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Verb production by individuals with Down syndrome during narration

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Abstract

Background: Despite research identifying verb knowledge as a strong predictor of later syntactic skills in typical development, virtually no research has examined verb development in Down syndrome.

Aims: The purpose of this study was to examine verb production (density, diversity, and type-token ratios) by individuals with Down syndrome in the context of story generation relative to two comparison groups – nonverbal cognitive ability level matches with typical development and chronological age matches with mixed-etiology intellectual disability.

Methods and Procedures: Thirty-five participants with Down syndrome (11–21 years), 27 participants with intellectual disability (13–20 years), and 29 participants with typical development (4–6 years) completed a narrative story generation task. Transcripts were coded and analyzed for verb production.

Outcomes and Results: Examining overall verb production, participants with Down syndrome produced narratives with less verb density than participants with typical development and had smaller verb type-token ratios than participants with intellectual disability. Upon examining lexical verb production, participants with Down syndrome produced narratives with less lexical verb density than participants with typical development.

Conclusions and Implications: The results indicate that individuals with Down syndrome have a developmentally appropriate diversity of verbs in their lexicon but are not using verbs as frequently as comparison groups.

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Keywords

Down syndrome; intellectual disability; expressive language; expressive vocabulary; verbs; word categories

1. Introduction

Verbs play a central role in typical syntactic development (e.g. Gleitman, 1990). Although delays in language development have been well-documented in Down syndrome (DS), especially in the domain of expressive syntax (Abbeduto & Chapman, 2005; Chapman, 1999; 2003; Chapman & Hesketh, 2000; 2007; Chapman, Seung, Schwartz, and Kay-Raining Bird, 1998), there is limited research addressing the use of verbs in this population. Understanding the pattern of verb production in DS would provide insight into the sources of their expressive syntax difficulties and identify possible targets for intervention. In this study, we examined verb production by individuals with DS.

DS is caused by the triplication of all or part of chromosome 21 (Jacobs, Baikie, Court Brown, & Strong 1959; Lejeune, Gautier, & Turpin, 1959; Pangalos et al., 1994) and affects 1 in every 691 live births in the United States (Parker et al., 2010). Individuals with DS often demonstrate unique patterns of strength and weakness within language. Expressive language, particularly morphosyntax and speech intelligibility, is often delayed relative to nonverbal cognitive ability and receptive language (Abbeduto & Chapman, 2005; Chapman, 1999; 2003; Chapman & Hesketh, 2000; Chapman, Kay-Raining Bird, & Schwartz, 1990; Chapman, Schwartz, & Kay-Raining Bird, 1991; Chapman et al., 1998; Kumin, 1994; McDuffie, Thurman, Channell, & Abbeduto, 2017). Receptive vocabulary skills, in contrast, are typically less impaired and more consistent with nonverbal cognitive ability level (Abbeduto et al., 2003).

In typical development (TD), verb learning has been linked to later syntactic development (Bassano, 2000; Bates & MacWhinney, 1982; 1987; Bresnan, 1978; 1982; Chapman, Streim, Crais, Salmon, Strand, & Negri, 1992; Gleitman, 1990; Gropen, Pinker, Hollander, & Goldberg, 1991; Tomasello & Merriman, 1995), and patterns of verb use distinguish children with specific language impairment from age-matched peers (Fletcher & Peters, 1984; Watkins, Rice, & Moltz, 1993). Because verbs are more complex than nouns, carrying both semantic and syntactic information, they are more difficult to learn on average, even for TD children (Bassano, 2000; Rice, Buhr, & Nemeth, 1990), and learning verbs requires that they are embedded in more semantically rich contexts than is required for nouns (Arunachalam & Waxman, 2011).

Verbs are, however, fundamentally linked to nouns because verbs require arguments, or additional words, to help complete their meaning (e.g. see Bock & Levelt, 1994; Chapman et al., 1992; Kim & Thompson, 2000; Michael et al., 2012; Thompson, Lange, Schneider, & Shapiro, 1997). The verb used in a sentence or phrase specifies how many arguments are required for that phrase to make sense and to be grammatical in the target language. For example, the verb *sleep* only requires one argument, a subject (e.g. *The baby sleeps*), whereas other verbs such as *chase,* or *put* may require two or three arguments to make sense

(e.g. *The dog chased the cat; Matt put the dishes in the dishwasher.*). Essentially, verbs are responsible for linking words within a sentence together, and as such, they play a key foundational role in syntax. If disrupted, then syntactic development could also be impacted.

1.1. Verb production in DS

Despite their importance to syntactic development, and the noted syntactic difficulties often reported in DS, verbs have been largely overlooked in this population. Some studies show that individuals with DS produce fewer verbs overall relative to TD children, whether matched by mean length of utterance (MLU; Hesketh & Chapman, 1998), receptive vocabulary (Michael, Ratner, Newman, 2012), or nonverbal cognitive ability levels (Channell, McDuffie, Bullard, & Abbeduto, 2015). However, Grela (2002) failed to find significant differences between individuals with DS and TD children matched on MLU in their production of verbs.

Differences in the elicitation techniques used across studies could be responsible for Grela's (2002) discrepant findings. For example, Hesketh and Chapman (1998) and Michael et al. (2012) both used narrative tasks, but Grela's (2002) data included language transcripts from the Child Language Database Exchange System (CHILDES; MacWhinney, 2000) that were collected during mother-child free play at home. Because narration may be cognitively taxing (e.g. Berman & Slobin, 1994), participants with DS might leave out key story grammar elements (e.g. character actions; Ashby, Channell, & Abbeduto, 2017; Channell et al., 2015), thus precluding the need for including a verb. It is also possible that children are simply more comfortable with their mothers during free play and therefore talk more and produce more verbs.

Grela's (2002) samples were also younger than those included in other studies. The average chronological age for Grela's TD comparison group was 2.50 years, and in fact, all the TD participants included were 2-year-olds. Across other studies, the average age of TD participants was 6.10 years (Michael et al., 2012), 4.48 years (Channell et al., 2015), and 3.08, 3.25, and 4.50 years (Hesketh & Chapman, 1998; who reported age in subgroups). Further, at 10 years, the average chronological age for Grela's group with DS was also younger than other studies, which included participants with average ages of 18.90 (Michael et al., 2012), 12.80 (Channell et al., 2015), and 14.58, 15.17, and 16.0 years (Hesketh & Chapman, 1998). At these younger ages, the participants in Grela's study in both groups may not have had sophisticated enough expressive language to reveal differences in verb use. That is, delays in verb use by individuals with DS may become increasingly apparent over time.

In contrast to the findings on the overall production of verbs, when examining the diversity of verbs produced (i.e. the variety or number of different verbs), studies have found that participants with DS may produce a greater variety of verbs than TD controls of similar developmental level and that this may be driven by lexical verbs specifically (Grela, 2002; Hesketh & Chapman, 1998). Lexical verbs are defined as those that act as main (e.g. *run*), phrasal (e.g. *running out*), or infinitive (e.g. *to run*) verbs. They serve as the main content verb, so to speak, and are distinguished from the functional or grammatical use of the verb forms of "do", "be", and "have" (which include copulas and auxiliaries). Additionally, some

researchers distinguish semi-auxiliary verbs (e.g. *gonna*; *wanna*) as yet another category because of their unique form (see Hesketh & Chapman, 1998). The distinction between the density and diversity of verb production potentially indicates that individuals with DS have reasonable vocabulary sizes but are not using these verbs as frequently.

Studies examining verb production in DS relative to other groups with intellectual disability (ID) are scarce. The existing evidence suggests that individuals with DS may struggle with verb production during narration relative to peers with fragile X syndrome of similar chronological ages and nonverbal ability levels (Channell et al., 2015). No research has examined verb diversity in DS relative to other groups with ID.

1.2. Verb comprehension in DS

Studies examining verb comprehension in DS have not found significant differences between groups with DS and TD (Loveall, Channell, Phillips, Abbeduto, & Conners, 2016; Michael et al., 2012) but have found differences between individuals with DS and mixed-etiology ID (Loveall et al., 2016). More specifically, Loveall et al. (2016) compared groups with DS, TD, and mixed-etiology ID and found that, relative to age-matched peers with ID, youth with DS performed lower on verb items on the Peabody Picture Vocabulary Test – 4th edition (PPVT-4; Dunn & Dunn, 2007). Further, this group difference was maintained even when controlling for overall receptive vocabulary and phonological memory. The two groups, however, did not perform differently on noun or attribute items, and no group differences were observed between the groups with DS and TD. These findings, although considered preliminary, highlight the importance of including multiple comparison groups to fully understand language in DS. It is important to note, though, that the PPVT-4 measures comprehension of the semantic content, not the syntactic potential of verbs, as the verbs are presented in isolation rather than in a carrier phrase or sentence. There is a need, therefore, to examine verb production in DS relative to comparison groups with ID and to examine this in non-isolated, more naturalistic contexts such as narration.

1.3 Current study

Additional research is needed to fully understand verb production in DS. There is a need for more studies that include comparison groups of both TD and ID. Utilizing comparison groups with TD allows researchers to see how individuals with DS perform relative to typical developmental patterns. However, using TD comparison groups does not address the issue of whether an observed profile of relative strength or deficit is unique to the phenotype of DS (that is, 'syndrome-specific') or more broadly attributable to ID. Utilizing comparison groups with ID allows for an examination of how participants with DS compare to other individuals of similar chronological age *and* ability levels, thereby addressing syndrome-specificity. Importantly, these data can be used to develop intervention approaches tailored specifically for DS, when needed, and applied more broadly to ID when appropriate.

The purpose of the present study is to replicate and extend previous work on verb production in DS. We did this by examining verb production in individuals with DS relative to both TD peers (as in previous studies) matched by nonverbal cognitive ability level and to individuals with mixed-etiology (non-DS) ID of other origins (not yet done) matched by chronological

age. Our research question, therefore, was: is there a difference between individuals with DS and those with mixed-etiology ID and/or TD in their production of verbs during narrative storytelling? To test this question, we examined group differences on three metrics of verb production:

a. Density (proportion of utterances that contain a verb)

b. Diversity (number of different verbs)

c. Verb type-token ratio (verb TTR; verb diversity relative to total number of different words produced).

In addition to our primary research question, and consistent with previous research (e.g. Hesketh & Chapman, 1998; Grela, 2002), we also conducted analyses that examined the use of lexical verbs to determine whether these were driving group differences in overall verb production.

2. Method

2.1. Participants

All participants came from a larger study on language development in DS (see Conners, Tungate, Abbeduto, Merrill, & Faught, 2018; Loveall et al., 2016) and were recruited from various schools, agencies, and research participation registries in Alabama, Wisconsin, and California. General inclusion criteria for participants across all groups to be in the larger study were: 1) native English speaker, 2) speech used as the primary mode of communication, 3) without an autism spectrum disorder diagnosis, and 4) no physical disabilities that prevented meaningful participation (e.g. use of hands to manipulate stimuli). Because DS is associated with vision (e.g. Stephen, Dickson, Kindley, Scott, & Charleton, 2007) and hearing (e.g. Buchanan, 1990) loss, these were also screened for in the larger study (see below).

Participants with DS and those with mixed-etiology ID were required to be between 10 and 21 years, pass the hearing screener (i.e. by responding to a tone verbally or physically two out of three times at 30dB HL or better in at least one ear at 1000, 2000, and 4000 Hz), and pass an autism spectrum disorder screener and/or an autism evaluation (i.e. Social Communication Questionnaire and/or Autism Diagnostic Observation Schedule with clinical best estimate). In addition, participants with mixed-etiology ID were required to have a school classification (i.e. determined by a licensed school psychologist) or clinical diagnosis of ID. Participants with TD were required to be between 4 and 21 years, not be receiving special education services, including speech-language therapy, and parents reported no diagnosis of attention deficit hyperactivity disorder. All participants were required to pass a vision screener using the LEA Near Vision Line Test (Good-Lite, n.d.) to ensure they could adequately see all test stimuli.

The present analyses included all participants from the larger study who completed the narrative language sampling task (i.e. used story-relevant speech on at least 75% of the pages) as part of that study. Thirteen participants with DS and one participant with TD did not meet this criterion and were excluded from analyses.

2.1.1. Group matching—Participants with mixed-etiology ID served as a chronological age matched comparison group, and participants with TD served as a nonverbal cognitive ability comparison group. We only considered groups matched if group comparisons were greater than $p = .50$ (suggested by Mervis & Klein-Tasman, 2004) with a small effect size (e.g. < .20) and a small variance ratio (suggested by Kover & Atwood, 2014; e.g. < 20). Both methods are based on the recognition that simply finding that two groups do not differ statistically significantly on a variable (i.e. $p > .05$) is not sufficient to justify accepting the null hypothesis (i.e. that the two population means are equal). Mervis and Klein-Tasman suggest a higher *p*-value (.50) to consider groups matched. Kover and Atwood argue that one can obtain a *p*-value of .50 because of inadequate power as well as because the two population means are the same, and thus suggest adding requirements around effect sizes and variance ratios. Matching on both methods increases the certainty with which we can claim that the groups are matched on nonverbal ability.

In the larger study, the full sample of participants with DS ranged in age from 10–21 years, while the full sample of participants with mixed-etiology ID ranged in age from 13–20 years. Therefore, to match the groups with DS and ID on chronological age in the present study, we excluded six of the youngest participants with DS. Our final samples of ID and DS were then adequately matched on chronological age, $t(60) = 0.33$, $p = .74$, Cohen's $d = .09$; variance ratio = 1.37.

Next, we compared groups on nonverbal cognitive ability (i.e. Leiter-R growth score values). Although the larger study included participants with TD from 4–21 years, to match the group with DS on nonverbal cognitive ability, only those ages 4–6 years were used in the present study. There was not a significant difference between the groups with DS and TD, ($t[62] = 0.74$, $p = .46$, Cohen's $d = .19$; variance ratio = 1.24); however, the group with ID had significantly higher nonverbal scores than both of the other groups (DS, [$t(60) = 2.72$, $p = .009$, Cohen's $d = .71$; variance ratio = 1.51]; TD, [$t(54) = 3.58$, $p = .001$, Cohen's $d = .96$; variance ratio = .82]). According to our criteria, groups were not considered matched on growth score values. To keep as many participants as possible, we therefore covaried Leiter-R growth scores in all analyses to account for the potential impact of nonverbal cognition on group differences.

2.1.2. Participants with DS (n = 35)—Age ranged from 11.70 – 21.96 years (Mean = 15.83, SD = 2.91), 37.1% male and 62.9% female. The sample was 71.4% White Non-Hispanic, 11.4% White Hispanic, 2.9% Black Non-Hispanic, 2.9% Asian/Pacific Islander, 8.6% Multi-Racial, and 2.9% Other. See Table 1 for additional descriptive characteristics.

2.1.3. Participants with mixed-etiology ID (n = 27)—Age ranged from 13.00 – 20.87 years (Mean = 16.07, SD = 2.49), 40.7% male and 59.3% female. The sample was 88.9% White Non-Hispanic, 3.7% White Hispanic, and 7.4% Black Non-Hispanic. The make-up of the group with ID was varied. Many did not know and/or did not report the cause of ID ($n = 10$) or reported genetic x environmental insult as the cause ($n = 3$). Another subset had fragile X syndrome ($n = 6$). All other causes of ID (e.g. cerebral palsy) were only represented with *n*'s = 1.

2.1.4. Participants with TD (n = 29)—Age ranged from 4.14 – 6.82 years (Mean = 5.24, SD = 0.72), 69% male and 31% female. The sample was 55.2% White Non-Hispanic, 3.4% White Hispanic, 34.5% Black Non-Hispanic, 3.4% Black Hispanic, and 3.4% Multi-Racial.

2.2. Measures

2.2.1. Nonverbal cognition (30–45 min.)—The *Leiter International Performance Test–Revised, Brief IQ* (Leiter-R; Roid & Miller, 1997) is a norm-referenced (for ages 2–21 years), standardized assessment and was used to measure nonverbal cognitive ability. We used the Brief IQ battery, which consists of four subtests: Figure Ground, Form Completion, Sequential Order, and Repeated Patterns. All subtests are administered nonverbally, and participants respond nonverbally. Brief IQ standard scores and age-equivalent scores were used to describe the samples, and growth score values (i.e. raw scores weighted for item difficulty) were used in analyses. The Brief IQ battery has good test-retest reliability for the ages included in this study (r = .88-.96) as well as good validity (correlates with Wechsler Intelligence Scale for Children, 3rd edition at r = .85).

2.2.2. Expressive language sampling procedure: Narration (10–15 min.)—This modified expressive language sampling procedure was developed by Abbeduto and colleagues to be sensitive to the needs of individuals with intellectual disabilities (e.g. Abbeduto, Benson, Short, & Dolish, 1995; Berry-Kravis, Doll, Sterling, Kover, Schroeder, Mathur, & Abbeduto, 2013; Kover, McDuffie, Abbeduto, & Brown, 2012). In the task, participants viewed a wordless picture book (Mercer Mayer's *Frog Goes to Dinner* or *Frog on His Own;* Mayer 1973; 1974) and after an initial viewing were instructed to tell the story to the examiner. During the initial viewing, the examiner controlled the length of exposure by turning the page every 10–12 seconds. When the participant was telling the story, the examiner waited 5–7 seconds after the participant finished talking before turning the page to allow participants adequate time for language planning. Examiners also used a standardized procedure for prompting when needed (see Channell, Loveall, Conners, Harvey, & Abbeduto, 2018). All participants' narrative language samples were audio-recorded during their story for later transcription. We used this task to analyze the production of verbs.

2.2.2.1. Transcription and Coding: Participants' audio-recorded narratives were digitally transcribed by trained personnel using Systematic Analysis of Language Transcription (SALT; Miller & Iglesias, 2006) software. Consistent with SALT conventions, participants' speech was first segmented into communication units (C-Units; an independent clause and is modifiers, including dependent clauses; Loban, 1976). Each participant's narrative was transcribed by a primary transcriber and checked by a secondary transcriber, with differences reconciled by the primary transcriber. Out of the full sample for the larger study, transcripts of 7 participants with DS (20%), 5 participants with mixed-etiology ID (19%), and 11 participants with TD (38%) were independently transcribed by a second set of transcribers and checked for inter-transcriber agreement on utterance segmentation, unintelligibility, abandoned utterances, mazes, overlaps, pauses, word identification, number of morphemes in words, and ending punctuation. Inter-transcriber agreement at the utterance level was averaged across these dimensions for each transcript. Average agreement was good

for the transcripts for the participants with DS (M = 86.46%, Range = 77.94 – 95.84), ID (M = 88.10%, Range = 77.69 – 94.22), and TD (M = 92.87%, Range = 86.05 – 96.36).

Transcripts were then coded for the presence of verbs by personnel trained to at least 90% agreement. Any verb produced during story-relevant speech received a code, regardless of whether it was used correctly in terms of syntax or semantics and regardless of whether the entire utterance was intelligible. Off-task speech (e.g. asking for a break) was not included. Eighteen transcripts (n = 7 DS; n = 5 mixed-etiology ID; n = 6 TD) from the current study's samples were coded by two independent coders and checked for inter-coder agreement regarding the number of verbs identified in each C-unit. Inter-coder agreement was high (. 97) for all verbs. More detail regarding transcription procedures and/or the coding scheme is available from the authors by request.

2.2.2.2. Dependent variables: Following transcription and coding, SALT was used to compute the dependent variables, including verb density, verb diversity, and verb TTR, for overall verb production and lexical verb production. For overall verb measures, all verbs (grammatical, lexical, main verbs, auxiliaries, etc.) were counted. Verb density was operationalized as the proportion of C-units containing at least one verb. Verb diversity was operationalized as the number of different verbs produced. Verbs using the same word root were counted only once, regardless of context of use or verb type (e.g. the verb form of "to be" was only counted one time, even if used as an auxiliary verb in one instance and as a copula in another). However, verbs with irregular number (e.g. *have* vs. *had*) or irregular tense endings (e.g. *teach* vs. *taught*) were counted separately. Verb TTR was operationalized as the number of different verb roots divided by the total number of different word roots. Only complete C-units were included in analyses (i.e. abandoned C-units, overlapping speech, and fully unintelligible C-units were excluded); partially intelligible C-units were included.

The narrative samples also were used to compute other variables for sample descriptive purposes, including MLU (i.e. mean length of C-units in morphemes, calculated using complete and fully intelligible utterances because it is not possible to determine length of unintelligible portions), lexical diversity (i.e. number of different word roots produced, calculated using complete utterances), and length (i.e. total number of C-units produced, calculated using complete utterances).

3. Results

3.1. Data Analysis

To address our research questions, we used analysis of covariance (ANCOVA) to compare groups on their production of verbs across three metrics: density, diversity, and verb TTR. All analyses included Leiter-R growth scores as a covariate. An alpha level of significance was set at .05. However, because we were interested in both DS vs. TD and DS vs. mixed-etiology ID contrasts, we followed up any marginally significant univariate analyses with pair-wise comparisons. Initial models examined overall verb production; for models reaching statistical significant, we analyzed additional models focusing specifically on lexical verbs.

Preliminary assumption testing revealed that several of the dependent measures were not normally distributed and that one participant in the group with ID was a statistical outlier on verb diversity. To control for these violated assumptions, each dependent variable was also analyzed separately using non-parametric statistics. The pattern of results was consistent across the two types of analyses. We have, therefore, only reported results from the ANCOVAs.

3.2. Descriptive Statistics and Correlations

Participant descriptive statistics are presented in Table 1. Means and standard deviations of the dependent variables are presented in Table 2. To further contextualize our group of interest, we conducted correlations among key variables in the group with DS. All dependent variables correlated significantly with nonverbal cognition, MLU, and lexical diversity. See Table 3 for correlation coefficients.

3.3. Primary Data Analyses

3.3.1. Overall verb density—There was a marginally significant difference between groups on verb density, $F(2, 87) = 2.64$, $p = .077$; partial eta squared = .06. Fisher's LSD pairwise comparisons revealed a significant difference in verb density between the groups with DS and TD (estimated marginal means = .75 and .86, respectively; $p = .03$). There were no significant differences between the groups with DS and mixed-etiology ID (estimated marginal mean = .81; $p = .25$) or between the groups with ID and TD ($p = .36$).

3.3.2. Overall verb diversity—There were no significant differences between groups on verb diversity, $p = .98$; partial eta squared = .001. Additional analyses examining overall verb diversity were conducted controlling for length and revealed the same pattern of results, $p = .55$; partial eta squared = .01. Because overall verb diversity was nonsignificant, we did not analyze lexical verb diversity.

3.3.3. Overall verb TTR—The ANCOVA revealed a statistically significant difference between groups in verb TTR, $F(2, 87) = 3.47$, $p = .04$; partial eta squared = .07. The difference in verb TTR was driven by a significant difference between the group with DS (estimated marginal mean = .32) and the group with ID (estimated marginal mean = .36), $p = .02$. There was also a marginally significant difference in performance between the groups with DS and TD (estimated marginal mean = .35; $p = .058$). There was not a significant difference between the groups with ID and TD ($p = .57$).

3.3.4. Lexical verb density—To complement the overall verb production findings that produced group differences, two additional ANCOVAs compared groups on lexical verb density and lexical verb TTR. Results of the first ANCOVA revealed a marginally significant difference between groups in lexical verb density, $F(2, 87) = 2.66$, $p = .076$; partial eta squared = .06. Pairwise comparisons revealed a significant difference between the groups with DS (estimated marginal mean = .63) and TD (estimated marginal mean = .73; $p = .03$). There were no significant differences between the groups with DS and ID (estimated marginal mean = .69; $p = .22$) or between the groups with ID and TD ($p = .40$).

3.3.5. Lexical verb TTR—A second ANCOVA examining lexical verb TTR did not find a significant difference between groups, $p = .74$; partial eta squared = .007.

4. Discussion

The purpose of the present study was to replicate and extend previous research on the production of verbs by individuals with DS by adding a comparison group of individuals with mixed-etiology ID matched by chronological age and statistically on nonverbal cognitive ability, in addition to a comparison group of TD children of similar nonverbal cognitive ability level. We employed three metrics of verb production: density (to reflect how often participants used verbs in their utterances), diversity (to measure the number of *different* verbs used), and TTR (total number of different verbs relative to number of different words produced). Each served a different purpose and collectively allowed for an in-depth analysis of verb production in DS.

Consistent with previous research (Hesketh & Chapman, 1998; Michael et al., 2012), our results indicated that participants with DS produced fewer C-units containing verbs (i.e. they had lower verb density scores) than participants with TD of similar nonverbal cognitive developmental level. Also consistent with previous research (Grela, 2002; Hesketh & Chapman, 1998), participants with DS in our study demonstrated relatively strong verb diversity (indicated by lack of significant group differences), though in our analyses participants with DS did not perform significantly better than comparison groups. Thus, although individuals with DS may have a large number of verbs in their vocabularies, they do not use them as regularly in their narration as younger, TD children of similar nonverbal cognitive ability levels.

It is not clear from our data why individuals with DS do not produce verbs as frequently as TD comparisons, despite producing just as wide of a variety of verbs. One possible explanation is that the production of verbs within sentences may tax cognitive skills, such as verbal short-term memory and working memory, that are already considered relative weaknesses in DS (e.g. Jarrold & Baddeley, 2001; Vicari, Carlesimo, & Caltagirone, 1995). This could manifest in difficulties accessing verbs (e.g. see Hesketh & Chapman, 1998) and holding and manipulating words, including verbs, in memory as they build sentences. It may also be tied to poor speech intelligibility (Kumin, 1994). Thus, individuals with DS may resort to omitting verbs from sentences, especially when verbs aren't obligatory by context (e.g. see Hesketh & Chapman, 1998) or required to get their meaning across to listeners.

Beyond replicating the verb density/diversity discrepancy relative to TD children, this study also extended prior research by including a chronological age-matched comparison group of individuals with mixed-etiology ID. Interestingly, there was not a significant difference between the groups with DS and ID in verb density, indicating that individuals with DS produced verbs as regularly as other individuals with ID. However, because our study was the first to include this comparison group, there is a need for replication.

We also examined group performance on verb TTR. Verb TTR considers verb diversity relative to the total number of different words produced, essentially accounting for potential

differences in expressive vocabulary. Group comparisons revealed a significant difference between the groups with DS and ID, and a marginally significant difference between the groups with DS and TD. In each case the group with DS had lower verb TTRs. This indicates that although individuals with DS had just as great of a variety of verbs in their vocabularies (as found in the verb diversity comparison), their narratives contained a lower percentage of different words that were verbs compared to the other participant groups, most notably the group with ID. This suggests that the syntactic frames associated with verbs may be problematic for individuals with DS and thus, they avoid verbs for syntactic reasons and rather than for lexical-semantic reasons.

Finally, we examined the production of lexical verbs specifically, as they have been highlighted in previous research (Grela, 2002; Hesketh & Chapman, 1998), to explore whether differences in lexical verb use were driving group differences in overall verb production. These analyses revealed a significant group difference in lexical verb density, again indicating that the group with TD produced more C-units that contained a lexical verb than the group with DS. Thus, underuse of lexical verbs may at least partly explain the differences observed in overall verb density.

However, the pattern of results changed for analysis of lexical verb TTR, as there were no longer significant group differences. This finding suggests participants with DS are producing a similar percentage of different lexical verbs to overall different words as their peers. Lexical verbs, therefore, do not appear to account for the observed group differences in overall verb TTR. Individuals with DS may, instead, not be using as many types of non-lexical verbs (i.e. auxiliary verbs and copula forms of “do”, “be”, and “have”) relative to other groups.

4.1. Links to Syntax

Although not directly tested in the present study, difficulties in verb production could underlie documented difficulties in expressive syntax for individuals with DS. To examine the relationship between verbs and syntax, we conducted correlations between our dependent measures of verb production and our measure of expressive syntax, MLU. As expected, MLU correlated significantly with all of the dependent variables in the group with DS. This provides some initial evidence that verb production is in fact related to syntactic abilities within DS. This is a particularly important consideration given the marked weaknesses in expressive syntax in this population, even relative to other domains of language development. These correlations, however, should be interpreted with caution, as the dependent verb variables were calculated from the same task as MLU. Further, correlations do not provide evidence of causation. It is possible that underuse of verbs underlies syntactic difficulties, but it is also possible that syntactic difficulties underlie reduced verb production, or even that neither causes the other.

Additionally, although MLU is an important clinical marker of syntactic development and serves as a convenient metric of expressive syntax in TD, it is possible that MLU overestimates syntactic ability level in individuals with communication disorders such as DS, whose sentences may become longer without becoming more syntactically complex (Scarborough, Rescorla, Tager-Flusberg, Fowler, & Sudhalter, 1991). This idea is seemingly

consistent with the pattern of findings across studies examining verb development in DS. Grela (2002) found that children with DS whose MLUs were in Brown's Stages III-IV did not differ in verb density from a group of TD peers matched on MLU. In contrast, Hesketh and Chapman (1998) did observe group differences, but their participants had slightly higher MLUs and were in Brown's Stages III, IV, and early V. The average MLU of our participants with DS was even higher at 6.67, although there was considerable variability. This could be evidence that, despite being related, verb production does not keep pace with MLU in individuals with DS. As MLUs increase for individuals with DS, their sentences may not necessarily become more syntactically complex. Instead, they may be using more simplistic language to convey their messages, often omitting verbs from their utterances.

4.2. Limitations and Future Directions

The present study was not without limitations. First, although we successfully matched the group with DS to the group with mixed-etiology ID on chronological age, the group with ID had higher nonverbal cognitive ability levels than the groups with DS and TD. Although we statistically controlled for this in analyses, future research should also examine the production of verbs in DS relative to other participants with ID of the same nonverbal cognitive ability level. The participants in the groups with DS and ID also spanned a wide age range; however, because chronological age was not correlated with our dependent variables, at least for the group with DS, it is unlikely this impacted our results. Further, although the group with ID was composed of participants with mixed-etiologies, six of those participants had fragile X syndrome. It is possible that the performance of the group with ID, then, includes some phenotypic characteristics of fragile X syndrome. Regardless, the group with ID provides an informative comparison to DS.

For the present study, we conscientiously decided to code verb use without requiring the correct grammatical or semantic use of the verbs. This allowed us to examine the extent to which individuals with DS were using verbs at all in their narratives, an important first step to understanding the complexities of verb production in this population. Given our initial findings, future studies may wish to consider accuracy of verb production to better understand how individuals with DS are using verbs both grammatically and semantically. Future research may also want to examine the use of arguments with verbs and how this impacts comprehensibility.

Future studies also should examine different verb types, such as the use of action, metalinguistic, and/or mental state verbs. Because some preliminary research has indicated that mental state language may be an area of relative difficulty for individuals with DS, (Beeghly & Cicchetti, 1997; Finestack, Palmer, & Abbeduto, 2012; Hesketh & Chapman, 1998; Keller-Bell & Abbeduto, 2007), this work should focus on mental state verbs relative to other parts of speech (e.g. adjectives), as well as the production of verbs, including mental state verbs, in other communication contexts (e.g. conversation). Future research should also directly test the relation of verb development to syntax within DS and examine the production of other understudied word categories, such as pronouns and adverbs, to gain a deeper understanding of language development in DS.

Finally, the present study focused on individuals with DS who speak English as their first language. An important question is how that capacity of individuals with DS to learn and use verbs interacts with the properties of the language to be learned. Are there cross-linguistic differences in the degree to which verbs are difficult for individuals with DS? Although there are few data on this point, there is some suggestion from studies using parent-report measures of early vocabulary that verbs also pose a challenge for children with DS learning Italian (Zampini & D'Odorico, 2011) but perhaps not for those learning Spanish (Checa, Galeote, & Soto, 2016). One direct assessment of language in Cypriot Greek adults with DS also reported mastery for tense and aspect of verb production (Christodoulou, 2013). It would be important to replicate and extend these findings using more direct assessment and observational measures of language. In any event, there is a pressing need for cross-linguistic studies of many facets of language learning and use in individuals with DS. Whether our findings replicate across languages and cultures remains to be determined.

4.3. Clinical Implications

These results indicate that clinicians should assess and possibly target verb production in clients with DS. Further, it may be possible to capitalize on strengths in vocabulary and focus on building syntax around known vocabulary words that are verbs. For example, clinicians could work with clients who have DS to learn different tenses of verbs and to use verbs in a variety of different syntactic frames. Clinicians could also ask questions and scaffold responses to ensure that clients practice producing verbs in each of their utterances. Clinicians should also work with parents and caregivers, teaching them to encourage their children with DS to incorporate verbs into their everyday language by varying their input during interactions with their children.

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Highlights

- Participants with DS used fewer utterances with verbs than TD comparisons
- Participants with DS used fewer utterances with lexical verbs than TD comparisons
- Diversity of verb use varied by analysis with some group differences
- Aspects of verb diversity were limited in DS relative to intellectual disability

What this paper adds?

The present study contributes to the literature on intellectual and developmental disabilities by examining the profile of verb production by individuals with Down syndrome relative to both typical development and to intellectual disability more broadly. Results indicate that during a narrative story generation task, participants with Down syndrome produced narratives with less verb density than participants with typical development and had significantly smaller verb type-token ratios than participants with intellectual disability. When examining lexical (main) verb production, specifically, participants with Down syndrome also produced narratives with less lexical verb density than participants with typical development. These results suggest that individuals with Down syndrome struggle with some aspects of verb production, which may be linked to difficulties with syntax. Understanding the pattern of verb production in individuals with Down syndrome will provide insight into the sources of their difficulties in expressive syntax and identify targets for intervention.

Table 1

Participant Descriptive Statistics

	DS*n* = 35		ID*n* = 27		TD*n* = 29	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Age	15.83	2.91	16.07	2.49	5.24	.72
	(11.70–21.96)		*(13.00–20.87)*		*(4.14–6.82)*	
IQ	45.69	9.51	53.22	10.57	107.28	13.22
	(36–71)		*(36–77)*		*(85–135)*	
AE	5.67	1.17	6.39	.99	5.46	1.15
	(3.67–8.42)		*(4.42–7.63)*		*(4.42–9.13)*	
GSV	470.17	10.62	477.00	8.64	468.28	9.53
	(449–492)		*(458–487)*		*(458–496)*	
MLU	6.67	3.06	7.31	1.82	6.93	1.23
	(2.23–18.43)		*(3.77–10.54)*		*(3.49–10.15)*	
Lexical Diversity	112.89	52.80	117.11	49.82	105.83	31.88
	(34–225)		*(36–309)*		*(47–168)*	
Length	62.57	28.29	66.19	59.63	57.86	24.16
	(22–132)		*(22–344)*		*(24–109)*	

Note: DS = Down syndrome. ID = mixed-etiology intellectual disability. TD = typical development. Age = Chronological age. IQ = Leiter-R Brief IQ Intelligence Quotient. AE = Leiter- R age equivalent scores. GSV = Leiter-R Growth Score Value. MLU = mean length of C-unit in morphemes, calculated using complete and intelligible utterances. Lexical diversity = number of different word roots produced, calculated using complete utterances. Length = total number of C-units produced, calculated using complete utterances.

Table 2

Original means and standard deviations for dependent variables

	DS*n* = 35		ID*n* = 27		TD *n* =29		Significant group differences[+]
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Verb density	.74	.23	.84	.17	.84	.19	TD > DS *p* =.03
	(.21–1.00)		*(.36–1.00)*		*(.35–1.00)*		
Verb diversity	36.86	19.65	42.26	21.76	36.48	13.82	
	(7–80)		*(16–134)*		*(13–67)*		
Verb TTR	.32	.06	.36	.05	.34	.06	ID > DS *p* = .02
	(.18–.41)		*(.22–.44)*		*(.17–.45)*		TD > DS *p* = .058
Lexical verb density	.62	.21	.72	.14	.71	.17	TD > DS *p* = .03
	(.16–.94)		*(.29–.88)*		*(.24–.97)*		
Lexical verb diversity	28.60	15.62	30.52	13.98	27.07	11.62	
	(6–58)		*(8–83)*		*(9 –60)*		
Lexical verb TTR	.25	.05	.26	.04	.25	.06	
	(.11–33)		*(.14–.33)*		*(.11–.36)*		

Note: DS = Down syndrome. ID = mixed-etiology intellectua disability. TD = typical development. TTR = type-token ratio.

[+]These group differences are based on estimated marginal means controlling for nonverbal cognitive ability (i.e. Leiter-R GSV), which are presented in the text. They are not based on the raw means presented in Table 2.

Table 3

Correlations among key variables for the group with Down syndrome

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	--											
2. IQ	.15											
3. GSV	.20	.89***	--									
4. MLU	.15	44**	.54**	--								
5. Lexical diversity	.01	.36*	.40*	.73***								
6. Length	.16	.08	.03	.09	.69***							
7. Verb density	.06	.27	.37*	.75***	.54**	.01	--					
8. Verb diversity	.07	.42*	.47**	.78**	.96**	.59**	.63**	--				
9. Verb TTR	.22	.36*	.45*	.53**	.40*	.03	.75***	.60***	--			
10. Lexical verb density	.08	.35*	.45**	.76***	.48**	-.09	.95***	.58***	.76***			
11. Lexical verb diversity	.08	.38*	.45**	.76***	.95***	.58***	.64***	.98***	.60***	.61***		
12. Lexical verb TTR	.23	.28	.39*	.47**	.34*	-.01	.70***	.52**	.89***	.77***	.59***	

Note: Age = Chronologica age. IQ = Leiter-R Brief IQ Intelligence Quotient. GSV = Leiter-R Growth Score Value. MLU = mean length of C-unit in morphemes, calculated using complete and intelligible utterances. Lexical diversity = number of different word roots produced within the first 50 C-units, calculated using complete utterances. Length = total number of C-units produced, calculated using complete utterances. TTR = type-token ratio.

* p <.05

** p <.01

*** p <.001