Journal of Intellectual & Developmental Disability, September 2011; 36(3): 184–196

informa
healthcare

The development of vocabulary in Spanish children with Down syndrome: Comprehension, production, and gestures

MIGUEL GALEOTE[1], EUGENIA SEBASTIÁN[2], ELENA CHECA[1], ROCÍO REY[1] & PILAR SOTO[2]

[1]*Universidad de Málaga, Spain, and* [2]*Universidad Autónoma de Madrid, Spain*

Abstract

Background Our main purpose was to compare the lexical development of Spanish children with Down syndrome (DS) and children with typical development (TD) to investigate the relationship between cognitive and vocabulary development in comprehension and oral and gestural production.

Method Participants were 186 children with DS and 186 children with TD, with a mental age (MA) of 8–29 months and matched on gender and MA. Information about vocabulary was obtained using a new Spanish adaptation of the MacArthur–Bates CDI for children with DS.

Results No significant differences in oral production were found. Lexical comprehension and gestural production of children with DS were superior. Similar to children with TD, gestural production in children with DS decreased as oral production increased.

Conclusion Our study provides evidence to support that lexical comprehension and gesture production are strengths in children with DS. With respect to oral production, our results do not support a specific dissociation between cognitive and lexical development.

Keywords: *Down syndrome, productive vocabulary, receptive vocabulary, symbolic gestures, cognitive development, MacArthur–Bates CDI*

Introduction

Children with Down syndrome (DS) are characterised by a language development delay which is greater than would be predicted from the cognitive delay itself (Chapman, 1995; Fowler, 1990; Vicari, Caselli, & Tonucci, 2000; Yoder & Warren, 2004). However, language abilities for this group are not uniform. More precisely, these children show a specific dissociation between different linguistic domains (i.e., better comprehension than production) and subdomains (e.g., better lexical than morphosyntactic abilities; Berglund, Eriksson, & Johansson, 2001; Cardoso-Martins, Mervis, & Mervis, 1985; Caselli et al., 1998; Chapman, 1995; Chapman, Schwartz, & Kay-Raining Bird, 1991; Chapman, Seung, Schwartz, & Kay-Raining Bird, 1998; Fowler, 1990; Miller, 1988, 1999; Vicari et al., 2000).

Lexical development in children with Down syndrome

There are reports that lexical development is somewhat preserved in these children compared to their other linguistic abilities (Fabbretti, Pizzutto, Vicari, & Volterra, 1997; Fowler, 1990; Rondal & Edwards, 1997). However, the current literature on this topic both on early stages and on older children contains a number of inconsistencies. Several studies have shown that productive vocabularies emerge at roughly the same mental age (MA) in children with DS and typically developing (TD) children, although delays are observed as children with DS grow older (Cardoso-Martins et al., 1985; Caselli et al., 1998). In contrast, other studies have found larger deficits in productive language than might be expected based on the children's nonverbal MA (Byrne, Buckley, MacDonald, & Bird, 1995; Fowler, Gelman, & Gleitman, 1994; Miller, 1988, 1992, 1999). According to Miller (1992), most children with DS already show deficits in their productive vocabulary in the early stages of lexical learning. Laws and Bishop (2003), and Ypsilanti, Grouios, Alevriadou, and Tsapkini (2005) reported that older children and adolescents with DS did not differ from nonverbal MA-matched controls. On the contrary, Roberts, Price, Barnes,

Correspondence: Miguel Galeote, Departamento de Psicología Evolutiva y de la Educación, Facultad de Psicología, Campus de Teatinos, s/n, 29071-Málaga, Spain. E-mail: mgaleote@uma.es

ISSN 1366-8250 print/ISSN 1469-9532 online
DOI: 10.3109/13668250.2011.599317

et al. (2007) found that children with DS had lower productive vocabulary than did TD children.

The results are more consistent when vocabulary production was assessed through naturalistic language samples, a more challenging context than standardised tests (Roberts, Price & Malkin, 2007). Chapman et al. (1998) found that children and adolescents with DS produced fewer total and different words in conversational and narrative language samples than did typically developing nonverbal MA-matched children. Also, Miller (1988) reported that productive vocabulary in language samples of preschoolers with DS was delayed relative to nonverbal cognitive level.

Regarding the lexical comprehension level of individuals with DS, several studies using standardised tests have found that individuals with DS did not differ from typically developing MA-matched children, adolescents, and young adults (Abbeduto et al., 2003; Chapman et al., 1991; Laws & Bishop, 2003). Moreover, recent studies have shown that for adolescents and young adults with DS, lexical comprehension exceeds both nonverbal cognitive levels and comprehension levels of more conceptually difficult words (Chapman, 2006). Strengths in lexical comprehension emerge in later adolescence and early adulthood, perhaps because of more life experiences due to greater chronological age (CA) (Chapman, 1995, 1997, 2006). However, other studies (Price, Roberts, Vandergrift, & Martin, 2007; Roberts, Price, Barnes, et al., 2007; Ypsilanti et al., 2005) have found that children with DS scored lower than TD nonverbal MA-matched children in lexical comprehension.

The inconsistency of findings for lexical comprehension and productive vocabulary may be due to diverse factors: the different sample sizes and age groups, different methodologies employed, and different statistical analyses. Roberts, Price, and Malkin (2007) also pointed to family (e.g., maternal education) and intervention factors. For example, with respect to sample sizes and age groups, Laws and Bishop (2003) included 19 participants with DS ranging from 10 to 19 years; Chapman et al. (1991, 1998) included 47 participants ranging from 5 to 20 years; Ypsilanti et al. (2005) included five adolescents with DS ranging from 14.2 to 14.11 years. The large within-group variability in individuals with DS may produce inaccurate interpretations of results, particularly with small sample sizes.

All the reviewed studies used standardised tests of vocabulary or language samples. Although both procedures have been widely used in the study of language development, they pose problems, particularly if used during the early stages of language. For example, as Mervis and Becerra (2003) pointed out, recordings of parent–child interactions consistently lead to underestimation of vocabulary size for at least two reasons: (a) Young children talk less when they find themselves in unfamiliar settings or around people they do not know well, and (b) It is impossible during a play session to simulate the wide variety of situations in which a child produces language. Similar problems arise when using standardised measures.

Parent reports' studies

Parent reports have provided a viable alternative to overcome these problems. One of the most well-known parent reports is the MacArthur–Bates Communicative Development Inventories (CDI; Fenson et al., 1993). The CDI provides a rapid overall evaluation which can be used for both screening and research purposes. Miller was a pioneer in using parent report measures to evaluate rates of vocabulary development in children with DS (Miller, 1992). (Miller, Sedey, and Miolo, 1995, have also demonstrated the validity of the productive vocabulary section of the CDI for children with DS.) In his 1999 review chapter (see also Miller, 1992), Miller described the main findings of two studies carried out by his research team. The first study used a cross-sectional design with children with a MA of 12–30 months. A group of children with DS ($n = 43$) was matched with a group of TD children ($n = 46$) on MA and socioeconomic status. The results revealed that TD children acquired significantly more words than children with DS at the same MA level. Furthermore, these differences increased with MA. The second study followed the youngest children from the first study (MA = 12–17 months). The children with DS ($n = 20$) were followed for 2 years and the TD children ($n = 23$) for 1 year, because of differences in their rate of cognitive growth. The results of this study were similar to those of the first. Furthermore, the gap between the two groups widened again as their MA increased. At the end of the study, TD children had vocabularies 4 times larger than children with DS. Miller concluded that children with DS have particular difficulty in language acquisition which cannot be accounted for purely by their general cognitive status. More precisely, Miller (1992) noted the emergence of a vocal production deficit for children with DS from a MA of 17 months onwards.

Several researchers have challenged Miller's (1992, 1999) conclusions. One of the first to do so was Caselli et al. (1998). The participants in Caselli et al.'s study were 40 children with DS (aged 10–49 months) and 40 TD children (aged 8–17 months)

matched on lexical comprehension. Word comprehension was chosen as the basis for matching the two groups because comprehension level is generally more consistent with the global cognitive level of children with DS. Caselli et al. found higher vocabulary sizes for the group with DS than for the TD group (although these differences were not statistically significant). The only difference in method compared to Miller's (1992) study was the fact that the children were matched on lexical comprehension rather than MA. Considering that, as previously indicated, lexical comprehension correlates with MA in children with DS, these results do not support Miller's hypothesis.

Similar results were found by Vicari et al. (2000). Participants were 15 children with DS, aged 4–7 years (*M* MA = 30.6 months), and 15 children with TD matched (as for Miller's 1992 participants) on MA and socioeconomic status. Vocabulary data were based on the Italian version of the CDI. The authors found a comparable level of word production in both groups, and concluded that children with DS show no specific dissociation between cognitive level and lexical development. The main difference between this study and that of Miller's team was the age range of the children with DS. However, as mentioned above, Miller found that the gap between productive vocabulary and MA increases with age. In order to support Miller's findings the Italian study (with older participants) should therefore have found greater differences rather than no differences.

Berglund, Eriksson, and Johansson (2001) carried out the largest scale study reported to date (330 Swedish children with DS, CA 1–5.6 years, and 336 TD children, CA 1.4–2.4 years). The language development measure was the Swedish version of the CDI. Berglund et al. observed almost identical growth patterns in the children with DS compared to TD children. On this basis, the authors proposed the existence of common growth patterns among the children, independent of the presence of dysfunction. Specifically, an exponential or a logistic curve yielded the highest explained variance. However, the fact that the children with DS and with TD were not matched on MA means that it is difficult to draw further conclusions beyond this point (this shortcoming has been acknowledged as a limitation of the study by its authors).

Galeote, Soto, Checa, Gómez, and Lamela (2008) studied the relationship between cognitive development and vocabulary size in both its vocal and gestural (symbolic gestures substituting oral words) modalities in a broad sample of Spanish children with DS. Participants in the study were 66 children with DS and 66 TD children, with a MA of 14–28 months, matched on the basis of their gender and MA. Information about vocabulary was obtained using an adaptation of the CDI for children with DS (Galeote, Soto, Lamela, et al., 2006; Galeote, Soto, Serrano, et al., 2006). The number of oral words produced by children with DS and TD children was similar. Once again, these results suggest no specific dissociation exists between cognitive and lexical development in children with DS.

The results of these studies challenge Miller's (1992) findings, since they appear to demonstrate that children with DS display similar developmental patterns of productive vocabulary to those of TD children. It must also be emphasised that the language development measure used was the same in all the studies examined above.

Relationships between productive vocabulary and lexical comprehension

The relation between productive vocabulary size and lexical comprehension size has scarcely been studied, yet it is important to know whether this relation is similar for children with DS and TD children. Caselli et al. (1998), using norms from the CDI-1, reported that average values in children with DS for word comprehension was notably greater than those for word production, revealing an asynchrony between these two domains. In order to evaluate the degree of delay in linguistic abilities in the children with DS, the values obtained for each child were compared with the normative scores reported in Caselli and Casadio (1995). The results were similar to findings for TD children (Caselli et al., 1995), with comprehension ahead of vocal production. In addition, as mentioned earlier, these authors compared the productive vocabulary of children with DS and TD children matched on vocabulary comprehension. Given that no differences were observed in productive vocabulary, these results suggest that the lag between word comprehension and word production was quite similar in the two groups. Singer Harris, Bellugi, Bates, Jones, and Rossen (1997), using the same CDI-1 norms, also found that during the early period of lexical acquisition, the relation between productive and receptive vocabulary size is the same as that found for TD children (Mervis & Becerra, 2003). Nevertheless, using standardised tests, Roberts, Price, Barnes, et al. (2007) did not find receptive vocabulary to be greater than productive vocabulary (adjusted *Ms* = 53.81 for receptive vocabulary, and 53.53 for productive vocabulary). However, the participants of this study had a substantially higher

chronological age. Perhaps the receptive-productive dissociation decreases with age.

Gestural production of words

It is worth noting that the study of lexical development in children with DS presents an important limitation: vocabulary production is taken into account only in its oral modality, whereas many children with DS spontaneously produce numerous gestures and signs to substitute words. In fact, gesture production is considered a strength of children with DS relative to their receptive and expressive language skills (Caselli et al., 1998; Chan & Iacono, 2001; Singer Harris et al., 1997). Thus, the different kinds of gestures and/or signs produced by these children should also be considered (Berglund et al., 2001).

To our knowledge, only two studies have been conducted that added symbolic gestures substituting words (words gestured) to oral vocabularies using the CDI. Miller (1992) described a study in which the gestural vocabulary sizes of children with DS and TD were compared. Miller reported that at 11 and 13 months of MA there was not a sign advantage in children with Down syndrome. At 17 months a sign advantage appeared, which disappeared at 20 and 23 months, such that oral and signed vocabularies were the same size again. At 26 months, oral vocabulary size increased dramatically while sign vocabulary size slightly decreased. Miller also compared the number of different words signed and spoken (as a composite measure of total vocabulary) to the vocabularies (oral) of TD children. The results showed that while signed words increased the overall vocabulary size of children with DS, the average vocabulary was smaller than that of TD children of the same MA. However, because Miller did not measure the gestures of the TD children, we do not know the extent to which their vocabulary size would have differed if gestures had been added to their oral vocabulary. Conversely, Galeote et al. (2008) compared the vocabulary sizes of both groups of children when words signed were added to oral vocabulary. In this case, total vocabulary sizes increased in both groups at a similar proportion, with no significant differences between groups. Galeote et al. (2008) also compared the gestural production of the two groups. The results were similar to those of Miller (1992). Specifically, the DS group produced more gestures than the TD group, but the pattern was similar: children produce a higher number of gestures in the early stages, when their oral vocabulary is smaller; as they acquire more spoken words, their production of gestures plateaus or even decreases.

Predictions

The contradictory findings in the literature reviewed require a more focused examination. Given the high individual variability found in people with DS, it is crucial to perform studies using larger samples. Thus, the main objective of this study was to analyse the relationship between cognitive development and vocabulary size in comprehension and in production, both in the oral and gestural (symbolic gestures) modalities, in a larger sample of Spanish children with DS than that included in Galeote et al. (2008; 66 vs. 186 children). Symbolic gestures are defined as those gestures that, when properly taught or spontaneously learnt, substitute specific lexical items (e.g., closing the hand with tight fingers and moving it towards the mouth to simulate "to eat"). We predicted that children with DS and TD children would comprehend a similar number of words. With respect to oral production, based on Miller's findings, we predicted the following: Similar vocabulary sizes will be found in children with DS and TD children during the very early stages of vocabulary acquisition, greater differences between children with DS and with TD will be found as the children grow older, and these differences will begin to become apparent from a MA of 17 months onwards. Based on the reported gestural abilities of children with DS, we predicted that the children with DS will produce a greater number of symbolic gestures. In addition, differences between the children with DS and the TD children will decrease when symbolic gestures are included in productive vocabulary. Information about vocabulary was obtained using the version of the CDI adapted to the developmental profile of children with DS included in Galeote et al. (2008; see section under *Instruments*).

Method

Participants

The participants were 372 Spanish children: 186 children with DS and 186 children with TD from 8 to 29 months of MA (assessed by the Brunet-Lézine Psychomotor Development Scale-Revised; Josse, 1997). Groups were further divided into seven 3-month age ranges in order to detect possible developmental differences: 8–10, 11–13, 14–16, 17–19, 20–22, 23–25, and 26–29 months. Means (and ranges) of the CA and MA of the participants are shown in Table 1 (for simplicity, in the text we identify the groups by their average age; for instance, "9" for the 8–10 group, etc.). All children had a monolingual Spanish background. Informed consent was obtained from the participants'

families and the research followed the ethical guidelines of the Spanish Psychological Society.

The families of children with DS were contacted through early intervention units (infant stimulation centers) and Down syndrome parent associations from different cities in Spain (mainly in the South). They were selected on the basis of the following criteria: cytogenetic documentation of Trisomy 21, and absence of neurosensory deficits and psychopathological disorders. All children received regular therapy from birth (this is common practice in Spain).

Children in the comparison group were recruited through several private and public child care centres and nurseries from Málaga (Spain) and its surroundings. TD children with neurosensory deficits and/or psychopathological disorders were excluded.

With respect to education of mothers of children with DS, 28.49% of mothers had completed compulsory secondary studies, 26.34% a Spanish Baccaulaureate or A Levels, 16.67% technical and further education (TAFE) and 27.96% a bachelor degree (one mother did not provide the information, 0.54%). With regards to education of mothers of children with TD, 31.72% of mothers had completed compulsory secondary studies, 24.19% a Spanish Baccaulaureate or A Levels, 13.98% technical and further education (TAFE) and 27.96% a bachelor degree (four mothers did not provide the requested information, 2.15%). A chi-square analysis showed nonsignificant differences between the two samples ($\chi^2 = 2.730$, $df = 4$, $p < .60$).

Children with DS and TD were matched on gender and on MA (the MA of each pair could not differ by more than 9 days). In addition, when possible, children were matched on birth order and/or mother's educational level. Specifically, 64 children (34.41%) were matched on mother's educational level, 35 (18.82%) on birth order, and 41 (22.04%) on both factors.

Instruments

For both samples, MA was assessed using the Brunet-Lézine Psychomotor Development Scale-Revised (Josse, 1997). This scale (a test similar to the Bayley Scales of Infant Development) assesses the development of children 1–30 months of age in four domains: postural control and motor function; oculomotor coordination or adaptation to objects; language; and social and personal relationships.

The lexical development measure employed in the present study was an adaptation of the CDI to the developmental profile of children with DS. We elaborated a single form which allows both word comprehension and verbal production skills to be assessed across the MA range covered by the original CDI (i.e., 8–30 months). A further significant modification concerns the assessment of symbolic or referential gestures: we added a third column to assess the comprehension and production of gestures representing specific lexical items. The total vocabulary checklist consists of 651 words organised into 21 categories.

In spite of the changes, our adaptation adheres to shared standards and procedures which ensure that it is comparable to the original CDI and contains its major structural categories (for a detailed description of the adaptation, see Galeote, Soto, Lamela, et al., 2006 and Galeote, Soto, Serrano, et al., 2006; for data regarding the adaptation's validity and reliability, see Galeote, Casla, Soto, Sebastián, & Rey, 2005).

Table 1. Chronological (CA) and mental (MA) age means and ranges in the DS and the TD groups

MA level	Group	Girls	Boys	Total	CA Mean (range)[a]	MA Mean (range)[a]
9	DS	15	12	27	16.15 (11.12–23.29)	9.18 (8–10.27)
	TD	15	12	27	9.06 (5.27–14.06)	9.21 (8.06–11)
12	DS	10	10	20	21.03 (13.07–29.10)	12.18 (11.12–13.21)
	TD	10	10	20	12.27 (11.06–16.18)	12.18 (11.06–13.27)
15	DS	9	14	23	25.15 (16.27–38.25)	15.06 (14.0–16.27)
	TD	9	14	23	15.06 (12.18–17.22)	15.06 (14–17)
18	DS	17	11	28	30.18 (19.28–42.04)	18.16 (17–19.27)
	TD	17	11	28	17.18 (13.21–20.13)	18.15 (17–19.27)
21	DS	10	23	33	50.27 (20.29–68.12)	21.18 (20–22.27)
	TD	10	23	33	21.19 (16.01–30.09)	21.11 (19.27–23)
24	DS	15	13	28	42.18 (27–64)	24.07 (23–25.24)
	TD	15	13	28	24.04 (19.11–31.07)	24.09 (23–25.24)
27	DS	13	14	27	57.20 (39–71.01)	27.17 (26–29.12)
	TD	13	14	27	27.09 (22.17–33.13)	27.16 (25.24–29.12)
Total	DS	89	97	186	36.07 (11.12–71.01)	18.27 (8–29.12)
	TD	89	97	186	18.20 (5.27–33.13)	18.26 (8.06–29.12)

Note. [a]Age is given in months and days.

The parents' task consisted of marking the words their children understood, produced, and/or gestured. The same inventory was also used for parents of the TD children. Only words produced or signed referentially and spontaneously were marked. Deviation from the standard pronunciation was acceptable for oral word production.

Procedure

Interviews were held with the parents of the participating children, either face to face or in small groups (up to five parents). We explained the aim of our research, the details of the inventory, and the content of the different sections, and also went through some items in more detail. During the interview, parents were told to observe their child for 1 week before filling in the inventory. All inventories were checked when collected to make sure that parents had filled them out correctly and completely.

The validity and reliability of the assessment of gestures was of special concern. This problem was tackled in two ways. First, numerous examples of symbolic gestures representing specific lexical items were given to parents during the initial interviews. They were then asked to give examples of gestures they had seen their children use. In addition to the inventory, parents were also given a sheet with several photos representing different types of gestures belonging to different word categories (see appendix in Galeote et al., 2008). Second, as mentioned previously, a second interview was held with the parents when the inventories were collected, during which their answers were checked.

Subsequently, we validated this aspect of the vocabulary in a group of 66 parents (25 parents of children with DS, and 41 parents of TD children). We asked them to describe each of their child's gesture. By analysing the parents' responses, we identified several categories that frequently presented problems: words for people, body parts, food and drink, clothes, objects and places at home, objects and places away from home, questions, prepositions, auxiliary verbs, periphrasis, and sentence connectors. We decided to be conservative and eliminate these categories from the data.

Care was taken to ensure that the interval between the measurement of MA and the assessment of vocabulary was as short as possible (during the period that parents were filling out the inventory).

Results

For scoring purposes, we took into consideration the total number of words marked by parents in lexical comprehension, oral production, and gestural production. Table 2 shows means and standard deviations for these variables, as well as for total lexical production combining the two modalities ("oral + gestural production"); that is, the sum of the words that were spoken and those that were produced only through gestures. It is important to note the presence of strong individual differences in both groups on all measures and at every MA level (see means and standard deviations in Table 2). Statistical analyses were performed with SPSS Version 17.0. An alpha level of .05 was used for all statistical analyses.

In order to assess the possible statistically significant differences between children with DS and TD children on the vocabulary measures, a $2 \times 7 \times 4$ mixed ANOVA was performed, treating group (DS and TD) and MA level (9, 12, 15, 18, 21, 24, and 27 months) as the between-subjects factors and vocabulary modalities (lexical comprehension, oral production, gestural production, and oral + gestural production) as the within-subject factors. Because Mauchly's sphericity test was statistically significant ($W = .089$, $df = 5$, $p < .000$), the degrees of freedom for the vocabulary term and its interactions were corrected through the Greenhouse–Geisser procedure. A significant main effect for vocabulary modalities was obtained: $F(\text{corrected } df = 2.035,\ 728.52) = 930.24$, $p < .000$, partial $\eta^2 = 0.722$. A significant effect of MA level also was obtained: $F(6, 358) = 150.96$, $p < .000$, partial $\eta^2 = 0.717$. Finally, and importantly, no difference was found on the group factor. That is to say, no differences were found between children with DS and with TD when data were considered globally.

Concerning the main effect of vocabulary modalities (with Bonferroni correction), we found the following order: lexical comprehension > oral + gestural production > oral production > gestural production.

Regarding the main effect of MA level (with a Bonferroni correction) we found that MA groups 9, 12, and 15 did not differ from each other, but they differed from all other MA groups. MA groups 18 and 21 did not differ from each other, but they differed from all other MA groups. The remaining MA groups, 24 and 27, differed from each other.

These results reflect general tendencies, but a more interesting set of results concerns the interactions. The vocabulary modalities × group, and vocabulary modalities × MA interactions were statistically significant: $F(\text{corrected } df = 2.035, 728.52) = 7.57$, $p < .001$, partial $\eta^2 = 0.021$, and $F(\text{corrected } df = 12.21,\ 728.52) = 92.419$, $p < .000$, partial $\eta^2 = 0.608$, respectively. No significant differences were revealed in the remaining interactions (group × MA, and vocabulary modalities × group × MA).

Table 2. Means and standard deviations for lexical comprehension, oral production, gestural production, and oral + gestural production combined

MA level	Group	*n*	Lexical comprehension Mean (*SD*)	Oral production Mean (*SD*)	Gestural production Mean (*SD*)	Oral + gestural production Mean (*SD*)	Total Mean (*SD*)
9	DS	27	58.93 (64.76)	3.33 (5.78)	12.11 (17.87)	15.33 (22.92)	89.70 (102.28)
	TD	27	39.56 (44.05)	1.93 (4.12)	6.48 (3.89)	8.37 (5.75)	56.33 (50.06)
	Total	54	49.24 (55.72)	2.63 (5.03)	9.30 (13.12)	11.85 (16.92)	73.02 (81.52)
12	DS	20	104.15 (64.14)	7.05 (11.40)	23.45 (16.52)	29.65 (26.26)	164.30 (105.25)
	TD	20	93.4 (75.85)	6.85 (6.46)	16.80 (11.18)	22.30 (14.37)	139.35 (100.41)
	Total	40	98.77 (69.54)	6.95 (9.15)	20.12 (14.32)	25.98 (21.23)	151.82 (102.32)
15	DS	23	170.52 (99.88)	17.48 (15.79)	28.17 (15.62)	42.09 (21.89)	258.26 (129.93)
	TD	23	108.26 (82.91)	14.00 (17.81)	19.35 (13.27)	30.61 (24.84)	172.22 (128.61)
	Total	46	139.39 (96.07)	15.74 (16.74)	23.76 (15.01)	36.35 (23.87)	215.24 (135.03)
18	DS	28	273.21 (119.83)	33.32 (28.02)	49.61 (25.82)	75.86 (35.74)	432.00 (177.42)
	TD	28	210.61 (72.03)	44.79 (48.02)	27.61 (23.72)	64.54 (46.83)	347.53 (153.93)
	Total	56	241.91 (102.93)	39.05 (39.38)	38.61 (26.96)	70.20 (41.67)	389.77 (169.59)
21	DS	33	306.64 (103.97)	70.00 (68.90)	50.94 (31.85)	109.12 (71.34)	536.69 (234.91)
	TD	33	302.70 (151.85)	81.00 (80.55)	31.24 (19.49)	100.61 (74.75)	515.54 (278.71)
	Total	66	304.67 (129.14)	75.50 (74.58)	41.09 (28.02)	104.86 (72.63)	526.12 (255.98)
24	DS	28	410.18 (122.29)	186.96 (155.29)	57.43 (38.51)	222.86 (147.13)	877.43 (417.40)
	TD	28	413.89 (126.98)	237.18 (141.82)	31.54 (18.31)	246.04 (134.40)	928.64 (377.69)
	Total	56	412.04 (123.53)	212.07 (149.42)	44.48 (32.61)	234.45 (140.11)	903.03 (399.25)
27	DS	27	515.22 (123.01)	382.85 (153.13)	52.96 (50.84)	397.59 (149.21)	1348.63 (434.29)
	TD	27	465.96 (133.04)	378.59 (135.06)	27.41 (24.31)	383.33 (153.57)	1255.29 (396.44)
	Total	54	490.59 (129.32)	380.72 (143.03)	40.19 (41.52)	390.46 (140.45)	1301.96 (414.54)
Total	DS	186	272.91 (182.10)	104.56 (156.77)	40.60 (34.93)	132.66 (154.26)	550.73 (489.62)
	TD	186	244.53 (185.61)	114.52 (157.33)	23.56 (19.75)	127.65 (152.88)	510.26 (483.51)
	Total	372	258.72 (184.17)	109.54 (156.92)	32.08 (29.59)	130.15 (153.38)	530.49 (486.34)

A simple effects analysis for vocabulary modalities × group (with a Bonferroni correction) revealed that the DS group differed from the TD group on lexical comprehension and gestural production. No significant differences between the DS and TD groups were found on oral production nor on oral + gestural production (see Figure 1). However, these results should be interpreted with caution given the small partial eta-squared obtained.

Regarding the vocabulary modalities × MA interaction, in all of the groups lexical comprehension was greater than any other type of productive vocabulary. Concerning the different types of productive vocabulary, we found that oral + gestural production was greater than oral production in every MA group. Oral production was greater than gestural production in the older MA groups (21–27) but no difference between oral and gestural production was observed in the younger MA groups (9–21). In the youngest MA groups (9–15) gestural production was similar to oral + gestural production, but in the remaining groups oral + gestural production was greater than gestural production. Therefore, oral and gestural production were equal in strength early on and continued that way until around 20–22 months, when oral production began to increase sharply.

The interaction vocabulary modalities × MA informs us of the trajectory of lexical development. On lexical comprehension, the 9 and 12 MA groups did not differ from each other. The 15 MA group did not differ from the 12 MA group, but it did differ from the 9 MA group. All the aforementioned groups differed from the remaining groups, which also differed from each other. These results suggest that lexical comprehension progressively increases with age. In the case of oral production, no differences were found between 9, 12, 15, and 18 MA groups. The 18 MA group did not differ from the 21 MA group, although the latter differed from the 9, 12, and 15 MA groups. All these groups differed from the remaining ones, which also differed from each other. These results suggest an early stage of gradual oral vocabulary development, followed by a strong acceleration at the age of 18–21 months. In the case of gestural production, the pattern was quite different. The 9 and 12 MA groups did not differ from each other. The 18 MA group and the remaining older groups did not differ from each other. The 15-month group did not differ either from the younger groups, or from the older ones. This pattern suggests a period of slow growth in gesture production which plateaus and then decreases slightly in the oldest age. For oral + gestural production, the pattern was somewhat more complex. Groups 9, 12, and 15 did not differ from each other. The 9-month group differed from the 18-month group. The 18-month group did

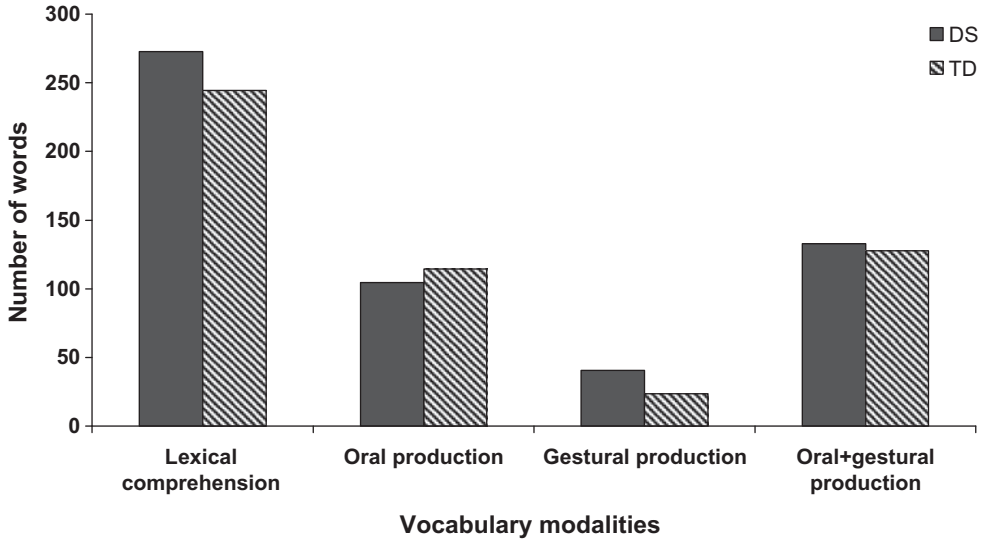

Figure 1. Total number of words in lexical comprehension, oral production, gestural production, and oral + gestural production for children with DS and TD.

not differ from the 21-month group, but the 12- and 15-month groups did. The aforementioned groups differed from the remaining groups, which also differed from each other. This sequence shows a more progressive growth, although again with an acceleration starting at the age of 18–21 months.

The lack of a significant group × MA interaction suggests that children with DS and TD children, overall, behaved similarly at each MA (see Figure 2a–d). Likewise, the lack of a significant vocabulary × group × MA interaction suggests that, at each MA, the DS group and TD group showed a similar pattern: (a) lexical comprehension was greater than oral production and gestural production at every MA; (b) levels of oral production, gestural production, and oral + gestural production were similar at the early ages, oral + gestural production pulled ahead of the others beginning at 17–19 months, and oral production pulled ahead of gestural production beginning at 20–22 months, also the time at which gestural production began to level off (even decreasing slightly at the oldest age); and (c) no differences in productive vocabulary, whether counting oral production or oral + gestural production. Also, at practically every MA, the DS group scored higher than the TD group on comprehension and gestural production.

Discussion

The results replicate those of our previous study (Galeote et al., 2008) with a sample notably greater: Significant differences were only found between children with DS and children with TD regarding gestural production whereas no significant differences were found on oral production or on oral + gestural production. Moreover, the present study also analyses lexical comprehension, a topic not covered in our previous study. Our discussion focuses on studies using parent reports, since they involve a methodology similar to that of the present study.

Developmental patterns of vocabulary modalities

The development pattern of lexical comprehension showed a linear growth and was similar in both groups of children. Nevertheless, the size of lexical comprehension vocabulary was greater in children with DS than in children with TD, not only in the general sense but practically at every MA level studied, countering our first prediction. However, this result should be interpreted with caution given that the partial eta-squared observed for the vocabulary × group interaction was very small. Nevertheless, it is an important finding considering that it is the first of its kind reported for children of the ages included in our study (Chapman, 2006, reported a larger receptive vocabulary in adolescents and young adults with DS). Our results confirm once again that receptive vocabulary is a strength in this population. Like Chapman (1995, 1997, 2006) and Roberts, Price, and Malkin (2007), we believe this strength is a result of more life experience due to greater CA.

As for productive vocabulary in oral modality, the developmental pattern was again similar in both groups of children. One of the more interesting results from the present research was the rapid acceleration in the development of oral vocabulary at around 18 and 21 months both in children with DS and TD. This is approximately the age at which a vocabulary

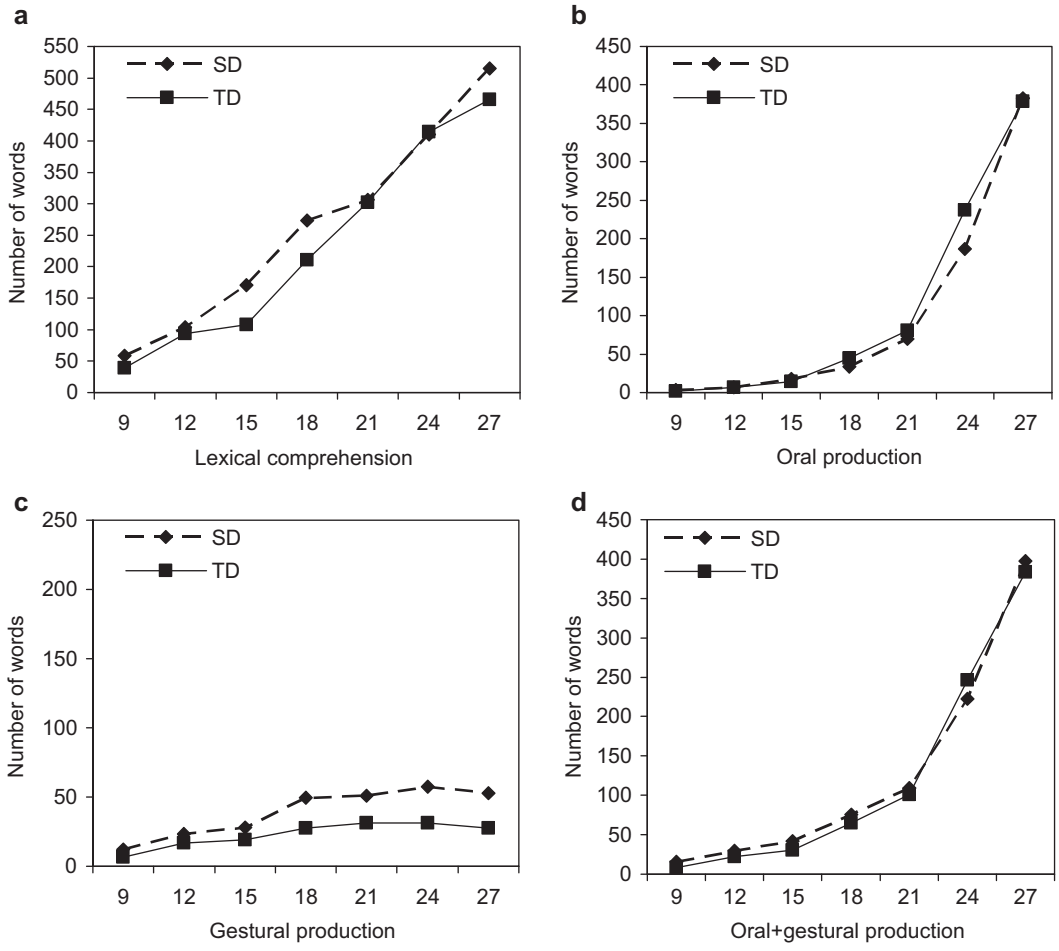

Figure 2. Number of words in (a) lexical comprehension, (b) oral production, (c) gestural production, and (d) oral + gestural production for children with DS and TD at each MA level.

explosion occurs in typical development (Benedict, 1979; Bloom, 1973; Nelson, 1973). Our predictions, based on the work of Miller (1992, 1999), have not been confirmed. Therefore, our results did not support Miller's hypothesis, given the significant vocabulary × group interaction and the lack of a significant vocabulary × group × MA interaction. Spanish children with DS and with TD of the same MA have similar vocabulary sizes in the oral modality. No significant differences in lexical production emerged after the MA of 17 months. On the other hand, these results are in line with those of Berglund et al. (2001), Caselli et al. (1998), Galeote et al. (2008), and Vicari et al. (2000), who used similar methodologies. Consequently, our results demonstrate that Spanish children with DS show no specific dissociation between cognitive and lexical development, at least at the levels of MA considered in this study. The lack of discrepancy between vocabulary production and other cognitive skills indicates that there is no general impairment in learning productive vocabulary for this group.

Based on the reported gestural production of children with DS, we had predicted that the children with DS in our study would show superiority in the production of symbolic gestures. The results supported this hypothesis and mirrored the findings of Galeote et al. (2008). Thus, we found that children with DS produced significantly more gestures than TD children. This superiority in gestural communication may be explained by the specific difficulties experienced by these children with oral language. In other words, children with DS compensate for their poor productive spoken language abilities through greater gesture production over a longer period. Poor speech intelligibility due to problems with articulation is one of the characteristics associated with DS throughout their lives (Kumin, 1994). However, it is worth noting the great similarity in the developmental pattern of gestural production for both groups of children. In this respect, children with DS produced a higher number of gestures in the early stages, when their oral vocabulary was smaller. However, their production of gestures levelled off as they acquired spoken

words and even slightly decreased at the oldest age. Importantly, a similar strategy has been observed in TD children, including the children of our sample (see Galeote et al., 2008, and Miller, 1992, for similar results). Iverson, Capirci, and Caselli (1994) and Volterra and Iverson (1995) have described changes in gestural and oral production, and have shown that the former typically decreases as the latter increases. Consequently, the strategy employed by children with DS could not be considered atypical, and their gesture and lexical development seems to proceed according to a pattern similar to that of TD children. In other words, our results seem to support a link between gesture and lexical development in children with DS. These findings support the results found by Iverson, Longobardi, and Casselli (2003) with a different measure. In that study, children with DS and TD were found to be generally similar in the size of their gestural repertoires and in their overall use of speech and gesture to communicate. Accordingly, it seems that there is no dissociation between gestural and oral production in children with DS.

Following the recommendation of Berglund et al. (2001) concerning the need to assess children's gestural vocabularies in the context of lexical development, we examined the children's oral vocabulary together with the gestures used as a substitute for oral words (oral + gestural production). This led to our prediction that differences between children with DS and children with TD will decrease when symbolic gestures are included in productive vocabulary. Because we did not find differences in oral production, this hypothesis was not supported. All we can expect based on our result is that productive vocabulary scores increased as a consequence of adding gestures. This is precisely what we found, but in both groups of children (indicated by the lack of statistically significant differences between the DS and TD groups). These results are in line with those of Galeote et al. (2008). However, they are different from those of Miller (1992), who compared the oral production of TD children with the oral + gestural production of children with DS, finding the latter to be smaller. Thus, it appears that children with DS and children with TD adopt a similar strategy of using gestures to refer to objects or events for which they lack words. Finally, the developmental pattern for oral + gestural production was similar to that found for oral production: an early stage of gradual development followed by a strong acceleration at the age of 18–21 months.

As mentioned earlier, very few studies have analysed the relationship between lexical comprehension and production. Caselli et al. (1998) and Singer Harris et al. (1997) (using the CDI) found that during the early period of lexical acquisition, the relationship between oral production and lexical comprehension for children with DS was the same as that found for TD children (although, see Roberts, Price, Barnes, et al., 2007, with a standardised test). In the present study, lexical comprehension of children with DS was larger than that of TD children, while oral production of both groups of children was similar in size. This result suggests a greater divergence between lexical comprehension and oral production in children with DS than in TD children. As mentioned earlier, this could be explained by more life experiences due to the greater chronological age of children with DS.

Some methodological issues concerning the study of vocabulary development in children

As shown above, our results are in disagreement with those of Miller (1992, 1999) although in line with those found by other researchers (Berglund et al., 2001; Caselli et al., 1998; Galeote et al., 2008; Vicari et al., 2000). The discrepancy between the aforementioned studies cannot be explained by the lexical measures they used, since all of them used the same one (CDI). This leads us to explore some other potential contributing factors. One such factor could be the existence of a bias in the sample of individuals who took part in the studies reviewed. One feature of the behavioural phenotype of individuals with DS in relation to language development is its high degree of individual variation. The use of the CDI with wide samples of children has shown that there is also a high variability among children with TD (see, for example, Bates, Dale, & Thal, 1995). Therefore, when the sample size is small, results can be distorted if some children show linguistic abilities at extreme ends of the scale. Galeote et al. (2008) suggested the need to carry out further studies with a greater number of children. The results of the present study confirmed the importance of using the largest sample size possible to observe the developmental tendencies that best characterise the group as a whole.

A second factor could be the procedure for administering the CDI. As Jackson-Maldonado, Thal, Marchman, Bates, and Gutiérrez-Clellen (1993) have demonstrated, the different ways in which inventories are administered can have a direct influence on the results. For this reason, we made every effort to refine the instructions, by making them as clear as possible and giving more examples, etc. This procedure ensured that the parents clearly understood the aim of our work and every part of the

inventory, as well as their task, and seemed to reduce the incidence of over-estimations and under-estimations, which are usually common in parental reports. Importantly, Caselli et al. (1998) and Vicari et al. (2000) used a similar procedure, and found similar results. By contrast, in the study of Miller (1999) (see also Miller et al., 1995) and Berglund et al. (2001) parents were sent the CDI by mail.

Finally, the procedure for matching the participants can also be crucial. In the studies by Miller (1992, 1999) and Miller et al. (1995), two groups of children (one with DS and the other with TD) were matched on MA and socioeconomic status. In our study, participants were matched one by one on gender and MA (the MA of each pair could not differ by more than 9 days). In addition, 75% of the children were also matched on mother's education level and/or birth order. This procedure may result in a more homogeneous sample.

Limitations and final remarks

Although our results are based on a relatively wide sample, they must nonetheless be interpreted with caution. First, although quite a wide MA range (8–29 months) has been included in this study, it is possible that group differences do not emerge until children have moved beyond the MA considered here. Second, we used a cross-sectional design. More longitudinal studies are needed in order to capture the dynamic process of change over time (Fidler, Most, & Philofsky, 2009). Third, our results are based purely on CDI measures. A recognised limitation of parental reports is that they do not give information about word frequency. Moreover, as indicated by Vicari et al. (2000), an evaluation based on structured tests and/or analysis of use in real-life contexts could reveal the existence of different profiles between children with DS and TD children. Fourth, the different types of words/gestures produced (e.g., nouns, predicates, etc.) were not considered. Had they been, the outcome could have been very different (although see Galeote, Sebastián, Casla, Rey, & Gómez, 2005). Fifth, it is also important to note the presence of strong individual differences in both groups. This result is typical in the early stages of language development. An important challenge for future research will be to identify the causes of these individual differences, given their importance in developing a true theory of language development as well as their importance for assessment and intervention. Lastly, many of the studies we reviewed in the introduction are from the 1990s, 1980s, or even earlier. Early intervention techniques have changed considerably since those times. Also, children with DS can be identified with diagnostic tests performed before birth, if not immediately after birth. As a result, children with DS are enrolled in early intervention programs soon after birth and their parents are immediately advised of the most appropriate intervention techniques. This might improve the children's lexical skills, as these skills usually receive the most clinical attention in young children. Finally, our results are limited to lexical development, which relates to cognitive development. As Rondal and Edwards (1997) pointed out, certain aspects of lexical development are conceptual by nature and can, therefore, be causally related to MA development. Very different results could have emerged with respect to morphosyntactic development. In particular, it has been postulated that syntactic production is the aspect in which children with DS show the greatest impairment (Chapman, 1995, 1997; Fowler, 1990; Miller, 1988). Many studies have suggested that the syntactic abilities of children with DS are much lower than would be predicted given their nonverbal cognition level (Fowler, 1988; Miller, 1988) or their receptive vocabulary (Chapman, Kay-Raining Bird, & Schwartz, 1990; Chapman et al., 1991).

Implications for research, assessment, and intervention

Our results seem to have clear consequences for research, methods of assessment, and intervention. With regard to research, our results highlight the importance of using large samples of participants and factoring in their mental age, whenever possible, in order to determine a given syndrome's phenotypic characteristics and developmental progression with some degree of reliability. Concerning methods of assessment, it has been discussed that slight differences in assessment procedures, even using the same measure, could produce different results. This aspect should receive particular attention in future studies. Regarding intervention, given that lexical comprehension is a major strength in the population of DS, therapists may find it effective to adapt their input language and instructions to the level of these children's receptive language: children with DS know more than they are able to say. With respect to gestures, many parents of children with DS show special concern about the use of gestures by their child, and expressly ask whether it might be detrimental to train children in gesture use given that it could impede their spoken language development. As the results of this study appear to confirm, children use gestures in accordance with a typical strategy in response to their speech difficulties, so that as their oral vocabulary expands, they progressively give up

the use of gestures. Therefore, it would probably be beneficial to explain to parents that sign instruction in the early stages of language development can help to improve initial communication and reduce frustration. Finally, it is important to keep in mind the wide variability observed across children. Given this variability, children may probably benefit from receiving a thorough language assessment, which could be used to develop an intervention plan that would reflect each child's unique strengths and weaknesses.

Author note

This research was supported by a grant from the Spanish Science and Innovation Ministry (Ministerio de Ciencia e Innovación) and by the European Regional Development Fund (Fondo Europeo de Desarrollo Regional [FEDER]; PSI2008-02748). The funding bodies have not imposed any restrictions on free access to or publication of the research data. The authors declare that they have no potential (financial or nonfinancial) conflicts of interest in the publication of this study.

Acknowledgement

We would like to express our thanks to the children and their families, and to the many therapists of Down syndrome associations and early intervention units, as well as to the staff and the people from the nurseries who participated in our research.

References

Abbeduto, L., Murphy, M. M., Cawthon, S. W., Richmond, E. K., Weissman, M. D., Karadottir, S., & O'Brien, A. (2003). Receptive language skills of adolescents and young adults with Down or fragile X syndrome. *American Journal on Mental Retardation*, *108*, 149–160. doi: 10.1352/0895-8017(2003)108<0149:RLSOAA>2.0.CO;2

Bates, E., Dale, P., & Thal, D. (1995). Individual differences and their implication for theories of language development. In P. Fletcher, & B. MacWhinney (Eds.), *The handbook of child language* (pp. 96–151). Oxford, UK: Blackwell.

Benedict, H. (1979). Early lexical development: Comprehension and production. *Journal of Child Language*, *6*, 183–200. doi: 10.1017/S0305000900002245

Berglund, E., Eriksson, M., & Johansson, I. (2001). Parental reports of spoken language skills in children with Down syndrome. *Journal of Speech, Language, and Hearing Research*, *44*, 179–191. doi: 10.1044/1092-4388(2001/016)

Bloom, L. (1973). *One word at a time: The use of single-word utterances before syntax*. The Hague, Netherlands: Muton.

Byrne, A., Buckley, S., MacDonald, J., & Bird, G. (1995). Investigating the literacy, language and memory skills of children with Down syndrome. *Down Syndrome Research & Practice*, *3*, 53–58. doi: 10.3104/reports.51

Cardoso-Martins, C., Mervis, C. B., & Mervis, C. A. (1985). Early vocabulary acquisition by children with Down syndrome. *American Journal on Mental Deficiency*, *90*, 177–184.

Caselli, M. C., Bates, E., Casadio, P., Fenson, J., Fenson, L., Sanderl, L., & Weir, J. (1995). A cross-linguistic study of early lexical development. *Cognitive Development*, *10*, 159–199. doi: 10.1016/0885-2014(95)90008-X

Caselli, M. C., & Casadio, P. (1995). *Il primo vocabolario del bambino* [Children's first words]. Milán, Italy: Franco Angeli.

Caselli, M. C., Vicari, S., Longobardi, E., Lami, L., Pizzoli, C., & Stella, G. (1998). Gestures and words in early development of children with Down syndrome. *Journal of Speech, Language, and Hearing Research*, *41*, 1125–1135.

Chan, J. B., & Iacono, T. (2001). Gesture and word production in children with Down syndrome. *Augmentative and Alternative Communication*, *17*, 73–87.

Chapman, R. S. (1995). Language development in children and adolescents with Down syndrome. In P. Fletcher, & B. MacWhinney (Eds.), *The handbook of child language* (pp. 641–663). Oxford, UK: Blackwell.

Chapman, R. S. (1997). Language development in children and adolescents with Down syndrome. *Mental Retardation and Developmental Disabilities Research Reviews*, *3*, 307–312. doi: 10.1002/(SICI)1098-2779(1997)3:4<307::AID-MRDD5>3.0.CO;2-K

Chapman, R. S. (2006). Language learning in Down syndrome: The speech and language profile compared to adolescents with cognitive impairment of unknown origin. *Down Syndrome Research & Practice*, *10*, 61–66.

Chapman, R. S., Kay-Raining Bird, E., & Schwartz, S. E. (1990). Fast mapping of words in event contexts by children with Down syndrome. *Journal of Speech and Hearing Disorders*, *55*, 761–770.

Chapman, R. S., Schwartz, S. E., & Kay-Raining Bird, E. (1991). Language skills of children and adolescents with Down syndrome: I. Comprehension. *Journal of Speech and Hearing Research*, *34*, 1106–1120.

Chapman, R. S., Seung, H.-K., Schwartz, S. E., & Kay-Raining Bird, E. (1998). Language skills of children and adolescents with Down syndrome: II. Production deficits. *Journal of Speech, Language, and Hearing Research*, *41*, 861–873.

Fabbretti, D., Pizzuto, E., Vicari, S., & Volterra, V. (1997). A story description task in children with Down's syndrome: Lexical and morphosyntactic abilities. *Journal of Intellectual Disability Research*, *41*, 165–179. doi:10.1111/j.1365-2788.1997.tb00693.x

Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P., … Reilly, J. S. (1993). *The MacArthur Communicative Development Inventories: User's guide and technical manual*. San Diego, CA: Singular Publishing Group.

Fidler, D. J., Most, D. E., & Philofsky, A. D. (2009). The Down syndrome behavioural phenotype: Taking a developmental approach. *Down Syndrome Research & Practice*, *12*(3), 37–44.

Fowler, A. (1988). Determinants of rate of language growth in children with Down syndrome. In L. Nadel (Ed.), *The psychobiology of Down syndrome* (pp. 217–245). Cambridge, MA: MIT Press.

Fowler, A. E. (1990). Language abilities in children with Down syndrome: Evidence for specific syntactic delay. In D. Cicchetti, & M. Beeghly (Eds.), *Children with Down syndrome: A developmental perspective* (pp. 302–328). Cambridge, UK: Cambridge University Press. doi: 10.1017/CBO9780511581786.010

Fowler, A. E., Gelman, R., & Gleitman, L. R. (1994). The course of language learning in children with Down syndrome: Longitudinal and language level comparisons with young normally

developing children. In H. Tager-Flusberg (Ed.), *Constraints on language acquisition: Studies of atypical children* (pp. 91–140). Hillsdale, NJ: Erlbaum.

Galeote, M., Casla, M., Soto, P., Sebastián, E., & Rey, R. (2005, July). *Adaptations of MacArthur CDI for the study of language development in children with Down syndrome:Validity and reliability*. Paper presented at the X International Congress for the Study of Child Language, Berlin, Germany.

Galeote, M., Sebastián, E., Casla, M., Rey, R., & Gómez, A. (2005, August). *The composition of early vocabulary in children with Down syndrome*. Paper presented at the XIIth European Conference on Developmental Psychology, La Laguna, Tenerife, Spain.

Galeote, M., Soto, P., Checa, E., Gómez, A., & Lamela, E. (2008). The acquisition of productive vocabulary in Spanish children with Down syndrome. *Journal of Intellectual & Developmental Disability*, *33*, 292–302. doi: 10.1080/13668250802441870

Galeote, M., Soto, P., Lamela, E., Checa, E., Pulido, L., & Rey, R. (2006). Adaptación de los Inventarios de Desarrollo Comunicativo MacArthur-Bates para el estudio del desarrollo del lenguaje en niños con síndrome de Down [Adaptation of MacArthur-Bates CDI for the study of language development in children with Down syndrome]. *Revista de Atención Temprana*, *9*, 4–16.

Galeote, M., Soto, P., Serrano, A., Pulido, L., Rey, R., & Martínez-Roa, P. (2006). Un nuevo instrumento para evaluar el desarrollo comunicativo y lingüístico de niños con síndrome de Down [A new instrument for assessment of the communicative and linguistic development in children with Down syndrome]. *Revista Síndrome de Down*, *23*, *1* (88), 20–26.

Iverson, J. M., Capirci, O., & Caselli, M. C. (1994). From communication to language in two modalities. *Cognitive Development*, *9*, 23–43. doi: 10.1016/0885-2014(94)90018-3

Iverson, J. M., Longobardi, E., & Casselli, M. C. (2003). Relationship between gestures and words in children with Down's syndrome and typically developing children in the early stages of communicative development. *International Journal of Language & Communication Disorders*, *38*, 179–197. doi: 10.1080/1368282031000062891

Jackson-Maldonado, D., Thal, D., Marchman, V., Bates, E., & Gutiérrez-Clellen, V. (1993). Early lexical development in Spanish-speaking infants and toddlers. *Journal of Child Language*, *20*, 523–549. doi:10.1017/S0305000900008461

Josse, D. (1997). *Escala de desarrollo psicomotor de la primera infancia Brunet-Lézine-Revisado* [Brunet–Lézine Psychomotor Development Scale-Revised (Spanish edition)]. Madrid, Spain: Psymtéc.

Kumin, L. (1994). Intelligibility of speech in children with Down syndrome in natural settings: Parents' perspective. *Perceptual and Motor Skills*, *78*, 307–313.

Laws, G., & Bishop, D. V. M. (2003). A comparison of language abilities in adolescents with Down syndrome and children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, *46*, 1324–1339. doi:10.1044/1092-4388(2003/103)

Mervis, C. B., & Becerra, A. M. (2003). Lexical development and intervention. In J. A. Rondal & S. Buckley (Eds.), *Speech and language intervention in Down syndrome* (pp. 63–85). London, England: Whurr.

Miller, J. F. (1988). The developmental asynchrony of language development in children with Down syndrome. In L. Nadel (Ed.), *The psychobiology of Down syndrome* (pp. 167–198). Cambridge, MA: MIT Press.

Miller, J. F. (1992). Development of speech and language in children with Down syndrome. In I. T. Lott & E. E. McLoy (Eds.), *Clinical care for persons with Down syndrome* (pp. 39–50). New York, NY: Academic Press.

Miller, J. F. (1999). Profiles on language development in children with Down syndrome. In J. F. Miller, M. Leddy, & L. A. Leavitt (Eds.), *Improving communication of people with Down syndrome* (pp. 11–39). Baltimore, MD: Brookes.

Miller, J., Sedey, A., & Miolo, G. (1995). Validity of parent report measures of vocabulary development for children with Down syndrome. *Journal of Speech and Hearing Research*, *38*, 1037–1044.

Nelson, K. (1973). Structure and strategy in learning to talk. *Monographs of the Society for Research in Child Development*, *38* (1–2, Serial No. 149).

Price, J., Roberts, J., Vandergrift, N., & Martin, G. (2007). Language comprehension in boys with fragile X syndrome and boys with Down syndrome. *Journal of Intellectual Disabilities Research*, *51*, 318–326. doi:10.1111/j.1365-2788.2006.00881.x

Roberts, J., Price, J., Barnes, E., Nelson, L., Burchinal, M., Hennon, E. A., … Hooper, S. R. (2007). Receptive vocabulary, expressive vocabulary, and speech production of boys with fragile X syndrome in comparison to boys with Down syndrome. *American Journal on Mental Retardation*, *112*, 177–193. doi: 10.1352/0895-8017(2007)112[177:RVEVAS]2.0.CO;2

Roberts, J. E., Price, J., & Malkin, C. (2007). Language and communication development in Down syndrome. *Mental Retardation and Developmental Disabilities Research Reviews*, *13*, 26–35. doi: 10.1002/mrdd.20136

Rondal, J. A., & Edwards, S. (1997). *Language in mental retardation*. London, England: Whurr.

Singer Harris, N. G., Bellugi, U., Bates, E., Jones, W., & Rossen, M. (1997). Contrasting profiles of language in children with Williams and Down syndromes. *Developmental Neuropsychology*, *13*, 345–370. doi: 10.1080/87565649709540683

Vicari, S., Caselli, M. C., & Tonucci, F. (2000). Asynchrony of lexical and morphosyntactic development in children with Down syndrome. *Neuropsychologia*, *38*, 634–644. doi: 10.1016/S0028-3932(99)00110-4

Volterra, V., & Iverson, J. (1995). When do modality factors affect the course of language acquisition? In K. Emmorey, & J. S. Reilly (Eds.), *Language, gesture and space* (pp. 371–390). Hillsdale, NJ: Erlbaum.

Yoder, P. J., & Warren, S. F. (2004). Early predictors of language in children with and without Down syndrome. *American Journal on Mental Retardation*, *109*, 285–300. doi: 10.1352/0895-8017(2004)109<285:EPOLIC>2.0.CO;2

Ypsilanti, A., Grouios, G., Alevriadou, A., & Tsapkini, K. (2005). Expressive and receptive vocabulary in children with Williams and Down syndromes. *Journal of Intellectual Disability Research*, *49*, 353–364. doi: 10.1111/j.1365-2788.2005.00654.x