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Research Article

Cross-Sectional Trajectories of Mental State Language Development in Children With Down Syndrome

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Purpose: This article (a) examined the cross-sectional trajectories of mental state language use in children with Down syndrome (DS) and (b) identified developmental factors associated with its use.
Method: Forty children with DS aged 6–11 years generated stories from a wordless picture book and completed an assessment battery of other linguistic, cognitive, and social–emotional skills. Their narratives were coded for mental state language density (the proportion of utterances containing mental state references) and diversity (the number of different mental state terms used).
Results: The emergence of mental state language use during narrative storytelling was observed across the sample; 0%–24% of children's utterances included references to mental states, and a variety of mental state terms were produced. Cross-sectional developmental trajectory analysis revealed that expressive vocabulary and morphosyntax were significantly related to increased mental state language density and diversity. Nonverbal emotion knowledge was significantly related to greater diversity of mental state terms used. Age and nonverbal cognition were not significant factors.
Conclusions: This first in-depth, within-syndrome characterization of mental state language use by school-age children with DS provides an important next step for understanding mental state and narrative development in this population. By identifying skills associated with the development of mental state language, this study provides an avenue for future longitudinal research to determine causal relationships, ultimately informing intervention efforts.

Down syndrome (DS) is the most common genetic cause of intellectual disability (Presson et al., 2013), meaning that individuals with DS usually have delayed cognitive development resulting in an IQ at least 2 *SD*s below the population mean and significant challenges in adaptive functioning (i.e., self-help and practical skills that contribute to independent daily living; Schalock et al., 2010). Although a wide range of skills are observed across individuals with DS (Karmiloff-Smith et al., 2016), the literature has documented a behavioral phenotype of relative strengths and weaknesses that are characteristic of many individuals with DS (Grieco et al., 2015). One of the most prominent features of the DS phenotype is difficulty with language development, particularly in the area of expressive language (Abbeduto et al., 2007; McDuffie et al., 2017). Within the expressive language domain, difficulties in narrative storytelling—communicating important stories or past events to others—have been observed (Boudreau & Chapman, 2000; Channell et al., 2015; Finestack et al., 2012; Hogan-Brown et al., 2013; Miles & Chapman, 2002).

A key component of well-developed narratives is the use of mental state language—references to people's emotions, thoughts, intentions, and so forth—that enables one to talk about internal states and perspectives. Mental state language enriches narratives by providing details such as character motivations and reactions; it also provides a prosocial avenue for expressing one's own thoughts and empathizing with others. In contrast, the failure to use mental state language constrains one's opportunities to discuss, empathize, and connect with others, thus impacting peer relations and social competence (Carpendale & Lewis, 2006; Symons, 2004). Because mental state language is so important for narrative storytelling and social interaction, it is important to understand how it develops in DS. Such data are critical to determining the need for and the nature of interventions to support narrative and social skills in individuals with DS. The purpose of this study, therefore, was to characterize the development of mental state language use during narrative storytelling by children with DS.

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Developmental Progression of Mental State Language Use

Typically Developing Children

In typical development, children begin using mental state language during play and conversation at about the age of 2.5 years. These early uses of mental state language tend to focus on perception (e.g., *see, hear*) or desire (e.g., *want, need*) words with many references to the self (Bretherton & Beeghly, 1982; Moore et al., 1994). By the age of 3 years, typically developing children are using basic emotion words (e.g., *happy, sad*; Bretherton et al., 1986), and by the age of 4 years, they are making some cognitive state references (e.g., *think, know;* Bretherton & Beeghly, 1982; Hughes & Dunn, 1998; Moore et al., 1994). Throughout the preschool years, mental state language use develops rapidly, with children increasing their frequency and diversity of use across referents ("self" vs. "other") and communication contexts (e.g., conversation and narration) over time, albeit with individual variation in rate of development (Bartsch & Wellman, 1995; Hughes & Dunn, 1998).

Individuals With DS

A limited number of studies have focused on mental state language use in children with DS across communication contexts. For example, during free-play, young children with DS have shown delayed mental state language use (Beeghly & Cicchetti, 1997; Tager-Flusberg, 1992). More specifically, compared to mental age–matched typically developing children, spontaneous use of mental state language was reduced in 2- to 7-year-olds with DS during play, both in the frequency and diversity of mental state words used (Beeghly & Cicchetti, 1997). Similarly, delays in mental state language use by 3- to 6-year-olds with DS during free play have been observed to the same degree as children with autism spectrum disorder matched on mean length of utterance (MLU), a metric of expressive morphosyntax (Tager-Flusberg, 1992). From this preliminary evidence of early uses of mental language, it appears that mental state language is delayed in young children with DS.

Assessing mental state language use in the context of narrative storytelling. As children enter the school-age years during middle childhood, narrative storytelling becomes a prominent context for everyday communication (Berman, 1995; McCabe & Peterson, 1991). Because mental state language is a key component of narratives, narrative storytelling also serves as an excellent context for examining mental state language use. In particular, the structure of fictional stories provides ample opportunity to discuss other characters' mental states rather than focusing only on one's own, which can happen during personal narratives. Furthermore, for school-age children with DS who often struggle with expressive language, narrative storytelling has the potential for serving as a functional communication context for teaching mental state language and other key skills.

Only one study to date has focused directly on mental state language use by individuals with DS during narration (Reilly et al., 1990). Reilly et al. (1990) documented less use of affective and other mental state terms in fictional narratives by adolescents with DS (exact ages not provided) compared to peers with Williams syndrome (matched on age and IQ) and children with typical development (matched on mental age from a full-scale IQ test). With four participants in each group, these data are best considered preliminary but again point to a delay in mental state language use in older children with DS in the context of narrative storytelling.

A few other studies examining broader aspects of narrative storytelling in adolescents and young adults with DS provide additional insight into their mental state language use (Finestack et al., 2012; Keller-Bell & Abbeduto, 2007). For example, Finestack et al. (2012) used the Narrative Scoring Scheme to examine the highlights of fictional narratives, including use of mental state language, in 12- to 23-year-olds with DS. They found no differences between those with DS and peers with fragile X syndrome (another form of intellectual disability) or younger typically developing children matched by nonverbal cognition or MLU. However, to examine mental state language, the groups were compared by whether they were categorically "poor" or "proficient" in their use of mental state terms and thus only captured a rough estimate of mental state language use.

Similarly, another study used "high-point analysis" to count only the number of mental state verbs (as opposed to other types of mental state language, such as adjectives) used in fictional narratives produced by 12- to 23-year-olds with DS (Keller-Bell & Abbeduto, 2007). They found no differences between the participants with DS and their age-matched peers with fragile X syndrome or younger typically developing children matched on nonverbal cognition. In contrast, Ashby et al. (2017) documented less inferential language (i.e., references to nonliteral aspects of a story that require inferencing, such as character motivations, actions, dialogue, and internal states) in the narratives of 10- to 16-year-olds with DS than in younger typically developing children matched by nonverbal cognition. Interestingly, however, these group differences in inferential language use were no longer significant after statistically controlling for MLU.

From these studies, the evidence seems mixed on whether mental state language is delayed relative to general developmental level in older children and adolescents with DS. Because the studies have only included coarse metrics of mental state language use across wide age ranges, it is difficult to draw many conclusions about the nature of mental state language development in this population. Furthermore, Ashby et al.'s (2017) findings on inferential language suggest that observed delays may reflect syntactic constraints, although this has not been directly tested. In other words, the degree of delay in mental state language use in DS and the contribution of syntactic limitations are not yet known. Similarly, how the behavioral phenotype of relative strengths and weaknesses in DS affects the development of mental state language use is also unknown.

Interventions targeting mental state language use. To our knowledge, in the literature, there are no evidence-based interventions designed to target mental state language in individuals with DS or other types of intellectual disability. One recent intervention, however, has targeted communication about emotions, specifically, through aided augmentative and alternative communication (AAC) with school-age children with DS during parent–child narrative storytelling (Na & Wilkinson, 2018). If upheld in future research, this may be a useful tool for increasing opportunities to communicate about others' emotions and learn emotional state vocabulary in this population. It could also be expanded to include communication about other types of mental states (e.g., cognition, desire).

There are also some promising narrative language interventions for older children and adolescents with DS or fragile X syndrome in which mental state language could be incorporated as a target (Finestack et al., 2017; Nelson et al., 2018). However, there is not yet an evidence base for interventions targeting mental state language in populations with intellectual disability such as DS. Thus, the current study fills a critical gap by characterizing mental state language and its related skills in this population. Importantly, determining the skills associated with mental state language use in DS will inform clinicians regarding relevant skills to assess and target within an intervention framework.

Skills Associated With Mental State Language Use

Typical Development

A foundational understanding of how mental state language use unfolds in typical development can provide guidance about the relevant factors to consider when examining mental state language use in DS. Mental state language use requires an array of supporting skills that can explain, at least in part, individual differences in typical development. For example, in the cognitive domain, abstract reasoning is needed to understand and reflect on the concept of internal (i.e., intangible) states and build mental representations of "self" and "other" (Carpendale & Lewis, 2006; Symons, 2004). Specific vocabulary (e.g., *think, know, happy, sad*) is also required to label these states. In addition, complex syntax (e.g., embedded clauses such as *He didn't know that the frog was in his cup*) and pragmatic skills (e.g., coordination of "self" and "other" perspectives) are needed to communicate mental state language. Although these foundational skills develop throughout childhood, like mental state language, they show rapid maturation during the preschool years. Children begin using a variety of sentence types, including the use of multiclause forms and various morphosyntactic features (e.g., adding prefixes and suffixes to change meaning, changing verb tense; Hoff, 2014). Along with an expanded vocabulary, these skills allow children to communicate more complex ideas and, importantly, use decontextualized language to talk about abstract concepts such as mental states. Likewise, talking about one's own and others' mental states can further facilitate the development of abstract reasoning (Carpendale & Lewis, 2006; Symons, 2004).

Also, during the preschool years, as children acquire the ability to take others' perspectives, emotion knowledge (e.g., knowing that a child whose toy just broke probably feels sad) develops (Bassett et al., 2012; Denham et al., 2003; Pons et al., 2003). Several studies have causally linked emotion knowledge and structural language abilities (e.g., vocabulary and syntax) to mental state language use, but with varying theories of directionality and the relative roles of each skill (e.g., Ensor & Hughes, 2008; Grazzani & Ornaghi, 2011; Harris et al., 2005; Ruffman et al., 2003; Symons, 2004). Regardless, emotion knowledge and structural language skills are intricately linked with mental state language use and collectively support children's social and communicative development.

The DS Phenotype

It is likely that some of the same skills that support mental state language use in typically developing children (cognitive reasoning, structural language, and emotion knowledge) are also important to mental state language development in DS. However, because individuals with DS also have intellectual disability, cognition is delayed. Furthermore, in contrast to typical development, skills tend to develop slowly and at disparate rates across domains in individuals with DS. This leads to a phenotypic profile of relative strengths and weaknesses across social, cognitive, and linguistic skills (Grieco et al., 2015).

As a whole, language is generally an area of relative weakness in DS (Abbeduto et al., 2007; McDuffie et al., 2017). Within language, the phenotype shows particular difficulty in expressive language and in morphosyntax, delayed even relative to nonverbal cognition (Chapman & Hesketh, 2000; Chapman et al., 1998; Finestack & Abbeduto, 2010; Kover et al., 2012; Miller, 1999). Another feature of the DS phenotype includes relatively strong social–emotional abilities, at least in early-developing skills (Cebula et al., 2010; Fidler, 2006; Fidler et al., 2008). Emotion knowledge—recognizing others' expressions of emotion and understanding their causes—appears as a strength in older youth and adults with DS. This comes from recent evidence that individuals with DS can recognize others' basic emotions during tasks when language processing and memory demands are low (Carvajal et al., 2012; Cebula et al., 2017; Channell, Conners, et al., 2014; Hippolyte et al., 2009; Pochon & Declercq, 2013; but see K. R. Williams et al., 2005). There is also evidence, however, that these rudimentary social–emotional strengths may not support later developing, more complex social cognitive abilities such as perspective-taking (Cebula et al., 2010; Hahn, 2016). The potential difficulty in perspective-taking paired with the challenges in expressive language so ubiquitous to the DS phenotype suggests that learning to use mental state language may be especially challenging for individuals with DS, although this requires further investigation.

The Current Study

The current study provides an in-depth examination of mental state language use in school-age children with DS during narrative storytelling. A developmental approach toward understanding narrative development and mental state language in DS is imperative for moving the field forward and guiding intervention for this population. This study takes an important next step by using what is known about the DS phenotype in conjunction with typical development to characterize how mental state language use unfolds in individuals with DS.

Accordingly, the specific aims were (a) to specify the cross-sectional developmental trajectory of mental state language use in DS and (b) to examine the influence of key developmental domains—nonverbal cognition, structural language (expressive vocabulary and morphosyntax/MLU), emotion knowledge, and age—on these trajectories. Age was also included as a developmental marker because, for populations with intellectual disability such as DS, age can serve as a general proxy for life experience or social development. The resulting data will reveal insights into the developmental skills that support and constrain mental state language use in DS, which will inform intervention work to promote its use.

Method

Participants

Forty school-age children with DS aged 6–11 years participated in this study. This age range in DS includes children whose cognitive developmental levels are expected to fall roughly within the 3- to 5-year range, when consistent mental state language use emerges during typical development. Additionally, due to the impact of mental state language on domains of functioning that become increasingly meaningful during adolescence (personal identity, reciprocal friendships) and adulthood (employment, community inclusion), this study focuses specifically on the development of this type of vocabulary in individuals with DS during middle childhood (i.e., ages 6–11 years), the formative years leading to adolescence.

Participants were recruited from national and regional parent support groups, community service providers, and participant registries (National Institutes of Health's DS-Connect, University of Alabama's Intellectual Disabilities Participant Registry), resulting in a sample from 10 states across the Midwestern, Southern, and Eastern United States. Children with DS in the current study used speech as their primary mode of communication, regularly spoke in phrases or sentences, and spoke English as their primary language.

Additional criteria for the current study were that the child (a) provided story-relevant speech on at least some of the book pages during the narrative storytelling task and (b) was sufficiently compliant that the examiner was able to maintain the child's interest and present each page of the book. Three children could not complete the narrative task due to behavioral noncompliance/refusal, resulting in a final sample size of 37 children aged 6.00–11.83 years (M = 8.60, SD = 1.67). Reported family income ranged from \$32,000 to \$500,000 annually (Mdn = \$100,000). The sample was 75.7% White, non-Hispanic; 13.5% Black or African American; 8.1% More than one race; and 2.7% Other. They were 64.9% female.

Overview of Procedure

Participants completed a battery of social, cognitive, and language assessments across one session with breaks provided as needed, although not all measures are pertinent to the current study. For the current study, participants completed a child narrative task from which mental state language and expressive morphosyntax were derived, the Expressive Vocabulary Test–Second Edition (EVT-2; K. T. Williams, 2007), the Leiter International Performance Scale–Third Edition (Leiter-3; Roid et al., 2013; test of nonverbal cognition), and the Emotion Judgment Test (EJT; Channell, Conners, et al., 2014; test of emotion knowledge). For this age group, narrative storytelling is an age-appropriate everyday communication context for the use of mental state language and thus was selected for the current study. Fictional narratives were elicited using a wordless picture book paradigm because fictional stories focus on other characters, providing structured opportunities to talk about others' mental states. They also provide a built-in story structure to ease the cognitive burden of narration. In other words, if school-age children with DS are able to talk about others' mental states, wordless picture books provide an optimal context for eliciting mental state language use.

The order of assessments was counterbalanced. The entire session lasted approximately 3 hr, including all breaks. Ten families participated at our laboratory on campus, whereas an assessment team traveled to nine sites (e.g., DS community center, public library, or hotel conference room) for the 27 families who could not travel to our laboratory. All sessions were completed individually with trained examiners and were video- and audio-recorded.

The examiners were the author and four of her master's students in speech-language pathology. The student clinicians were trained to fidelity by the author. Fidelity training involved learning to administer the test battery one-on-one in the laboratory and then practicing with young, typically developing pilot participants. After each pilot participant, the author provided the student with verbal and written feedback. Once the student accurately administered the assessments to two consecutive pilot participants, she was considered fully trained. To determine fidelity of administration in the child narrative task, a scoring rubric was used. The rubric assigns points for correctly administering specific elements of the task, including adherence to the script, waiting the appropriate amount of time before prompting or turning the page, appropriately using the prompt hierarchy, and so forth (see Channell et al., 2018, for specifics). Achieving a minimum of 90% accuracy with two consecutive pilot participants was required to reach administration fidelity for this task. Additionally, the author was present for the testing sessions of the participants with DS to ensure that student clinicians maintained procedural fidelity. The author intervened if needed and determined when to exclude an individual's data due to examiner error. All data were double-scored and double-entered, with discrepancies resolved by the author.

Test Battery

Child Narrative Task

A narrative language sampling task was used to capture participants' mental state language use and morphosyntax via story generation from a wordless picture book.

Procedure. Procedures developed by Abbeduto and colleagues (Abbeduto et al., 1995; Kover & Abbeduto, 2010; Kover et al., 2012) were followed such that participants were shown *Frog Goes to Dinner* (Mayer, 1974) or *Frog on His Own* (Mayer, 1973; book version counterbalanced across the sample). During the initial viewing, the examiner showed the child each page of the book without discussing the story (approximately 10–12 s of exposure to each page spread). Next, the participant was instructed to tell the story to the examiner while looking through the book pages a second time. A hierarchy of examiner prompts was scripted and used as needed to minimize examiner influence on the child's story while keeping the child on task (see Channell et al., 2018, for specifics).

Transcription. A team of transcribers trained to fidelity using Systematic Analysis of Language Transcripts (Miller & Iglesias, 2012) software conventions digitally transcribed the child narrative samples verbatim from audio recordings. Children's utterances were segmented into communication units (C-units; i.e., an independent clause and any modifiers, which could include a dependent clause), recommended for children with language levels beyond the age of 3 years (Loban, 1976). Each sample was first transcribed by a primary transcriber and then checked by a second transcriber, with differences resolved by the primary transcriber. Twenty percent of the narrative language samples were transcribed independently by a different transcriber to assess consistency across the life of the project. Intertranscriber agreement ranged from 87% to 94%, averaging 90% across the dimensions of utterance segmentation, unintelligibility, abandoned utterances, mazes, overlaps, word identification, number of morphemes in words, and ending punctuation, with agreement computed at the utterance level.

Coding mental state language. One master's student and one undergraduate honors student in speech-language pathology coded the transcripts for use of mental state language by the child. All instances of mental state language were coded unless used in speech that was clearly off task (e.g., asking the examiner a nonstory question) or idiosyncratic and not representative of a mental state (e.g., *I don't know* or *happily ever after*).

Each mental state term was coded by subcategory at the word level. This included references to cognition (e.g., *think, know*), desire (e.g., *want, wish*), perception (e.g., *see, hear*), emotion behaviors (e.g., *laugh, cry*), emotion states (e.g., *happy, sad*), and physiological states (e.g., *hungry, tired*). The subcategory coding scheme was adapted from others commonly used in the literature on typically developing children (Bartsch & Wellman, 1995; LaBounty et al., 2008). Specifically, LaBounty et al.'s (2008) subcategories of "thought" (cognitive) words, desire words, and emotion words were used. For the current study, however, emotion words were subdivided into emotion states (adjectives) and emotion behaviors that are representative of underlying states (verbs) to reflect use of different parts of speech (see Tager-Flusberg, 1992). Additionally, to keep the focus on internal states, references to personality traits (e.g., *nice, funny, shy*) were not coded. Physiological states, however, were included as a subcategory (see Wellman et al.,1995). See Appendix B for a list of the mental state words used by participants and their subcategories.

Coders were initially trained by the author to apply the coding scheme to practice transcripts of children's narratives that had been previously coded in a pilot study. Each coder was provided with feedback prior to coding the next practice transcript. Once the coder independently coded two consecutive transcripts with at least 85% agreement for the individual word codes by subcategory (i.e., the number of agreements for the individual subcategory divided by the number of mental state words identified in the "standard" transcript), she was considered trained to fidelity. Also, with these training transcripts, each coder surpassed 95% agreement at the utterance level (i.e., the presence or absence of a mental state term, regardless of subcategory) compared to the "standard" transcript.

During coding of the current study's participant transcripts, if a coder was unsure about a particular word, she flagged it for consensus discussion with the other coder and the author. Additionally, 20% of the participants' narratives were coded independently by the second coder to assess consistency. Average intercoder agreement, defined as the number of agreements at the utterance level regarding the presence or absence of mental state language, was 99%. Average agreement for the individual codes within transcripts was 81% (*Mdn* = 92%), influenced more heavily by the limited amount of mental state language in some of these transcripts.

Measures of mental state language. Two metrics of mental state language were computed for analyses: "density" (the proportion of C-units containing at least one mental state term) and "diversity" (the number of different mental state terms used). Density provides a metric of how frequently the individual included mental state language in their narrative. Diversity indicates how many different mental state vocabulary terms the individual used in the narrative; this differentiates someone who may be using only the same one or two terms frequently throughout the narrative from one who uses a broader variety of terms. Abandoned and interrupted C-units were excluded from analyses, resulting in the exclusion of 3% of participants' C-units.

Measure of morphosyntax. Transcripts derived from the child narratives were also used to assess children's expressive morphosyntax. Mean length of C-unit (MLU) in morphemes was computed in Systematic Analysis of Language Transcripts. For this variable, in addition to abandoned and interrupted utterances, C-units containing unintelligible portions were also excluded from analyses. Fifteen percent of children's C-units contained some unintelligible segments (5% of which were completely unintelligible C-units).

EVT-2 (K. T. Williams, 2007)

The EVT-2 is a standardized assessment of expressive vocabulary knowledge normed for ages 2.5–90+ years. Participants were asked to say the name of the object, person, or action displayed in a picture by answering the examiner's question using a single-word response. Split-half reliability ranged from good to excellent (.88–.97) across the age ranges of the normative sample, and test–retest reliability was strong (.94–.97). Age-based standard scores were used in analyses. Standard scores are missing for three participants due to examiner error regarding basals and ceilings.

Leiter-3 (Roid et al., 2013)

The Leiter-3 is a standardized assessment of nonverbal cognition normed for ages 3–75 years. It is administered nonverbally such that the examiner uses only gestures and facial expressions to prompt, and the examinee responds via pointing or other nonverbal means. The Leiter-3 demonstrates good internal consistency reliability across composite scores (.94–.98). We administered the four cognitive subtests (Figure Ground, Form Completion, Classification and Analogies, and Sequential Order) that yield a nonverbal IQ composite score, which was used in analyses.

EJT (Channell, Thurman, et al., 2014)

The EJT is a nonverbal measure of emotion knowledge that assesses the participant's ability to recognize other children's emotions (happiness, sadness, and fear) from dynamic videos of their facial expressions and/or the social context (e.g., a child dropping their ice cream cone). The EJT was modeled after common child emotion knowledge tasks used in the typical population but modified for use in populations with intellectual disabilities such as DS who have limited language processing abilities. The modifications were to make the presentation of the stimuli nonverbal (e.g., showing videos rather than telling vignettes) and to provide a nonverbal response option. The EJT has been validated in a sample of school-age youth with DS and a sample of typically developing preschool-age children, with good internal consistency reliability (i.e., .81–.87; Channell, Thurman, et al., 2014).

Procedure. Short videos were presented to participants on an iPad. Emotion cues varied across face-only, context-only (facial expression digitally masked), and context-plus-face conditions. The video sets were counterbalanced by emotion cue condition (six videos per condition, expressing happiness, sadness, or fear twice each).

After each video, the examiner paused and asked the participant to verbally label, if possible, how the child felt from choices presented by the examiner (*happy*, *sad*, or *scared*) and to point to the schematic drawing representing how the child felt. Because schematic faces were used as the nonverbal response method, participants were required to pass a screener to ensure they could reliably identify each emotion. This involved pointing to the correct schematic face in response to the examiner's emotion label (e.g., *Point to the happy face*) at least two out of three times with feedback. Four participants could not pass the screener and thus were not administered the EJT.

Measure of emotion knowledge. Participants received 1 point for labeling and 1 point for pointing to the correct emotion across the 18 trials. All participants in this sample were able to provide verbal labels in addition to pointing responses, so composite scores (i.e., the proportion correct across response methods and emotion cue types) were used in primary analyses. A fourth video condition was also presented at the end of the EJT but not included in this study's analyses because it yields supplementary scores on a different scale that do not factor into the emotion knowledge composite.

Results

Aim 1

To examine the emergence of mental state language use across the sample, the distribution of scores for both mental state language density (i.e., the proportion of utterances containing mental state language) and diversity (i.e., the number of different mental state terms used) was plotted. See Table 1 for descriptive information. Six participants (16%) did not include any mental state language in their narratives. On average, 9% of children's utterances contained mental state language, although scores were highly variable (density score: $M = 0.09$, $SD = 0.07$). The average diversity score was 4.03 words, again with high variability ($SD = 4.19$). The most commonly used mental state words were *happy* (emotion adjective), *sad* (emotion adjective), *see* (perception), and *cry* (emotion verb). See Appendix A for a list of the commonly used terms in participant narratives.

Aim 2

To explore the characteristics associated with both mental state language density and diversity measures, cross-sectional developmental trajectories were examined (Thomas et al., 2009). Using principles of linear regression, trajectories of mental state language use (outcome variables: density and diversity) were plotted over each independent variable (developmental markers: MLU, expressive vocabulary, emotion knowledge, nonverbal cognition, age). For each model, assumptions of normality, linearity, and constant variance were checked and met. Potential outliers were identified, and models were fit both with and without them to evaluate their overall influence. Main results are presented from models excluding the outliers, although results are also provided when outliers were included to show

Table 1. Mental state language (MSL) and other key variables.

Variable	Range	*M* (*SD*)
MSL density (proportion of C-units containing MSL)	.00–.24	.09 (.07)
MSL diversity (number of different mental state terms used)	0–17	4.03 (4.19)
Mean length of C-unit (MLU) in morphemes	1.18–8.17	3.47 (1.82)
EVT-2 standard scores[a]	41–94	65.41 (13.03)
Leiter-3 nonverbal IQ	41–75	59.92 (8.87)
EJT emotion knowledge proportion scores[b]	.17–1.00	.78 (.20)

Note. MLU = mean length of utterance; EVT-2 = Expressive Vocabulary Test–Second Edition; Leiter-3 = Leiter International Performance Scale–Third Edition; EJT = Emotion Judgment Test.

[a]*n* = 34. [b]*n* = 33.

their influence. The models remained significant with or without the outliers, with the exception of expressive vocabulary predicting mental state language density scores, as indicated below. All figures represent the final models excluding any outliers.

MLU

The model examining mental state language density relative to MLU was significant, $F(1, 33) = 27.31$, $p < .001$, $R^2 = .45$, demonstrating a linear increase in the proportion of C-units containing mental state language with increasing MLU (i.e., expressive morphosyntax; $\beta = .67$). See Figure 1a for a visual representation of this cross-sectional trajectory. Two bivariate outliers were identified and determined to significantly influence the model and thus were excluded from the model reported (MLU $\beta = .43$, $p = .01$ when outliers were included).

The model examining mental state language diversity relative to MLU also was significant, $F(1, 34) = 56.12$, $p < .001$, $R^2 = .62$, demonstrating a linear increase in the number of different mental state terms used with increasing expressive morphosyntax ($\beta = .79$; see Figure 1b). In this model, one bivariate outlier was determined to have undue influence and thus was excluded from the model reported (MLU $\beta = .69$, $p < .001$ when the outlier was included).

Additional exploratory analyses were conducted using MLU from only the utterances that did not contain any mental state language (MLU range: 1.18–8.04, $M = 3.35$, $SD = 1.74$) to determine if MLU was still associated with mental state language use during narration. The pattern of findings was consistent with those from the original MLU models—both models for density ($p = .02$, $R^2 = .15$) and diversity ($p < .001$, $R^2 = .58$) relative to MLU from utterances without mental state language were significant.

Expressive Vocabulary

The mental state language density model including expressive vocabulary was significant, $F(1, 31) = 7.27$, $p = .01$, $R^2 = .19$, demonstrating a linear increase in the proportion of C-units containing mental state language with increased vocabulary knowledge ($\beta = .44$; see Figure 2a). Again, one bivariate outlier was determined to have undue influence and thus was excluded from the model reported. This model was not significant when the outlier was included (Expressive Vocabulary $\beta = .26$, $p = .14$).

The mental state language diversity model with expressive vocabulary also was significant, $F(1, 31) = 16.04$, $p < .001$, $R^2 = .34$, demonstrating a linear increase in the number of different mental state terms used with increased vocabulary knowledge ($\beta = .58$; see Figure 2b). One bivariate outlier was excluded from the model, and the pattern of results remained the same (Expressive Vocabulary $\beta = .45$, $p = .01$ when the outlier was included).

Emotion Knowledge

For mental state language density, the model including emotion knowledge was not significant, $F(1, 31) = 1.88$, $p = .18$, $R^2 = .06$. However, the model was significant for mental state language diversity, $F(1, 31) = 6.09$, $p = .02$, $R^2 = .16$, indicating a linear increase in the number of different mental state terms used with increasing emotion knowledge ($\beta = .41$; see Figure 3).

Nonverbal Cognition

The model examining mental state language density relative to nonverbal cognitive IQ was not significant, $F(1, 35) = 0.65$, $p = .43$, $R^2 = .02$. The model examining mental state language diversity across nonverbal cognition also was not significant, $F(1, 35) = 0.11$, $p = .75$, $R^2 = .003$.

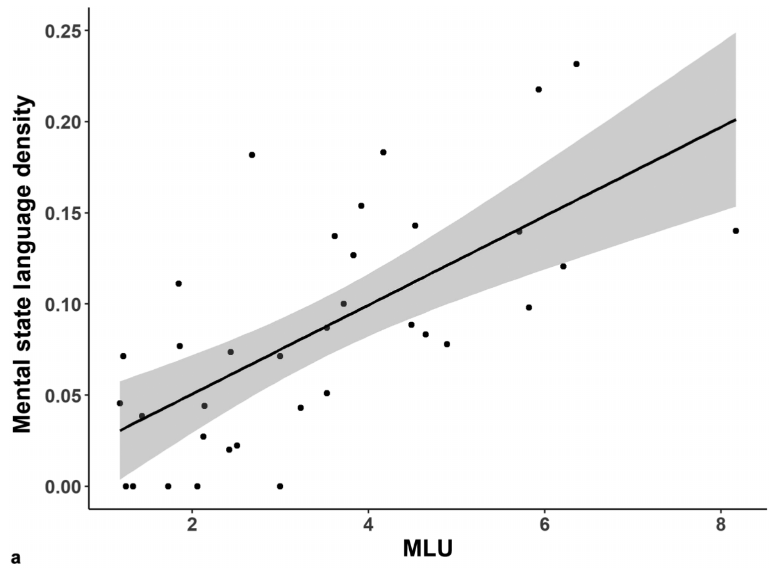
Age

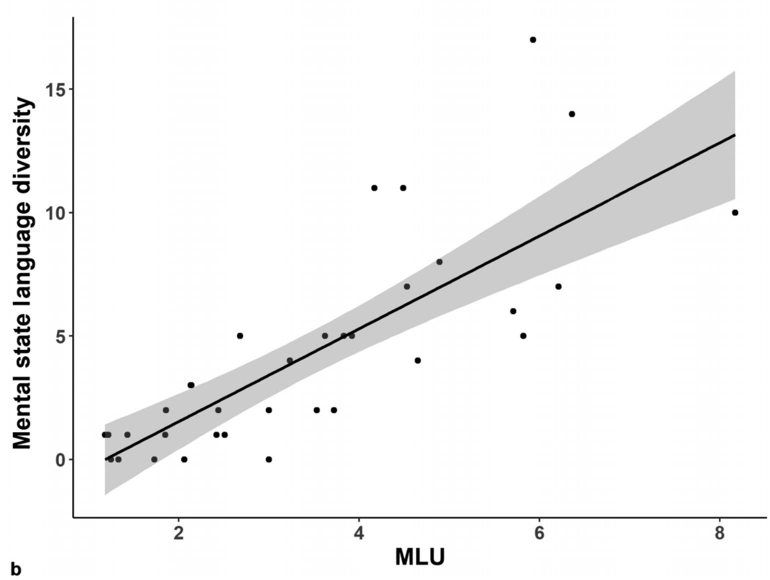
Neither model examining mental state language use across age was significant—density: $F(1, 35) = 0.03$, $p = .86$, $R^2 = .001$; diversity: $F(1, 35) = 1.73$, $p = .20$, $R^2 = .05$.

Discussion

This study contributes to the literature on mental state language in DS in two major ways with strong clinical implications for assessment and intervention. First, by using a more exhaustive coding scheme (i.e., counting every use of a mental state term), this investigation provides a detailed characterization of mental state language density and diversity during narrative storytelling in school-age children with DS. This expands upon the more simplistic metrics of mental state language use during narration from previous

Figure 1. Mental state language (a) density and (b) diversity relative to mean length of C-unit (MLU).

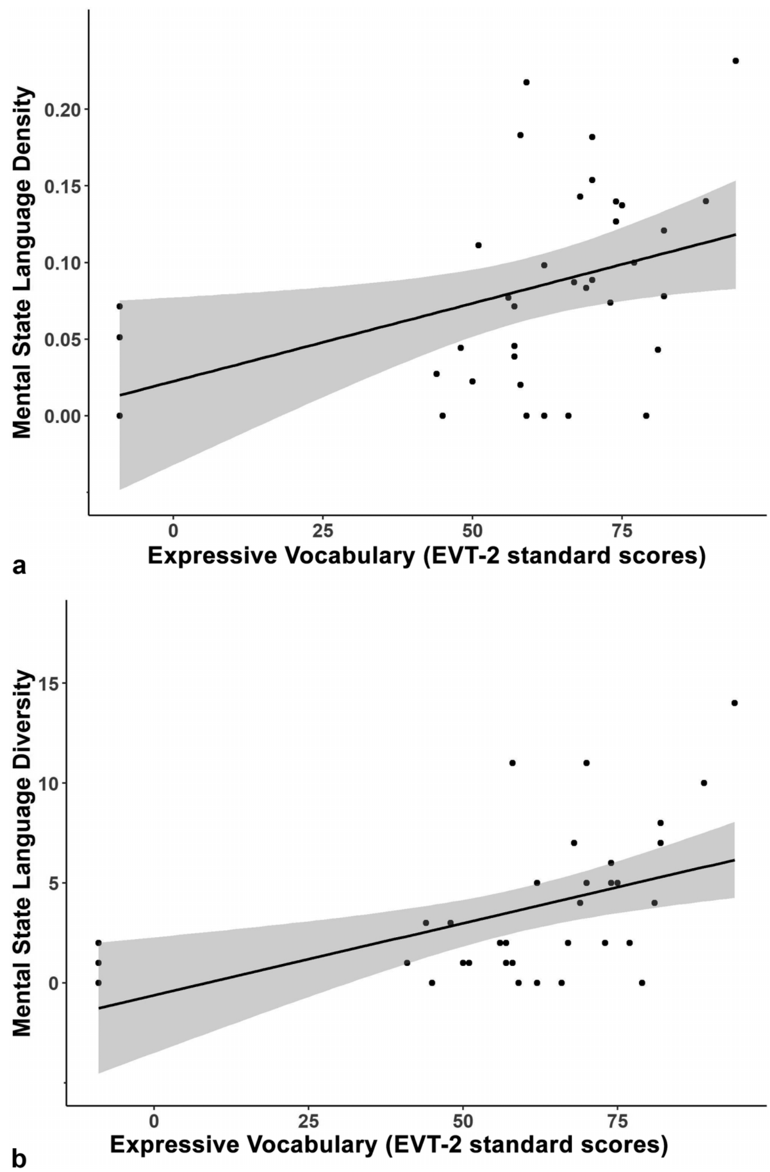




studies (e.g., categorical estimate of poor-to-proficient mental state use, counting only mental state verbs; Finestack et al., 2012; Keller-Bell & Abbeduto, 2007). This more expansive measure of mental state language has important implications for assessment, as it provides a more comprehensive measure of spontaneous mental state language use in this population. A more comprehensive measure will enable clinicians to identify the types of mental state references a child is and is not using, guiding treatment planning. Second, this was the first study to focus specifically on middle childhood (i.e., 6–11 years old) in DS, at the ages in which narrative storytelling in general is expected to develop, rather than broadly mixing adolescents and adults as in previous research.

Results indicated that some children (16%) did not include any mental state language in their narratives. Others included some mental state language that varied from 2% to 24% of total story utterances. Thus, the emergence of mental state language use during narration was represented in this study's sample of 6- to 11-year-olds with DS. These data provide a foundation for understanding how mental state language use emerges during narrative storytelling in this population. Specifically, the data suggest that, although mental state language is developing during middle childhood in DS, this comes at later ages than in typical development. Thus, mental state language use during narration is delayed in DS. Because it is delayed, clinicians working with children who have DS should assess use of mental

Figure 2. Mental state language (a) density and (b) diversity relative to expressive vocabulary. EVT-2 = Expressive Vocabulary Test–Second Edition.

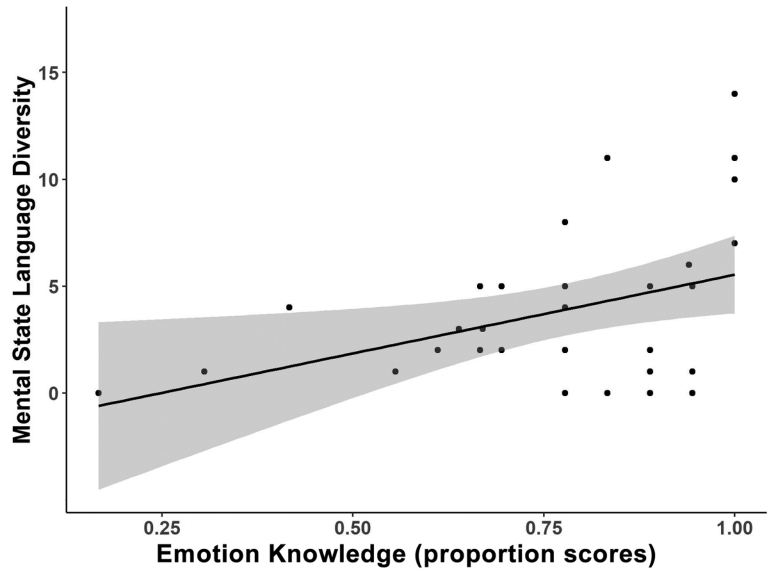


state vocabulary and consider interventions that support its development.

There was a wide range of mental state language development represented across the sample. The next step, therefore, was to determine which factors explained the variability observed in mental state language use in order to identify related skills that may be targeted in future interventions to support mental state language development in DS. This was accomplished by addressing the second aim—to map mental state language use relative to key developmental markers and aspects of the DS phenotype. Cross-sectional trajectory analyses were conducted to examine mental state language use relative to structural expressive language (vocabulary and morphosyntax), emotion knowledge (a foundational social–emotional skill), nonverbal cognition (IQ), and age.

Interestingly, in the current study's sample, mental state language use did not increase with age or nonverbal IQ. This is noteworthy because age serves as a proxy for life experiences (such as general experience with social interaction) and is often a significant factor in skill development beyond the cognitive delay associated with intellectual disability in populations like DS. Because mental state language does not appear to increase with age in school-age children with DS, the notion that this skill is simply delayed—developing more slowly but on par for developmental expectations—is not a likely explanation. The fact

Figure 3. Mental state language diversity relative to emotion knowledge.



that nonverbal IQ, a metric of general developmental delay, also was not significantly associated with mental state language use further supports this conclusion. One hypothesis based on the available evidence is that skills in specific domains (i.e., structural language—vocabulary and morphosyntax; social–emotional abilities—emotion knowledge) are relevant to mental state language use and thus important to focus on to promote mental state and narrative language in DS. Future research should explore this possibility.

The current study's analyses also revealed that density of mental state language (i.e., the proportion of utterances containing any mental state language) significantly increased with expressive vocabulary and morphosyntax (MLU), suggesting that the frequency of mental state language use develops in line with general vocabulary learning and morphosyntactic growth. This is important because expressive language, especially morphosyntax, is a relative weakness in the DS phenotype (Grieco et al., 2015; McDuffie et al., 2017). Thus, this aspect of the phenotype may also be limiting the opportunities to use mental state references during narration. Likewise, improving morphosyntactic abilities may also result in additional opportunities for children with DS to use mental state vocabulary once they acquire it.

The participants with DS in the current study also used a variety of mental state terms in their narratives, ranging from 0 to 17. Similar to the density outcome measure, mental state language diversity (i.e., the number of different mental state vocabulary words used) also was significantly associated with growth in expressive vocabulary and morphosyntax across the sample. That is, the variety of terms used to reference others' mental states is related to both general vocabulary and morphosyntax in DS. Additionally, emotion knowledge was associated with increased diversity of mental state language. That is, children with more developed emotion knowledge abilities also used a wider vocabulary of mental state language in their narratives. Again, neither nonverbal cognition nor age showed a significant relationship with mental state language diversity.

Assessment and Intervention: Clinical Implications and Future Research

From these findings, both structural language and nonverbal emotion knowledge represent developmental domains important to aspects of mental state language use in DS. Expressive vocabulary was measured by a separate standardized assessment and still showed a strong positive relationship with mental state language density and diversity during narration, strengthening interpretation of the findings. Morphosyntax was measured by MLU within the context of the narrative language sample and thus, perhaps not surprisingly, showed the strongest association with mental state language use. Although the strength of this finding may be due, in part, to the fact that MLU and mental state language were derived from the same language sampling context, the magnitude of their associations (45% and 62% variance explained in the two models) suggest an important relationship. Moreover, the analysis of MLU from utterances that did not contain any mental state language also supports the importance of this relationship. That is, these findings are not simply an effect of the length (proxy for complexity) of the story utterances that include mental state language.

This finding is consistent with Ashby et al.'s (2017) findings that inferential language use (mental state and other references to nonliteral aspects of a story that require inferencing, such as character motivations, actions, or dialogue) by 10- to 16-year-olds with DS was no longer delayed relative to cognition-matched typically developing controls after accounting for differences in MLU. However, Ashby et al.'s study also measured MLU from the same narrative language sampling context as inferential language. Future work, therefore, should expand on these findings by examining the relation of mental state language and morphosyntax assessed in different contexts (e.g., conversational language sample, standardized assessment). Such research will provide additional insight into the relationship between morphosyntax and mental state language use in DS and should lead to better specification of appropriate targets for language interventions in this population. These findings also indicate that language-based interventions designed to increase expressive language use (e.g., MLU) may mutually benefit mental state language use in this population.

Research into individual differences in mental state language use among typically developing children points to several important developmental domains, especially cognition, structural language (Carpendale & Lewis, 2006; Symons, 2004), and social–emotional development (e.g., Ensor & Hughes, 2008; Grazzani & Ornaghi, 2011; Harris et al., 2005; Ruffman et al., 2003). The current study's results provide preliminary evidence for structural language (both expressive vocabulary and morphosyntax) and to some extent social–emotional abilities (represented by the foundational skill of emotion knowledge) as factors important to mental state language development in DS. Furthermore, the nonverbal nature of the measure used to assess emotion knowledge still showed a significant relationship to mental state language diversity. This finding reveals that the relationship is not merely an artifact of language-based abilities but instead is indicative of the importance of broader social–emotional development for children with DS.

The nonverbal nature of the emotion knowledge measure does not, however, preclude a role of language. In particular, at least in typical development, the use of emotional language facilitates emotion knowledge and vice versa (e.g., Bretherton et al., 1986; Grazzani & Ornaghi, 2011; Ruffman et al., 2003). Emotion words were the mental state terms used most often by children with DS in the current study, fitting with the idea that emotion knowledge is important to mental state language development in this population as well. Future work, therefore, should untangle this relationship in order to determine if and how training in emotion recognition, for example, may facilitate emotional state and broader mental state language use for children with DS. This is especially important because emotion knowledge is considered a relative strength in DS, at least relative to weaknesses in expressive language and morphosyntax. Thus, it represents a tractable skill that could be leveraged in intervention to promote language and narrative development.

One potential method for teaching children with DS about emotions and increasing opportunities to talk about emotions is an emotion communication intervention developed by Na and Wilkinson (2018). Most recently, Na et al. (2018) have demonstrated initial effectiveness of this intervention in increasing parent–child discussions of emotions during shared storybook reading with school-age children who have DS. The intervention used aided AAC to provide opportunities to talk about storybook characters' emotions. The intervention also trained parents to ask open-ended questions to elicit more talk about emotions. Both parent and child talk about emotions increased as a result, showing promise in this approach to increasing emotion-based communication in children with DS with limited spoken language abilities. The current study's findings of limited mental state language use by school-age children with DS who are verbal and able to engage in narrative storytelling suggest that a similar approach may need to be applied more broadly to children with DS with and without aided AAC. Furthermore, the current study's findings of the role of nonverbal emotion knowledge in children's mental state language development support the principles of Na and Wilkinson's intervention to combine emotion knowledge and language in a narrative language intervention framework for individuals with DS.

Beyond Na and Wilkinson's (2018) AAC-based intervention targeting emotion communication, there is currently no empirical evidence on language-based interventions targeting broader talk about mental states (i.e., talk about cognitions, desires, etc., in addition to emotions) in individuals with DS or other intellectual disabilities. However, it is possible that Na and Wilkinson's intervention could be expanded to include communication about other mental states beyond emotions. One particularly advantageous feature of this intervention is that it is designed for children with limited spoken language skills. Thus, it could potentially be applied to even younger children with DS with more limited spoken language to boost their emotion knowledge and mental state vocabulary earlier in life, before the delays in mental state language use become prominent in the school-age years.

Limitations and Future Directions

This first in-depth characterization of mental state language use by school-age children with DS provides an important next step for understanding mental state and narrative language development in this population. Future work should assess mental state language in DS relative to other populations. For example, direct comparisons to typically developing children matched by developmental level would contextualize the degree of delay experienced in DS. Additionally, comparisons to individuals with intellectual disability of other etiologies would confirm whether the observed pattern of mental state language development is specific to DS or characteristic of those with intellectual disability more broadly. Based on the preliminary evidence provided by this study, one would expect that mental state language use in DS is not a characteristic of intellectual disability more broadly because nonverbal cognition was not significantly associated with its use. Instead, factors more specific to the DS phenotype (e.g., low MLU relative to nonverbal cognition) were identified as important to mental state language development. Thus, the skills identified by this study provide guidance into which skills future work should consider when determining their impact on mental state language use (and vice versa) in children with DS.

Another limitation to the current study is that mental state language was only assessed using a narrative language sampling procedure. This procedure, designed to prompt story-related talk yet minimize scaffolding, serves a metric of spontaneous mental state language use. Thus, it is unknown whether children with DS may show increased use of mental state language when prompted by open-ended questions (e.g., questions prompting inferential language; see Tompkins et al., 2013; van Kleeck, 2008). Future research should consider alternative sampling procedures aimed at prompting for mental state language to determine whether this is an effective strategy. Participants' comprehension of others' mental states within the narrative is also unknown. Future research, therefore, should also consider asking comprehension questions about the story characters and their mental states after administering the narrative task. Based on the known difficulties with syntactic comprehension and verbal working memory in individuals with DS (Abbeduto et al., 2007; Grieco et al., 2015; McDuffie et al., 2017), care should be taken to simplify such questions as much as possible.

The intelligibility of children's utterances may have affected the measure of mental state language in this study. Across the sample, 15% of children's utterances contained some unintelligible speech, and it is possible that mental state language was included in some of these unintelligible segments. As discussed previously, future research should consider assessing communication of mental states during narrative storytelling across modalities (e.g., speech and aided AAC). Other methodological limitations included the difficult nature of administering assessments to a population of children who may have problems with inattention, challenging behaviors, and limited speech intelligibility. These factors could impact children's ability to perform (i.e., demonstrate their abilities) within the context of a testing session, and they could also lead to an increased likelihood of the examiner deviating from the protocol. For this reason, the author (principal investigator) was present during all testing sessions and made decisions regarding when to exclude an individual's data due to examiner error. However, judgment calls were still required. Additionally, the experimental nature of the mental state language coding scheme and training procedures for the coders is another study limitation. Thus, replication of the current study using the same methodological and coding procedures is highly recommended.

Finally, because the current study only tested correlational associations through a cross-sectional design, causality has not been established. Future research should include longitudinal designs that can provide causal evidence, further illuminating how mental state language use emerges and develops over time in this population. A more thorough understanding of the developmental course of mental state language use in DS would provide insight into when mental state language intervention would be most beneficial for children with DS.

Conclusions

Results from this study suggest that mental state language use is delayed in children with DS and is still quite limited during the school-age years. Thus, mental state language and related skills (e.g., emotion knowledge, expressive vocabulary and morphosyntax) should be assessed and, as needed, targeted within language-based interventions in this population. Results also suggest that age is not a major factor in determining the timing of intervention to support mental state language use in DS, at least during middle childhood. Similarly, IQ is not a significant factor. Instead, other factors, such as level of expressive language, play a more central role. In terms of treatment targets, based on this study's findings, interventions designed to promote expressive vocabulary, morphosyntax, and emotion knowledge may be particularly effective. Early interventions could benefit from focusing specifically on emotion knowledge and communication about emotions, even before children with DS have acquired the language to talk about mental states (e.g., using AAC to provide opportunities to communicate about emotions and their causes and consequences; Na & Wilkinson, 2018).

Future longitudinal research focusing on the relative contributions of structural language (using additional measures of morphosyntax) and emotion knowledge over time will further clarify their roles in mental state language development. Specifying which skills influence mental state language use across development in individuals with DS will guide intervention efforts by identifying which skills to target and when to target them. Ultimately, the goal is to enhance mental state and narrative language and promote social communicative development in this population.

This study also highlights how narrative storytelling provides a fruitful context for assessing mental state language use in this population. An advantage to using narrative language sampling to assess mental state language is that it circumvents the issues associated with traditional standardized language tests in populations with intellectual disabilities (e.g., floor effects, lack of authenticity; Channell et al., 2018). Fictional narrative is a particularly useful context because it provides the opportunity to talk about others' mental states, whereas personal narratives may be more limited to discussing one's own mental states. Finally, narrative storytelling may also serve as a useful framework for teaching mental state language use in DS, particularly with tools such as wordless picture books that provide visual supports to decrease cognitive and linguistic burden. Future research is needed to explore this possibility. Future work should also consider other communication contexts for mental state language use as well as environmental influences (e.g., parent–child interactions; Na & Wilkinson, 2018; Nelson et al., 2018) in order to identify multiple potential routes for intervention.

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Appendix A

Mental State Words Most Commonly Used by Participants

Word	Number of participants (%)	Total number of occurrences (within and across participants)
Happy (emotion adjective)	10 (27.03)	23
Cry (emotion verb)	10 (27.03)	16
See (perception)	9 (24.32)	19
Sad (emotion adjective)	9 (24.32)	15
Mad (emotion adjective)	7 (18.92)	22
Scared (emotion adjective)	7 (18.92)	11
Saw (perception)	7 (18.92)	10
Wanna (desire)	6 (16.22)	7
Like (emotion verb)	6 (16.22)	6
Want (desire)	4 (10.81)	22
Try (desire)	4 (10.81)	12
Angry (emotion adjective)	4 (10.81)	4
Hurt (physiological state)	4 (10.81)	4
All other words	(< 10)	

Appendix B

All Mental State Word Roots Used by Participants

Cognition	Desire	Perception	Emotion behaviors	Emotion states	Physiological states
Believe *Decide* *Find* *Know* *Mean* (thought reference; e.g., "*meant to*") *Notice* *Remember* *Think* *Understand*	*Like* (referencing object) *Love* (referencing object) *Need* *Try* *Want*	*Feel* (referencing touch) *Hear* *Listen* *See* *Smell* *Watch*	*Attack* (directed toward character) *Cry* *Feel* (referencing mental state) *Gasp* (referencing surprise/ fear) *Hate* *Laugh* *Like* (referencing character) *Love* (referencing character) *Miss* (referencing character) *Scare* *Scream* *Smile* *Surprise*	*Afraid* *Angry* *Excited* *Fright* *Happy* *Hurt* (referencing emotion) *Mad* *Sad* *Scared* *Surprised* *Upset*	*Hurt* (referencing pain) *Sick* *Tired*