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'Captain Grey and the Greedy Aliens': Obtaining normative on a new test for the production of verbs at sentence level in children

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'Captain Grey and the Greedy Aliens': Obtaining normative on a new test for the production of verbs at sentence level in children.

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I wish to thank Carol-Anne Murphy for all her help and guidance during supervision of this project.

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Research Report

‘Captain Grey and the Greedy aliens’: Obtaining normative data on a new test for the production of verbs at sentence level in children.

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Abstract

Background - Verbs are known to be central to sentence production (Levelt 1989). Children with SLI (CwSLI) have been found to have significant difficulty with both verb knowledge and the production of sentences around verbs (Hansson and Bruce 2002). Current clinically available assessments fail to elicit a range of verb types and verb argument structures with varying degree and complexity. The story retell ‘Captain Grey and the Greedy aliens’ provides an opportunity for an efficient and valid measure of children’s verb production abilities to be gathered which are more representative of their underlying language abilities than the de-contextualized assessments currently available.

Objectives- The aim of this pilot study is to gather normative data on children’s verb comprehension, mean length of sentence production, and their verb argument structure accuracy, to allow for future identification of strengths and weaknesses in the sentence production of children with language impairments. It aims to investigate the sensitivity and reliability of the assessment tool, to establish the clinical utility of the story re-tell. It also aims to investigate whether verb comprehension is a predictor of both mean sentence complexity and verb argument structure accuracy.

Methods- 91 school-aged children (4;06-12years) were recruited. A verb comprehension task consisting of 36 target verbs, and a story retell task designed to elicit a variety of verb types from a range of semantic and syntactic classes were implemented.

Results- Normative data revealed developmental progression through the age groups on all three variables. Verb comprehension was found to be a significant contributor to the development of both mean sentence complexity development and verb argument structure accuracy.

Conclusions- The story retell 'Captain Grey and the Greedy Aliens' could be a useful tool for examining verb types that are problematic for CwSLI. A larger sample size is required in order to validate the clinical utility of the story retell tool.

Keywords- SLI, TD children, normative data, sentence production, story retell, mean sentence complexity, verb argument structure accuracy.

What this paper adds

What is already known on this subject

It is widely known that children with SLI have a greater difficulty with the acquisition of verbs, verb types and their associated structures than their TD peers.

What this paper adds

The research provides support for the use of mean sentence complexity scores and verb argument structure accuracy scores of typically developing children to be compared against errors made by children with suspected language difficulties through the use of a story retell tool 'Captain Grey and the Greedy Aliens'.

Introduction

CwSLI have a deficit in language acquisition and use in the absence of any obvious causal factors, such as autism, hearing impairment or mental retardation (Owen 2010). Major deficits have been reported around variable use of tense and agreement (Rice et al 1995), deficits around sentence building, the use of fewer obligatory arguments and the omission of more optional arguments than their TD peers (King 2000).

Verbs are known to be central to sentence production. Sentence processing models (Garrett 1988; Levelt 1989; Haegmen 1991) agree that where to map the nouns in a sentence is largely determined by the verb.

An investigation into the use and production of verbs and their associated structures will be discussed for TD children as well as CwSLI. An outline of elicitation techniques and formal assessments currently available in relation to verbs and sentence production will also be given, in order to validate the need for this study.

The properties of verbs make them a complex and lexical class for both acquisition and production. Verbs are known to be conceptually and semantically more complex than nouns due to their encoding of relational rather than referential terms and the specific attention required to the syntactic environments in which they can be used (Pinker 1989). It is now well attested that verbs are acquired through learning the relation between the verbs semantic argument structure and it's syntactic structure. Arguments have been put forward for both syntax providing a fundamental guide to children's interpretations of the verbs they are learning (Bloom 1999; Fisher 1996) and for argument structure patterns emerging from generalizations made after significant item-based learning (Goldbeg 1999; Tomasello 2000).

Typical Development

Characteristic properties of verbs

Valian (1991) claims that intransitive frames are easier for children to produce early in development than transitive frames because they do not require a direct object argument. However, Theakston et al (2001) suggested that children were not selecting argument structure on the basis of syntactic complexity, but instead the frames used by the children's mothers, regardless of transitivity. Naigles and Hoff-Ginsberg (1998) found the more often a verb appeared in the input, the more often and more flexibly it was used in the child speech corpus 10 weeks later, extending Brown's (1958) original conjecture about the role of input frequency in noun acquisition to the domain of verbs. The more frames in which a verb is heard, the more distinctive it will be from others and the earlier it will be acquired (Naigles 1996).

Bowerman (1982) documented a developmental pattern of syntactic errors that children make in the production of locative verbs, finding that children between the ages of four and seven often over-regularize the locative form with the content encoded as direct object. It has been hypothesized (Gropen et al 1991) that children make use of a universal linking rule known as 'object affectedness' to account for this pattern of errors, but also for how they are eventually unlearned. Bowerman (1982) notes this pattern of development is suggestive of a process of re-organization, in which a child discovers that a set of verbs, acquired independently, have a common kind of mapping of semantic arguments onto syntactic roles. Most children below age three do not understand the subject verb object word order (Tomasello 2006). Studies of argument structure development in children indicate that the acquisition of the full range of argument structure options for complex verbs extends at least into adolescence (Thordardottir and Weismer 2002a).

Sentence Complexity

Complex sentences are structures that are built up of simpler sentences through the recursive operations of co-ordination and embedding (Bowerman 1979). The use of complex sentences is considered to develop significantly during the school-aged

years (Schuele and Dykes 2005) and is expected to continue to do so during the course of adolescence, particularly in the context of narratives.

Children with SLI

While CwSLI have been noted to have significant difficulty with the acquisition of grammatical morphology, (Rice et al 1995; Leonard et al 1997), significant difficulties with verb knowledge and the production of sentences around verbs are also evident.

Verb Knowledge

General All Purpose (GAP) Verbs

Rice and Bode (1993) have argued that CwSLI rely more heavily on general all purpose (GAP) verbs than TD children. Jones and Conti-Ramsden (1997) investigated this hypothesis in the spontaneous speech of CwSLI. Similar to findings of Watkins et al (1993), no significant differences were found between the groups on the proportion of GAP verbs used by CwSLI and their age and vocabulary-matched peers. Thordardottir and Weismer (2001) investigated 50 CwSLI and 50 NL matched on CA to examine whether children with SLI use high frequency verbs to a greater extent than NL controls. Results found both groups were indistinguishable in high frequency (GAP) verb use, indicating that their use is part of normal language development.

Argument Structure

Preliminary evidence has suggested that argument structure is not well controlled by CwSLI. King and Fletcher (1993) found both CwSLI and TD school-aged children displayed argument structure errors, but the CwSLI produced a greater frequency and range of errors, suggesting a potential difference between their performance and that of others. Grela and Leonard (2000) elicited samples using simple intransitive, transitive and di-transitive verbs with and without a prepositional phrase from three groups of children, SLI, aged-matched controls and MLU-matched controls. The overall error rate was higher for the CwSLI as compared to both the

age and MLU-matched counterparts, however, both CwSLI and their MLU-matched peers were more likely to omit the auxiliary when producing sentences that required three arguments compared to sentences that required only one or two arguments. The addition of a prepositional phrase did not influence the results, showing that it is the number of arguments, rather than sentence length, which resulted in the above findings, demonstrating that CwSLI are more affected than their TD children by increases in syntactic complexity (Grela and Leonard 1997; Fletcher 1997).

Change of state and Change of location verbs

Ebbels et al (2012) investigated the abilities of CwSLI in their accurate use of both change of state and change of location verbs in sentences. Similar to Kelly (1997) the SLI group was particularly affected and made more errors on change of state verbs than all three TD controls. The study is an extended support of previous findings (Bowerman 1982; Gropen et al 1991) which shows that change of state verbs are more prone to linking errors for both TD and CwSLI than change of location verbs. Reverse linking (Pinker 1994) is the process whereby one can use the syntactic construction in which a verb appears as a cue to the verb's meaning. This pattern of verb use is likely to be due to inaccurate semantic representations, which could be due to limited use of reverse linking (Shulman and Gudeman 2007). Studies in lexical semantics (Talmy 1990; Levin 1985) have suggested that many semantic classes contribute to the meaning of verbs. Deficits in verb semantics in CwSLI have been thoroughly investigated (Fletcher and Peters 1984; Kelly 1997). Hansson and Bruce (2002) found that CwSLI could equally label actions when compared to their age matched peers, however, a heavier reliance on immature strategies of sentence production was noted when the CwSLI were compared with their age-matched controls, signifying how verb comprehension can impact on sentence production complexity.

Cognitive state verbs

Children's use of cognitive state verbs (CSVs) are thought to be challenging for both TD children and CwSLI due to a variety of cognitive, syntactic and semantic demands

(Eisenberg 2003; Owen and Leonard 2007; Naigles 2000). A study conducted by Johnston et al (2001) found that 4 year old CwSLI use CSVs less often than age matched peers and speculate that the syntactic demands associated with CSVs could be the reason for the delayed use by the SLI group. Owen Van Horne and Lin (2011) conducted a study to examine the use of CSVs and the syntactic frames associated with these verbs in the spontaneous language of 23 (5; 1-8;0) year old CwSLI and 22 aged (5;0-7; 11) and 20 vocabulary-matched (4;0-4; 11) TD peers. Previous studies have suggested that CwSLI continue to have difficulty with CSVs and complement clauses as they get older (King and Fletcher 1993; Reilly et al 2004) while others have suggested that it is an area that resolves (Marinellie 2004). Results from Owen Van Horne and Lin (2011) were similar to the findings of Norbury and Bishop (2003) with the results showing that CwSLI were as proficient as their peers in the use of CSVs in conversational language samples.

Sentence complexity

It is well established that many young CwSLI have difficulty producing complex sentences (Leonard 1995). Gillam and Johnston (1992) found that CwSLI exhibited more grammatical errors in complex utterances whilst compared to aged-matched children in both spoken and written narratives.

Elicitation Techniques

Throughout the above studies, a range of elicitation techniques have been identified- spontaneous speech (Leonard et al 1997), linguistic probes (Rice et al 1995) Elicitation tasks (Owen 2010). However, elicitation technique chosen can bring about varying results. Thordardottir (2008) found children with SLI produced less accurate verb morphology in narrative and expository discourse contexts than in conversational contexts, as the rate of complex sentences is higher in narrative and expository discourses(Nippold et al 2005). Unlike samples elicited in conversational speech, content, length and complexity can all be controlled in a story re-telling task (Gazella and Stockman 2003). Using the same story with different groups of TD

children allows a range of skills to be assessed including argument structure, lexical diversity and formulation skills (Cullata et al 1983; Liles 1993).

Assessments

A range of assessments is available for children in relation to verb production and comprehension, including the CELF 4 (Semel et al 2003), The RDLS (Edwards Letts and Sinka 2011) and the RAPT (Renfrew 1997). However, all the above lack comprehensiveness as they fail to elicit a range of verb types and verb argument structures with varying degree of complexity. Adult formal assessments, such as the VAN (Webster and Bird 2000) and the VAST (Bastiaanse et al 2002) contain subtests that assess verb production in sentences (Bastiaanse et al 2005). Although comprehensive in their assessment of different verb types and argument structures, they are not standardized for the child population.

Current Study

The aim of the current study is to collect and analyze data from 91 typically developing children ranging from 4;06-12 years through a story re-tell task 'Captain Grey and The Greedy Aliens' (Murphy 2013) which is designed to elicit predetermined verbs varying in type and complexity, in order to allow for identification of strengths and weaknesses in the sentence production of children with language impairments. This pilot study will assess the sensitivity and reliability of the assessment tool in order to establish the clinical utility of the story retell. Previous studies have indicated that age, vocabulary knowledge and sentence production are inter-related. In order to investigate these assumptions, analyses will be conducted to assess the relationship between age and mean sentence complexity, and the relationship between age and verb argument structure accuracy. Regression analysis will be conducted to investigate whether verb comprehension is a predictor of mean sentence complexity and/or verb argument structure accuracy.

Method

Ethical Approval

Ethical approval was received from the Faculty of Education and Health Sciences Research Ethics Committee prior to conduction of this study. Participant agreement via parental consent was acquired prior to data collection commencing. Where possible, child consent was also obtained.

Participants

Participants included 91 school-aged children attending Irish primary schools aged (4;06-12 years) whose primary language was English. Based on narrative data from previous studies, it was deemed that the current story re-tell tool would be too complex an elicitation method for children younger than 4;06. The four participating primary schools were recruited from the south of Ireland, from counties Cork and Clare.

The sample included 38 males and 53 females, as there was no requirement for an even gender split. The breakdown of age groups was as follows (See Table 1).

Age Bands	N	Mean Age (months) (SD)	Range (months)
4;06-5;05	7	62.1 (2.4)	58-65
5;06-6;05	17	71.6 (3.4)	65-77
6;06-7;05	17	82.6 (4.2)	78-89
7;06-8;05	9	94.6 (4.3)	90-101
8;06-9;05	9	109.0 (4.2)	102-113
9;06-10;05	12	119.3 (3.7)	114-125
10;06-12;00	20	133.3 (6.0)	127-144
Combined sample	91	98.7 (25.4)	58-144

Table 1- Characteristics of the sample

The aim initially was to recruit a larger number of participants in the youngest age band (N=20), as it was anticipated that there might have been greater variation and more errors evident within this age band. Ceiling effects were expected to be seen for some of the children from 8 years onwards, hence wider age bands with lower numbers at the upper end of the range were initially proposed. However, after the

recruitment process, the number in each group was altered and revised from the original. A larger number of participants were recruited for the oldest age group (10;06-12;00). Fewer participants were recruited for the youngest age group due to the timing of the data collection. Data collection began in late January, which meant that many of the junior infants were a few months beyond the lower limit of the youngest age band.

An information pack explaining the purpose of the study and inviting participants was sent to each school. The children who were suitable for participation in the study were given an explanatory letter and a consent form to take home. Parents were advised that the study was seeking to recruit children who had no known speech, language, and/or communication difficulty, no known hearing difficulty, and no known intellectual disability.

Design

A cross sectional study design was used, with data collected at one point in time deeming this design appropriate. Other standardization studies obtaining normative data (Conti-Ramsden 2011; Dodd et al 2003) have similarly used this design method and it was deemed appropriate for a pilot standardization study.

Materials

The Test of Verb Knowledge (TOVK) is an assessment designed to assess verb comprehension. It incorporates 36 verbs of varying semantic and syntactic classes, presented as a drawing in a picture-pointing format, with three other distracter verbs.

The story retell tool 'Captain Grey and the Greedy Aliens' (Murphy 2013) was designed to assess both verb argument structure production and mean sentence complexity development of children with SLI. A story retell offers a valid method of measuring children's production of verb abilities. It is a constrained task which allows for control over the verbs elicited whilst also providing a more realistic sample of what the child would be likely to produce in a spontaneous speech sample, compared to a de-contextualized structured task such as sentence elicitation

or an imitation task, the current methods of verb production assessment for children e.g. CELF 4(Gazella and Stockman 2003).

The verbs included in the story retell contain a mixture of high and low frequency verbs, using a frequency cut-off of 120 per million. A variety of verb types were also included, such as, transitive, optionally transitive verbs presented in intransitive form, intransitive and di-transitive verbs. (See Appendix 1) The inclusion of such a variety of verb types was necessary in order for the assessment to be deemed sufficiently sensitive to capture a range of abilities and difficulties with verb production. Verbs from a range of semantic and syntactic classes such as; change of state, change of location, manner of motion, and cognitive state verbs were required, as research has established that different semantic classes of verbs can cause difficulty for children during particular stages of development.

Procedure

Each child was seen individually in the presence of a student pair, with one student conducting assessment and another monitoring and recording responses. TOVK responses were recorded on paper form, Captain Grey story retell was audio-recorded using a Dictaphone; any comments from the child on the test or test process or behaviors such as distractibility, poor attention to the task that would bear on interpretation of results were also noted.

The TOVK was administered first as it requires no verbal response. It thus places no pressure on the child to verbalize in the initial part of the session and allows them to relax with the researcher. The child was asked to point to the target verb. There were three initial trial items to introduce the child to the test format.

The story retell task (Captain Grey) is a wordless picture book, which has colorful scenes, designed to appeal to the children and to illustrate the target verbs in scenes that support their related sentence structures. The child looks at the pictures, while the researcher tells the story. The child is instructed to retell the story. After the child has told the story, if the child has not used target verbs, the researcher goes back to the pictures where target verbs were not elicited. Graduated prompts are offered. First, the child is asked "tell me about this picture" with the tester pointing

to the scene that includes the verb. If this does not elicit the verb, a second sentence generation prompt is given: 'Can you make a sentence with the word "name of verb" to describe what happened in this picture?'

The duration of each assessment varied from 25mins- 45mins. The variation in the length of the interview was influenced by the detail of response given for each picture, level of prompting required, the attention and motivation of the children, and the level of distractibility.

The story retell was transcribed verbatim.

Analysis

The transcripts were divided into utterances for analysis based on segmenting rules developed by Owens (2004: adapted in Paul 2007):

- A sentence or command counted as one utterance.
- Pauses, inhalations, and falling intonation marked the end of an utterance.
- Sentences with a conjoining 'and' were separated into two utterances if the 'and' was followed by a subject. E.g. "He pushed his spaceship and then he ran into his mother's house."

Utterances were then scored for a number of different measures.

Mean Sentence Complexity (MSC) was calculated by giving each utterance containing the target verb a score for length of 1-6, based on the complexity evident within the utterance (See Table 2).

Scores for length were added up to provide a length total and divided by the number of utterances to reveal the MSC score.

Example	Type	Score
She is eating	1 argument	1
The girl is bouncing the ball	2 arguments	2
The lady's picking the strawberry off the plant	2 arguments + 1 adjunct	3
The man is giving the present to the girl	3 arguments	3
She dropped a glass and smashed it. The boy was hungry so he bit an apple	Coordination	4
The man is climbing up the ladder to fix the roof	Infinitive	4
I plant plants to make my garden look nice	Infinitive different subject	5
She is picking the strawberry to eat it and put it and put the other two ones into the bowl.	Coordination and embedding	6
When I went to a birthday party I was sad that I had to leave	Multiple embedding	6

Table 2-Scoring rubric for mean sentence complexity

Verb Argument Structure (VAS)% was calculated by investigating if the utterance containing the target verb used the correct VAS. A score of 1 was given for correct verb argument structure. A score of zero was given for omission of any obligatory arguments, incorrect mapping, or wrong use of the verb. A total score was ascertained by adding up all the utterances containing correct VAS and dividing by the number of target verbs produced.

In order to establish reliability of the analysis procedure, 20 % of transcripts from the younger age bands, and 10% of the older age bands were scored and analyzed by two examiners involved in the study. A percentage agreement of 90% was established. In circumstances when this wasn't reached, the examiners consulted with the PI in order to assess the variations and agree consistency on correct scoring for the specific types of utterances and errors causing difficulty. A percentage for

both MSC and VAS% was calculated using the equation X/Y multiple by 100, where X was the lowest score and Y was the highest score obtained by each researcher.

1. Descriptive statistics (mean, range, etc.) and a test of normality were conducted on the normative data for TOVK, MSC and VAS%.
2. Due to non-normal distributions for TOVK, MSC and VAS%, non-parametric analysis was conducted to investigate the relationship between age and verb knowledge (TOVK score), age and MSC, and age and VAS %.
3. Partial Correlation was carried out to investigate the relationship between verb knowledge (TOVK score) and sentence production (MSC and VAS%), whilst controlling for age.
4. Multiple regression was conducted to calculate the variance in both MSC and VAS% accounted for by age and verb knowledge (TOVK score).

Results

Descriptive statistics for the three variables are presented below (See Table 3).

Variable	N	Mean	SD	5% Trim. Mean	Range	Median	Skew.
TOVK	91	29.35	3.40	29.50	21-36	30.00	-.680
MSC	91	2.83	0.43	2.85	1.33-3.61	2.84	-.705
VAS%	91	92.22	10.67	93.73	27.08-100	95.83	-3.321

Table 3- Descriptive statistics for the entire age group

TOVK was not normally distributed across the age group. The data (See Figure 1A) violated the Shapiro-Wilks assumption ($\text{sig}=.001$; $p<.05$), with the histogram indicating the presence of negative skew.

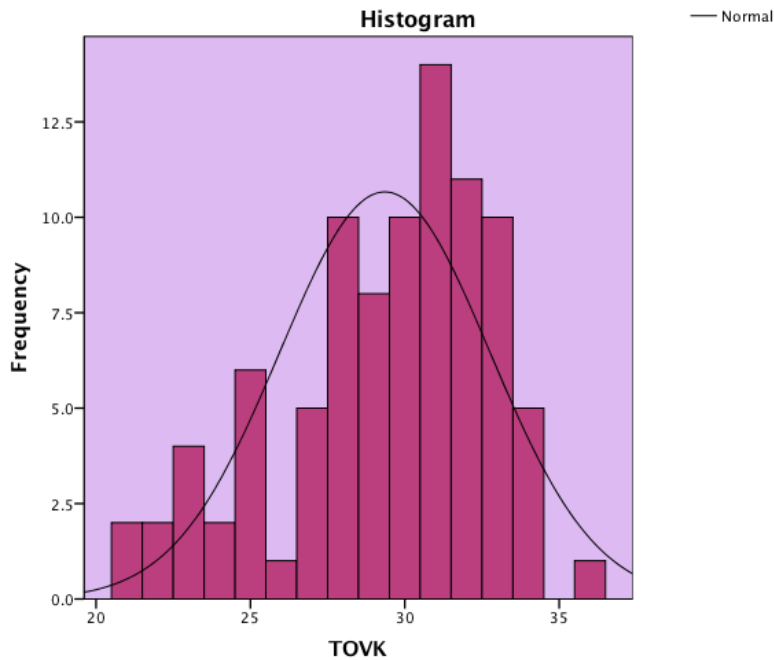


Figure 1A-Distribution of Mean TOVK scores across the age group.

VAS % scores were not normally distributed, with the data (See Figure 1B) violating the Shapiro-Wilks assumption ($\text{Sig}=.000$; $p<.05$). Negative skewness was indicated.

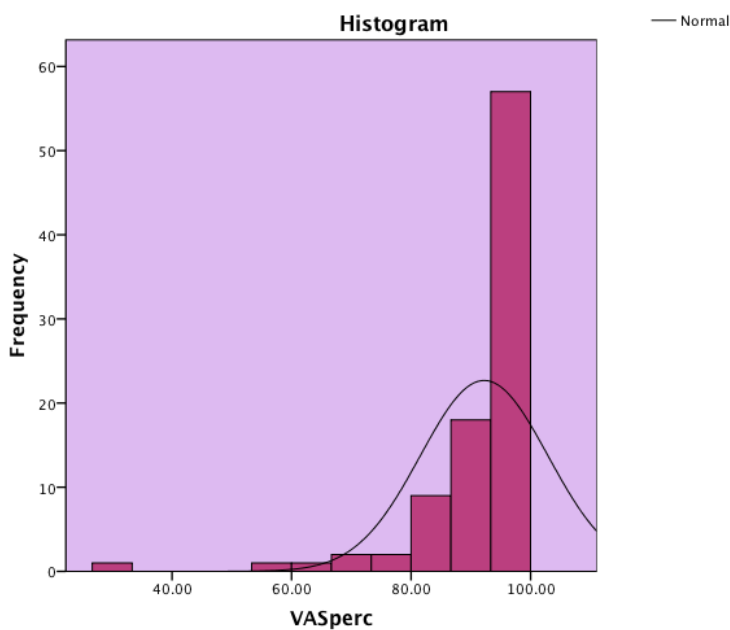


Figure 1B-Distribution of Mean VAS% scores across the age groups.

MSC was not normally distributed. The data (See Figure 1C) violates the Shapiro-Wilks assumption (Sig.=. 012;p<. 05). Negative skewness was revealed through investigation of the histogram.

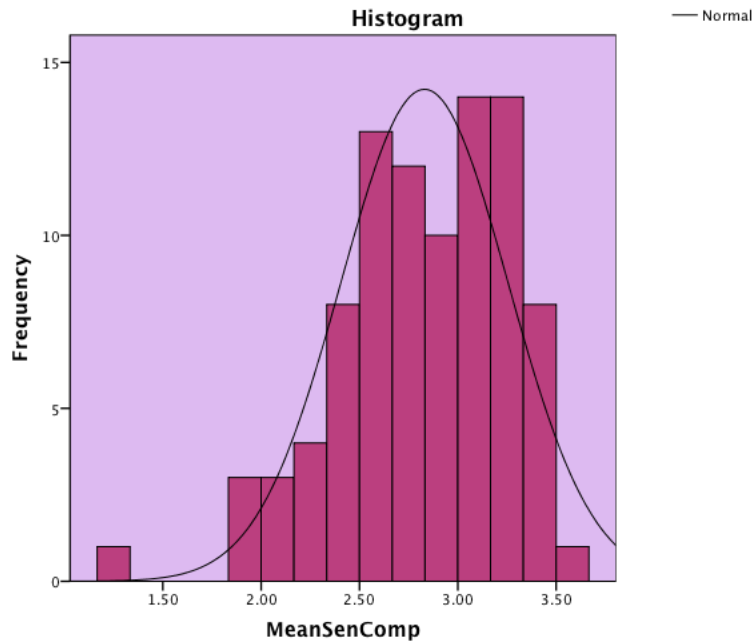


Figure 1C- Distribution of Mean MSC scores across the age groups.

Descriptive statistics are presented for TOVK (See table 4), MSC (See table 5) and for VAS%(See table 6) across the age groups.

Within each age group for MSC, a range of raw scores was observed. Two outliers were observed across the age groups. One outlier was evident in group 7;05-8;06, receiving a MSC mean of 3.37. The other outlier was from age group 8;06-9;05 and received an MSC mean of 3.25. As they were not having a significant impact on the overall mean they were included in the data set. Mean MSC scores plateau for the last two groups, from 9;06-10;05 to 10;06-12;00.

A range of raw scores was observed for VAS% across the age group. Four outliers were observed, two from group 9;06-10;05 who both received a score of 95.83% on VAS%. One outlier from group 5;06-6;05 obtained a score of 97.92%, while the remaining outlier from group 6;06-7;05 received a score of 72.82%. As the outliers were not having a significant impact on the overall mean they were included in the

data set. The mean raw score for VAS % increased through the age groups until age group 10;06-12;00 when a decrease was observed. Ceiling effects were noted in all age groups except the youngest age group 4;06-5;05.

Age Group	N	Mean	SD	5% Trimmed	Range	% @ Ceiling	Median	CI
4;06-5;05	7	24.43	3.05	24.31	21-30	NONE	25	21.61-27.25
5;06-6;05	17	26.18	2.88	26.14	22-31	NONE	26	24.70-27.66
6;06-7;05	17	28.71	2.80	28.84	22-33	NONE	29	27.27-30.15
7;06-8;05	9	31.11	1.69	31.18	28-33	NONE	31	29.81-32.42
8;06-9;05	9	30.78	2.49	30.64	28-36	11.11%	31	28.86-32.69
9;06-10;05	12	31.08	1.93	31.09	28-34	NONE	31	29.86-32.31
10;06-12;00	20	31.85	1.79	31.94	28-34	NONE	32	31.01-32.69

Table 4 - Descriptive statistics by age group for TOVK

Age Group	N	Mean	SD	5% Trimmed Mean	Range	Median
4;06-5;05	7	2.28	0.61	2.28	1.33-3.13	2.10
5;06-6;05	17	2.50	0.28	2.50	2.00-3.02	2.52
6;06-7;05	17	2.67	0.31	2.68	1.91-3.29	2.70
7;06-8;05	9	2.97	0.41	2.97	2.47-3.41	3.14
8;06-9;05	9	3.24	0.26	3.25	2.83-3.61	3.25
9;06-10;05	12	3.04	0.24	3.05	2.60-3.29	3.06
10;06-12;00	20	3.07	0.22	3.08	2.59-3.45	3.09

Table5-Descriptive Statistics by age group for MSC.

Age Group	N	Mean	SD	5% Trimmed Mean	Range	% @ Ceiling	Median
4;06-5;05	7	74.15	24.68	75.56	27.08- 95.74	None	80.43
5;06-6;05	17	87.65	9.25	88.36	62.50- 100.00	5.88%	89.58
6;06-7;05	17	92.20	7.53	92.51	78.72- 100.00	17.65 %	95.83
7;06-8;05	9	95.51	3.60	95.51	91.11-100.00	22.22%	95.83
8;06-9;05	9	95.60	5.15	96.03	83.33-100.00	11.11%	16.67
9;06-10;05	12	97.65	3.24	98.02	88.63-100.00	41.67%	97.92
10;06-12;00	20	96.19	4.41	96.50	86.95-100.00	35%	97.91

Table 6-Descriptive Statistics across the age groups for VAS%

Percentile rank scores were derived for TOVK (See Table 7), MSC (See Table 8), and VAS%(See Table 9), which can be used for comparison with other children’s scores on each of the variables listed. For example, a child aged between 6;06-7;05 who receives an MSC mean score of 2.49 would be placed in the 25th percentile. Tables representing scores equivalent to standard deviation cutoffs of .5SD were also derived (See Appendix 1) for each of the three variables- TOVK, MSC, and VAS%.

	Age Groups	Percentiles						
		5	10	25	50	75	90	95
TOVK	4;06-5;05	21.00	21.00	21.00	25.00	25.00	.	.
	5;06-6;05	22.00	22.80	23.00	26.00	28.50	31.00	.
	6;06-7;05	22.00	23.60	27.00	29.00	31.00	32.20	.
	7;06-8;05	28.00	28.00	30.00	31.00	33.00	.	.
	8;06-9;05	28.00	28.00	28.50	31.00	32.00	.	.
	9;06-10;05	28.00	28.30	29.25	31.00	33.00	33.70	.
	10;06-12;00	28.00	28.20	31.00	32.00	33.00	34.00	34.00

Table 7- Percentile Scores for TOVK

	Age Groups	Percentiles						
		5	10	25	50	75	90	95
MSC	4;06-5;05	1.3300	1.3300	1.9300	2.1000	2.7400	.	.
	5;06-6;05	2.0000	2.0640	2.2850	2.5200	2.6600	2.9400	.
	6;06-7;05	1.9100	2.2300	2.4900	2.6900	2.8700	3.0740	.
	7;06-8;05	2.4700	2.4700	2.5400	3.1400	3.3850	.	.
	8;06-9;05	2.8300	2.8300	2.9950	3.2500	3.4650	.	.
	9;06-10;05	2.6000	2.6090	2.8800	3.0550	3.2500	3.2870	.
	10;06-12;00	2.6000	2.7930	2.8750	3.0900	3.2250	3.3440	3.4450

Table 8-Percentile scores for MSC across the age group

	Age Groups	Percentiles						
		5	10	25	50	75	90	95
VAS%	4;06-5;05	27.0800	27.0800	58.3300	80.4300	93.6200	.	.
	5;06-6;05	62.5000	71.0360	84.3700	89.5800	93.6800	98.3360	.
	6;06-7;05	78.7200	79.0800	85.1000	95.8300	97.9100	100.0000	.
	7;06-8;05	91.1100	91.1100	91.6650	95.8300	98.9600	.	.
	8;06-9;05	83.3300	83.3300	93.7450	97.9100	97.9200	.	.
	9;06-10;05	88.6300	90.7900	96.3275	97.9150	100.0000	100.0000	.
	10;06-12;00	86.9640	87.4650	92.6575	97.9100	100.0000	100.0000	100.0000

Table 9-Percentile scores for VAS% across the age groups

Correlation analysis

The relationship between age and VAS % (Fig. 2A) was investigated using Spearman's Rho correlation coefficient (as the assumption of normality was violated). There was a strong, positive correlation between the two variables ($r = .53$, $p < .001$, 2-tailed) but as the scatter plot below indicates there are children across the age bands from 5;06-12;00 achieving maximum scores for verb argument structure accuracy.

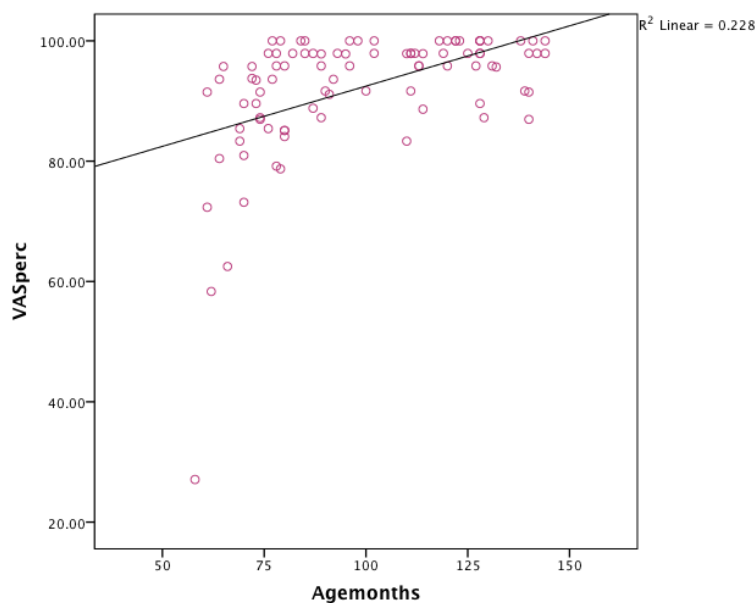


Figure 2A- Correlation between age and VAS%

The relationship between age and MSC was investigated using Spearman-Rho Correlation (as the assumption of normality was violated). There was a strong positive correlation (Fig. 2B) between the two variables ($r = .65, p < .001, 2\text{-tailed}$).

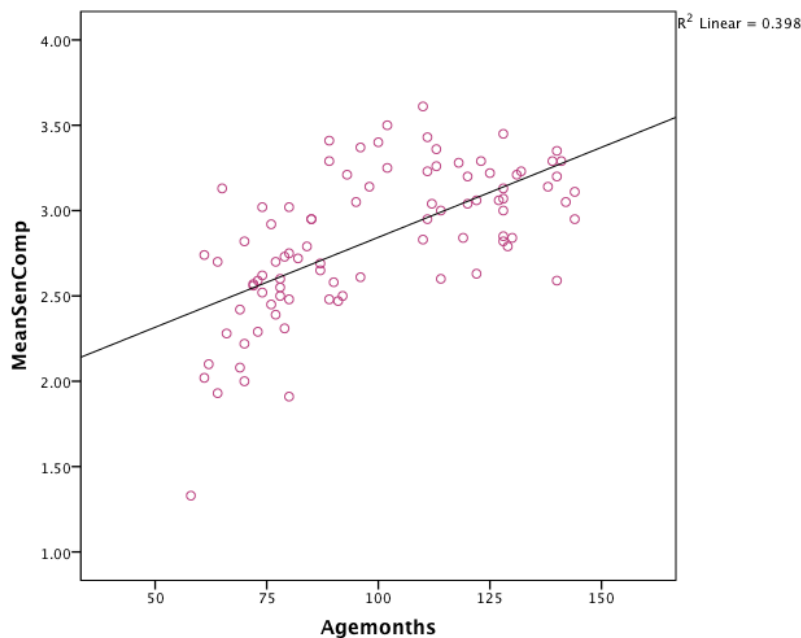


Figure 2B-Correlation between Age and MSC

Partial Correlation

Partial correlation was used to explore the relationship between TOVK and VAS%, and TOVK and MSC, while controlling for age. There was a strong, positive, partial correlation between TOVK and VAS%, controlling for age, $r = .37, p < .001, 2\text{-tailed}$. An inspection of the zero order correlation ($r = .55$) suggested that controlling for age had very little effect on the strength of the relationship between these two variables. There was a strong, positive, partial correlation between TOVK and MSC, controlling for age, $r = .35, p < .001, 2\text{-tailed}$. An inspection of the zero order correlation ($r = .62$)

suggested that controlling for age had very little effect on the strength of the relationship between these two variables.

Multiple Regression

Standard multiple regression was used to assess the ability of both age and TOVK to predict VAS%. Preliminary analysis revealed a Cook's D value greater than 1 (1.005) for one of the subjects. The outlier was identified and removed from the data set, prior to re-running of the analysis. Correlation between the two independent variables =0.64, which was below 0.7, so all variables were retained in the sample. Tolerance value= .588 (more than 0.1), and VIF value=1.70 (not greater than 10) indicated no violation of the assumption of multi-collinearity. The results indicate that a model combining age and TOVK was significant at the 5% level: $F(939.67)=20.079$, $P<0.001$, explaining 30 % of the variance in VAS% (adjusted R square value=. 300), and is statistically significant (sig.p=. 000; <. 0005). Of the two variables, TOVK makes the largest unique contribution (beta=. 359;sig.=. 000), although age also made a statistically significant contribution (beta=. 260;sig.=. 027). Standard multiple regression was used to assess the ability of age and TOVK to predict MSC. Correlation= .655, which is below .07, so all variables were retained. Tolerance value =. 571 (more than 0.1) and the VIF value= 1.75(less than 10) indicate that the assumption of multi-collinearity was not violated. The results indicate that a model combining age and TOVK was significant at the 5% level: $F(3.86)=17.747$, $P<0.001$, explaining 46.1% of the variance in MSC (adjusted R square value=. 461), and is statistically significant (sig.p=000; <. 0005). Of the two independent variables, age makes the largest unique contribution (beta=. 394; sig.=. 000), although TOVK is also statistically significant (beta=. 362; sig.=. 001).

Verb Error Analysis

Qualitative analysis of the verbs targeted through the story retell ascertained that the 5 most difficult verbs across the age group included Clear (N=24; 26.37%), Pour (N=21; 23.08%), Fill (N=17; 18.68%), Bet (N=17; 18.68%) and Told (N=12; 13.19%). The percentages reflect the number of children who use the relevant verb argument

structure incorrectly. All the above verbs are low frequency ranging from a frequency of 23-110. The verbs that caused most difficulty were from a range of semantic and syntactic classes (See Table 10).

Verb	Frequency	Transitivity	Class
Clear	Low (59)	Ditransitive	Syntactic-Alternating change of location
Pour	Low (37)	Transitive	Semantic- Verb of creation
Fill	Low (110)	Transitive	Syntactic- Change of state
Bet	Low (23)	Transitive (Sentence complement)	Syntactic- Cognitive State Verb
Told	Low	Transitive (Sentence Complement)	Semantic- Verb of communication

Table 10- Characteristics of verb errors

Sentence Complexity

Qualitative analysis reveals variations in the complexity of sentences used across the age bands. The lowest overall MSC mean score was revealed in the youngest age group 4;06-5;05(m=28). Through qualitative analysis, it was revealed that a larger proportion of the utterances were simple sentences (83.13%) with a much smaller percentage of complex sentences being evident (16.87%). Primary examples of utterance evident in this age group included: "The aliens destroyed all the plants."(Score of 2, simple sentence, 2 obligatory arguments)

"The men leaved Planet bog and went to the other planet."(Score of 4, simple conjoining)

No score of 6 was given with this age band for the use of embedding and conjoining.

The highest overall MSC mean score was reached in group 8;06-9;05(M=3.24) with 58.20% comprising simple sentences and a slightly smaller proportion of the utterances containing complex sentences (41.80%).

Example of a complex utterance elicited in this age group included:

"Captain bog leaned against the table and told the soldiers that they were going to arrest the aliens."(Score of 6, conjoining and embedding).

Inter-rater reliability was established at 95.54% for MSC and 97.34% for VAS%.

Discussion

The language samples of 91 children (4;06-12;00) were analyzed in order to obtain normative data from Irish school-aged children in relation to three variables on a newly designed story retell tool. Inter-rater reliability was conducted and the tool was shown to have a high reliability in relation to the scoring of the three variables. The tool is intended for future clinical use with children with SLI. The three aspects relating to verb knowledge and use captured in the story included - verb comprehension (TOVK), mean sentence complexity (MSC) and verb argument structure accuracy (VAS%). It was hypothesized that scores all of these variables would increase with age.

There was a strong correlation between age and the three variables with an overall developmental progression throughout the ages. TOVK showed a decrease in overall mean for group 8;06-9;05. Similar to MSC, outliers scoring towards the lower end caused this decrease.

Verb Argument Structure Accuracy

A slight decrease in range and mean for VAS % in the upper age band was noted. Although a high proportion of the age group (10;06-12;00) reached ceiling (35%), a larger number of participants were included in this age group (N=20). With a broader sample size, ceiling effects may not have had as big an impact on the overall mean score compared to the other age groups.

Many children, including those from the younger groups exhibited some ceiling effects in VAS%. No children aged 4;06-5;05 reached ceiling, but proportions of the other age groups did achieve a perfect score (ranging from 5.88% at 5;06-6;05 to 41.67% at 9;06-10;05). Chiat (2001) reported research showing that by the age of four children were including obligatory subject arguments. Although, a very small percentage of ceiling effects are evident for the younger age groups, the presence of these may be reflective of the scatter of abilities possible in typically developing children. Only some of the children in the oldest age group (10;06-12;00) reached ceiling. These results support evidence found in other studies of argument structure,

which indicate that the acquisition of the full range of argument structures options for some complex verbs extends at least into adolescence (Thordardottir & Weismer 2002a). Findings are representative of Ebbels et al (2012) also, who found that all TD groups in her study as well as CwSLI continue to have difficulties with argument structure into adolescence, with the most prominent difficulty being argument structures of change of state verbs.

Verb error analysis was conducted qualitatively to establish what verbs TD children had the most difficulty with. Only one verb received no errors (Fall), which is an example of an intransitive verb. All the intransitive verb targets in the assessment received fewest errors. This would be in line with claims by Valian (1991) who stated that intransitive frames are easier for children to produce early in development, as they do not require a direct object argument. Both transitive and di-transitive verbs were found to cause the most difficulty. 'Clear' is an example of a di-transitive verb, and was found to cause the most difficulty across the age sample. These findings were to be expected as sentences with di-transitive verbs are considered to be more complex than sentences with intransitive or transitive verbs (Grela and Leonard 2000). Errors were also evident in the argument structure of transitive verbs. The most prominent feature was the omission of the subject argument. These findings would concur with the study conducted by Bloom (1993) who hypothesized a production-based limitation, whereby TD children are less likely to produce the subject because the length of the sentence taxes their processing system. The target verb 'Bet' was often misinterpreted as 'to beat'. This may be a consequence of the Hiberno-English dialect. 'Bet' was also interpreted on one occasion as the name 'Beth'.

The most difficult verbs were all low frequency verbs. High frequency verbs appeared to cause significantly less trouble for the sample, which supports previous research (Thordardottir and Weismer 2001a; Watkins et al 1993) who found that extensive use of high frequency verbs appears to be part of normal language development. Similar results have been found in Ambridge et al (2008) and Brooks et al (1999) who found that participants had the greatest preference for use of high frequency verbs, with a much smaller preference being evident for low frequency verbs. These studies help to validate the 'entrenchment' hypothesis (Braine and

Brooks 1995), which predicts the more often a child hears a verb in particular constructions in the input, the less likely they will be to produce an overgeneralization error of this verb. Both cognitive state verbs and change of state verbs appeared to be problematic for the current sample. The most consistent error with the change of state verb (Fill) was incorrect mapping which is consistent with the findings of Bowerman (1992) and Gropen et al (1991) who found that change of state verbs are more prone to linking errors than other semantic classes of verbs. Difficulty with cognitive state verbs was also evident among a small majority of the sample. As suggested by Owen and Leonard (2007), this may be due to a variety of cognitive, syntactic and semantic demands.

Sentence Complexity

The overall mean scores for MSC were shown to increase throughout the age groups. The maturity of a speech sample can be determined by looking at the proportion of the utterances, which are complex (Paul 2012). For the group with the overall lowest MSC mean score (4;06-5;05), 16.87% of the utterances elicited were found to be complex sentences. These findings are similar to conclusions drawn from the work of Paul (1981) who found that normally developing children at an average age of 4 or 5 years should have 20% of their sentences containing embedded or conjoined clauses. The progression of overall mean scores through the age groups is due to the use of more complex sentences. The age group (8;06-9;05) received the highest overall mean ($M=3.24$), with 41.80% of the utterances containing complex sentences. This is consistent with the findings of Schuele and Dykes (2005) who found sentence complexity increases significantly throughout the school-aged years, with a lower proportion of simple sentences being evident.

A plateau effect was evident in both groups 9;06-10;05 and 10;06-12;00. Qualitative analysis revealed that three of the children in group 9;06-10;05 received scores to the lower end compared to the other children in this age band. This may have caused variation in the scores, bringing the overall mean down. Five of the children were identified with scores in the lower end for age group 10;06-12;00. However, there were also a larger number of children in this age group compared to all the

other age bands. This may have resulted in more variation in the sample resulting in the overall mean being of a slightly lower score.

Sensitivity of the assessment tool

It has been established that CwSLI continue to exhibit difficulty with verb production beyond early school years, therefore a measure that is sensitive to developments across the age range is required to expose the grammatical breakdown in older CwSLI. Percentile rank scores and standard deviation cutoffs provided for each age band could support use of the story retell 'Captain Grey and the Greedy Aliens' to further assess verb knowledge and sentence production in school aged children with language difficulties. In recent years, the investigation of language development in CwSLI has shifted to an increased focus on verb learning and verb use (Rice 1991). Standard deviation cutoff's of .5SD for both mean sentence complexity scores and verb argument structure accuracy scores significantly illustrate the sensitivity of the assessment tool. This allows for the opportunity to investigate where children are at developmentally in relation to verb production and verb argument structure accuracy.

Relationship of TOVK with MSC and VAS%

The language samples were also analyzed to investigate whether verb comprehension (TOVK) is a predictor of both MSC and VAS%. It was hypothesized that as verb comprehension increased, so would MSC and VAS %.

The most significant contributor to VAS% was found to be TOVK, although age was also significant. 46.1% of the variance in MSC could be predicted by age, as it was found to be the most significant contributor. TOVK was also significant however. A strong positive partial correlation was found for both VAS% and MSC, suggesting that controlling for age had very little influence of the strength of the relationship between both TOVK and VAS%, and TOVK and MSC irrespectively. A number of studies have been established in the literature, which compare both age-matched and grammar-matched TD peers to CwSLI to validate the importance of verb comprehension in relation to sentence complexity development and verb argument

structure accuracy. Ebbels et al (2012) investigated CwSLI verb argument structure difficulties, in particular the verb argument structure difficulties associated with cognitive state verbs. CwSLI were compared against grammar matched (GM), vocabulary-matched (VM), and chronologically-age match (CM) TD peers. None of the VM or CAM matched controls made more than one error on change of state verbs, while three errors were identified with the GM controls. These results are similar to the findings of this study by indicating that verb comprehension plays an important role in verb argument structure accuracy. These findings are in line with the hypothesis, thus supporting the use of both MSC and VAS% as a developmental index that changes predictably with both age and verb comprehension (TOVK) and underscore the importance of assessing verb knowledge in CwSLI who have sentence production difficulties.

Features of Language observed

- A number of the participants were noted to over generalize the past tense, e.g. 'stealed', 'spreaded'. This was particularly evident in the younger age bands. An ubiquitous feature of language acquisition is the overgeneralization of various linguistic inflections, in which the child generalizes a regular rule to irregular forms. This phenomenon of English past tense inflections being over generalized frequently has been stated to be part of typical language development up to 6 years of age. (Brown 1973)
- Participants were noted to use some of the target verbs as nouns. This was noted with the verbs 'cover', 'phone' and 'emailed' e.g. cover- " he put the cover on the shield." Such instances were accounted for however, in the scoring rubric. In the above sample, the utterance received a score of zero for verb argument structure, as the targeted argument structure was not produced. A score of 2 for length was given for use of a simple sentence with two obligatory arguments.
- Filled pauses ('em', 'eh', etc.) and word repetitions were used by the majority of the sample whilst eliciting the story. This has been found to be part of typical language development (Thordardottir and Weismer 2002b), who found that the

relative frequency of maze types, remained constant across age, conversational and narrative contexts for both TD children and CwSLI.

General Difficulties associated with test administration

- A small majority of the sample was observed to be unable to produce the target verb in a sentence, even after the second prompt was given.
- 10 of the children included in the sample were noted to make a sentence containing the target verb, which was completely unrelated to the target story. This however had no bearing on scores received for mean sentence complexity and verb argument structure accuracy, as the scoring rubric took into account these types of difficulties.
- Two children assessed were excluded from analysis for specific reasons. One child was extremely shy during test administration and did not co-operate with the activity. The assessment was ended early as testers did not want to put the child under undue stress in order to complete the assessment. Another child's data was removed from analysis, as the testers felt there may be an undiagnosed language difficulty. The test was carried out, but the data was not included in the analysis.

Considerations

A number of factors must be taken into consideration when interpreting the results.

The normative data represented in this paper was based on a small representative sample. Paul (2007) states that in order to standardize an assessment, a large representative sample must be utilized, with a minimum of 100 subjects per age group as a lower limit.

This was a preliminary pilot study that included only children deemed to have no known speech, language, and communication, hearing and/or intellectual difficulties. If in future, the tool were to be used for comparing norms with language impaired children, it would be necessary to include children with a full range of language

abilities in order to increase identification accuracy (Pena, Spaulding and Plante 2006).

The sample should ideally contain individuals from more than one geographical area in order to be truly representative of Irish TD children. It only included children from a small proportion of the country, so the norms cannot be deemed sensitive to socio-linguistic variations.

Although a high reliability percentage was established for the story retell tool, initially high variability between scores for mean sentence complexity was evident. Particular difficulty was evident in relation to how to separate utterance and the scoring of the more complex sentences of embedding and conjoining. The group of testers met four times in order to establish correct procedures. After thorough discussion, agreement was reached in relation to all aspects of the scoring of the assessment tool. Specific training would be required for all clinicians prior to use of the story retell tool.

Specific criteria around the number of prompts that were to be given were outlined from the outset. In some cases however, examiners found they needed to provide more support to some of the younger children to encourage completion of the assessment. Any critical variations in level of support given to some of the children could have undue influence on the children's production. The children who received extra prompts however were not identified as outliers.

Recommendations

To conclude, further normative sampling (e.g. 100 children per age group; Paul 2007) on the three variables should be carried out in order to obtain a reliable sample that can be clinically useful in the identification of problems in CwSLI.

Further development of the story retell for clinical use should explore the impact of prompting and ways of modifying elicitation procedures to ensure no undue influence of excessive prompting. Secondary analysis could be conducted without the prompted data included in order to quantify if the assessment is equally sensitive across the age range if only the non-prompted scores are included. Evidence that a child is found to require significant prompts might influence approaches to intervention, as the clinician would have a better understanding of

how much support the child needs in order to produce language. Secondly, requirements around prompting might also point to memory issues that warrant further assessment.

Secondary analysis of the data set could also be conducted in relation to morphological development. This could be a useful comparison for CwSLI who are known to have significant difficulty in this area.

Conclusion

Results of this investigation have significant implications for the study of children with language difficulties, with particular attention to mean sentence complexity development and verb argument structure accuracy. It is well established that CwSLI have problems related to verb and sentence production (Kelly 1997; Leonard 1995). It is essential that reliable and representative normative data around verb comprehension, verb argument structure accuracy, and mean sentence complexity development is readily available in order to have a reliable measure to compare with CwSLI. The data analyzed indicates that mean sentence complexity and verb argument structure accuracy develop as age progresses, thus highlighting the sensitivity of the Captain Grey assessment tool with verb comprehension as assessed by the TOVK also showing a clear progression with age.

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Appendix 1-Table of Standard deviation cut-off scores for TOVK, MSC AND VAS%

Age Groups	-3	-2.5	-2	-1.5	-1	-.5	MEAN	+.5	+1	+1.5	+2
4;06-5;05	15.25	16.78	18.31	19.84	21.37	22.90	24.43	25.96	27.49	29.02	30.55
5;06-6;05	17.54	18.98	20.42	21.86	23.30	24.74	26.18	27.62	29.06	30.50	31.94
6;06-7;05	20.31	21.71	23.11	24.51	25.91	27.31	28.71	30.11	31.51	32.91	34.31
7;06-8;05	26.01	26.86	27.71	28.56	29.41	30.26	31.11	31.96	32.81	33.66	34.51
8;06-9;05	23.28	24.53	25.78	27.03	28.28	29.53	30.78	32.03	33.28	34.53	35.78
9;06-10;05	25.26	26.23	27.20	28.17	29.14	30.11	31.08	32.05	33.02	33.99	34.96
10;06-12;00	26.45	27.35	28.25	29.15	30.05	30.95	31.85	32.75	33.65	34.55	34.45

Table 1-Standard Deviation scores for TOVK across the age groups.

Age Groups	-3	-2.5	-2	-1.5	-1	-.5	MEAN	+.5	+1	+1.5	+2
4;06-5;05	.42	.73	1.04	1.35	1.66	1.97	2.28	2.59	2.9	3.21	3.52
5;06-6;05	1.66	1.8	1.94	2.08	2.22	2.36	2.50	2.64	2.78	2.92	3.06
6;06-7;05	1.61	1.77	1.93	2.09	2.35	2.51	2.67	2.83	2.99	3.15	3.31
7;06-8;05	1.71	1.92	2.13	2.34	2.55	2.76	2.97	3.18	3.39	3.60	3.81
8;06-9;05	2.46	2.59	2.72	2.85	2.98	3.11	3.24	3.37	3.5	3.63	3.76
9;06-10;05	2.32	2.44	2.56	2.68	2.80	2.92	2.04	3.16	3.28	3.40	3.52

Table 2- Standard Deviation scores for MSC across the age groups.

Age Group	-3	-2.5	-2	-1.5	-1	-.5	MEAN	+.5	+1	+1.5	+2
4;06-5;05	1.11	13.45	25.79	38.13	50.47	62.81	74.14	86.49	98.83	100	100
5;06-6;05	59.87	64.50	69.13	73.76	78.39	83.02	87.65	92.28	96.91	100	100
6;06-7;05	69.58	73.35	77.12	80.89	84.66	88.43	92.20	95.97	99.74	100	100
7;06-8;05	84.71	86.51	88.31	90.11	91.91	93.71	95.51	97.31	99.11	100	100
8;06-9;05	80.12	82.7	85.28	87.86	90.44	93.02	95.60	98.18	100	100	100
9;06-10;05	87.93	89.55	91.17	92.79	94.41	96.03	97.65	99.27	100	100	100
10;06-12;00	82.93	85.14	87.35	89.56	91.77	93.98	96.19	98.40	100	100	100

Table 3- Standard Deviation Scores for VAS% across the age groups.

Appendix 2- Verb frequency and semantic classes of target verbs

VERB	TRANSITIVITY IN THE PROBE-#args required in the narrative context	SEMANTIC CLASS	Frequenc y	INCL IN EARLIER Verb test
Live	IT		H (329)	
Steal	T	Change of possession	L (48)	
Capture	T	Change of possession	L (31)	
Chase	T	Verb of motion	L (21)	Y
Destroy	T	Change of state- Destruction		
Clear	DT	Alternating change of location	L (59)	
Sweep	DT	Alternating change of location	L (31)	
Empty	DT	Alternating change of location	L (11)	
Phone	T	Communicatio n	H	
Fly	T	Manner of movement	L (90)	
Email	T	Communicatio n		
Lean	T	Change of location	L (49)	
Push	T	Direction of movement	L (107)	
Run	IT (unerg)	Manner of movement	H (406)	
Pour	T	Verb of creation?	L (37)	
Spread	DT	Change of state	L (59)	
Fall	IT (unacc)	Manner of movement	H (273)	
Pick	T	Change of state	H (150)	Y
Peel	T	Change of state		
Grate	T	Change of state		
Cover	DT	Alternating change of state	H (191)	
Turn	DT	Change of state	H (465)	
Give	DT	Change of possession	H (1284)	Y
Stuff	DT	Alternating	L (12)	

		change of location			
Fill	T	Change of state	L (110)		Y
Leave			H (647)		
Land	T	Manner of movement	L (38)		
Stay	IT (unerg)		H (183)		
Yawn	IT (unerg?)	Bodily action			
Lean	DT	Change of location as used/ Spatial configuration	L (49)		
Shake			L (93)		
Jump	IT (unnerg)	Manner of movement	L (52)		
Drop	T	Change of location	L (107)		Y
Run	IT (unerg)	Manner of movement	H (406)		
Groan	IT (unerg)	Sound emission			
Throw	DT	Change of location	L (115)		
Sink	IT (unacc)	Change of location	L (32)		
Crawl	IT (unerg)	Manner of movement	L (12)		
Capture	T	Change of possession	L (31)		
Bring	T	Verb of transfer	H (439)		
Put	DT	Change of location	H (700)		
Bet	T(Takes sentence complement)	Cognitive state verb	L(23)		
Pretend	T(Takes sentence complement)	Cognitive state verb	L (27)		
Think	T (Takes sentence complement)	Cognitive state verb	H (1520)		
Hide	T	Change of location	L (64)		