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**Key words:** inferential comprehension, developmental language disorder

### Declaration of interest

The authors declare that there is no conflict of interest.

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**Abstract**

Background: Children with developmental language disorder (DLD) demonstrate poor oral inferential comprehension. Research investigating the skills which underpin oral inferential comprehension in young children with DLD is necessary in order to better understand, and improve, inferential comprehension in this population.

Aims: This study aimed to profile the language and cognitive skills which contribute to oral inferential comprehension in young children with DLD.

Methods & Procedures: Seventy-six children aged 5 to 6 years, with a diagnosis of DLD, were assessed on a wide range of language and cognitive measures. Oral inferential comprehension of narrative was the primary outcome measure.

Outcomes & Results: Narrative macrostructure and microstructure, literal comprehension, vocabulary, phonological loop and theory of mind were significant predictors of inferential comprehension in bivariate analyses. However, multivariate regression analysis indicated that only narrative retell macrostructure and theory of mind contributed a significant amount of unique variance to inferential comprehension.

Conclusions & Implications: This study profiled the skills contributing to oral inferential comprehension in young children with DLD, to support the clinical and theoretical understanding of the ability in this population. The findings have implications for future intervention studies.

1. **What is known:** Many children with developmental language disorder demonstrate poor oral inferential comprehension. However, little is known about the profile of skills which contribute to this ability.
2. **What this study adds:** This study assessed a comprehensive range of language and cognitive skills, and found that narrative macrostructure and theory of mind contributed significant individual variance to inferential comprehension scores.
3. **Clinical implications:** The findings provide practical information for clinicians about the skills which underlie oral inferential comprehension in young children with DLD which can support the development of evidence-based interventions targeting inferential comprehension.

## **Introduction**

Children with developmental language disorder (DLD) have significantly disordered language development which impacts functional communication, in the absence of a differentiating condition (Bishop et al., 2016). Many children who meet criteria for DLD (formerly called specific language impairment), demonstrate particularly poor ability in the higher level oral comprehension skill of inferencing (Bishop and Adams, 1992, Botting and Adams, 2005, Norbury and Bishop, 2002).

Inferential comprehension involves going beyond information which has been explicitly stated (i.e. literal comprehension) (Bishop, 2014). Some types of inferences are necessary for comprehension to be successful, to fill 'gaps' in comprehension, whereas others enhance understanding, creating a deeper level of meaning. Thus, inferencing can involve drawing on background and contextual knowledge to link information, form predictions, fill gaps, and enhance understanding of written and/or spoken language (Bishop, 2014, van Kleeck, 2008, van Dijk and Kintsch, 1983).

Successful inferential comprehension is critical for effective communication. Poor inferencing can have a significant impact on an individual's communication, with potentially adverse effects on social relationships, participation in academic tasks, as well as general everyday activities (e.g. understanding books and TV shows) (van Kleeck, 2008). For young children, poor oral inferential comprehension is likely to have a significant, adverse, and ongoing impact on later reading comprehension, a skill closely related to academic achievement (van Kleeck, 2008). Inferential comprehension of narratives has been found to be predictive of later narrative retelling and comprehension skills in typically developing 4 to 6 year old Finnish-speaking children (Lepola et al., 2012). Additionally, early oral inferential comprehension of narratives is a predictor of later reading comprehension (Silva and

Cain, 2015), and inferencing was found to be an important, unique predictor of reading comprehension in 8 to 11 year old English-speaking children (Cain et al., 2004). As such, it is important to understand the skills contributing to inferencing in young children with DLD in order to develop targeted interventions.

### **Development of inferential comprehension**

In one of the few studies exploring the development of inferential comprehension, Filiatrault-Veilleux, Bouchard, Trudeau, and Desmarais (2016) found that typically developing French-speaking children were able to form causal inferences (e.g. a character's internal response) from 3 years of age, with more complex inferential comprehension skills (e.g. prediction) developing around 5 to 6 years. It is evident that typically developing children are able to successfully engage in inferential comprehension from a young age, however more research is required to provide a clearer understanding of the general progression of these skills (Filiatrault-Veilleux et al., 2016).

One of the main contexts in which young children engage in inferencing is during the shared reading of narratives. Exposure to story books is strongly related to the development of inferential comprehension skills as children are actively engaged in understanding. According to van Kleeck (2008), inferential comprehension of narratives involves three types of inferences: causal, evaluative, and informational. Causal inferences, which relate clearly to narrative structure and comprehension, include predictions, linking information within or across texts or with background knowledge, and inferring character feelings, attitudes, and motives (van Kleeck, 2008). Judgements of morality or convention are required to form evaluative inferences, and informational inferences involve providing unstated information on narrative setting (character, time, place), elaborating on information using

background knowledge, or defining words from information provided (van Kleeck, 2008). These types of inferences inherently lend themselves to the narrative context. As such, narratives present a naturalistic context in which to assess and support the development of inferential comprehension in children.

### **The relationship between inferential comprehension and language and cognitive skills**

Past research has demonstrated that young typically developing children draw on a number of language and cognitive skills for inferencing. A study of 131 typically developing French-speaking children aged 4 to 6 years assessed a wide range of skills including sentence comprehension, working memory, vocabulary, and grammar (Potocki et al., 2013). The combined language and cognitive skills accounted for 44% of the variance in overall narrative (listening) comprehension ability, which included both literal *and* inferential questions. Potocki et al. (2013) found that working memory, sentence comprehension, grammatical, and morphological skills contributed significant unique variance. In a separate study of 221, 4 to 6 year old Italian-speaking children, semantic knowledge (as reflected by a measure of verbal intelligence involving defining words and identifying associations) accounted for significant individual variance in *overall* narrative comprehension (Florit et al., 2011).

Most studies investigating oral comprehension have reported the contribution of language and cognitive skills to overall (i.e., inferential *and* literal) comprehension. In contrast, Silva and Cain (2015) investigated inferential and literal comprehension separately in 82, 4 to 6 year old typically developing English-speaking children. Silva and Cain (2015) explored the relationship between lower level language and cognitive skills (i.e., receptive vocabulary, grammar, verbal memory), literal and inferential narrative comprehension, and later reading comprehension, and found

receptive vocabulary to be the only significant predictor of inferential comprehension (Silva and Cain, 2015). Karasinski and Ellis Weismer (2010) assessed inferences during oral narrative comprehension in an older age group of 527, 13 year old students who had either typically developing language, low cognition, DLD, or non-specific language disorder. They investigated the skills which predicted significant individual variance in distant inferencing (which involves linking information across paragraphs with background knowledge, or prediction) for the participant group as a whole. Significant predictors included receptive vocabulary, working memory (a task requiring judgement and verbal recall), and following instructions (Karasinski and Ellis Weismer, 2010).

Similar skills have been demonstrated to be important for *reading* comprehension in older typically developing children. A longitudinal study of 102 English-speaking children with average reading ability aged 7 to 9 years found that verbal IQ and vocabulary contributed significant variance to reading comprehension (Oakhill et al., 2003). When verbal IQ and vocabulary were controlled, comprehension monitoring, story structure knowledge, constructive inferencing, verbal working memory, and phonological awareness contributed independent variance to reading comprehension when the children were assessed at 7 to 8 years. At 8 to 9 years, receptive syntax and working memory measures (including digit, word, and sentence repetition) accounted for significant unique variance in reading comprehension (Oakhill et al., 2003).

Given these findings, a number of language and cognitive skills can be hypothesised to contribute to oral inferential comprehension. The skills suggested to be important for oral inferential *and* literal narrative comprehension in young typically developing children include vocabulary and semantic knowledge, working memory,

and grammatical comprehension (Florit et al., 2011, Potocki et al., 2013, Silva and Cain, 2015). Similarly, these also appear to be important for oral inferential comprehension in adolescents with typically developing language, low cognition, DLD, and non-specific language disorder (Karasinski and Ellis Weismer, 2010).

Theoretically, a number of skills may contribute in a bottom-up and/or top-down way to inferential comprehension. As a higher level skill, inferencing relies on the contribution of bottom-up processes. These include holding linguistic information in memory (phonological loop/short-term memory), accessing and analysing grammatical structures, accessing the necessary meanings in the lexicon (vocabulary), and completing these language processes rapidly online during communication (linguistic processing speed) (Bishop, 2014).

Van Dijk and Kintsch (1983) proposed a model of written discourse comprehension which involved multilevel processing across three specific levels, and can be applied to oral comprehension. The first level, surface representation, is an exact representation of the language read, and draws heavily on bottom-up processes, such as working memory. This surface representation is maintained for a very short period of time in memory, after which an online representation of its meaning is maintained in the textbase (van Dijk and Kintsch, 1983). This second level, the textbase, requires integration of bottom-up processes to provide a shallow meaning representation of the discourse. The highest level in van Dijk and Kintsch's (1983) model, the situation model, provides the top-down influence necessary for successful discourse comprehension. The situation model is a representation of knowledge that is relevant to the discourse (such as general knowledge, prior experiences). It contains individualised summary representations of information which can be used and updated in experiences with new discourse (van Dijk and

Kintsch, 1983). Situation models are created by schemas, which are conceptual representations of stereotypical situations or structures.

Comprehension of oral and written discourse is thought to take place during the continual comparison and updating between the textbase and situation model, utilising both bottom-up and top-down skills (van Dijk and Kintsch, 1983). Inferences are thought to be made, and coherence established, during this process (Graesser et al., 1994 ).

A number of top-down processes and skills may influence the quality of situation models available to an individual and, as such, impact inferencing. These include the comprehension of, and experiences involved in, understanding and thinking about other people's perspectives (theory of mind). Some skill components in theory of mind (e.g. attributing mental states) and inferential comprehension (e.g. inferring emotions) are closely related in young children (Desmarais et al., 2016, Ford and Milosky, 2003).

Additionally, the better specified the schemas which are available to an individual, the greater their ability to organise incoming discourse information (van Dijk and Kintsch, 1983, Bishop, 2014). As such, narrative schemas (as reflected in narrative retelling tasks) may support inferential comprehension.

Executive functioning, which includes a range of cognitive skills such as inhibition and cognitive flexibility, has been shown to contribute significant variance to *reading* comprehension difficulties in children aged 9 to 15 years (Potocki et al., 2015, Sesma et al., 2009). In particular, the ability to suppress (or inhibit) irrelevant information is important to allow for successful comprehension (Gernsbacher et al., 2004). As such, inhibition may contribute to successful *oral* inferential comprehension.

It remains unclear whether children with DLD draw on the same skills as typically developing children during oral inferential comprehension. As children with DLD generally show poor inferential comprehension, a key component of successful reading comprehension, it is vital to understand the skills which contribute to oral inferential comprehension in order to develop and trial targeted early interventions in this population. To current knowledge, only two intervention studies have been conducted which have focused on improving oral inferential comprehension in young children with DLD (van Kleeck et al., 2006, Desmarais et al., 2013). This highlights the need to investigate the relationship between language and cognitive skills and inferential comprehension in this population.

### **Aims**

This study aimed to identify the language and cognitive skills which significantly contributed to oral inferential comprehension in a group of young children with DLD, through administration of a comprehensive range of word, sentence, and discourse level language and cognitive measures.

### **Methods**

The Curtin University Human Research Ethics Committee and the Western Australian Department of Education provided ethics approval for this study. Principal and teacher consent was obtained from two metropolitan Language Development Centres in Western Australia. Language Development Centres are specialist language schools which provide intensive language-based schooling to children with developmental language disorder (DLD) in the early primary years, with support from speech and language therapists. Students demonstrating a profile of skills consistent with DLD are offered a place following referral from a speech and language therapist which includes case history, standardised and norm-referenced language

assessments, non-verbal IQ assessment by a registered psychologist, and developmental and behavioural checklists.

Parent/guardian consent was received for 78 pre-primary students. Seventy-six participants passed a hearing screen and presented with mostly intelligible speech at discourse level within known context. Participants were aged between 5;2 to 6;2 (years; months) with an average age of 5;7, and the sample consisted of 60 males (78.9%) and 16 females (21.1%). Six of the participants spoke a language other than English at home, and five of those participants had been exposed to English since infancy. Participants completed a battery of assessments with the primary researcher over four to five individual assessment sessions of 15 to 20 minutes each.

### **Measures**

A range of language and cognitive skills were assessed, with inferential comprehension of narrative as the primary outcome (see Table 1).

Participants were assessed at their school and the battery of assessments was administered in the same order. Teachers completed two checklists for each participant, assessing theory of mind development, and general communication and pragmatic skills. The assessments were scored according to assessment manuals or author guidelines. Inter-rater reliability was completed using intra-class correlation (ICC) for 10% of the assessment sample scored by a speech and language therapist who was not involved in the research. Inter-rater agreement was adequate for all measures, with ICC values indicating excellent reliability (ICCs > .75, range = .961 – 1) (Cicchetti, 1994).

**Insert Table 1 here**

The Squirrel Story Narrative Comprehension Assessment (NCA) (Dawes et al., 2018) was developed for this research based on the Narrative Comprehension of Picture Books task by Paris and Paris (2003), adapted to be used in conjunction with the Squirrel Story Narrative Assessment on iPad (Carey et al., 2006, Dawes, 2017). The Narrative Comprehension of Picture Books task includes inferential and literal comprehension questions designed for wordless picture books, and was shown to generalise across narratives, have appropriate internal consistency, inter-rater reliability, and concurrent and predictive validity over a series of three studies (Paris and Paris, 2003). The questions were adapted by the researchers for use with The Squirrel Story narrative as a measure of *oral* narrative comprehension.

Each participant watched and listened to The Squirrel Story narrative on iPad and was then asked the comprehension questions while looking through the narrative pictures again. The responses were transcribed and scored offline by the primary researcher. The Squirrel Story NCA includes 14 inferential questions and 5 literal questions. A scoring scale (0, 1, or 2 points for each question) and guide was created based on the scoring guide developed by Paris and Paris (2003). This provided total scores for inferential comprehension (out of 28) and literal comprehension (out of 10). A pilot study of typically developing children ( $n = 40$ ) was used to develop the scoring guide (Dawes, 2017). Inter-rater reliability (ICC value) was .961 for inferential comprehension scores and .979 for literal comprehension scores.

Following the comprehension questions, the participant was asked to listen to the story again and then retell the story while looking through the pictures. The narrative retells were transcribed offline. The Squirrel Story Narrative Assessment scoring guidelines were followed using the rating scales on the iPad app for

narrative retell macrostructure (story structure and story content ratings), and narrative microstructure (level of language used/syntax and vocabulary ratings). Inter-rater reliability was .974 for macrostructure and .983 for microstructure.

The bear/dragon task and the grass/snow task were administered as per the description by Carlson (2005). For the bear/dragon task, the participant watched an iPad video with puppets, and was asked to follow simple instructions (e.g. 'touch your knee') given by a 'nice' bear puppet and ignore instructions given by a 'naughty' dragon puppet. For the grass/snow task, the participant was asked to point to a white card when they heard the word 'grass' and a green card when they heard the word 'snow'. Both tasks were scored using a scale of 0, 1, or 2 points per item for a total score out of 20.

Both receptive and expressive vocabulary skills have been found to be significant predictors of oral narrative comprehension in young children (Tompkins et al., 2013, Silva and Cain, 2015). As such, the receptive and expressive vocabulary scores were included as a combined measure to provide an overall reflection of vocabulary use and understanding.

Standard descriptive statistics (means, standard deviations and ranges) were used to summarise the scores for all measures. A series of bivariate regression analyses were conducted with inferential comprehension score as the dependent variable, and each of the 12 measures as independent variables. A multiple regression analysis was then conducted to identify which of these variables were independently associated with inferential comprehension. A final model was obtained through a method of backwards elimination, whereby the least significant variable was dropped from the model, one at a time, until all variables remaining in the model were significantly associated with the outcome. Pairwise interaction

terms between these independent variables were then explored for statistical significance. Data analyses were conducted using the SPSS version 22 software, and a  $p$ -value  $< 0.05$  was taken to indicate a statistically significant association in all tests.

## Results

Firstly, participants who did not meet the selection criteria were removed from the sample. Eight participants were excluded from the total sample ( $n = 76$ ) based on a negative Social Interaction Deviance Composite and a General Communication Composite score below 55 on the Children's Communication Checklist-2 (Bishop, 2003a). This indicated that these participants' primary difficulty was in the pragmatic domain of communication (i.e., communicative profile indicative of autism spectrum disorder). One participant was excluded due to a Performance IQ standard score on the WPPSI indicating borderline nonverbal functioning, therefore not meeting participant selection criteria of low average or average/above average nonverbal functioning<sup>1</sup>.

Of the remaining 67 participants included for analysis, 51 were males (76%) and 16 were females (24%). The mean age of participants at the commencement of assessment was 5;7, ranging from 5;2 to 6;2 ( $SD = 3.62$  months).

The means and standard deviations of the language and cognitive measures are provided in Table 2.

### **Insert Table 2 here**

A power analysis was conducted to determine whether the sample size was sufficient to detect 'moderate' relationships between inferential comprehension and

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<sup>1</sup> Please note that this study was completed prior to the publication of the CATALISE consortium (Bishop et al., 2016) and therefore non-verbal IQ (low average or above) was used as inclusion criteria for the analyses.

each of the variables. With an alpha-level of 0.05, 67 participants provided 80% power to detect a relationship between inferential comprehension and each of the language and cognitive variables which exhibited a small to moderate effect size ( $f^2 = 0.12$ ).

Testing was completed to determine whether age, gender, and language/s spoken were confounders in the analyses. These variables were ruled out as potentially confounding covariates because participants were the same age, there was no gender difference in terms of inferential comprehension ( $t[65] = 0.405$ ,  $p = .687$ ), nor inferential comprehension difference between participants who did or did not speak a language other than English at home ( $t[65] = .118$ ,  $p = .906$ ).

Bivariate regression models were tested for each of the 12 language and cognitive variables in order to identify which were significant predictors of inferential comprehension. Variables which appeared to be significantly associated from these analyses included: narrative macrostructure and microstructure, literal comprehension, vocabulary, phonological loop and theory of mind (see Table 3).

Multiple regression showed that, of the 6 variables which appeared to be significantly associated with inferential comprehension on bivariate analysis, only narrative macrostructure and theory of mind appeared to remain independently associated following backwards elimination (see Table 4). This indicated that, once these two variables were included in the model, addition of any of the other variables did not add significantly to the model. Examination of the final model showed that these two independent variables accounted for 26% of the variance in inferential comprehension ( $R^2=0.26$ ). Narrative macrostructure and theory of mind were both positively associated with inferential comprehension. For example, as narrative

macrostructure score increased by one unit, inferential comprehension score increased by 1.06 units (95%CI: 0.4 – 1.7).

**Insert Table 3 here**

**Insert Table 4 here**

## **Discussion**

This study aimed to examine which particular language and cognitive skills made a significant contribution to inferential comprehension ability in a group of children with DLD, in order to add to our theoretical understanding in this area and, in turn, to inform our clinical practice. Significant predictors identified in this study included the language skills of narrative retelling ability, literal comprehension of narrative, overall vocabulary, and the cognitive skills of theory of mind and phonological short-term memory. Each of these explained from 5.5 to 18.3% of the variance in oral inferential comprehension scores in bivariate analyses. However, only narrative macrostructure and theory of mind remained significantly associated with inferential comprehension following analysis using multiple regression.

The findings both confirm and advance our current understanding, which is primarily based on the body of research which has investigated narrative comprehension in young typically developing children, rather than children with DLD. For example, in typically developing 4 to 6 year old Italian-speaking children, Florit et al. (2011) found that significant variance in overall story comprehension was accounted for by measures of receptive vocabulary and semantic knowledge (word definitions and identifying similarities). Similarly, in a longitudinal study of 130 typically developing Finnish children, Lepola et al. (2012), measured narrative

listening comprehension using a combination of the number of story grammar elements included in a retell and responses to four comprehension questions (narrative production was not considered or reported separately). Narrative listening comprehension at age 4 predicted inferencing skill at age 5, which in turn predicted narrative listening comprehension at age 6, while vocabulary knowledge and sentence memory were related to concurrent but not to later narrative listening comprehension.

Receptive vocabulary, working memory, sentence comprehension (judgement of similar meaning), as well as grammatical and morphological knowledge, were significant predictors of overall narrative comprehension in 4 to 6 year old French-speaking children (Potocki et al., 2013). In their study, comprehension was evaluated using yes/no questions, half of which were based on information explicitly stated in the text (i.e., literal comprehension) while the remainder required the generation of inferences. In contrast to the present study, no measure of expressive narrative was obtained (Potocki et al., 2013). In typically developing 4 to 6 year old English-speaking children, Silva and Cain (2015) found that receptive vocabulary emerged as the only significant predictor of inferential narrative comprehension in a task based on that of Paris and Paris (2003), among receptive vocabulary, grammar, and verbal memory. While a narrative re-tell was collected as part of the data, it was not reported.

Similar to Potocki et al. (2013) and Lepola et al. (2012), for young typically developing children, Karasinski and Ellis Weismer (2010) found that receptive vocabulary, receptive grammar, and working memory measures were significant predictors of inferential comprehension in a mixed group of adolescents. While

vocabulary and phonological memory measures were significant in the bivariate analyses in the current study, the multiple regression indicated that they did not contribute significant unique variance to inferential comprehension. These contrasting findings may reflect that different profiles of skills are important for inferential comprehension in different populations (i.e. typically developing vs. developmental language disorder). Alternatively, the results may indicate that the skills contributing to inferential comprehension in children with DLD may change over time. In particular, this may reflect the gradual development of skills which tend to be particularly weak in children with DLD, such as vocabulary, grammar, and working memory.

The inclusion of discourse production measures in the present study allowed an investigation beyond the word and sentence level. Vocabulary, grammar and phonological memory are clearly critical bottom-up skills required for successful comprehension, and also contribute to narrative microstructure (Bishop, 2014). However, it can be hypothesised that the construction of a coherent situation model used for inferential comprehension draws heavily on top-down skills which rely on well-specified schema, including narrative macrostructure. As such, when all of the language and cognitive skills were considered in multiple regression, the bottom-up skills did not emerge as significant, unique predictors. Additionally, it is possible that children with DLD draw on skills such as vocabulary to a lesser extent to support inferencing as compared to typically developing peers, which may contribute to their poorer inferential comprehension skills.

Phonological loop performance is generally poor in children with DLD and was just over one standard deviation below the mean for this study's participants ( $M = 84.78$ ). Our findings indicated that while phonological loop ability and literal

comprehension were significant individual contributors to oral inferential comprehension ability, when considered as part of a multivariate analysis, they did not contribute unique variance. While phonological loop ability is hypothesised to contribute directly to the surface representation during language comprehension, and hence to literal comprehension, its influence on inferential comprehension in children with DLD is unknown. Strong phonological loop abilities would indicate that an individual has greater capacity to store linguistic information in working memory (which is retained for only a few seconds). Hypothetically, better phonological loop abilities would have a positive impact on comprehension overall, as over short periods of time the individual would be able to hold, and thus recall, more verbal information. However, inferential comprehension involves linking information, and as such requires more than just recall. Thus, how long (and how accurately) phonological information is held in working memory, may be a less important factor in inferential comprehension. This is supported by previous research in young typically developing children which found that areas of working memory were significant predictors of combined literal *and* inferential narrative comprehension (Lepola et al., 2012, Potocki et al., 2013), but not of inferential narrative comprehension alone (Silva and Cain, 2015). As such, and given the current findings, phonological loop ability may contribute more directly to literal comprehension, which draws more heavily on recall of information via linguistic information in the surface representation.

The inclusion of a measure of theory of mind was based theoretically on the premise that it would influence comprehension in a top down way via the situation model – integrating long-term knowledge with social cognition. Whilst theory of mind has not usually been included in studies of inferential comprehension, a meta-analysis identified overall poorer theory of mind in children with DLD compared to TD

children across the age range of 4 to 12 years (Nilsson and de López, 2016). The finding of a significant contribution of theory of mind to inferential comprehension of narrative discourse highlights the difficulty experienced by the DLD participants in understanding the perspectives of others, which is a critical aspect of being able to make appropriate inferences (e.g. understanding the character's motivation, goals, and feelings in a story).

### Theoretical Implications

Our findings support the notion that, at an individual level, both bottom-up and top-down skills are contributors to discourse-level inferential comprehension in children with DLD (van Dijk and Kintsch, 1983, Bishop, 2014). However, the key skills which contributed uniquely to inferential comprehension were both language-based (narrative macrostructure) and cognitive (theory of mind) top-down skills.

The narrative macrostructure of a narrative retell reflects the schematic structures available to an individual, as schemas provide a scaffold to attach information to during online discourse comprehension in order to understand, remember, and then reproduce a text. As such, poorly specified schemas may have an adverse impact on discourse-level skills, including inferential comprehension (Bishop, 2014). In contrast, well-specified schemas should support the creation of accurate and stable situation models which are drawn on during the process of discourse comprehension (van Dijk and Kintsch, 1983). The findings support the notion that schemas support inferential comprehension: the better specified and robust the schemas available to an individual, the better scaffolding is provided to support the process of inferential comprehension (van Dijk and Kintsch, 1983). Given this, supporting and developing schema in young children with DLD should improve

the ability to establish and maintain organised processing of discourse-level language, thus facilitating inferential comprehension.

Theory of mind may influence inferential comprehension in a top-down way. As mentioned, many aspects of theory of mind are closely related to inferencing (e.g. thinking about character motivations or feelings) (Desmarais et al., 2016, Ford and Milosky, 2003). Theory of mind development is facilitated through the variety and quality of interactions and contexts for interactions to which a child is exposed (e.g. storytelling, family discussions) (Westby and Robinson, 2014). This development of a robust theory of mind may therefore provide a structure for long-term stored information which can be integrated in a top-down manner to influence and support the process of inferential comprehension.

In summary, the results indicate that top-down skills are critical contributors to inferential comprehension in young children with DLD. Most importantly, the findings indicate that inferential comprehension may rely to a significant extent on higher level skills (i.e. narrative schema and theory of mind). Given the importance of oral language comprehension to reading comprehension, these findings have implications for the understanding of oral and written inferential comprehension in this population.

A number of the language and cognitive skills which were hypothesized to be predictors of inferential comprehension in children with DLD did not emerge as significant contributors. For example, language comprehension requires adequate grammatical skills working in a bottom-up manner to break down (and understand) the language structures used. While grammar skills may be important during the process of inferential comprehension (i.e. to understand a question), they did not significantly contribute to inferencing in this group of children with DLD. This indicates that, while word- and sentence-level grammar intervention is extremely important for

children with DLD, these intervention targets at the word and sentence level are unlikely to improve discourse-level inferential comprehension.

Additionally, the measures of linguistic processing (rapid naming), episodic buffer, and inhibition did not emerge as significant predictors. Other studies have found that executive functioning contributes to reading comprehension (Sesma et al., 2009, Potocki et al., 2015). Future research should further investigate the relationship of these skills with literal and inferential comprehension separately.

### Clinical Implications

The findings of this study inform speech and language therapists' understanding of the skills which may contribute significantly to inferential comprehension of narratives in young children with DLD. The findings should support the development of targeted, evidence-based interventions to support and improve oral inferential comprehension in this population.

Narrative macrostructure was the greatest individual predictor of inferential comprehension. This indicates that narrative macrostructure can be considered an important intervention target to both support, and improve, oral inferential comprehension in young children with DLD. As such, an intervention context focused at the discourse-level which supports the development of narrative schema may be most effective (i.e. rather than word- or sentence- level).

Additionally, while literal comprehension was a significant predictor in the bivariate regressions, it was not significant in the multivariate analysis. This supports the concept that literal comprehension is distinct from inferential comprehension. As such, speech and language therapists should consider literal and inferential comprehension as related but independent skills in both assessment and intervention.

Theory of mind has previously been identified as an important area of intervention for children with communication difficulties, however, it is not a common area of practice for most speech and language therapists (Westby and Robinson, 2014). This study's findings indicate that theory of mind should be considered in the understanding of inferential comprehension in young children with DLD, and may be important to target in intervention to support the development of inferential comprehension.

### **Limitations**

The skills which contributed to oral inferential comprehension in this study reflect one group of 5 to 6 year old children with DLD. As such, replication of these findings and longitudinal investigations of the skills contributing to oral inferential comprehension in children and adolescents with DLD are required. Additionally, this study investigated oral inferential comprehension of narratives, reflecting discourse-level comprehension and, as such, inferential comprehension at lower levels (e.g. text-connecting inferences at the sentence-level) may draw on a different profile of skills.

A larger sample would have allowed the identification of relationships exhibiting a smaller effect size on bivariate analyses. However, smaller effect sizes may have little clinical relevance. A larger sample size would also have provided more power for the multiple regression analyses. It would be useful for future research to address these limitations, to include a typically developing group of children for comparison, and different age groups of children with DLD.

The Narrative Comprehension Assessment of literal and inferential comprehension developed for this research was not standardised. However, there is a paucity of standardised assessments which: assess inferential comprehension in

the narrative context (i.e. not based on a single picture) with young children; include a range of inferential comprehension questions, and; which provide separate scores for literal and inferential comprehension. The assessment was adapted from the Narrative Comprehension Task researched over a number of studies by Paris and Paris (2003) and inter-rater reliability in this study was appropriate.

The inhibition tasks also presented a limitation as they were not standardised and the results of both tasks indicated ceiling effects. As such, the results of the inhibition tasks need to be interpreted with caution. Further research is needed to provide valid and reliable executive functioning assessments for young children (Willoughby et al., 2012).

Additionally, the initial selection of assessments was restricted for a number of reasons (analytical limitations, assessment time with participants, assessment complexity, and the literature available at the time of selection). It would have been useful to include a wider range of assessments, such as those assessing vocabulary depth (Cain and Oakhill, 2014), the central executive component of working memory (Potocki et al., 2013), and other executive functioning skills, such as switching (Pauls and Archibald, 2016).

## **Conclusions**

This study has identified the language and cognitive skills which contributed to oral inferential comprehension of narratives in 5 to 6 year old children with developmental language disorder. Both language (narrative retelling macrostructure and microstructure, literal comprehension, overall vocabulary) and cognitive (theory of mind, phonological loop) skills were significant individual predictors of inferential comprehension in the group of children with DLD, while narrative macrostructure and theory of mind remained significantly associated with inferential comprehension on

multiple regression. These findings contribute to the theoretical and clinical understanding of oral inferential comprehension in young children with DLD, and will support the development of targeted, evidence-based interventions to improve inferential comprehension in this population.

**Table 1: Assessment Battery**

<b>Language Area</b>	<b>Assessment</b>
<i>Inferential and literal narrative comprehension</i>	The Squirrel Story Narrative Comprehension Assessment (Dawes et al., 2018), created by the researchers for this study and adapted from the Narrative Comprehension of Picture Books task (Paris & Paris, 2003)
<i>Narrative retell</i>	Squirrel Story Narrative Assessment on iPad (Carey, Leitão, & Allan, 2006)
<i>Expressive single-word vocabulary</i>	Expressive Vocabulary Test – Second Edition (EVT-2) (Williams, 2007)
<i>Receptive single-word vocabulary</i>	Peabody Picture Vocabulary Test – Fourth Edition (PPVT-4) (Dunn and Dunn, 2007)
<i>Expressive grammar</i>	Word Structure subtest of the Clinical Evaluation of Language Fundamentals Preschool – Second Edition (CELF-P2) (Semel et al., 2006) <sup>a</sup>
<i>Receptive grammar</i>	Test for Reception of Grammar – Second Edition (TROG-2) (Bishop, 2003b)
<i>Linguistic processing speed</i>	Rapid Naming subtests of the Comprehensive Test of Phonological Processing (CTOPP) (Wagner et al., 1999)
<b>Cognitive Area</b>	
<i>Working memory – phonological loop</i>	Phonological Memory subtests of the Comprehensive Test of Phonological Processing (Wagner et al., 1999)
<i>Working memory – episodic buffer</i>	Sentence Imitation subtest of the Test of Language Development – Primary, Third Edition (TOLD-P3) (Hamill and Newcomer, 1997)
<i>Inhibition (go/no-go; verbal response inhibition)</i>	Bear/dragon task and grass/snow task (Carlson, 2005)

<i>Nonverbal IQ</i>	Core Performance IQ (PIQ) subtests (Picture Concepts, Matrix Reasoning and Block Design) of the Wechsler Preschool and Primary Scale of Intelligence – Third Edition (WPPSI-3) (Wechsler, 2002) <sup>b</sup>
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**Teacher Checklists**

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<i>Theory of Mind</i>	Theory of Mind Inventory (ToMI) (Hutchins et al., 2010)
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<i>General Language and Pragmatics</i>	Children’s Communication Checklist-Second Edition (Bishop, 2003a)
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*Note.* <sup>a</sup> If a participant had completed the Word Structure subtest of the CELF-P2 in the 6 months prior to assessment, the assessment was not readministered.

<sup>b</sup> If a participant had been assessed on the WPPSI in the previous 18 months (i.e. for their referral to the LDC) the assessment was not readministered.

**Table 2: Means, Standard Deviations and Ranges of Measures (*n* = 67)**

Measure	Mean	Standard Deviation	Range	Maximum score
Inferential comprehension	12.51* (15)	3.44	4 – 19	28
Literal comprehension	4.37* (5.8)	1.35	1 – 7	10
Narrative retell – macrostructure	3.40* (4.8)	1.19	1 – 6	7
Narrative retell – microstructure	2.66* (4.3)	1.03	1 – 5	6
CELF-P2 Word Structure – expressive grammar	7.28** (10)	2.75	1 – 14	-
TROG-2 – receptive grammar	81.97** (100)	12.32	60 – 107	-
EVT-2 and PPVT-4 – combined vocabulary	98.85** (100)	8.43	80 – 118	-
CTOPP – phonological loop	84.78** (100)	7.65	64 – 106	-
CTOPP – rapid naming	92.97** (100)	13.84	61 – 127	-
TOLD-P3 Sentence Imitation – episodic buffer	5.69** (10)	2.46	1 – 12	-
ToMI – theory of mind	12.51** (15.53)	3.18	4 – 18	-
Inhibition – Dragon/Dog	18.94*	1.92	9 – 20	20
Inhibition – Grass/Snow	17.01*	3.32	3 – 20	20

*Note.* \* = assessment raw scores; \*\* = assessment standard scores; the standardised or typically developing mean is shown in brackets next to the group mean score when available; maximum score indicates the maximum attainable (ceiling) score for raw score tasks.

**Table 3: Relationships between Inferential Comprehension and Each Predictor in the Bivariate Regression Analyses.**

Predictor	Unstandardised Regression coefficient	$\eta^2$	$p$
Narrative macrostructure	1.121	.183	.001*
Narrative microstructure	1.145	.146	<.001*
Literal comprehension	0.704	.108	<.001*
Expressive grammar	0.231	.049	.294
Receptive grammar	0.040	.040	.124
Vocabulary	0.093	.055	.001*
Phonological loop	-0.065	.017	.018*
Linguistic processing (rapid naming)	-0.002	<.001	.934
Episodic buffer (sentence repetition)	0.120	.020	.245
Inhibition – dog/dragon	0.032	.005	.773
Inhibition – grass/snow	-0.006	.001	.955
Theory of mind	0.320	.126	<.001*

**Table 4: Variables Identified as being Independently Associated with Inferential Comprehension in Multiple Regression Analysis.**

<b>Predictor</b>	<b>Unstandardised Regression coefficient</b>	<b>95% CI</b>	<b><math>\eta^2</math></b>	<b><i>p</i></b>
Narrative macrostructure	1.06	0.43 – 1.70	0.15	0.001
Theory of mind	0.30	0.06 – 0.54	0.09	0.014

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