines the child's receptive language ability. The researcher shows 4 pictures each time, describes one of them and asks the child to show the picture that matches the description.

The relating vocabulary task consists of 15 items and evaluates the child's ability to understand and relate words which are presented visually and which express meanings that are related between them. The researcher shows a picture-stimulus each time and then 4 other pictures follow. The child has to find which two (out of 4) pictures match the picture-stimulus.

The matching images to words task consists of 23 items and evaluates the child's ability to understand words which are related with everyday meanings. The researcher shows 4 pictures each time and asks the child to choose two of them by saying "Show me the ... (ice-cream for example)"

The oral vocabulary task has two parts and evaluates the child's expressive language ability and the ability to give the definition of common words. The first part consists of 14 items. The researcher asks the child to find a word that starts with a specific syllable pointing at the same time the picture that shows it. The second part consists of 15 items and the researcher asks the child to describe a common word (e.g. a dog).

5. Statistical analysis

The statistical analyses followed were a) *Cronbach's alpha reliability analysis* was used in order to show if all items were suitable for this measurement b) *Correlation analysis* was used in order to reveal potential correlations between the variables (the 4 semantic tasks) c) *MANOVA analysis* was used in order to show if the independent variable (children with DS or with TD) affects the dependent variables (tasks) d) *ANOVA for repeated measures* was used in order to find whether there is a dominance of receptive over expressive tasks in DS.

6. Results

Cronbach alpha analysis which was used in order to reveal potential reliability between the four tasks showed that there is an overall high reliability between the four tasks (.931).

The *Correlation analysis* showed a high correlation between the matching images to words task and relating vocabulary (.860), high correlation between matching images to words and oral vocabulary (.861) and medium correlation between matching images to words and receptive task (.574). In addition, there was a high correlation between relating vocabulary and oral vocabulary (.863) and a medium correlation between relating vocabulary and receptive vocabulary (.611). Finally, there was a medium correlation between receptive and oral vocabulary (.575).

A *one way multivariate analysis of variance* (MANOVA) was conducted to determine the effect of the children's development (TD, DS) on the four dependent variables (matching images to words, relating vocabulary, receptive and oral vocabulary). Statistically significant differences were found between the two groups on the dependent measures (Wilks' $\Lambda = .11$, $F_{4,25}=50.94$, $p<.001$). Table 1. contains the means and the standard deviations of the dependent variables for the two groups. All the following univariate tests were significant indicating statistically significant differences between the two groups on matching images to words ($F_{1,28}=112.01$, $p<.001$), relating vocabulary ($F_{1,28}=119.78$, $p<.001$), receptive vocabulary ($F_{1,28}=20.14$, $p<.001$) and oral vocabulary ($F_{1,28}=107.81$, $p<.001$). Children with DS gave fewer correct answers than children with TD in all semantic tasks, as shown in Table 1.

The results from *ANOVA for repeated measures* showed that the performance of the children with DS in all receptive tasks (receptive vocabulary, relating vocabulary, matching images to words) was higher at a statistically significant level [F (df 4, 56) = 36.31, $p<.001$] than the expressive task (oral vocabulary) as shown in Table 2.

	DS	TD	F value	P value
receptive vocabulary*	6.27 (SD:1.6)	8.50 (SD:1.05)	20.144	<0.01
relating vocabulary**	2.57 (SD:1.12)	7.15 (SD:1.16)	119.779	<0.01
match images to words***	3.79 (SD:0.81)	7.01 (SD:0.85)	112.009	<0.01
oral vocabulary****	1.95 (SD:1.33)	7.23 (SD:1.45)	107.809	<0.01

*out of 12, **out of 15, ***out of 23, ****out of 29

Table 1. Mean number of correct answers in the semantic tasks in DS and TD children

Receptive tasks: receptive vocabulary, relating vocabulary, matching images to words
Expressive task: oral vocabulary

	Oral Vocabulary	Receptive Vocabulary	Relating Vocabulary	Matching Images to words
Expressive task	1.95 (SD: 1.6)			
Receptive tasks		6.27 (SD: 1.6)	2.57 (SD: 1.12)	3.79 (SD: 0.81)
F value		15.40	73.59	71.72
P value		<0.01	<0.01	<0.01

Table 2. Mean number of correct answers of DS children in the receptive and expressive tasks

7. Discussion

In summary, we found that the semantic domain of language is a region of deficit in children with DS. Our findings are in line with those of other studies which proved that vocabulary acquisition and expression are vulnerable in this specific population (Fowler 1998). Moreover, these results support previous findings identifying weaknesses in expressive language ability compared to receptive in DS (Boudreau & Chapman 2000).

Recent findings have shown that children with DS experience more difficulties in the expressive area rather than the receptive one, compared with typically developing children (Chapman 2006; Glenn & Cunningham 2005). Our findings come in line with these researches, since children with DS in our study achieved low scores in all semantic tasks, but made more errors in the expressive task.

In other words, in this study as well as in previous ones (Nash & Snowling 2008; Roberts et al. 2007), receptive language, though poor, is proven to be the strongest area in semantics, when compared to expressive. This might explain some vocabulary strengths documented in children with intellectual disability in general (Facon et al. 2002). The young age of our sample could also provide an explanation for the low scores obtained in both receptive and expressive tasks since it has been shown that semantic abilities increase with age in DS (Riva, Nichelli & Devoti 2000).

8. Limitations and Future Directions

However, our results should be treated with caution since this study was only a small-scale investigation, with a limited number of experimental tools and the children with DS who consisted our sample were not followed longitudinally. Therefore, more

longitudinal research studies in DS are needed with large samples as well as a variety of experimental tools, which will be followed from childhood right through adolescence and adulthood.

In addition, since the bulk of the research in DS concerns the English language, more research is needed in the Greek language in this specific population which might reveal differences in the reception and expression of phonology, syntax and semantics which might be due to the fact that these two languages are very different in the various language domains.

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