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Inferential abilities in Down syndrome: Examining verbal and nonverbal contributors to narrative comprehension in adolescents and adults

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Abstract

Language profiles of individuals with Down syndrome (DS) reveal a pattern of heterogeneous abilities, with receptive vocabulary exhibiting strengths over receptive grammar, and expressive language lagging behind. Little is known about inferential abilities in this population, in either children or adults, despite inferencing playing a pivotal role in language comprehension. Inferential abilities are particularly relevant to the successful understanding of narratives, as story plots combine explicit (factual) and implicit (inferential) information. This study investigated inferential abilities in 26 English-speaking adolescents and adults with DS (age: 13-43, M=22.9 years) compared to 23 young vocabulary-matched typical controls (age: 4-11, M=6.96 years). Inferencing was assessed through a narrative comprehension task, which targeted understanding of story characters' goals and internal states (ISs). Participants with DS showed poorer comprehension of inferential questions, across both goals and ISs, with vocabulary level and receptive grammar positively contributing to the comprehension of inferences. Working memory showed a positive albeit non-significant relationship with inferencing ability, while executive functioning skills had no effect. Our results suggest that difficulties understanding, and potentially expressing, inferential information relating to story characters' goals and ISs persevere into adulthood in individuals with DS. Such difficulties are moderated by general verbal abilities and seem driven by poor grammatical skills. We discuss the contributions of verbal and nonverbal abilities to inference-making in Down syndrome, and potential implications for future research.

Keywords: Down syndrome, narrative comprehension, inferential abilities

Introduction

Down syndrome (DS) is a neurodevelopmental condition caused by the overexpression of genes on chromosome 21 (Trisomy 21), affecting about 1 in 1000 live births (Wu & Morris, 2013). It is commonly associated with mild to moderate levels of intellectual disability (ID) (Chapman & Hesketh, 2000) and a profile of delays in verbal as opposed to visuospatial memory (Jarrold & Baddeley, 2001; Campbell et al., 2013), characterised by pervasive difficulties across language domains (Martin, Klusek, Estigarribia, & Roberts, 2009).

Language profile in Down syndrome

Despite considerable individual variability, receptive vocabulary is typically in line with nonverbal abilities in individuals with DS (Laws & Bishop, 2003), particularly in the early stages of development, with receptive skills surpassing expressive language abilities (Chapman, Seung, Schwartz, & Kay-Raining Bird, 1998). The emergent receptive language profile, however, is far from homogeneous, and the gap evidenced between children with DS and those without DS tends to widen with age. In adolescents, receptive vocabulary skills are shown to be significantly more advanced than receptive syntax (Chapman, Schwartz, & Bird, 1991). In fact, morphosyntax exhibits weaknesses across both comprehension and production. Children and adults with DS show difficulties with comprehension and production of grammatical morphemes (Hesketh & Chapman, 1998; Eadie, Fey, Douglas, & Parsons, 2002; Caselli, Monaco, Trasciani, & Vicari, 2008), as well as complex syntactic constructions, such as relative clauses, questions and passives (Joffe & Varlokosta, 2007; Frizelle, Thompson, Duta, & Bishop, 2019; Perovic & Wexler, 2019). In adolescents, syntax is impaired beyond the level of non-verbal mental age (Vicari, Caselli, & Tonucci, 2000), expressive vocabulary level (Berglund, Eriksson, & Johansson, 2001) and mean length of utterance (Chapman et al., 1998) when compared to typically developing (TD) control matches. Pragmatic skills appear to be an area of relative strength in DS compared to other developmental disorders (Abbeduto, Chapman, Fletcher, & Miller, 2005; Klusek, Martin, & Losh, 2014; Martin, Losh, Estigarribia, Sideris, & Roberts, 2013; Roberts, Price, & Malkin, 2007), however, discrepancies between social, cognitive and language skills in this population give rise to a complex profile (Lee et al., 2017). Aspects of conversational pragmatics, such as turn-taking, communication repairs and staying on topic are in line with mental age expectations (Laws & Bishop, 2004; Martin et al., 2009; Johnston & Stansfield, 1997), while other aspects such as elaboration, topic maintenance and use of stereotyped language appear delayed (Roberts et al., 2007; Laws & Bishop, 2004). Pragmatic development rests on a range of concurrent developmental factors, and seems to be largely dependant upon cognitive and structural language abilities, such as vocabulary, and morphosyntax (Fabbretti, Pizzuto, Vicari, & Volterra, 1997; Laws & Bishop, 2004). In the cognitive domain, individuals with DS have been shown to exhibit difficulties in Theory of Mind (ToM; see Cebula, Moore, and Wishart (2010), for review), that is the ability to draw inferences about the state of mind of others, and executive functioning (e.g., working memory, planning, initiation) (Lanfranchi, Jerman, Dal Pont, Alberti, & Vianello, 2010). These skills are known to relate to pragmatic language in typical development (Gooch, Thompson, Nash, Snowling,

& Hulme, 2016), and show associations with pragmatic language in children with DS (Lee et al., 2017).

Inferential abilities in narrative comprehension

Inferential abilities play a pivotal role in language comprehension and are particularly relevant to the successful understanding of narratives, as story plots combine explicit (factual) and implicit (inferential) information. Comprehending the gist of a story involves understanding and reasoning about the causal relations between events unfolding, as well as story characters' internal states (ISs). Indeed, story elements, such as characters' desires, thoughts and feelings, are rarely made explicit. Listeners must be able to integrate information from different sources to reach conclusions about the emotional state and intentions of characters, integrating events internal to the story and their own background knowledge of social interactions, causal relationships and narrative structures.

Children with ID and language impairment exhibit difficulties in both verbal recall and inferential ability in narratives (Crais & Chapman, 1987). However, few studies have adopted narratives as a means to investigate comprehension of inferential information in DS, a population characterised by variable degrees of ID and pervasive language difficulties. In general, children with DS are able to produce recognizable, albeit simple, narratives and a show relatively good ability to appropriately respond to follow-up questions (Loveland, McEvoy, Tunali, & Kelley, 1990). However, they may produce more implausible inferences in their stories than TD controls (Kay-Raining Bird, Chapman, & Schwartz, 2004). Despite typically recalling fewer events, young children with DS (6 to 7-year-olds) appear to be sensitive to the causal structure of complex age-appropriate narratives (Kim, Kendeou, van den Broek, White, & Kremer, 2008), attesting to the quality of their mental representations. Nevertheless, a dissociation has been observed in their narratives between expressive language and nonverbal abilities. Boudreau and Chapman (2000) report that children and adolescents with DS recalled more story content and produced more language compared to expressive-language matched controls, but failed to show the same advantage relative to controls matched on nonverbal mental age, suggesting a specific difficulty verbalising story content rather than a difficulty understanding the events expressed in the narrative. Young adults are also outperformed by language-matched TD controls on comprehension of narrative inferences about characters' intentions and internal states, while their performance remains in line with nonverbal abilities (Martzoukou, Nousia, & Marinis, 2020). This points towards language abilities, and particularly syntax, playing a role in story comprehension, possibly affecting the expression of inferential information involving the attribution of character's goals and ISs. In the domain of emotion understanding, in fact, children with DS are shown to recognise emotions, provided the task minimises verbal demands (Pochon & Declercq, 2013).

This study

The current study examines inferential comprehension in a group of adolescents and adults with DS using a picture-supported narrative task. Participants listened to a short, pre-recorded narrative and were asked to retell the story, before answering a set of comprehension questions. Questions were designed to assess participants' ability to infer key information about the intentions and internal states of characters in the story, as well as to speculate on their reaction to plausible scenarios in the narrative. The current analysis reports on narrative comprehension and examines whether adolescents and adults with DS perform at the level predicted by their receptive vocabulary abilities, as compared to a group of younger TD controls matched on receptive vocabulary. We compare group performance on comprehension questions as a whole, as well as comparing their performance on questions targeting story characters' goals and questions targeting story characters' internal states separately, in relation to receptive vocabulary level. Finally, we assess the extent to which aspects of structural language skills, such as receptive grammar, and cognitive domains, such as working memory and executive functioning, contribute to inferential comprehension in our group of adolescents and adults with DS. Previous studies have suggested that speakers may understand more than they communicate, especially in the case of young narrators (Bohnacker, 2016; Lindgren, 2019). Given the well-documented dissociations observed in DS between cognitive, receptive and expressive abilities, it is possible that individuals with DS construct a greater understanding of the implicit relationships between characters and events than they are able to verbalise in their narrative production, and this may underline observed weaknesses in inferential skills (Boudreau & Chapman, 2000). By adopting a comprehension task which provides targeted prompting to assess understanding of inferential information, the current study aims to reduce, albeit not entirely remove, the additional processing and verbal demands involved in narrative production, which may lead to underestimating inferential abilities in individuals with DS.

Methods

Participants

Participants with DS were a group of 26 adolescents and adults (10 females) diagnosed with Trisomy 21 aged 13;7 to 41;7 years (mean: 22.9 years, SD: 8.02) . Our control group was 23 typically developing (TD) children (10 females) aged 4;2 to 10;7 years (mean: 6.9 years, SD: 1.96), matched on raw score of a receptive vocabulary measure (mean age equivalent DS: 6.96 years (SD: 2.25) ; mean age equivalent TD: 7.66 years (SD: 1.93). The majority of participants were monolingual, however, 5 participants with DS and 7 controls indicated they were exposed to other languages at home.

The study was approved by the Research Ethics Committee at University College London (UCL) (ID: 2693/014).

Table 1: Mean descriptive scores and standard deviations for background measures for the two groups

Score	Down syndrome	TD Controls
BPVS-3 RS	96.35 (26.24)	106.87 (21.11)
TROG-2 PC	63.7 (0.11)	-
TROG-2 SS	55 (0)	-
NR Backwards RS	1.92 (1.93)	4.32 (2.28)
BRIEF-2 GEC RS	118.2 (20.55)	86.5 (18.4)

Note: *p<0.05; **p<0.01; ***p<0.001
Note: RS - Raw Score; PC - Percent Correct; SS - Standard Score. BRIEF-2 GEC RS - higher scores indicate poorer performance.

Measures

LITMUS - MAIN. Narrative comprehension was assessed via the comprehension task of the LITMUS Multilingual Assessment Instrument for Narratives (MAIN) (Gagarina et al., 2012, 2019), a picture-supported activity designed to assess narrative abilities. The current paper reports our participants' performance on story comprehension as assessed by 10 questions, asked after listening to and retelling the Cat story. The questions targeted inferential aspects of the story, namely understanding of characters intentions (i.e. Goals, 3 questions) and internal states (IS, 6 questions). Participants answered goal questions such as 'Why does the cat jump forward?' (example target answer: 'To catch a butterfly'), IS questions such as 'How does the cat feel?' (e.g. 'sad') or 'Imagine that the boy sees the cat. How does he feel?' (e.g. 'angry'), and a final general plot question 'Will the boy be friends with the cat?' (e.g. 'no because the cat ate the fish'). Answers were transcribed and scored according to MAIN guidelines (Gagarina et al., 2019). Participants received one point for each answer reflecting a state of events presented in the story, or zero points for failing to provide an answer, providing an incorrect or irrelevant answer, and answering 'I don't know'.

BPVS-3. Receptive vocabulary was assessed via the British Picture Vocabulary Scales (BPVS-3) (Dunn & Dunn, 2009). This test assesses comprehension of lexical items of decreasing frequency and increasing abstraction. Participants listen to a word and select the picture on a page of four that best matches the word. Here we analyse the BPVS-3 Raw Score (RS) as a measure of receptive vocabulary level.

TROG-2. Receptive grammar was assessed via the Test for Reception of Grammar (TROG-2) (Bishop, 2003). This test assesses comprehension of increasingly complex sentences containing different grammatical structures. The participant listens to the sentence and is asked to point to the picture matching the sentence. Instead of the number of blocks passed, here we analyse the percentage of items correctly answered (a ratio of correct items to total items attempted) as a more sensitive measure of receptive grammar.

CELF-5 Number Repetition. Working memory (WM) was assessed via the Number Repetition (NR) subtest of the Clinical Evaluation of Language Fundamentals (CELF-5)

(Wiig, Semel, & Secord, 2003). In this subtest, participants are asked to listen to and repeat number strings of increasing length in the same order and in reverse order. Here we analyse the Number Repetition Backwards Raw Score (the total number of backwards items passed) as a measure of verbal working memory.

BRIEF-2. Executive functioning was assessed by informant report via the Behaviour Rating Inventory of Executive Function (BRIEF-2) (Gioia, Isquith, Guy, & Kenworthy, 2015). Caregivers completed the questionnaire which assesses aspects of behavioural, emotional and cognitive regulation. Here we analyse the general executive composite (GEC) Raw Score (RS) .

Procedure

Participants took part in the assessments remotely over the course of two or three sessions. All tasks were administered by the investigator over a videoconferencing call. Some participants joined the call accompanied a caregiver, while others completed the tasks independently. Participants were shown stimuli pictures via screen-sharing: pictures for the narrative task were presented on PowerPoint slides, while stimuli for the standardised assessments were presented using a visualizer camera. Standardised assessments were administered according to manual instructions. The narrative task was presented digitally, closely following administration guidelines for MAIN (Gagarina et al., 2019) and previously trialled online adaptations (Kapalková, Slancová, & Nemcová, 2021; Karl, 2023). Participants listened to and retold the Cat story, before answering 10 comprehension questions. Questions were read aloud by the experimenter while participants observed the story pictures on screen. Before each question, relevant pictures were highlighted by a red border and pointed out by the investigator.

Statistical Analysis

Responses to the MAIN questions were treated as a binary dependent variable with the levels 0 for incorrect and incomplete answers and 1 for correct answers. All other measures were included as continuous fixed effect variables in the respective models. The data were preprocessed using the tidyverse package and binomial generalized linear mixed models were performed using the lme4 package in R (version 4.1.0, R Core Team, 2018). Each model included random effects for participants. Data and code are available at https://osf.io/2a5tr/.

Results

Table 2 shows descriptive statistics for group performance on the comprehension task. Overall, adolescents and adults with DS provided answers that correctly attributed goals and internal states (ISs) for 62% of the questions, while typical controls answered 89% of questions correctly.

The following sections report the results for separate models built to address three research questions that focus on dif-

Table 2: Mean correct answers (standard deviation) and range for comprehension scores for the two groups

Score	Down syndrome	Controls
Comprehension Total	6.19 (2.71)	8.87 (14.6)
Total (range)	1 - 10	5 - 10
Goal questions	2.12 (0.95)	2.91 (0.29)
Internal state questions	3.92 (1.81)	5.52 (0.95)
Plot question	0.15 (0.37)	0.44 (0.51)

ferent aspects of inferencing abilities in our samples of participants with DS and TD children.

Inferencing abilities in English-speaking adults and young people with Down syndrome

The first model focused on whether and in which ways participants with DS and TD children differ in their performance on the MAIN task. To this end, the comprehension score was modelled as a function of the interaction of group and receptive vocabulary level (BPVS-3 Raw Score), with sex and bilingualism as controlling variables.

The results, as presented in Table 3, highlight the following findings. The coefficients and standard errors (SE) associated with each variable are reported. There is a significant positive effect of receptive vocabulary level (verbal mental age) on comprehension scores ($\beta = 0.035$, SE = 0.009, p < 0.001), indicating that as the vocabulary level (verbal mental age) of participants increases, comprehension scores also tend to improve. The group variable demonstrates a positive impact on comprehension scores ($\beta = 3.693$, SE = 1.708, p < 0.05), indicating that participants belonging to the TD group exhibit significantly higher comprehension scores compared to the group with DS.

The interaction term between vocabulary level and group is found not to be statistically significant ($\beta = -0.022$, SE = 0.017, p = 0.18). As illustrated in Figure 1, although this interaction term is not significant, the effect of vocabulary appears particularly relevant for the group with DS, where comprehension scores show greater gains with increases in vocabulary level. The effect appears less pronounced for TD controls, where comprehension scores tends to be at ceiling across vocabulary levels.

Table 3: Regression results (Coefficients and Standard Errors (SE)) for total comprehension score in the two groups

Variable	Coefficient (SE)
Vocabulary level	0.035*** (0.009)
Group	3.693* (1.708)
Sex	−0.467 (0.359)
Bilingualism	0.189 (0.409)
Vocabulary level:Group	−0.022 (0.017)

Note: *p<0.05; **p<0.01; ***p<0.001

The variable representing sex does not show a statistically significant effect (β = -0.467, SE = 0.359, p = 0.19), as

does the association between bilingualism and comprehension scores ($\beta = 0.189$, SE = 0.409, p = 0.65).
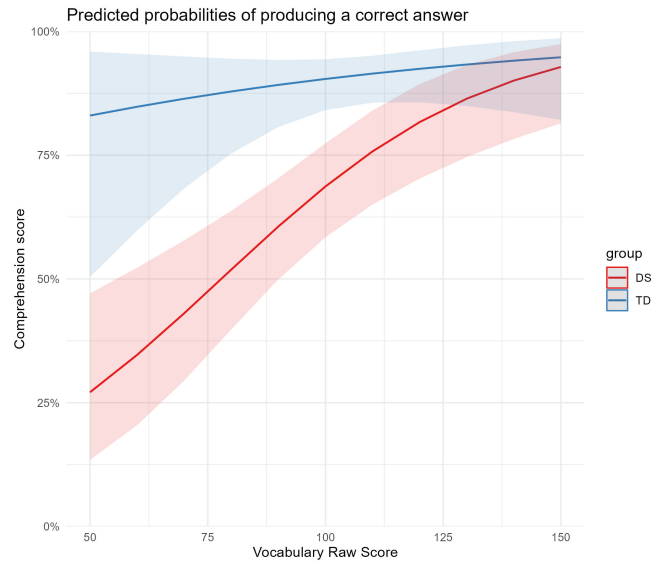

Figure 1: Predicted probabilities plot showing comprehension scores as a function of receptive vocabulary level (BPVS-3 Raw Score) and group.

Effects of question type on inferencing abilities

The second model assessed how different types of comprehension questions (i.e., targeting story characters' goals vs. their internal states) affect comprehension scores. To this end, the comprehension score was modelled as a function of the interaction of group and question type, including vocabulary level, sex and bilingualism as controlling variables.

Table 4: Regression results for comprehension scores per question type in different groups

Variable	Coefficient (SE)
Vocabulary level	0.032** (0.008)
Group	2.564** (0.889)
Question Type	−0.983** (0.325)
Sex	−0.511 (0.393)
Bilingualism	0.034 (0.437)
Group:Question Type	−1.084 (0.878)

Note: *p<0.05; **p<0.01; ***p<0.001

In examining the effects of various factors on comprehension scores across different question types, the regression results, as outlined in Table 4, reveal the following insights: Vocabulary level exhibits a significant positive effect on comprehension scores ($\beta = 0.032$, SE = 0.008, p < 0.01), indicating that as participants' receptive vocabulary skills increase, their comprehension scores also tend to improve across question types, highlighting the positive association between verbal mental age (as measures by receptive vocabulary) and narrative comprehension performance. Group membership also

significantly influenced comprehension scores (β = 2.564, SE = 0.889, p < 0.01). TD participants demonstrated higher comprehension scores across both question types compared to the group with DS, indicating a group-specific impact. Question type also showed a statistically significant effect on comprehension scores (β = −0.983, SE = 0.325, p < 0.001), indicating that participants generally obtained lower scores on questions about ISs as opposed to questions about goals. Sex did not significantly impact comprehension scores (β = −0.511, SE = 0.393, p = 0.19), indicating no sex-based difference in comprehension scores among participants. Bilingualism seemed to have a positive effect on comprehension scores, but the association was not significant (β = 0.034, SE = 0.437, p = 0.94). The interaction term Group:Question type did not reveal a statistically significant effect ((β = −1.084, SE = 0.878, p = 0.22).

Individual differences in inferencing abilities

The third model examined whether chronological age, structural language skills, such as receptive grammar, and cognitive factors, such as working memory and executive functioning, contribute to predicting inferential comprehension scores in adolescents and adults with DS. To this end, the comprehension score was modelled with years of age, backwards number repetition scores (CELF-5 NR Backwards Raw Score), executive functioning composite scores (BRIEF-2 GEC Raw Score) and receptive grammar score (TROG-2 Percentage Correct Score) as predictor variables. Here, we present the model for the DS group only. The regression results for the total comprehension score are presented in Table 5. In short, receptive grammar (β = 0.051, SE = 0.026, p < 0.05) was the only significant contributor to comprehension performance, with verbal working memory approaching significance (β = 0.248, SE = 0.135, p = 0.066), suggesting increased receptive grammar and working memory scores are associated with stronger performance on the comprehension of inferences. Chronological age showed a weak non-significant trend pointing towards a worsening of comprehension performance with increasing age (β = −0.035, SE = 0.026, p = 0.18), while executive functioning level showed no association with comprehension scores (β = 0.007, SE = 0.009, p = 0.41).

Table 5: Regression results for total comprehension score for participants with DS

Variable	Coefficient (SE)
Chronological age (years)	−0.035 (0.026)
Working memory (CELF-5 NR)	0.248· (0.135)
Executive functioning (BRIEF-2)	0.007 (0.009)
Receptive grammar (TROG-2)	0.051* (0.026)

Note: ·p<0.07; *p<0.05; **p<0.01; ***p<0.001

Discussion

This study investigated inferential abilities in English-speaking adolescents and adults with DS, compared to a group of younger TD controls matched on receptive vocabulary. Inferencing was assessed using the comprehension task from the narrative instrument LITMUS MAIN (Gagarina et al., 2012, 2019), which required participants to answer questions about goals and internal states (ISs) of characters in a story they had previously heard and retold. The method of evaluating inferencing skills via a set of precise comprehension questions targeting specific elements of a narrative, such as story characters' goals, and internal state terms, was chosen to facilitate cognitive load. It has been shown that picture-supported narratives tend to promote inferencing (Boudreau & Chapman, 2000), while comprehension generally represents a relative strength in DS. Compared to controls, participants with DS obtained significantly lower comprehension scores, irrespective of sex or bilingual status, indicating they produced more erroneous attributions of goals and ISs overall. Similar patterns in their performance were revealed for scores on IS and goal questions independently, with lower scores on both question types. Such findings point to inferential difficulties in adolescence and early adulthood that go beyond what expected on the basis of receptive vocabulary skills in individuals with DS.

These results are in line with reports that inferential abilities might be affected by expressive and cognitive factors in DS, a population associated with both language difficulties and intellectual disability (Crais & Chapman, 1987). Martzoukou et al. (2020) report a disadvantage for Greek-speaking adults with DS on parallel questions from another MAIN story relative to expressive vocabulary, a pattern similar to the one observed in our samples for receptive vocabulary. In contrast, participants with DS in Martzoukou et al. (2020)'s study performed in line with nonverbal TD controls. It is possible that in our study, receptive vocabulary matching overestimated inferential abilities involved in narrative comprehension, given the relative strengths individuals with DS exhibit in this area. Level of receptive vocabulary was shown to modulate comprehension performance, particularly for the group with DS, with increases in verbal mental age corresponding to increases in narrative comprehension scores. In contrast, the effect was less pronounced for TD controls, who tended to display ceiling effects on comprehension scores across the sample. Therefore it would seem that while attempting to minimise cognitive load for individuals with DS, the task might not have presented enough challenge to capture nuanced variability in young TD abilities. Nevertheless, results indicate that adolescents and adults with DS show difficulties answering questions about inferential aspects of narratives relative to the abilities of TD children at a similar receptive vocabulary level. Despite this discrepancy, receptive vocabulary level appears to be a positive contributor to performance for individuals with DS.

Our sample with DS exhibited considerable individual

variability. Many participants were able to provide accurate and considerably elaborate responses, which encompassed both the use and understanding of internal state (IS) terms. Most incorrect answers from the group with DS were attempts that inappropriately attributed ISs (e.g., saying that the cat is angry when it is happy). Some answers misinterpreted the characters' ISs, particularly in response to theory of mind questions, such as "Imagine that the boy sees the cat. How does the boy feel?" (D8), and in other cases questions about one character's feelings were answered by referring to states or events experienced by a different character. By contrast, typical controls produced considerably fewer errors and the majority of their incorrect answers concentrated on the most cognitive demanding questions, such as "Do you think the boy will be friends with the cat? Why?" (D10), in addition to question D8 above. Adults with DS also found these questions more difficult, though a review of overall performance seemed to set apart individuals who answered most questions correctly, individuals who made errors primarily on higher-level questions, and individuals who made errors on most questions. This indicates individual performance varied amongst our sample, though it remains to be determined which factors, amongst the possible candidates, play a role.

In order to tease apart the contribution of cognitive and language abilities, the effects of individual predictors on comprehension of inferences were also examined. Chronological age, as well as our measures of executive functioning, failed to significantly contribute to comprehension scores in the group with DS. Receptive grammar, on the other hand, showed a positive contribution suggesting that better receptive grammar skills are associated with higher comprehension scores for inferential information. Verbal working memory only approached significance, but exhibited a similar trend of greater verbal working memory span being associated with greater comprehension scores.

Chronological age failed to show a significant relationship with comprehension performance, possibly suggesting that this type of inferential comprehension isn't affected by developmental changes or age-related decline in the age span captured by the present study, even after accounting for aspects of cognitive and language abilities. It should be acknowledged that our study adopted a cross-sectional approach, and as such may have failed to capture any age-related trajectories associated with comprehension abilities. Additional longitudinal investigations into the inferential abilities of adolescents and adults with DS would shed further light on whether individual developmental trajectories for inferential abilities can be established in relation to chronological age.

Executive functioning, a set of cognitive skills thought to support pragmatic development (Gooch et al., 2016), showed no contributions to comprehension of inferences for adolescents and adults with DS in our sample. This clashes with previous reports that executive functioning is associated with pragmatic abilities in school-age children with DS (Lee et al., 2017). Such disparity may be accounted for by age differ-

ences between the samples, as Lee et al. (2017) assessed children of school-age in a developmental period where EF and pragmatic skills might be developing concurrently. Although the study also used BRIEF-2 as a measure of EF, correlations with pragmatic language were only evident for caregiver and clinician report measures, but not fot the measure of pragmatic language reliant on direct assessment and verbal production. It is possible that informant as opposed to direct assessments of pragmatic language, such as narratives, capture different pictures of pragmatic functioning as they differ in content, perspective, modality and context.

In order to assess the comprehension of inferential aspects of story-telling, the task from MAIN elicits verbal responses. As such, in order to demonstrate understanding participants had to rely upon their expressive, as well as receptive and inferential abilities. Studies suggest that speakers, especially children, may often know more than they verbalise in their narrations (Bohnacker, 2016; Lindgren, 2019), and the same may be true of individuals with DS (Boudreau & Chapman, 2000). As discussed previously, both language comprehension and expressive abilities in DS are impaired, and it is possible that difficulties in language skills present a barrier to demonstrating inferential understanding. Results show that receptive grammar did play a role in predicting inferential comprehension in our sample with DS, suggesting structural language skills did affect performance. Notably, verbal working memory approached significance, pointing to the likely role of expressive abilities in this type of verbal inferencing task. However, as the present report did not include direct measures of expressive language, it remains unclear to which extent the expressive component of the task may have affected performance and whether individual language predictors explain unique variance not accounted for by general cognitive ability. Future studies should seek to investigate the individual contributions of expressive language abilities to the successful verbalisation of inferences.

Conclusions

In conclusion, comprehension of inferences presents difficulties in adolescents and adults with DS aged 13-42 years when controlling for receptive vocabulary. The group with DS exhibited considerable individual variability in their answers to comprehension questions about goals and ISs. Better receptive vocabulary abilities predicted increased performance on the narrative comprehension task for individuals with DS, as did receptive grammar abilities. Verbal working memory also showed a positive but non-significant association with comprehension scores, however other individual predictors, such as age and EF did not contribute significantly. Future studies should assess the separate contributions of expressive and receptive language to narrative inference. As pragmatic skills continue to develop past childhood, longitudinal assessments of inferential abilities in adolescents and adults with DS will be key to uncovering developmental and age-related trajectories in inferential skills.

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