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Complex sentence production by adolescents with Down syndrome

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ABSTRACT
The use of complex syntax was investigated in narrative language samples of older children and adolescents with Down syndrome (n = 24) and a group of typically developing children matched on mean length of utterance. Both groups used conjoined and subordinate sentence forms and did not differ significantly in either the proportion of utterances containing complex sentences or in the variety of complex sentence types used. The analysis of developmental patterns suggested a similar order of acquisition across groups. The findings indicate that syntactic development in individuals with Down syndrome continues into late adolescence and is not limited to simple syntax. This study does not support earlier findings of a critical period effect in syntactic development in Down syndrome based on age or syntactic complexity.

Research has consistently indicated that the language development of children and adolescents with Down syndrome differs in important ways from that of children with typical language development. A specific phenotypic profile has emerged that includes a strength in vocabulary comprehension development relative to children of the same chronological age, as well as children of the same mental age (see the review in Chapman & Hesketh, 2000). However, syntactic development has been found to be disproportionately delayed relative to nonverbal cognition, particularly in language production. Thus, individuals with Down syndrome, as a group, exhibit a specific language impairment that is not explained by cognitive limitations and is most pronounced in syntax (Chapman & Hesketh, 2000; Fowler, 1990). Many previous studies have concluded that most individuals with Down syndrome encounter a roadblock in their syntactic development, which is associated either with a critical age or critical linguistic com-

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plexity (Fowler, 1990; Fowler, Gelman, & Gleitman, 1994; Rondal, 1996). In contrast to these reports, a recent investigation of older adolescents with Down syndrome has demonstrated continued growth in mean length of utterance (MLU) throughout adolescence, which indirectly suggests continued growth in syntax (Chapman, Seung, Schwartz, & Kay-Raining Bird, 1998). The purpose of this study is a more direct investigation of syntactic development in this age range.

Previous comparisons employing naturalistic conversational language samples have raised two important issues related to this syntactic deficit. First, these studies have indicated that most individuals with Down syndrome reach a ceiling in their MLU, with little subsequent development. Rondal (1996) reported, from a review of several previous studies of individuals with Down syndrome, that MLU increases linearly up to approximately age 15, after which a plateau is evident. This plateau effect has been alternatively associated with chronological age (passing a "critical period") or with linguistic complexity (the transition into complex syntax; Fowler, 1990; Fowler et al., 1994). Second, researchers have questioned whether MLU increases reflect types of development that are equivalent for individuals with Down syndrome and children with typical language development. It has been suggested that individuals with Down syndrome, as well as individuals with other forms of cognitive challenges, may add to their MLUs merely by elaborating phrase structures and juxtaposing utterances without truly developing complex syntax or by using less sophisticated sentence structures than MLU-matched control children (Rondal, 1978; Scarborough, Rescorla, Tager-Flusberg, Fowler, & Sudhalter, 1991).

Several factors have been suggested that may contribute to the observed divergence between vocabulary and syntactic development that has been repeatedly documented as part of the language profile in Down syndrome. One of these is differences in word knowledge of children with Down syndrome as compared to children with typical language and of the same mental age (MA) (Chapman et al., 1998; Chapman & Hesketh, 2000), permitting them to exhibit a strength in vocabulary comprehension relative to younger peers. Indeed, these children have a considerably higher chronological age than the MLU-matched peers and have had vastly different life experiences. This is evident in the content of the language samples, that is, in the topics of discussion and the sophistication of the discourse on a conceptual and semantic level. Although pragmatic aspects have not been studied formally, researchers have reported their informal impressions of differences of this kind (Fowler, 1990; Fowler et al., 1994). A recent study of narrative content in recounting a silent film, *The Pear Story,* revealed more episodic elements than in the narratives of MLU-matched controls but equally poor use of linguistic ties and connective markers (Boudreau & Chapman, 2000).

Although a vocabulary strength may account for part of the vocabulary–syntax gap, there also remains evidence of a specific syntactic deficit, which exceeds expectations based on cognitive level (Chapman et al., 1998; Fowler, 1990). One explanation that has been offered is that individuals with Down syndrome experience specific limitations in computational aspects of language. From a competence view of language acquisition, language is divided into con-

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ceptual (semantic and pragmatic) aspects and computational (morphosyntactic) aspects. Whereas computational aspects are typically acquired quite rapidly and early in life (with the possible existence of a "critical period" in this respect), conceptual development continues throughout life (cf. Rondal, 1994, 1996). Evidence advanced for specific limitations in computational aspects of language in Down syndrome includes the observation that individuals with Down syndrome exhibit a plateau in their MLU development. Such plateaus are reported to occur at around an MLU level of six morphemes per utterance, a level frequently reached approximately by age 15 (Rondal, 1996). Second, an analysis of grammatical structures used by young adolescents with Down syndrome has indicated that although their use of complex syntax is comparable to that of MLU-matched peers, it is extremely limited (Fowler, 1990; Rondal, 1996). The use of grammatical morphology has been reported to be less consistent compared to that of peers with normal language development. Even though individuals with Down syndrome use a variety of grammatical morphemes, they have been reported to omit a larger number of morpheme types and tokens than their peers (Chapman et al., 1998) and to continue to evidence inconsistent use of even the earliest acquired ones, indicating that full mastery may never be achieved (Fowler, 1990; Fowler et al., 1994). This apparent inability to reach higher levels of morphosyntactic development has been attributed to chronological age, with computational development essentially stopping once these individuals pass a critical period extending roughly to the onset of puberty (Fowler, 1990; Lenneberg, 1967; Rondal, 1996).

Alternatively, the detailed longitudinal investigation of a single girl with Down syndrome revealed that she reached a similar plateau in her development as early as between ages 7 and nine years, suggesting that the plateau effect is not tied primarily to chronological age, but rather to linguistic complexity (Fowler et al., 1994). From a longitudinal study of individuals with Down syndrome spanning an age range of 4–19 years, Fowler (1988) described language development in this population as being characterized by stages, or periods of relatively rapid growth alternating with plateaus, during which development slowed dramatically or stopped altogether. A very noticeable plateau occurred during middle childhood (ages 8–15 years, MLU 3.2), and there was a subsequent period of modest growth from age 15 to 19 years. Most of the language learning took place before age 8, and the highest level attained was characterized by an MLU of 3.5–4 and only limited use of syntax. These stages were hypothesized to be associated with chronological age as well as cognitive development and linguistic complexity. On this view, the computational requirements of complex syntax represent an insurmountable obstacle to most individuals with Down syndrome, although it should be noted that there are reports of individuals with exceptional language development who have broken this barrier and developed sophisticated syntax (Rondal, 1994, 1995).

Another possible source of the syntactic difficulty that has been proposed is a deficiency in auditory short-term memory. A number of studies have documented auditory memory limitations in children with Down syndrome relative to their mental-age peers (see the review in Kay-Raining Bird & Chapman, 1994). One way in which an auditory-processing deficit might hamper syntactic

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learning might be in that it makes it hard to learn longer sequences of words or to hold sequences in memory for processing. According to the Child Talk model of language development (Chapman et al., 1992), syntactic structures are learned from exposure in a variety of situations. Individuals with auditory memory problems would require more instances to learn these complex sentence forms, and thus more time. This model does not assume a division of language competence and performance or a separation between conceptual and computational aspects of language.

In contrast to reports of a ceiling in MLU growth, Chapman et al. (1998) documented a significant increase in measures of expressive syntax in a cross-sectional study of older adolescents with Down syndrome who had progressed well beyond either of the supposed age-related critical periods. The study included individuals with Down syndrome in four age groups ranging from 5 to 20 years of age. The MLU evidenced a significant effect of age group. A significant linear trend was found, whereas quadratic and cubic trends, which would have indicated slowed or arrested development, were not significant. In addition, the analysis of the frequency of different utterance lengths, from 1 to 13 morphemes, yielded a comparable pattern across groups of individuals with Down syndrome and comparison groups with typical language development. These findings stand in sharp contrast to reports of arrested syntactic development in Down syndrome and do not support a critical period view based on chronological age. To the extent that MLU growth reflects true gains in complex syntax, these findings also fail to support the view that most individuals with Down syndrome are limited to simple syntax in their language production.

However, the observation that MLU continues to grow up to age 20 in samples of adolescents with Down syndrome does not necessarily imply that they are making advances in syntactic skills during this period. Longer utterances result from growth in a number of language skills, including lexical, morphological, and syntactic abilities. These may contribute to MLU to varying degrees at different points in development and in different populations. There has been concern that MLU is a reliable index of language development only in early stages (e.g., Miller & Chapman 1981; Rondal, Ghiotto, Bredart, & Bachelet, 1987; Scarborough, Wyckoff, & Davidson, 1986). Scarborough et al. (1991) followed four children with Down syndrome longitudinally between the ages of roughly 4–11 years. MLU growth in this period was compared to that of several other groups, including children with typical language development, children with specific language impairment (low language scores with normal-range nonverbal cognitive scores), and two groups of children with cognitive involvement of a source different from Down syndrome. The questions that were asked concerned both the rate of increase of MLU in these different populations as well as how well MLU predicted grammatical development, as indexed by the Index of Productive Syntax (IPSyn) scores. Both the observed MLU range (1.26–4.22) and the range of IPSyn scores (26–83) were similar to those of the typical language group. Consistent with earlier findings, MLU was found to be a better predictor of IPSyn scores below than above an MLU of 3 for all groups of children. However, concerns were raised that prediction errors were more likely to be in the direction of overestimation of grammatical development, particu-

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larly for the groups with language impairment. In addition, the authors concluded that, even with IPSyn scores similar to those of the typical language group, the participants with cognitive limitations (Down syndrome and Fragile X groups) might have severe syntactic limitations relative to that group.

In the IPSyn coding system (Scarborough, 1990), credit is given for a variety of language forms, including semantic relations, grammatical morphology, noun and verb phrase elaboration, and several types of sentence embeddings and conjoinings. It is thus similar to MLU in that there are a number of different ways to earn a high score. Fowler et al. (1994) reported scores for the complex sentence subscale of the IPSyn for four adolescents with Down syndrome aged 10–13 years. Although overall IPSyn scores were comparable for the group with Down syndrome and an MLU-matched group of children with typical language, the children with Down syndrome scored higher on this subscale. However, they made extremely limited use of complex sentences and were characterized as having stabilized at a stage directly preceding, and at the verge of, complex sentence development.

The different findings of Chapman et al. (1998), compared to previous studies, may be attributed in large part to methodological differences, the most important ones being the sampling context, sample size, and age range of the participants. Previous reports were based on conversational samples; however, Chapman et al. used narrative as well as conversational samples. Narrative samples have consistently been found to elicit longer utterances than conversational samples. In the language sample reference database collected in Wisconsin (Leadholm & Miller, 1992), narrative samples produced a higher MLU for all age groups of children with typical language (ranging in 2-year intervals from 3 to 13). Similar effects of utterance length are associated with these sampling contexts in other populations, including children with a language or learning disability (MacLachlan & Chapman, 1988) and children and adolescents with mental retardation (Abbeduto, Benson, Short, & Dolish, 1995). Contexts defined as narrative do not necessarily involve a storytelling format, but they involve an interaction format that is distinct from a typical conversation. In Leadholm and Miller, as well as in MacLachlan and Chapman, narratives were elicited by asking participants to relate personal events, such as a birthday party or a favorite book or movie. This is similar to the context used in the present study. Abbeduto et al. used a wordless picture book to elicit their narrative samples. Consistent with these studies that compared conversational and narrative contexts, Chapman et al. (1998) found significant differences between the two sampling contexts, such that MLU and measures of vocabulary diversity (number of words and number of different words) were higher in the narrative samples than in the conversational samples. This indicates that the narrative context elicited a more varied and complex use of language and was, therefore, more appropriate than conversational samples for the evaluation of syntactic complexity. Another characteristic of the language sample data of the Down syndrome group was a wide range of individual differences, which makes it clear that adequate sample sizes are needed to obtain a representative picture of this group.

The third methodological difference of interest is the age range of the participants. The present study used a larger age range than previous studies, extending

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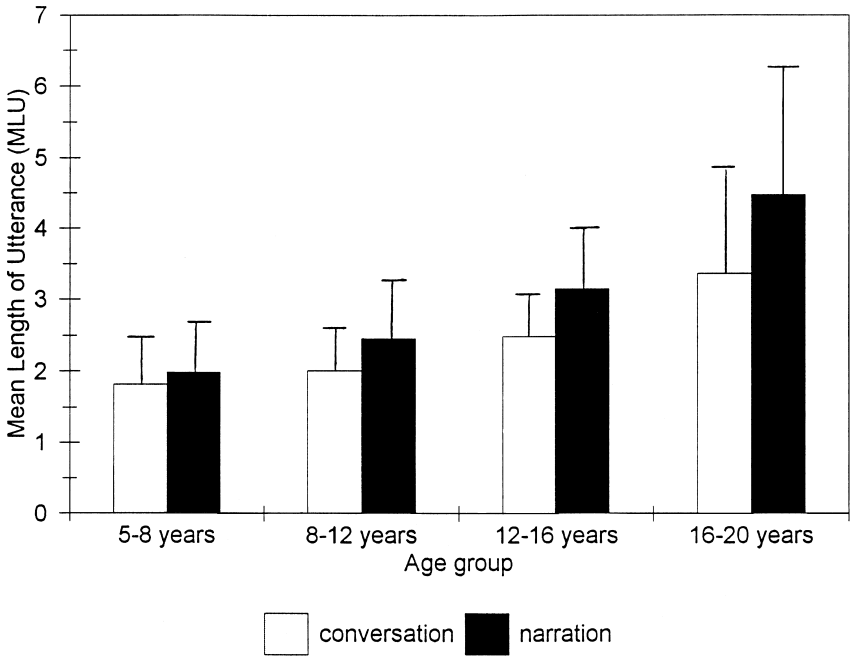


Figure 1. The MLU by age group in conversational and narrative samples of individuals with Down syndrome studied by Chapman et al. (1998).

the upper range to include older adolescents and young adults. Chapman et al. 1998 found that MLU continued to increase throughout this large range. Significant age effects were found with a significant linear trend but no significant quadratic or cubic trends. Figure 1 shows the MLU by age group obtained by Chapman et al. for individuals with Down syndrome aged 5–20 years in the two sampling contexts (note that our study includes only the two oldest age groups portrayed in this figure). MLU increased with age throughout this age range in both conversational and narrative samples, with the largest increases occurring in narrative samples and at the higher end of the age range. Neither conversational nor narrative MLU changed significantly from ages 5 to 8 to 8 to 12 years, although the narrative MLU evidenced more change than the conversational MLU in this age range. MLU increased significantly between subsequent age groups in both contexts, but increases were larger in narration, most notably after age 16, although the variability also became larger at this point. Other participant background variables appear to be comparable to previous studies: IQ scores averaged 50, but with a considerable range; all participants had received speech and language therapy; most participants had had an early period of signed communication (see the detailed description in Chapman et al., 1991, 1998, including hearing assessment. However, hearing status is not consistently reported and thus cannot be compared across studies; the Chapman

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et al. studies included individuals with mild hearing loss). From this, it can be concluded that the plateauing effect and failure to find evidence of complex syntax in individuals with Down syndrome may have been an artifact of the sampling context, the age of the participants, and the relatively small sample sizes used.

Although Chapman et al.'s findings suggest that syntactic development continues throughout the age range they studied, these conclusions were based on length of utterance measures rather than a direct analysis of syntactic structures. In this study, we analyzed the actual use of complex sentences in the narrative language samples of the two oldest groups of adolescents with Down syndrome as well as the two youngest groups of children with typical language development, providing a comparison group matched on MLU. The following questions were asked: (a) Do adolescents with Down syndrome differ from MLU-matched peers in typical language development in the types of complex sentences produced or the proportion of utterances containing complex sentences? (b) Do adolescents with Down syndrome appear to acquire complex sentence types in a similar order to typically developing children matched on MLU? (c) Do adolescents with Down syndrome evidence a limit at simple syntax or plateau in their use of complex sentences?

METHOD

Participants

Participants were 24 children and adolescents with Down syndrome ranging in age from 12;5 to 20;4 years (*M* 16;5, *SD* 2;4) and a control group of 22 children with typical language development, ranging in age from 2;1 to 4;0 years (*M* 3;1 *SD* 0;6). The groups were equivalent in terms of mean MLU (Down syndrome group: 3.77, *SD* 1.54; preschool group: 3.51, *SD* 1.22). All these children were part of a larger longitudinal study of language development in Down syndrome conducted by the second author (e.g., Chapman et al., 1998; Chapman, Schwartz, & Kay-Raining Bird, 1991; Hesketh & Chapman, 1998). The longitudinal study comprised four age groups of individuals with Down syndrome recruited from Wisconsin and northern Illinois. The present study includes the two older age groups of children with Down syndrome and the two younger age groups of children with typical development. All participants had oral language as their primary means of communication. Participants with Down syndrome were required to have a pure tone average of 45 dB HL or better in the better ear on the day of testing (determined at 500, 1000, and 2000 Hz).

Procedure

The use of complex sentences was examined in 12-min narrative language samples collected as part of a protocol including a number of production and comprehension measures. The samples were collected in an interaction in which the examiner elicited narrative discourse by a variety of probes, such as asking participants to talk about their favorite book, movie, or activity or about pictures

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brought from home. The analysis included all complete and intelligible child or adolescent utterances produced in a 12-min sample. The samples were transcribed orthographically and analyzed according to Systematic Analysis of Language Transcripts (SALT) conventions (Miller & Chapman, 1993) as part of the original studies for which they were collected. The reliability of this transcription was verified at the time of transcription and has been reported in previous studies (e.g., Chapman et al., 1998). Agreement was checked in terms of the inclusion of morphemes, utterance segmentation, and mazing behavior. For the syntactic analysis conducted for the present study, all complete and intelligible utterances were coded for the presence of several types of complex sentence types. Words and morphemes uttered as part of mazes (i.e., false starts, dysfluencies, revisions) were not included in this analysis. To ensure reliability of coding, 13 randomly selected samples (27% of all the samples, 6 from children with Down syndrome and 7 from the preschool children) were rescored by an independent scorer, a research assistant who had background in linguistics and had been trained in the scoring procedure. Reliability of coding of the complex sentences was calculated in terms of the number of interrater agreements over the total number of complex sentence codings by either coder (this represents the total number of opportunities for agreement). The interrater agreement was 95.3% (142/149 decisions) for samples of children with Down syndrome and 94.9% (112/118 decisions) for samples of preschool children.

The categorization of complex sentences was based on that detailed by Paul (1981), with certain exceptions: the "let us" form was not considered to form a complex sentence, and utterances that contained both a conjoining and an embedding form of complexity were specified in an additional category. The following are definitions of the complex sentence categories and examples. The category labels are from Paul (1981); the examples are from the language samples of this study. A sentence was considered complex if it contained one or more of these constructions. Utterances that met multiple criteria were classified under all possible categories (see the following discussion of certain categories that are redundant with others for the purpose of counting the number of complex sentences).

1. Conjoined sentences. Sentences in this category have two or more full clauses, containing, minimally, a subject and a verb within a single utterance. A conjunction such as *and, but, so, before,* or *after* may or may not be used to join the clauses. Clauses that were juxtaposed without an intonation boundary were coded as conjoined unless their content precluded such interpretation. Examples are: "Here's you and here's Jenny"; "And there's a big crack on the floor and water's coming up from it."

2. Simple infinitive clauses with equivalent subjects. These are clauses marked by the infinitive particle *to,* in which the subject is the same as that of the main clause. Catenatives (transcribed as *gonna, wanna, hafta, sposta, liketa,* and *trynta*) were considered to be semiauxiliary forms and so clauses including them were not part of this category. However, the fully pronounced versions (e.g., *going to, have to*) were included. Taking into consideration local dialect, the

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construction *try and* [*verb*] was regarded as a variant of the more standard form, *try to* [*verb*]. Certain syntactically ambiguous forms were not counted as infinitive clauses because they seemed to operate as prepositional phrases (e.g., *go to sleep,* which was considered parallel to *go to bed*). Examples are: "And cookie monster tried to get one from somebody too"; "I like to see Mr. Spock."

3. Full propositional complements. These are complete clauses that may or may not be introduced by *that* and that occupy a complement position in a sentence. This category does not include clauses introduced by a *wh*-word. Direct and indirect quotes were not included in this category (see category 12). Examples are: "Bridget thought that they were swimming pools"; "I'm pretending these are from this year."

4. Simple, noninfinitive wh- *clauses.* These are clauses that are introduced by a *wh*- word (e.g., *when, what, where, why, how, if,* or *like*), do not contain the infinitive particle *to,* and fill an obligatory spot in the main clause. Examples are: "I don't know what it's about"; "Looks like it still sank"; "That was when I was a little girl."

5. Infinitive clauses with different subjects. These are clauses marked by the infinitive particle *to,* in which the subject is different from that of the main clause. In other respects, these clauses are like those in category 2. Examples are: "Tell Scott to bring me over to the park"; "I want you to hold Mr. Bear"; "His mom told him to put them back."

6. Sentences with relative clauses. Relative clauses modify a noun. They may or may not be introduced by a relative pronoun (such as *which, who,* or *that*). Relative clauses were included in this category only if they were part of a fully formed sentence (in contrast, see category 14). Examples are: "It's all I can remember"; "There was a lion who wanted to drink."

7. Sentences with gerund clauses. Clauses in this category contain a gerund (*-ing* verb form) as part of a noun clause. Clauses in which the gerund was used with the verbs *keep* (*on*) [*verbing*] and *go* (*on*) [*verbing*] were considered parallel to the progressive with the auxiliary *be* (as in, "And then the water keep running down"). Examples are: "There's grandma riding"; "Look at the panda lying there."

8. Unmarked infinitive clauses. Infinitive clauses in this category are not introduced by the infinitive particle *to* but otherwise are similar to the clauses in categories 2 and 5. Examples are: "That makes it stay up"; "And they helped her do stuff"; "Watch me go"; "Go eat."

9. Wh- *infinitive clauses.* Clauses in this category are marked by both a *wh*-word and the infinitive particle *to*. Examples are: "Because she knows how to drive one"; "My mama told me how to do it."

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10. Quotes as full clauses. This category contains both direct and indirect quotes that consist of a full clause. Both categories of quotes (10 and 15) contain quotes introduced by the verb *go,* meaning *say*. Examples are: "And he said 'What are you doing?'"; "And Josh says he's too heavy"; "And my mom said 'wait.'"

Additional categories. Several additional categories were coded that were not included in the frequency count of complex sentences for either of two reasons. Categories 11, 12, and 13 reflect different kinds of multiple conjoined or embedded clauses. This coding is redundant in that each of the types of complex structures has already been coded in terms of categories 1 to 10. Categories 14–16 are not true complex sentences in that they do not have all the elements required to qualify them as such. Consequently, they were analyzed separately. Utterances of this type were considered to be of interest in that they might be primitive forms of, or precursors to, complex sentences. These additional categories are outlined next.

11. Conjoined embeddings. These are utterances that contain a conjoined construction and, in addition, at least one other complex construction. Examples are: "My sister got married to my brother-in-law because he likes to take pictures"; "They were being quiet because they didn't want them to know what they were doing."

12. Multiple embeddings. Sentences may contain more than one type of complex constructions. In this category are utterances that contain more than one subordinate clause (i.e., at least two embedded clauses of any of the categories 2 to 10, but not including the conjoint main clause type, category 1). Examples are: "Then he went to find grass to eat"; "Bigbird has to go to find a family."

13. Multiple conjoining. More than two full sentences (main clauses) are conjoined within a single utterance. Conjunctions such as *and, but, so, before,* or *after* may or may not be used. Examples are: "He rose from the dead and then the woman came and looked into cave"; "And then he took the sheep and put a fork into him and he get a knife and cut it."

14. Relative clauses without a complete sentence. Utterances with a relative clause but without a completed main clause were coded in this category. Because these utterances are not grammatically complete, they are not, strictly speaking, complex sentences. They were nevertheless coded because a number of clauses of this type were noted in the transcripts. Examples are: "A chair that is falling down the kitchen step"; "The lady that go with a doggie."

15. Quotes without a full clause. This category contains direct and indirect quotes in which the quote is not a full clause. Examples are: "One goes gobblegobble and one goes moomoo"; "Gotta go byebye"; "Mama bear said, 'Too soft.'"

16. Conjoined verb phrases. In this category, two or more verb phrases are conjoined within a single utterance. These are not truly complex sentences be-

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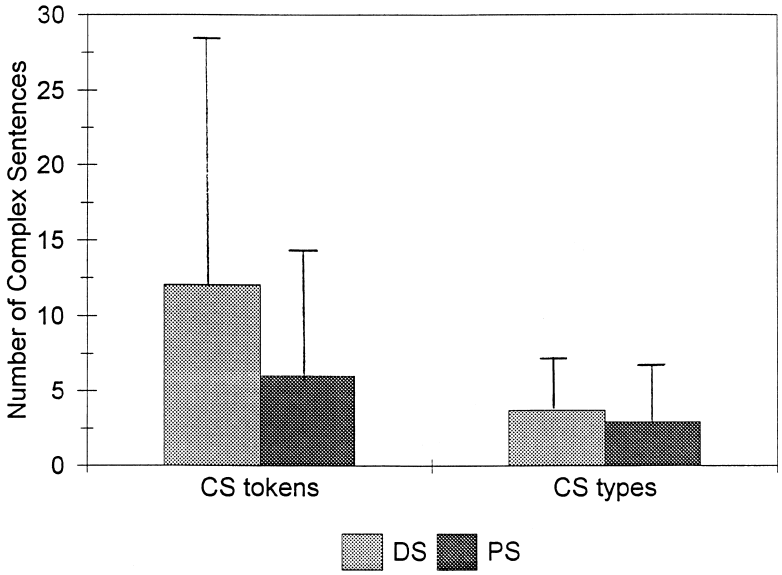


Figure 2. The number of complex sentence (CS) types and tokens used by individuals with Down syndrome (DS) and the preschool control children (PS).

cause the verb phrase does not contain a subject and is thus not a full clause. In many cases, verbs were conjoined that evidently had the same subject. In other utterances, although no subject might have been specified for one of the verbs, the context indicated that the verbs had different subjects (e.g., "cooking and water dump out"). These latter utterances especially could be viewed as a simplified form of conjoined clauses. Examples are: "They went and ate the cake all up"; "And go back and go eat"; "The ball gets all dirty and throw up in the sky"; "Cooking and water dump out."

RESULTS

Number and type of complex sentences

The individuals with Down syndrome, as a group, used a greater number of complex sentences than did the preschool control children (see Figure 2). However, they also had significantly more utterances in their samples, and thus more opportunities for the use of complex sentences. To account for this difference, we analyzed the number of complex sentences used in a sample as a proportion of the total number of utterances in that sample. The proportion of utterances containing complex syntax was larger for the Down syndrome group than for the control group (see Figure 3), but also had considerably more variability. Figure 3 shows that for both groups, the average proportion of utterances containing complex sentences is less than 10%. Group differences were evaluated

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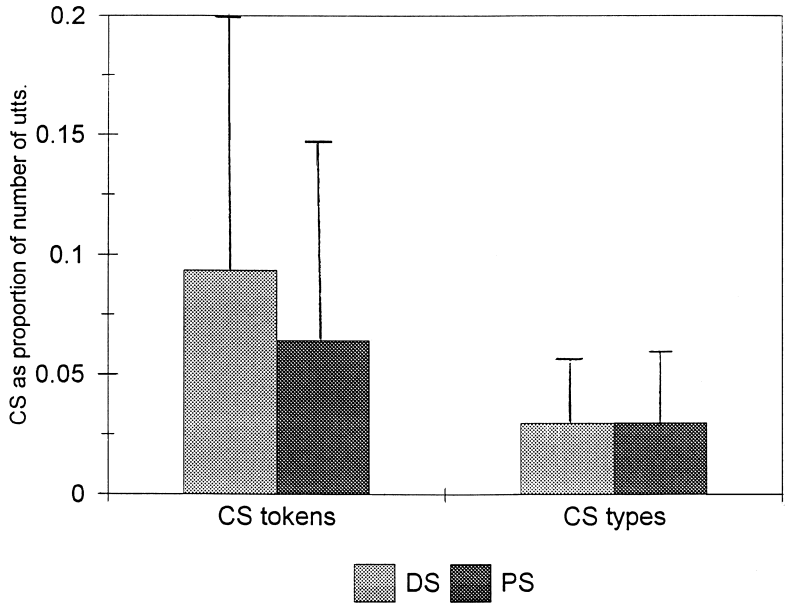


Figure 3. The number of complex sentence (CS) types and tokens as a proportion of the total number of utterances by individuals with Down syndrome (DS) and the preschool control children (PS).

by the use of one-way analyses of variance (ANOVAs). Arcsine transformation was employed for proportion data. Group differences were not statistically significant for either number of complex sentences, $F = 2.302$, $p = .136$, or complex sentences as a proportion of total number of utterances, $F = 1.156$, $p = .288$. To investigate the source of the large variability in the Down syndrome group, we plotted a frequency distribution (Figure 4), comparing the groups in terms of number of participants per percentage complex utterances. Figure 4 shows that the Down syndrome group spanned a larger range of percentages; for some participants with Down syndrome, complex sentences made up as much as 39% of their utterances, compared to a maximum of 22% in the control group. In the NL group, all but one of the participants had 15% or less complex sentences in their samples, whereas for the Down syndrome group, five participants exceeded the 15% mark to varying degrees. The Down syndrome group also had fewer participants who made no complex utterances.

Next, we were interested in possible group differences in the diversity of the complex sentence types used by the two groups. First, we examined the number of different types of complex sentences used. The group mean for this measure was higher for the Down syndrome group than for the control group (see Figure 2), but again, this group difference was not significant, $F = .963$, $p = .332$. Given that the opportunity for the use of different types is also dependent on the overall number of utterances, we again accounted for this by expressing the

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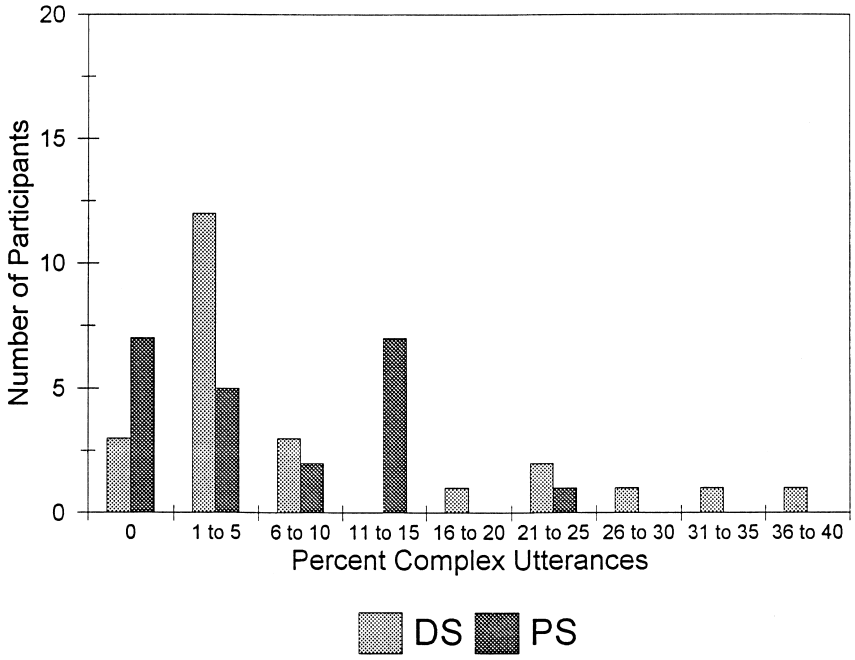


Figure 4. The frequency of use of complex sentences by individuals with Down syndrome (DS) and preschool control children (PS). The figure shows the number of participants in each group with complex sentences constituting 0–40% of their total number of utterances in intervals of 5%.

number of different complex sentence types as a proportion of the total number of utterances. When complex sentence variety was expressed in these terms, the group means and standard deviations were very similar (see Figure 3), and the lack of a significant group difference was confirmed by statistical analysis, $F = .001$, $p = .976$.

Another indication of the degree of syntactic complexity is the use of multiple embeddings or conjoinings within a single utterance. This measure was obtained by adding categories 11, 12, and 13. Once again, the mean number of multiply complex utterances was considerably higher for the Down syndrome group (1.66; *SD* 3.11) than for the preschool control group (.48; *SD* .87), but it was also considerably more variable. The group difference in means was not statistically significant, $F = 3.13$, $p = .084$. As a final measure of syntactic complexity, we examined utterances in categories 14 to 16, which include sentence types that have some characteristics of complex sentences but do not have all the components necessary to be considered true complex sentences. Utterances of this type were more common in samples of children with Down syndrome than in the samples of the preschool children (Down syndrome: 3.67; *SD* 4.18; preschool: 1.95; *SD* 2.28), but the difference was not statistically significant, $F = 2.90$, $p = .096$.

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Table 1. *Mastery of complex sentences types by MLU level as depicted in terms of the proportion of participants at each level using the complex sentence types* (*50 and 90% criteria*)

	MLU level				
	2–2.99 (9/*8*)	3–3.99 (4/*3*)	4–4.99 (4/*7*)	5–5.99 (3/*1*)	6–7.99 (3/*1*)
Conjoined sentences	22/*13*	**75**/***100***	**100**/***100***	**100**/***100***	**100**/***100***
Inf. clause, same subj.	33/*0*	0/***100***	**75**/***86***	**100**/***100***	**100**/***100***
Full prop. compl.	22/*0*	0/*0*	**75**/*43*	**67**/*0*	**67**/***100***
Noninf. *wh-* clause	33/*13*	**75**/***67***	**100**/***57***	**100**/*0*	**67**/***100***
Inf. clause, diff. subj.	0/*0*	0/*33*	0/*43*	**67**/*0*	33/*0*
Relative clause	0/*0*	0/*33*	**75**/*43*	**100**/*0*	**100**/***100***
Gerund clause	**55**/*25*	25/***67***	25/*29*	**67**/***100***	33/*0*
Unmarked inf. clause	22/*13*	0/*33*	**50**/*14*	33/*0*	33/*0*
Wh- inf. clause	0/*0*	0/*0*	0/*14*	33/*0*	0/*0*
Multiple embedding	0/*0*	0/*0*	25/*0*	**100**/*0*	**100**/***100***

Note: Complex sentence types used by at least 50% of participants at a level are in bold; those used by 90% or more are bold and underlined; and preschool control children are in italics. Results are shown for individuals with Down syndrome and preschool control children. Children with MLUs below 2.0 (one child with Down syndrome and two control children) did not produce any complex sentences. The sample size is in parentheses.

Developmental pattern

Both the group of adolescents with Down syndrome and the control group of preschool children span a considerable range of MLU levels. In order to gain insights into developmental effects in complex sentence use within each group, we formed subgroups based on MLU level in increments of 1 and analyzed the use of complex sentences within each subgroup. The highest MLU group includes children with MLUs of 6+ and includes the one participant in the study whose MLU exceeded 6.99 (Down syndrome group). Table 1 depicts the percentage of children in each MLU group who used each type of complex sentence. Following Paul (1981), the table highlights the MLU levels at which particular complex sentence types are used by 50% of the children and, where applicable, the MLU level at which they are used by 90% of the children. This analysis reveals that, from an early age, several sentence types are used frequently (by children with low MLUs), including conjoined sentences (category 1) and infinitive clauses with equivalent subjects (category 2). Simple noninfinitive *wh-* clauses (category 4), relative clauses (category 6), full propositional complements (category 3), and multiple embedded clauses (category 12) each appear a little later, but their use appears to increase fairly systematically with MLU. The use of gerund clauses (category 7) is a little less consistent but occurs over a fairly wide MLU range. The three remaining sentence types appear only infrequently and with no clear relationship to MLU: these include infinitive

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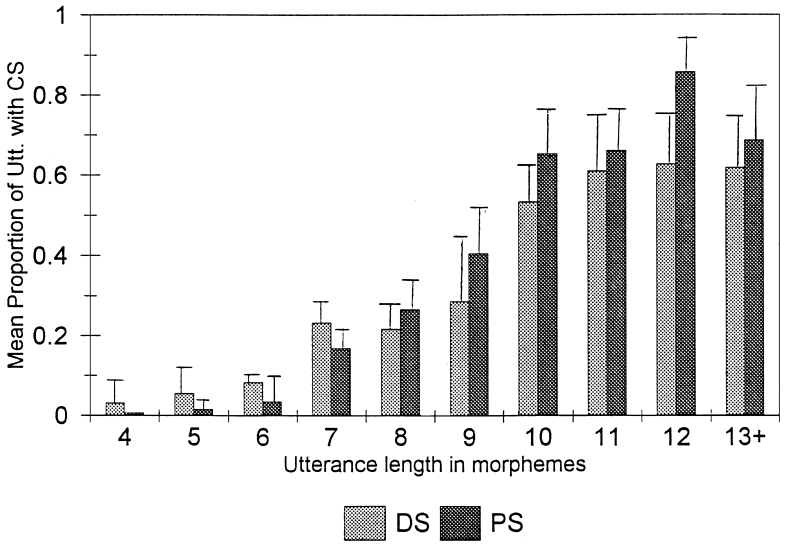


Figure 5. The proportion of utterances containing complex sentences (CS) as a function of the utterance length for individuals with Down syndrome (DS) and preschool control children (PS).

clauses with different subjects (category 5), unmarked infinitive clauses (category 8), and *wh-* infinitive clauses (category 9). The pattern of use of the complex sentence types is similar across groups of children in terms of sentence types used as well as their order of acquisition, as inferred from these cross-sectional samples of children. To further compare the groups in terms of their mastery of complex sentences, we counted the number of times the MLU subgroups reached either the 50% or 90% criterion for a complex sentence type. The participants with Down syndrome reached the 90% criterion in 11 cases and the 50% criterion in 12 additional cases. The corresponding numbers for the preschool group are 12 and 4 cases, respectively.

Length versus complexity

In order to further examine the relationship between utterance length and syntactic complexity, we computed the proportion of utterances at each utterance length (from 1 to 13+ morphemes) that contain complex syntax (see Figure 5). For both groups, the proportion of utterances with complex syntax make up a higher proportion of the total number of utterances as utterance length increases. However, the graph suggests an interaction effect between utterance length and group. Individuals with Down syndrome have a higher proportion of complex sentences for short utterances; however, this is reversed for the longer utterances. Only 42–68% of utterances of 10–13+ morphemes produced by the individuals with Down syndrome are complex, compared to 69–89% for the chil-

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dren in the control group. To test the significance of utterance length effects, ANOVA analysis was conducted with group as the between subjects factor and utterance length as the within subjects factor (treated as repeated measures). This revealed a significant main effect of utterance length, $F(9, 90)$ 7.85, p = .000, with no other significant effect.

DISCUSSION

The motivation for this study was the controversy that has surrounded the syntactic development of children and adolescents with Down syndrome. In spite of claims that most individuals with Down syndrome are severely limited in their syntactic learning, case studies have been reported that are clearly exceptions to this rule. Further, contrary to claims of severely slowed or arrested MLU development in late childhood or adolescence, there have been reports of continued linear growth in MLU in late adolescence. In this study, our goal was to conduct a detailed syntactic analysis of the same language samples that demonstrated such linear growth. The question was whether this growth in MLU reflects true growth in the use of complex sentences.

The results of this study demonstrate that adolescents with Down syndrome, as a group, do use complex sentences and that their use of complex syntax is commensurate with their MLU, in terms of both frequency of use and variety of complex sentence types. In comparison with preschoolers with typical language development matched on MLU, no significant differences were found in either the number of complex sentence tokens, number of complex sentence types, or the proportion of utterances in the sample that contained complex syntax. In each of these measures, the group of individuals with Down syndrome actually had a higher mean and higher upper range than the control children, although the group differences were not statistically significant. There was greater variability in the Down syndrome group, but closer examination revealed that this group had fewer members using no complex sentences than the control group and that the upper range of percentage complex sentences was considerably higher in the Down syndrome group than in the control group. Therefore, the high performance of the Down syndrome group cannot be attributed to the inclusion of a few unusually advanced individuals. On the contrary, most of the participants with Down syndrome (19/24) used complex syntax.

These results indicate that the MLU increases previously reported in adolescence reflect true syntactic development. In turn, this does not support the notion that adolescents with Down syndrome have entered a stage of stagnation in the development of computational aspects of language or the claim that most individuals with Down syndrome reach a ceiling at the level of simple syntax. Therefore, the claim that adolescents with Down syndrome have passed a critical period for development, as defined in terms of chronological age or in terms of linguistic complexity, is inconsistent with the findings of this study. The differences in findings between the present and previous studies most likely resulted from methodological differences related to sampling context, age of the

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participants, and sample size, as previously discussed. In other respects, the participant characteristics were similar.

An analysis of complex sentence use by MLU level permitted an estimation of the order of acquisition of the complex sentence types by each group of children. The two groups evidenced a similar pattern, with the order of acquisition roughly as follows: conjoined sentences (MLU 3–3.99), infinitive clauses with equivalent subjects (MLU 3–4.99), noninfinitive *wh-* clauses (MLU 3–3.99), relative clauses (MLU 4–5.99), gerund clauses (MLU 2–3.99, inconsistent), full propositional complements (MLU 4–6.99), multiple embeddings (MLU 5–7.99), infinitive clauses with a different subject (infrequent), unmarked infinitive clauses (infrequent), and *wh-* infinitive clauses (infrequent). This developmental sequence is in fairly good agreement with that reported for normal language development by Paul (1981), although the mastery of several constructions occurs a little later in this study for both groups. It should be noted that many of the sentence types appear from the data reported here to be mastered at a lower MLU level by the adolescents with Down syndrome (including full propositional complements, infinitive clauses with a different subject, relative clauses, gerund clauses, unmarked infinitive clauses, and multiple embeddings), whereas only one type (infinitive clause with the same subject) is mastered earlier by the control group. This may be a result of the fact that the participants with Down syndrome had more utterances in their samples, and thus a greater opportunity to show their proficiency.

Another potential explanation that must be considered is the use of MLU matching with large age differences. Matching on MLU is an attempt to roughly equate the groups in terms of linguistic complexity. However, this results in samples that remain highly mismatched on certain other variables, notably age and life experience. This type of matching, therefore, allows for an examination of the effects of these other factors on utterance length and complexity. Because the participants with Down syndrome are much older than their MLU controls, their narrative samples are likely to be of considerably higher conceptual complexity. Although this aspect was not evaluated formally in this study, the subjective impression from reading the samples certainly supported this claim. Complex sentences often serve to convey content that is cognitively, as well as linguistically, more advanced. Examples include mental states in relation to events; additive, temporal, causative, and contrastive relationships between events; and the foregrounding and backgrounding of information, especially the marking of what is already known and what is new information for the listener. Individuals whose language comprehension and nonverbal cognition are more advanced than their language production – thus demonstrating a specific expressive language impairment, as is the case for our participants with Down syndrome (see Chapman et al., 1998) – may, nevertheless, attempt to convey such cognitively complex content in narrative contexts. Boudreau and Chapman (2000) demonstrated that individuals with Down syndrome included a higher number and type of events than controls in a narrative recounting of a 6-min wordless film presented at a later test time to the continuing participants in the longitudinal study of which the present study was part. In addition, the language samples used in

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this study were described previously as demonstrating a higher incidence of one-word utterances and word omissions in the Down syndrome group compared to controls, with typical language thus limiting utterance length, but not necessarily the conceptual or syntactic complexity.

Together, the higher conceptual complexity, the high frequency of one-word utterances, and the word and morpheme omissions would all contribute to the finding of more complex utterances at lower MLUs in the Down syndrome group. This underscores the fact that MLU increases result from a combination of factors including semantic, syntactic, and cognitive development, as well as sampling context. Nevertheless, the finding of more complex utterances at low MLUs strengthens the conclusion that the individuals with Down syndrome fully meet the expectations of complex sentence use based on their MLU level. In addition, the developmental pattern, which involves greater variety and mastery as MLU increases, further demonstrates the contribution of complex sentence development to MLU growth for both groups and the fact that syntactic development continues throughout the MLU range covered, with no evidence of a plateau effect. Finally, group comparisons of the use of constructions that meet some, but not all, requirements of complex sentences yielded similar results as comparisons of true complex sentences. This provides further evidence for the claim that the developmental sequence is similar for both groups.

Even with continued syntactic growth in adolescence among individuals with Down syndrome, syntax develops more slowly than vocabulary, with the divergence between the two areas increasing with time. This study was not designed to directly analyze the potential sources of this difficulty, but some inferences can be made. If individuals with Down syndrome have a specific limitation in computational aspects of language, as some have suggested, it can at least be concluded that the ability to make progress in the computational area is maintained throughout late adolescence and allows for continuous growth, resulting in the acquisition of complex sentence structures. Thus, syntax may develop more slowly, but there do not appear to be preset limitations as to the complexity of the structures that can be acquired. It has also been proposed that deficits in auditory processing may be responsible for the slow growth in syntax. A limited ability to hold auditory information in memory would be expected to be most detrimental to the learning of long sequences, such as complex sentences. However, because no specific grammatical or computational deficit is assumed, there is no upper limit on the kind of linguistic complexity that can be learned, given sufficient practice. The results of this study, which show a slow but continuous growth in syntax, can be taken as consistent with this view.

Fowler et al. (1994) offered another potential scenario relative to the effect of auditory memory limitations. They hypothesized that the effect of memory limitations on syntax might be more pronounced in syntactic performance than in syntactic competence. Memory and production factors (such as articulation) would impose limits on such performance factors as utterance length, which would mask a more advanced syntactic competence. To test this hypothesis, Fowler et al. examined language samples of individuals with Down syndrome, with an eye for the occurrence of advanced syntactic structures not yet mastered by control children with typical language development matched on MLU. How-

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ever, these researchers found little evidence of complex syntax use by either group. The present study offers an opportunity to reexamine this hypothesis because it used narrative samples in which complex syntax is used. Both groups used utterances ranging from 1 to over 13 morphemes. For both groups, the proportion of utterances containing complex syntax generally increased with increasing utterance length. However, there was a trend for a lower proportion of complex sentences at long utterance lengths (10+ morphemes) for the group with Down syndrome than for the control children. This suggests that even though the individuals with Down syndrome demonstrated the ability to produce complex sentences, a relatively high proportion of their long utterances lacked complex syntax. It thus did not appear that an inability to produce long utterances prevented them from demonstrating a greater underlying competence.

The source of this observed trend may be similar to the previously discussed finding that the participants with Down syndrome showed a mastery of some complex sentence types at lower MLU levels than did the MLU controls, that is, related to the overall higher conceptual complexity of the content conveyed in the samples of the Down syndrome group compared to the preschool-age control group. There are some differences in interpretation, however, between the mastery of complex sentences at low MLU levels and the use of complex syntax in relatively short utterances. This is because MLU is an average, and is therefore susceptible to the frequent use of one-word utterances. Therefore, a high use of complex sentences in a sample with a low MLU may still leave the impression that only the longest utterances contain complex syntax. The trend shown in Figure 5 indicates, by an examination of individual utterances, that this is less likely to be true for the individuals with Down syndrome than for the control subjects. From this trend and the previous finding that individuals with Down syndrome tend to shorten their utterances by omitting morphemes and words, one could speculate that these omissions represent a trade-off effect, such that the overall utterance length tends to be reduced when syntactic complexity is high. This could be a result of these individuals' limitation in auditory memory.

The results of this study indicate that in individuals with Down syndrome, syntactic development continues throughout late adolescence. This suggests that, if there is a critical period for syntactic learning based on age, linguistic complexity, other factors, or some combination, these individuals have not passed it. Compared to many previous studies that have found a limited use of complex syntax by most of their individuals with Down syndrome, the fact that this study employed narrative samples appears to be crucial in that the narrative context calls for more complex sentence structures than does a conversational context. Although the findings presented here clearly demonstrate significant syntactic development in adolescence, it should be kept in mind that a cross-sectional sample was used. A more definitive conclusion could be drawn from a longitudinal study directly examining within-subject development over time.

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