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Does the Development of Syntax Comprehension Show a Premature Asymptote Among Persons With Down Syndrome? a Cross-Sectional Analysis

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<1>Abstract

Uncertainty persists regarding the post-childhood trajectory of syntactic acquisition of persons with Down syndrome (DS). In some studies, asymptote is reached in the early teens, whereas others find syntax continuing to develop at least into early adulthood. This study addressed the issue using a cross-sectional approach. Receptive syntax and vocabulary were tested in 62 children, adolescents and young adults with DS matched on chronological age and cognitive level with 62 participants with intellectual disability (ID) of undifferentiated etiology. On both tests there were significant effects of chronological age and diagnosis, but the chronological age × diagnosis interactions were nonsignificant. We concluded that comprehension of vocabulary *and* syntax does not asymptote prematurely in individuals with DS relative to those with other forms of ID.

Key Words: *intellectual disability; Down syndrome; syntax comprehension; receptive vocabulary; developmental trajectory; critical period; premature asymptote*

Persons with Down syndrome (DS) are known to have significant weaknesses with language acquisition. Although the sequences and patterns of their language development are generally comparable to those observed in the typical child (e.g., Berglund, Eriksson, & Johanson, 2001; Facon & Magis, 2016; Facon, Magis, & Courbois, 2012; Facon, Nuchadee, & Bollengier, 2012; Hart, 1996; Loveall, Channell, Philipps, Abbeduto, & Conners, 2016; Polišenská & Kapalková, 2014; Scarborough, Rescorla, Tager-Flusberg, Fowler, & Sudhalter, 1991; Tager-Flusberg, Calkins, Nolin, & Baumberger, 1990), numerous studies have shown that language development in DS is particularly slow and plateaus at a very low level in adulthood (e.g., Berglund et al., 2001; Fowler, 1988; Fowler, Gelman, & Gleitman, 1994). The morphosyntactic component of their language development is particularly affected, whether in comprehension or expression. Indeed, at virtually every stage of development, their grammatical abilities fall well below their nonlinguistic abilities. In fact, this is probably the most pronounced language weakness of individuals with DS (Abbeduto, Warren, & Conners, 2007; Martin, Klusek, Estigarribia, & Roberts, 2009; Roberts, Price, & Malkin, 2007; Ypsilanti & Grouios, 2008).

Uncertainty persists regarding the evolution of syntactic acquisition beyond childhood. We know that, ultimately, language development of persons with DS does not reach typical adult levels (Rondal & Edwards, 1997). However, it is still unclear as to *when* it reaches its asymptote.

Do language learning in general and syntax acquisition in particular continue during or even beyond early adulthood? Do they asymptote early in adolescence? If the latter, no progress would occur beyond 12-14 years. These questions originate from the critical period hypothesis widely popularized by Lenneberg (1967), who stated that language learning stagnates at puberty because of maturational constraints linked to changes in neuroplasticity. Beyond adolescence, the acquisitions would be far more difficult, especially in the morphosyntactic component of language. Although he has no solid empirical underpinnings relating to children and adolescents with DS, his prediction about them is clear and definite:

> In virtually all [...] cases, language development comes to a complete standstill in the early teens, so that these individuals are arrested in primitive stages of language development that are perpetuated for the rest of their lives. Training and motivation are of little help (Lenneberg, 1969, p. 640).

On the basis of a literature review, Rondal and Comblain (1996, 2002, see also Rondal, 2010) concluded that there are arguments in favor of a critical period ending at age 12-14 years for the phonological and morphosyntactic components of language development of persons with DS. The semantic and pragmatic components would be less affected and, therefore, could lead to slow but real progress, potentially up to 30-40 years of age. However, a closer look at individual studies often reveals conflicting results, such as in the following examples. In Fowler's (1988) longitudinal study (see also Fowler et al., 1994), the mean length of utterance and the index of productive syntax were computed on utterances of 10 children with DS from 4 to 13 years of age who were visited every 6 months for 4 to 7 years. Results showed syntactic development leveling off as early as 8 years of age, as though syntactic abilities of persons with DS had plateaued at a level corresponding to that of 3- to 4-year-old typically developing children.

In another longitudinal study, Chapman, Hesketh, and Kistler (2002, see also Chapman, Seung, Schwartz, & Kay-Raining Bird, 1998) examined the development of receptive and productive syntax of 31 participants with DS 5 to 20 years old at the start of the study. Their syntactic level was evaluated four times over a 6-year period using the Test of Auditory Comprehension of Language-Revised (TACL-R, Carrow-Woolfolk, 1985), and the mean length of spontaneous utterances was obtained in 12-minute narrative tasks. Results showed a steady increase with chronological age in the average length of verbal productions suggesting an increase of syntactic abilities even *beyond* adolescence. In contrast, a decline of syntax comprehension was observed between adolescence and adulthood and only a shallower increase between 12 to 18 years. However, this result is not confirmed by Laws and Gunn (2004), who noted a significant increase of scores on the Test for Reception of Grammar (TROG, Bishop, 1983) between 11 to 16 years among their participants with DS.

Cross-sectional comparisons between children, adolescents, and adults with DS conducted by Rondal and Comblain (1996) gave still different results. Receptive skills were measured using two standardized tests, one of vocabulary, the other of morphosyntax (personal pronouns, definite and indefinite articles, verbal inflexions, coordinate clauses, subordinate clauses, relative clauses, negative and passive sentences). The authors assessed productive language skills using a standardized test of productive vocabulary and the mean length of utterance obtained from free play or conversational speech. To summarize, results indicated stable performance for nearly all receptive and productive measures between adolescence and adulthood. Between childhood and adolescence, the results were more complex. The differences were nonsignificant (indicating a lack of progress) for the level of productive vocabulary and the comprehension of personal pronouns, articles, verbal inflections, subordinate clauses, and passive sentences. However, progress was observed for mean length of utterance, receptive vocabulary, and comprehension of coordinate clauses, relative clauses, and negative sentences.

These conflicting results could reflect methodological differences among the studies. For example, mean length of utterance was computed in a narrative context by Chapman et al.

(2002), while it was estimated in a conversational setting in the Fowler (1988) and Fowler et al. (1994) studies. And it turns out that the narrative context promotes utterances of greater complexity (Abbeduto et al., 2007). Similarly, receptive syntax was evaluated with different tests in the Laws and Gunn (2004) and Chapman et al. (2002) studies. Other methodological factors are probably also involved, as in Rondal and Comblain’s (1996) study in which cognitive level was not very well controlled and the samples were very small (11 to 16 participants per age group). Finally, no control groups of persons with intellectual disability (ID) without DS have been included in these studies. Consequently, no conclusions can be drawn regarding possible developmental specificities among persons with DS.

Overall, it is therefore not yet possible to draw a clear picture of the developmental trajectory of syntactic skills of persons with DS nor, in particular, to specify the period when they reach their asymptote. The present work addressed this issue using a cross-sectional developmental approach focused on the development of receptive language about which, as noted above, conflicting results persist. Beyond a better knowledge of language development of persons with DS, the objective was to help to stir a debate whose educational implications are important. Indeed, if one takes for granted Lenneberg's (1969) position and some of the above-mentioned studies' results, there are no strong reasons either to continue language education beyond childhood or to maintain, among the parents, the hope of a possible growth of language abilities.

However, if progress is observed during adolescence or even in early adulthood, this pessimistic view will no longer be tenable.

<1>Present Study

A test of receptive syntax and one of receptive vocabulary were administered to children, adolescents and young adults with DS who were matched on chronological age and on a measure of nonverbal cognitive development with participants with ID of undifferentiated etiology. Syntax and vocabulary test scores were regressed on chronological age and the slopes of regression lines of the two groups were compared. If a premature asymptote occurs for participants with DS, their regression lines should exhibit an inflection point earlier than those observed for participants with undifferentiated etiology. However, it is also possible that the slope of their regression lines is zero. In either case, one might well conclude that participants with DS *specifically* present a premature arrest of language development. Conversely, if the relationship between chronological age and syntax or vocabulary comprehension is similar for the two groups, the hypothesis of a *specific* developmental trajectory of language acquisition of persons with DS would be seriously questioned.

The comparison of participants with DS vs. undifferentiated etiology while holding ID constant will allow separation of the effect of trisomy 21 from that of ID on chronological age-related changes of test scores. Indeed, with only one group of participants with DS, both ID and specific genetic etiology could be invoked to explain the results (see, Dykens, Hodapp, & Finucane, 2000; Fidler, Daunhauer, Will, Gerlach-McDonald, & Schworer, 2016; Yoder & Warren, 2004). However, contrary to a very widespread usage in the ID field, no control-group of typically developing participants was formed. Indeed, although this practice is essential in most cases, the objective of the present study was to examine the relationship between chronological age and receptive language of children, adolescents, and young adults with ID. Thus, the addition of a group of typically developing participants

matched both on chronological age *and* a measure of nonverbal cognitive development with our participants with ID was technically unfeasible given the target age ranges of the tests used, the mean chronological age (nearly 15 years) and the mean nonverbal intelligence level (approximately 5 years) of participants with DS and undifferentiated etiology included in the study (see below).

Contrary to several above-mentioned studies exclusively focused on syntax, a measure of lexical development was also included to check whether the issue of premature asymptote concerned only the syntactic component of language development. According to the conclusions of the literature review by Rondal and Comblain (1996, 2002), no inflection point should be observed for the lexical development of either group.

<1>Method

<2>Participants

There were two groups of participants diagnosed as having ID who, according to their age, were enrolled in special education schools for youngsters with mild to severe ID by the Commission Départementale d'Education Spéciale (Departmental Committee for Special Education) or the Commission des Droits et de l'Autonomie des Personnes Handicapées (Committee on the Rights and Autonomy of Persons with Disabilities). All were from French-speaking families. The first group included 62 children, adolescents, and young adults (25 males and 37 females) diagnosed as having DS (trisomy 21) matched on chronological age and nonverbal cognitive level with a group of 62 participants with undifferentiated etiology (36 males and 26 females). This group was composed of persons with ID of unknown origin and of persons with ID of various causes (e.g., genetic syndromes [except DS], fetal alcohol syndrome, pre or perinatal brain injuries, infectious disease, and epilepsy).

The younger participants (up to the age of 14) attended specialized schools called Instituts Médico-Pédagogiques, which offer a curriculum aimed to promote the development of personal independence, socialization, communication, physical skills and, if appropriate, school subjects. The older participants attended specialized schools called Instituts Médico-Professionnels or

Section d'Initiation et de Première Formation Professionnelle. These schools aimed to reinforce previous achievements while providing basic vocational training.

Participants were tested as part of a larger study on language development of persons with ID supported by the French National Research Agency and approved by the Ethics Committee of the Cognitive and Affective Sciences Laboratory (SCALab, University of Lille).

<2>Instruments

<3>Test for reception of grammar. The French version of the Test for Reception of Grammar (F-TROG, Lecocq, 1996) was individually administered with no time limits by master’s students in developmental psychology or by contract psychologists trained in psychometrics. Testing sessions were conducted individually in quiet rooms situated near participants’ classrooms or workshops. The F-TROG comprises 92 items intended to assess syntax comprehension among children aged 4 to 12 years. For each item, the participant must select from among 4 drawings presented on a single page the one corresponding to a sentence spoken by the examiner. Like the English versions (Bishop, 1983, 2003), the F-TROG evaluates comprehension of various linguistic constructions (e.g., negative sentences, simple sentences with prepositions, reversible active sentences, simple sentences with singular or plural articles, reversible passive sentences, and embedded sentences). A recent study using the F-TROG with typically developing participants and those with undifferentiated etiology or DS yielded Cronbach’s alphas = .792, .804 and

.809, respectively. It also showed that the rank order of item difficulty was remarkably similar for participants with and without ID (Facon & Magis, 2016). All participants received all 92 items.

<3>Raven's Colored Progressive Matrices. The 36 items of Raven's Colored Progressive Matrices (RAVEN, Raven, Court, & Raven, 1998) were administered to all participants to obtain an estimate of their nonverbal cognitive level. This test was chosen because of its simplicity and speed of administration and scoring, its reliability, and the great similarity of item response profiles to which it gives rise for participants with and without ID (Facon, Magis, Nuchadee, & DeBoeck, 2011; Facon & Nuchadee, 2010; Van Herwegen, Farran, & Annaz, 2011).

<3>Echelle de Vocabulaire en Images Peabody. The Echelle de Vocabulaire en Images Peabody (EVIP, Form B, Dunn, Thériault-Whalen, & Dunn, 1993 — the French version of the PPVT) was used to assess the participants' receptive lexical knowledge. For each item of the EVIP, the participant must select from among four pictures presented on a single page the one corresponding to a word spoken by the examiner. The test covers the age range 2½ to 18 years. It comprises 170 items belonging to different categories such as nouns, verbs or adjectives, root and inflected words, concrete vs. verbally defined words, or basic, superordinate, or subordinate nouns. Given the average developmental level of our participants (approximately 5 years), only the first 140 items were actually used, and those 140 were given to all participants. This test was used in a recent study conducted with participants with and without ID. Cronbach's alphas approached .90, and the rank order difficulty of items was very similar across the two types of participants (Facon, Nuchadee, & Bollengier, 2012).

<2>Statistical analyses

Separate hierarchical regression analyses were performed on EVIP and F-TROG to estimate the contributions of chronological age, diagnostic status (undifferentiated etiology vs. DS) and the chronological age × status interaction. Chronological age was entered first in the regression equations. The status variable, coded 0 and 1 for participants with undifferentiated etiology and those with DS, respectively, was then entered followed by the interaction term (chronological age × status). A main effect of diagnostic status would indicate an overall performance difference between the two groups for the age-span considered. On the other hand, a significant interaction would indicate a between-groups difference in slope and, thus, a difference in rate of syntax or vocabulary comprehension development. Since the purpose of the study was to examine the absolute differences in developmental trajectories of the two groups of participants, data analyses were conducted using only raw scores.

In a multiple regression analysis, the first preliminary step is to ensure that the relationship between the dependent and independent variables is linear. This verification was essential in the present context given the possibility of a premature asymptote and, thus, of a curvilinear relationship between chronological age and F-TROG and/or chronological age and EVIP.

It was done by comparing adjusted squared multiple correlation coefficients ($R^2_{adj.}$) obtained using linear and quadratic equations (Cohen, Cohen, West, & Aiken, 2003).

<2>Results

Descriptive statistics for chronological age, RAVEN, EVIP and F-TROG are given in Table 1. Because of the matching procedure, the group mean differences for chronological age and RAVEN of the two groups were nonsignificant ($t_{2\text{-}tailed}$ = 0.189, *df* = 122, *p* = .851 for chronological age; $t_{2\text{-}tailed}$ = -0.060, *df* = 122, *p* = .952 for RAVEN), as were the Levene tests for homogeneity of variance ($F_{(1,122)}$ = 0.689, *p* = .408 for CA, $F_{(1,122)}$ = 0.002, *p* = .968 for RAVEN). The correlation between chronological age and Raven was also nonsignificant for both groups (*r* = .069, *p* = .592 and *r* = .178, *p* = .166 for participants with undifferentiated etiology and DS, respectively). Consequently, if between-group differences in developmental trajectories were observed for receptive syntax and/or vocabulary, the distributions of nonverbal intelligence scores and chronological ages of each group could not be invoked as potentially confounding factors (Facon, Magis, & Belmont, 2011).

Comparisons between $R^2_{adj.}$ coefficients obtained using linear and quadratic equations showed that for neither EVIP nor F-TROG did the quadratic term significantly improve predictability over that obtained using the linear term alone. In fact, $R^2_{adj.}$ coefficients were lower if anything in the quadratic than in the linear models ($R^2_{adj.\ linear}$ = .179 and $R^2_{adj.\ quadratic}$ = .169 for

EVIP; $R^2_{adj.\ linear}$ = .053 and $R^2_{adj.\ quadratic}$ = .041 for F-TROG). Analyses of the residuals revealed an EVIP outlier (standardized residual > 3). The EVIP regression analyses were therefore rerun while excluding the outlier, but the differential of $R^2_{adj.}$ coefficients between the two models was of the same order as previously ($R^2_{adj.\ linear}$ = .195 and $R^2_{adj.\ quadratic}$ = .193).

The same comparisons were conducted for the group of participants with undifferentiated etiology and gave similar results ($R^2_{adj.\ linear}$ = .167 and $R^2_{adj.\ quadratic}$ = .154 for EVIP; $R^2_{adj.\ linear}$ = .020 and $R^2_{adj.\ quadratic}$ = .019 for F-TROG). Therefore, subsequent statistical analyses were conducted within a linear framework.

The main results of the regression analyses of EVIP and F-TROG are presented in Table 2, and the corresponding bivariate plots in Figure 1. In the figure, raw scores were standardized to *z* scores based on the combined group's mean and standard deviation (SD) to facilitate the visual analysis of performances of each group of participants on the two tests. Analyses of the residuals revealed an EVIP outlier (standardized residual > 3). Consequently, the EVIP analysis was rerun while excluding this observation. Although no notable change in the model parameters was observed in this second analysis, we chose to exclude this outlier from all subsequent analyses of EVIP.

<INSERT TABLE 1 HERE>

<INSERT TABLE 2 HERE>

Results in Table 2 indicate that chronological age was significantly related to both vocabulary and syntax comprehension with a larger effect for vocabulary (R^2 = .155) than for syntax (R^2 = .038). Diagnostic status also had a significant effect on both dependent variables. The increase of R^2 was .12 for vocabulary and .198 for syntax. For both measures, participants with undifferentiated etiology performed better than those with DS as is clear in the two bivariate distributions displayed in Figure 1.

For vocabulary, as for syntax, the introduction of the interaction term in the regression equation did not significantly increase the variance accounted for. Indeed, the increase of R^2 is only .002 for vocabulary and .0002 for the syntax. Thus, the strength of the relationship between chronological age and lexical or syntactic knowledge is the same for the two groups, as is well illustrated by the parallelism of the regression lines (Figure 1).

As can be seen in Table 2 and Figure 1, the strength of the relationship between chronological age and vocabulary appears greater than that for chronological age and syntax. To statistically test this difference, we compared the correlation coefficient between chronological age and vocabulary (r = .393, N = 123, p < .001) with that between chronological age and syntax (r = .177, N = 123, p < .001). Given the strong correlation between the scores on the two tests (r = .741, N = 123, p < .001), we used the Steiger (1980) test for comparing dependent correlations implemented in the *cocor* R package (Diedenhofen &

Musch, 2015). The comparison showed a significant difference between the two correlations (z = 3.470, N = 123, p = .0005). Consequently, one may conclude that the relationship between chronological age and test scores is indeed greater for vocabulary than for syntax. Note that this result cannot be attributed to the correlation between chronological age and group status since the latter is practically zero (r_{pb} = -.008, N = 123, p = .958) given the matching of groups on chronological age. We then compared the point-biserial correlation between group status and test scores on vocabulary (r_{pb} = -.350, N = 123, p < .001) and syntax (r_{pb} = -.442, N = 123, p < .001). This time, however, the Steiger (1980) test returned a nonsignificant result (z = 1.546, N = 123, p = .122).

<INSERT FIGURE 1 HERE>

<2>Discussion

The aim of this study was to compare the developmental trajectories of vocabulary and syntax comprehension of participants with DS or undifferentiated etiology in order to know whether a premature asymptote arises for participants with DS. Although the chronological effect size was small for syntax and moderate for vocabulary (4% and 15% of the explained variance, respectively), results showed a linear increase of test scores between childhood and adulthood for participants with undifferentiated etiology and those with DS. Moreover, the absence of an interaction between chronological age and diagnostic status indicated that the rate of receptive language development was similar for the two groups. The results also showed that the relationship between chronological age and test scores was significantly stronger for vocabulary than for syntax and that participants with undifferentiated etiology performed better than participants with DS, whatever the test. However, the two groups' performance differential on the two tests was not statistically significant.

The nonsignificant chronological age × diagnostic status interaction as well as the lack of a significant quadratic component in the relationship between chronological age and test scores challenge the idea of a premature asymptote of language development of people with DS, and of their syntactic acquisition in particular. This contradicts Lenneberg's (1967) and Fowler's (1988) positions on this crucial aspect of language learning and calls into question Lenneberg's (1969) pessimistic predictions about the relevance of language interventions for people with DS beyond the early teens. Our results also contradict those of Chapman et al. (2002) which showed that syntax comprehension decreases during late adolescence among participants with DS. This discrepancy may be due to difference between study designs (cross-sectional in our study, longitudinal in that of Chapman et al. [2002]). The type of test used in the two studies is perhaps also involved. Chapman et al. (2002) relied on the TACL-R (Carrow-Woolfolk, 1985) while we used the F-TROG. Thus, it is possible that the difference in outcomes resulted at least in part from differences in the measures' contents or their psychometric properties. It must be noted, in this regard, that our results have now been nicely confirmed by a new cross-sectional study of German participants with DS that shows improvements in their TROG scores between childhood and late adolescence (Witecy & Penke, 2017).

The notion of a critical period must be relativized in view of data collected in the years since its first formulation by Penfield and Roberts (1959) and its subsequent elaboration by Lenneberg (1967). Indeed, it is now accepted that the age span of optimal language acquisition is far more extended than previously supposed and that the expected sharp drop-off in performance beyond the "critical" window of learning is more the exception than the rule (Hakuta, Bialystok, & Wiley, 2003). Thus, one does better to speak of an "optimal" or "sensitive" period rather than a "critical" period (Morgan, 2014; Newport, 2006; Werker & Tees, 2005). A distinction must also be made between the phonological and syntactic aspects of language development on the one hand, and its semantic and pragmatic aspects on the other. Indeed, the notion of an optimal period seems far more relevant for the phonological and syntactic components of language development than it is for the two other components (Kuhl, 2010; Rondal, 2010; Stevens & Neville, 2009). The present results are in line with these changes of perspective on the notion of a critical period. On the one hand, continuous progress between childhood and adulthood is observed for both vocabulary and syntax for both groups of participants. This supports the idea of a relatively extended window for language development and a lack of sharp drop-off in language learning rates, even with regard to syntax. On the other hand, the results corroborate the distinction made between syntactic and semantic-lexical aspects of language development by showing, for the two groups of participants, a less pronounced relationship between age and syntax than between age and vocabulary. As a matter of fact, these differences of developmental trajectories are consistent with the notion of different processes underlying these two aspects of language.

The lower performances of participants with DS on both vocabulary and syntax confirm previous work showing that language development is a recognized weakness among persons with DS, especially its syntactical component (e.g., Abbeduto et al., 2007; Chapman & Kay-Raining Bird, 2012; Roberts et al., 2007). What causes this weakness? Although research is still needed to establish with certainty the causal relationships, it is probably the result of multiple difficulties such as sleep disorders (Edgin, Clark, Massand, & Karmiloff-Smith, 2015), auditory impairment (Chapman, 2006), incomplete automatization of speech-related processes (Silverman, 2007) and weaknesses in attention (Borella, Carretti, & Lanfranchi, 2013; Brown et al., 2003), verbal short-term/working memory (e.g., Chapman & Hekseth, 2001; Chapman & Kay Raining Bird, 2012; Jarrold & Brock, 2012; Lee, Maiman, & Godfrey, 2016) or explicit verbal long-term memory (Vicari, 2012; Vicari, Costanzo, & Menghini, 2016). These weaknesses, especially those related to memory, are also observed in other groups of persons with ID (Lee et al., 2016). However, they are particularly pronounced among those with DS (Conners, Moore, Loveall, & Merrill, 2011; Nichols et al., 2004) and, consequently, possibly explain why their performance in syntax and vocabulary are lower than those of participants with undifferentiated etiology (see, McDuffie, Thurman, Channell, & Abbeduto, 2017). This interpretation is reinforced by the greater effect of clinical status on syntax than on vocabulary. Although not statistically significant (p = .122), this small differential effect is possibly related to the fact that syntax comprehension is strongly constrained by cognitive abilities such as verbal short-term/working memory (Chapman et al., 2002; Laws & Bishop, 2004; Laws & Gunn, 2004; Miolo, Chapman, & Sindberg, 2005; Montgomery, Gillam, & Evans, 2015; Montgomery, Magimairaj, & Finney, 2010). Indeed, children with poor verbal short-term/working memory skills encounter difficulties in understanding complex and even simple sentences, which impedes the leaning of syntactic structures. This necessarily results in lower performance on receptive syntax tests.

The present study, as well as that of Witecy and Penke (2017), focused only on receptive tests. As such, they cannot be considered as definitive. Studies using expressive language tests are needed to determine whether or not persons with DS have a premature asymptote of their productive language. Indeed, the literature on this question is still very much up in the air because of the use of the studies' disparate measures of expressive language (see, Abbeduto et al., 2007).

A second limitation of this study, especially from the standpoint of generalization, was that it concerned only participants with undifferentiated etiology or DS. Thus, it would make sense to follow up by conducting comparable analyses with other etiological groups (e.g., Williams or Fragile X [FX] syndromes) in order to determine whether or not the present results hold regardless of the origin of ID. In this respect, some researchers have reported a decrease in IQ over time in children with FX syndrome (e.g., Dykens et al., 1989), a result related to the negatively accelerating annual growth of their intellectual skills during childhood (Hall, Burns, Lightbody, & Reiss, 2008). Thus, it would be interesting to know whether the same phenomenon is observed for their language competencies. However, given the strong similarities of the language comprehension profiles of participants with FX and DS (Oakes, Kover, & Abbeduto, 2013), it is possible that, just like their peers with DS, those with FX do not have a premature asymptote.

The lack of solid data on family background of participants is another limitation. Since family SES, parental education or educational attitudes and practices of parents are related to language development among typically developing children (Hart & Risley, 1995; Hoff, 2006; Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Vasilyeva, Waterfall, & Huttenlocher, 2008) and those with ID (Price, Roberts, Vandergrift, & Martin, 2007; Warren, Brady, Sterling, Fleming, & Marquis, 2010), parental education, SES, and educational practices should certainly be included as covariates in future studies on the developmental trajectories of language components of persons with ID.

The cross-sectional analyses of the present study open them to several well-known potential limitations. However, all cross-sectional data are not necessarily corrupted by the potential biases attributed to such designs, and the longitudinal approach itself is not without potential flaws (Shadish, Cook, & Campbell, 2002). Moreover, given the matching procedure, the fact that chronological age, clinical status and cognitive level of participants were not correlated with one another increases the internal validity of the study. In fact, as suggested by Hertzog (1996), one of the best ways to study development is to begin with comparisons of extreme-age-groups, continue with full cross-sectional studies and, then extend the analyses with longitudinal or, better, cross-sequential designs (see also Thomas et al., 2009). Thus, the next stage of this study would involve a longitudinal or cross-sequential approach that would test and extend the present findings. Beyond its methodological interest, the use of the longitudinal or cross-sequential approaches would make it possible to identify inter-individual differences of developmental trajectories among participants from the same etiologic group and thus to determine the exogenous (e.g., SES) or endogenous (e.g., cognitive abilities) variables that cause them.

The main implications of the present study are twofold. First, the absence of a premature asymptote for participants with DS is important and encouraging from an educational point of view insofar as it justifies the continuation beyond childhood of interventions focused on language learning. Second, the present results indicate that all aspects of language development of persons with DS are not necessarily specific. In fact, our data show that even if participants with DS have lower performances than those with undifferentiated etiology, the developmental trajectories of the two groups are highly similar with respect to vocabulary and syntax comprehension. This finding is in line with studies showing that many aspects of language development of persons with ID in different etiological groups are similar to what is observed among typically developing children (e.g., Berglund et al., 2001; Facon & Magis, 2016; Facon et al., 2012; Hart, 1996; Laws & Gunn, 2004; Loveall, et al., 2016; Polišenská, Kapalková, & Novotková, 2018; Reilly, Losh, Bellugi, & Wulfeck, 2004; Rondal, 2007; Scarborough et al., 1991; Tager-Flusberg et al., 1990). Indeed, these studies suggest

> ... that language development in individuals with ID, including those with DS, proceeds, in major ways, as it does in TD [typically developing] individuals. Similar sequences of steps are documented until final plateaus are reached. Development in individuals with ID is slower and remains in many respects incomplete. There are no clear indications, however, that the basic mechanisms involved in each domain of language development radically differ (Rondal, 2007, p. 64).

From this standpoint, the widespread idea of a well-defined language phenotype associated with each syndrome should be tempered by the well-documented inter-syndromic overlaps, and the wide within-syndrome variations (Abbeduto, McDuffie, Thurman, & Kover, 2016; Rondal, 2010).

In conclusion, the present findings do not indicate a premature asymptote of language comprehension in people with DS in general, nor of their syntactic acquisition in particular. Although this result is encouraging from the viewpoint of language intervention, further studies are needed to verify whether this finding holds for other clinical groups and other tests, particularly of expressive language.

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Table 1

Descriptive Statistics for Chronological Age (CA) and Raw Scores on the RAVEN, the EVIP and the F-TROG

	CA (in years)*		RAVEN*		EVIP		F-TROG	
	UND	DS	UND	DS	UND	DS	UND	DS
Mean	14.92	14.80	13.63	13.68	71.66	59.53	57.35	45.27
SD	3.83	3.50	4.44	4.47	19.01	12.11	14.91	8.49
Min	6.69	7.21	3	4	37	24	25	27
Max	20.62	21.85	30	31	129	87	87	67
Skewness	-0.63	0.13	0.73	0.89	0.46	-0.37	-0.11	0.39
Kurtosis	-0.69	-0.60	2.25	2.80	0.20	0.36	-0.72	0.13

Note. *Matching variables. CA = chronological age; RAVEN = Raven Colored Progressive Matrices; EVIP = Echelle de Vocabulaire en Images Peabody; F-TROG = French version of the Test for Reception of Grammar; UND = participants with ID of undifferentiated etiology ($n = 62$); DS = participants with Down syndrome ($n = 62$). The standard errors for skewness and kurtosis are 0.30 and 0.60, respectively.

Table 2

Multiple Regression Analyses of EVIP and F-TROG Scores of Participants With ID of Undifferentiated Etiology or DS

Variables in the equation		R^2	Overall F	p	b	Partial F	p
		EVIP					
Step 1	CA	.155 [.054, .283]	22.159	< .001	1.733 [1.004, 2.462]	22.159	< .001
Step 2	CA	.275 [.139, .405]	22.731	< .001	1.721 [1.042, 2.399]	25.239	< .001
	Status				-11.086 [-16.012, -6.160]	19.851	< .001
Step 3	CA	.277 [.134, .401]	15.162	< .001	1.892 [0.967, 2.817]	16.396	< .001
	Status				-11.087 [-16.028, -6.145]	19.737	< .001
	CA × Status				-0.373 [-1.738, 0.992]	0.293	.590
		F-TROG					
Variables in the equation		R^2	Overall F	p	b	Partial F	p
Step 1	CA	.038 [.000, .128]	4.822	.03	0.722 [0.071, 1.373]	4.822	.03
Step 2	CA	.236 [.107, .364]	18.717	< .001	0.694 [0.111, 1.277]	5.561	.02
	Status				-11.994 [-16.231, -7.758]	31.411	< .001
Step 3	CA	.236 [.101, .359]	12.390	< .001	0.744 [-0.048, 1.537]	3.456	.065
	Status				-11.995 [-16.249, -7.741]	31.164	< .001
	CA × Status				-0.110 [-1.285, 1.065]	0.034	.853

Note. R^2 = squared multiple correlation coefficient; b = unstandardized regression coefficient; CA = chronological age; Status = respectively 0 and 1 for participants with intellectual disability (ID) of undifferentiated etiology and participants with Down syndrome (DS); EVIP = Echelle de Vocabulaire en Images Peabody; F-TROG = French version of the Test for Reception Of Grammar; $N = 123$ for the EVIP analysis; $N = 124$ for the F-TROG analysis. Numbers between brackets refer to 95% confidence intervals.

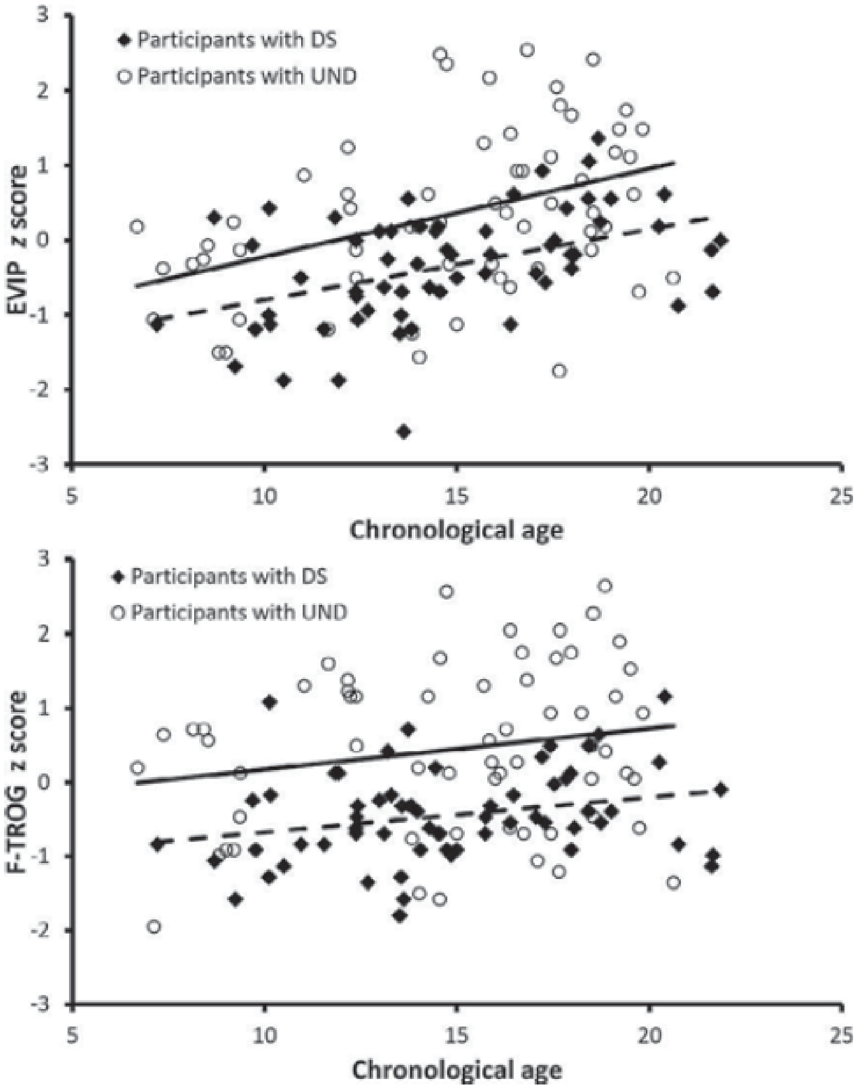

Figure 1. EVIP (top panel) and F-TROG (bottom panel) *z* scores as a function of chronological age for participants with ID of undifferentiated etiology and those with DS. EVIP = Echelle de Vocabulaire en Images Peabody; F-TROG = French version of the Test for Reception of Grammar; UND = participants with intellectual disability (ID) of undifferentiated etiology (n = 61); DS = participants with Down syndrome (n = 62). Solid lines correspond to the simple linear regression lines of participants with ID of undifferentiated etiology, dashed lines to the simple linear regression lines of participants with DS.