The effect of different speaker accents on sentence comprehension in children with speech sound disorder

Authors:
Jennifer Harte (corresponding author)
Department of Speech and Hearing Sciences, Brookfield Complex, University College Cork, College Road, Cork, Ireland.
Tel.: +353 (0)21 4901609
Email: j.harte@ucc.ie

Dr. Pauline Frizelle
Department of Speech and Hearing Sciences, Brookfield Complex, University College Cork, College Road, Cork, Ireland.

Prof. Emeritus Fiona Gibbon
Department of Speech and Hearing Sciences, Brookfield Complex, University College Cork, College Road, Cork, Ireland.

December 2017

Abstract

There is substantial evidence that a speaker's accent, specifically an unfamilar accent, can affect the listener's comprehension. In general, this effect holds true for both adults and children as well as those with typical and impaired language. Previous studies have investigated the effect of different accents on individuals with language disorders, but children with speech sound disorders (SSDs) have received little attention. The current study aimed to learn more about the ability of children with SSD to process different speaker accents. Fifteen children with SSD aged between 4;01 and 5;11 years, and 16 typically developing children matched on language ability, age, socioeconomic status, gender and cognitive ability participated in the current study. A sentence comprehension task was carried out with each child, requiring them to follow instructions of increasing length spoken in three different accents – (i) a local Irish (Cork) accent, (ii) a regional North American accent and (iii) a non-native Indian English accent. Results showed no significant group difference and speaker accent did not significantly impact children's performance on the task. The results are discussed in relation to factors that influence accent comprehension, and their implications for children's underlying phonological representations.

Introduction

In the present day, people are likely to encounter an individual with an accent that differs from their own (Bruce, To & Newton, 2012). Research with both neuro-typical adults and adults with compromised language systems shows that different accents can negatively impact language processing (e.g. Adank, Evans, Stuart-Smith & Scott, 2009; Bruce et al., 2012). A significant effect of accent on spoken language comprehension has also been found in many studies with children, with most studies investigating typically developing (TD) children. The relevant literature has also shown that children's performance with non-local accents can be dependent on short-term exposure to accents (Bent & Frye, 2016), speech embedded in noise (Bent, 2015) and the type of task used (Van Heugten & Johnson, 2016). Harte, Oliveira, Frizelle and Gibbon (2016) recently reviewed the literature examining accent comprehension ability in children, and highlighted participant age and vocabulary size as two of the key explanations for the range in children's ability to process non-local or unfamiliar accents (i.e. difficulties understanding an unfamiliar accent may be reduced with either increased age or a larger vocabulary size (see Allen, O'Leary & Gibbon, 2016; Bent, 2015;

Jeffries, 2015; Mulak, Best, Tyler, Kitamura & Irwin, 2013; Nathan, Wells & Donlan, 1998; O'Connor & Gibbon, 2011; Van Heugten, Krieger & Johnson, 2015)).

The key focus of the current study was to explore the effect of different speaker accents on the comprehension of sentences in children with speech sound disorder (SSD). One of the main findings highlighted by Harte et al. (2016) was the lack of research examining the effect of accent on language in children with speech and language difficulties. Thus far, to the best of our knowledge, there has only been one published paper examining the effect of speaker accent on receptive language in children with speech difficulties. Nathan and Wells (2001) conducted a study with 18 monolingual children aged 5 to 6 years with speech impairments from London, in the UK. The authors did not differentiate the diagnoses of children with speech impairments (e.g. articulation disorder, phonological delay/disorder). They tested children using a familiar London accent and an unfamiliar regional Glaswegian accent in an auditory-lexical decision task. Nathan and Wells (2001) found that children with speech difficulties performed similarly to the control group on the task in the familiar accent condition. However, groups differed in their performance with the unfamiliar regional accent, with the children with speech difficulties having significantly more difficulty comprehending the unfamiliar accent than that which was familiar. The language skills of all participants were also measured, with the speech disordered group scoring significantly lower than the control group. Therefore, it is difficult to rule out language skills as a confounding variable in the accent comprehension results of the speech impaired participants.

Frizelle, Harte, Gibbon and Fletcher (2017) recently examined the comprehension of sentences presented in a local Irish (Cork) accent, a neutral Irish accent and a regional Northern Irish accent (considered "unlikely to be heard in the local area") by Irish children with language impairment (LI). Forty-three children with LI were included in the study, ranging in age from 5;0 to 8;11 years (mean age= 6;04 years). They were compared to a language-matched control group of 45 younger TD children, aged from 3;09 to 7;01 years (mean age= 4;10 years). Results showed a significant effect of accent on receptive language ability in both children with LI and the language-matched TD group. Sentences presented in the local and neutral Irish accents were significantly easier to understand than the regional Northern Irish accent, but no significant interaction between accent and group was revealed. Therefore, the difficulty experienced with the unfamiliar regional accent was no greater for the LI group than for the younger, language-matched TD children.

The study by Frizelle et al. (2017) showed that children with LI did not differ from younger TD children in their comprehension of a non-local regional accent. However, some of these participants with LI also had SSD. Given the fact that children with SSD can have problems with phonological processing (discussed further below), we might anticipate a particular risk of accent processing difficulties. Therefore, a natural extension of the work of Frizelle and colleagues (2017) and that of Nathan and Wells' (2001) was to investigate the effect of accent on sentence comprehension in children with specific SSD (speech difficulties without concomitant language difficulties). Moreover, Frizelle and colleagues and Nathan and Wells (2001) examined the effect of *regional* accents on language comprehension, and it has been established that non-native accents can be more difficult to understand than regional accents (Adank et al., 2009; Bruce et al., 2012). The current study therefore examined the effect of both regional and non-native accents on the language comprehension ability of children with SSD.

In addition to the different types of accents used by researchers, the type of task used in studies has also varied. Research has gradually moved from tasks examining the effect of different accents on comprehension of isolated single words (e.g. Best, Tyler, Gooding, Orlando & Quann, 2009; Nathan et al., 1998), to tasks examining word recognition or repetition using words embedded in sentences (Holt & Bent, 2017; Mulak et al., 2013; Van Heugten et al., 2015; White & Aslin, 2011). Researchers have found that toddlers' and pre-schoolers' accent comprehension skills were more robust when words were presented in a sentence context rather than in isolation (Creel, Rojo, & Paullada, 2016; Van Heugten & Johnson, 2016). Focus has also shifted to processing non-local accents at sentence level using sentence repetition and sentence comprehension tasks. The current study differed from that of Nathan and Wells (2001) by using a test of sentence comprehension to examine the effect of accent on receptive language in children, which may be more reflective of real-world language processing.

In addition to examining the effect of speaker accent on receptive language in children with SSD, an accent comprehension task may also reveal more about the phonological processing skills in this population, namely the quality of their phonological representations. The presence of imprecise or underspecified phonological representations has implications for speech output, literacy and word learning in children (Stackhouse & Wells, 1997). There is evidence that children with SSD can have phonological processing difficulties, such as imprecise underlying phonological representations that are not easily accessed (Bird & Bishop, 1992; Leonard, 1985; Rvachew & Grawburg, 2006; Sutherland &

Gillon, 2005). However, research in children with specific SSD has produced conflicting results (Nathan, Stackhouse & Goulandris, 1998).

Assessment of phonological representations usually relies on children's ability to imitate words or name pictures, both of which present an obvious problem for children with SSD who can have difficulties with motor planning, programming or production. Even though these children may have accurate representations of certain phonemes in words, difficulties in articulating those phonemes will impact their performance on an expressive test examining the accuracy of their representations. Receptive-based tasks have been shown to be a more valid assessment method for this population and usually involve minimal pairs containing mispronunciations or non-words (Nathan, Stackhouse et al., 1998; Sutherland & Gillon, 2005). However, the use of accented speech, which contains systematic variations in pronunciations, is an alternative and possibly more appropriate method of tapping into these children's phonological representations (Mulak et al., 2013). Nathan et al. (1998) suggested that in comparison to comprehending familiar accented speech, children's ability to process unfamiliar accents requires more precise phonological representations. Phonological representations, or more generally lexical representations, change as children mature and develop their vocabulary, and generally progress from being more holistic (i.e. where whole words are the smallest unit) to more precise or segmental (i.e. where sub-lexical components, such as syllables and initial phonemes, are the smallest units perceived) (Fowler, 1991). This theory, suggesting that a word's representation changes over time, is referred to as the lexical restructuring hypothesis (Walley, 1993), and was recently supported by Ainsworth, Welbourne and Hesketh (2015), who found that pre-school aged children's phonological representations became more segmented and accurate as they developed.

Additionally, according to Best et al. (2009), with certain accents, a word's phonological form can remain intact even if the phonetic realisation is different, requiring phonological constancy. Constancy in this context applies to the ability to accept a variable form of a recognisable word across more than one acoustic environment. Therefore, the flexibility of phonological representations can be considered important for comprehending variable speech. Jeffries (2015) found that female children who had parents with a non-local accent performed better in a familiar vs. unfamiliar speaker recognition task than those who had a parent from the local area, suggesting that these children had more flexible representations developed through increased and varied accent exposure. Creel (2012) stated, "rather than sensitivity to altered pronunciations, accent processing requires flexibility: can listeners tell they are hearing a variant of a familiar word, despite not having heard that exact variant before?" (p. 698). Bent (2015) also highlighted the importance of perceptual flexibility for the comprehension of words with novel pronunciations. Therefore, the accent comprehension task used in the current study could be considered an appropriate assessment of the flexibility of children's phonological representations. Furthermore, it does not require children's explicit phonological awareness or the use of metacognitive skills that are usually required in tasks such as receptive accuracy judgment tasks or lexical decision making tasks often used to explore phonological representations in children (Ainsworth et al., 2016). If children with SSD and children with typical speech development differ in their ability to comprehend sentences spoken in different accents, as shown by Nathan and Wells (2001) at single-word level, results may be interpreted as showing that children with SSD have deficits at the level of phonological representation.

The current study aimed to address two research questions: Is there a significant difference in children's ability to understand sentences spoken in a local, regional and non-native accent (i.e. is there any accent effect), and do children with SSD and a language-matched control group differ in their ability to understand sentences spoken in different accents? In keeping with the literature, this study hypothesises that children with SSD will have significantly more difficulty comprehending instructions spoken in the regional and non-native accents than in the local accent, and this accent effect will be greater in the SSD group of children than in the control group.

Methodology

Participants

The participants were 18 children with SB (aged 7-12 years, mean = 9;02), 18 age-matched TD children (TDA), and 18 language ability-matched TD children (TDL; mean age = 7;08). Each group had one bilingual participant; the others were monolingual Irish-English speakers.

Ten subtests of the 2015 version of PEPS-C (Profiling Elements of Prosody in Speech-Communication)[4] for Irish-English were administered to each child. These subtests assess Auditory discrimination and Imitation of prosodic patterns; and comprehension and production of prosody functions: Turnend (questions vs. statements); Affect (like vs. dislike); Boundary (using prosody to group words into grammatical units) and Contrastive stress (emphasising different words in an utterance).

Children with SSD were recruited from speech and language therapy services in the southwest of Ireland. Parents of potential participants were contacted if children met the following inclusion criteria (a) aged between 4;0 and 5;11 years, (b) had a diagnosis of phonological delay or disorder (based on their previous speech and language therapy reports), (c) achieved a standard score of below 7 on an assessment of phonology (Diagnostic Evaluation of Articulation and Phonology; DEAP; Dodd, Hua, Crosbie, Holm & Ozanne, 2002; which was later administered by the first author), (c) had language abilities within the average range, (d) had no evidence of a significant sensory, physical or learning difficulty, (e) were monolingual English speakers, (f) had parents who were native English speakers, and (g) lived in Cork, Ireland for the previous three consecutive years. Eighteen children met the inclusion criteria and were seen for assessment, but three children were subsequently excluded as a result of failing the hearing-screening test (n=1), and performing within the average range on the DEAP (Dodd et al., 2002) (n=2). Therefore, 15 children (male:7; female:8) completed the experimental task. Participants' ages ranged from 4;01 years to 5;11 years (M=4;11 years, SD=6.02 months).

Twenty-four children with typical development were recruited from primary schools and preschools in the southwest of Ireland to form the control group. With the exception of speech development, the same inclusion criteria applied. The TD group had no history of speech difficulties, established by parental report. From those initially recruited a total of eight TD children were excluded from the study due to failing the hearing-screen (n=3), non-age-appropriate speech (n=2), non-attendance following the first session (n=2) and an inability to complete the experimental sentence comprehension task (n=1). This resulted in the inclusion of 16 TD children in the study (male:8; female:8), aged from 4;04 to 5;09 years (M=4;11 years, SD=5.77 months).

The groups were language matched based on their Core Language raw score on the Clinical Evaluation of Language Fundamentals–Preschool 2^{UK} (CELF-$P2^{UK}$; Wiig, Secord & Semel, 2006). Independent sample t-tests showed no significant difference between the two groups on this measure of language (t (29)= 1.09, p= 0.28). In addition, there was no significant difference between groups in chronological age (t (29)= 0.12, p= 0.904) or cognitive ability (t (29)= 1.53, p= 0.14). The socioeconomic status of each group was matched using the 2011 Pobal HP Deprivation Index developed by Haase and Pratschke (2012). Refer to table 1 for a full summary of group demographics and screening test results. Ethical approval was obtained from the Cork Teaching Hospitals Clinical Research Ethics Committee (ECM4(q)03/02/15).

Assessments

Children's speech was assessed using the Phonology Assessment of the DEAP (Dodd et al., 2002). Responses were transcribed and analysed for the percentage of consonants correct (PCC), and children's PCC was compared with standardised Irish norms (Dodd et al., 2002). All 15 children with SSD received PCC standard scores below the average range (*M*=3.93, *SD*=1.39), with PCC raw scores ranging from 40% to 84%. Nine children produced error patterns typical of a younger child, thereby classifying them as phonologically delayed. Examples of delayed error patterns included deaffrication (e.g. "fish"-[fɪʃ]→[fɪs]) and fronting of velars (e.g. "book"-[bʊk]→[bʊt]). Six children also produced non-developmental error patters and were diagnosed with a phonological disorder. Examples of disordered error patterns included initial consonant deletion (e.g. "rabbit"-[ɹæbɪt]→[æbɪt], "swing"-[swɪŋ]→[ɪŋ]) and backing (e.g. "giraffe"-[d̠ʒəɹæf]→[gəɹæp], "train"-[tɹeɪn]→[keɪn]). All TD participants scored within the average range on this test. TD participants' PCC ranged from 86% to 100% (*M*=96.56, *SD*=4.08), with a mean standard score of 10.94 (*SD*=1.57).

Children were not considered for participation if their speech difficulties were resulting from dyspraxia or childhood apraxia of speech (CAS), cleft lip and/or palate, or dysarthria. Therefore, in order to examine their oral motor anatomy and to test oral and speech motor control, the Oro-Motor Assessment of the DEAP (Dodd et al., 2002) was also administered. All participants scored within the average range on this test. Participants' cognitive ability was assessed using the Raven's test of Progressive Matrices (Raven, 2008), and again, all children scored within normal limits (i.e. standard score of 85 or greater). Each child's language ability was tested using the CELF-P2^{UK} (Wiig et al., 2006). A Core Language score was obtained by administering three subtests – Sentence Structure, Word Structure and Expressive Vocabulary. All children presented with age-appropriate language skills (i.e. received a Core Language standard score of 85 or above). A summary of the results is shown in table 1. All children also passed a hearing-screen bilaterally at frequencies of 1000, 2000 and 4000Hz at 25dB hearing level.

Table 1. Description of group demographics and standardised assessment results (standard scores).

	Group							
	SSD			TD				
N	15			16				
Gender (m:f)	7:8			8:8			Significance	
Measure	**Mean**	***SD***	**Range**	**Mean**	***SD***	**Range**	***t***	***p***
Age	4;11	0;6	4;01-5;11	4;11	0;6	4;04-5;09	0.12	.904
SES Index	4.79	4.15	-6.3-9.1	5.72	3.38	-1.5-10.2	0.68	.502
DEAP- PCC	64.73	18.59	21-84	96.56	4.08	86-100		
CELF- Core RS	59.8	8.46	42-75	63.06	8.16	49-81	1.09	.28
CELF- Core	103.87	8.98	88-119	107.81	8.46	94-129		
CELF- Sent	10.27	2.12	8-15	10.13	2.13	7-15		
CELF- WS	10.13	2.39	6-13	11.75	1.34	10-15		
CELF- EV	11.6	1.99	9-15	12.06	2.11	8-18		
Ravens RS	18.8	3.47	12-24	17.06	2.84	13-23	1.53	.14
Ravens	109.33	11.48	85-125	103.13	8.14	85-115		

Note. SSD= speech sound disordered; TD= typically developing; SES Index= socioeconomic index score; RS= raw score; DEAP- PCC= Diagnostic Evaluation of Articulation and Phonology: Percentage Consonants Correct; CELF-Core= Clinical Evaluation of Language Fundamentals – Preschool 2^{UK}: Core Language score; Sent= Sentence Structure subtest; WS= Word Structure subtest; EV= Expressive Vocabulary subtest; Ravens= Raven's Test of Progressive Matrices.

Speaker accents

Three female adults aged between 34 and 50 years were recruited as the speakers for the accent comprehension task. These speakers were healthcare professionals and were experienced in administering standardised tests. The local native speaker was born and lived in the same area as the children participating in the study (Cork, in southwest Ireland) and spoke Southern Irish English typical of native residents of Cork. The second speaker was originally from Los Angeles, California and at the time of recording lived in Cork, Ireland for three years. She was a monolingual English speaker and could be classified as having a *General American* accent, which is the most commonly used accent on television in the

United States and without any clear regional characteristics it corresponds to the average listener's perception of a North American accent (Wells, 1982c). Therefore this speaker acted as the *regional* accented speaker for this study (henceforth referred to as the North American accent/speaker or the regional accent). The *non-native* speaker was from Nagpur in India, and lived in southern Ireland for nine years at the time of recording. She spoke with accent features typical of Indian English (henceforth referred to as the Indian English accent or non-native accent). This speaker was trilingual, speaking Gujarati, Hindi and English. Audio files containing examples of the speakers' accents are available on the Open Science Framework https://osf.io/a2845/?view_only=fbdd581bcacf4c658f7d34f2832e3fa4.

The Cork accent was included in this study as it was considered to be the most familiar accent to children living in Cork. The North American and Indian English accents were selected on the basis that they differ significantly from the local Cork accent in their phonetic realisation through their differing vowel systems, consonantal features or prosodic features. Specifically, Indian English is a syllable-timed accent, in comparison to the Cork and North American accents which are stress-timed, and Hindi-influenced English has stress placement and intonation patterns that are considered unusual to native English speakers (Panday, 2015; Pickering & Wiltshire, 2000). All three accents are rhotic with /r/ in prevocalic position; the North American accent produces /r/ as an approximant [ɹ], [ɻ], and in some cases uses r-colouring [ɚ], the non-native accent produces /r/ as a flap [ɾ] or retroflex flap [ɽ] and in the Cork accent /r/ has a dark resonance (Wells, 1982b, 1982c). However, only the Cork and North American accents are rhotic in vowel+/r/ environments (Wells, 1982b, 1982c). All three accents also differ in their vowel systems; the Cork accent has a large range of short and long vowels, with a tendency to use monophthongs (e.g. [eɪ]→ [e]), the North American accent merges certain vowels (e.g. merging of [ɑ] and [ɔ]) and the Indian English accent has a reduced vowel system, similar to the vowel system of Gujarati (Hickey, 2004; Trudgill & Hannah, 1982; Wiltshire & Harnsberger, 2006).

A 9-point equal-appearing scale was used to measure the perceived difference between the three experimental accents. Fifteen monolingual Irish English-speaking adults were recruited to rate the three speakers. They were aged between 18 and 55 years (*M*=34.3 years, *SD*=11.6), had no linguistic or phonetic training, and lived in Cork, Ireland. Based on a 30 second story excerpt read by each of the three speakers, they were rated on four parameters using the scales– (a) accent strength (1= *weak accent*, 9 = *strong accent*), (b) accent comprehensibility (1= *difficult to understand*, 9= *easy to understand*), (c) likeliness to be heard in the local area (1= *unlikely*, 9= *very likely*) and (d) familiarity of the accent (1= *unfamiliar*, 9= *familiar*). The local speaker from Cork, Ireland was rated to be the easiest to understand (8.7); the most likely to be heard around Cork (8.3); the most familiar to listeners (8.3); and to have the weakest accent (6.4). The North American speaker was rated to be easy to understand (8.3); to have the strongest accent (7.2); had a score of 4.7 in terms of likelihood to hear in the local area; and a score of 6.7 in terms of familiarity. The Indian English accent was rated the most difficult to understand (5.2); the least likely to be heard in the local area (4.1); the most unfamiliar to listeners (4.6); and was given an accent strength score of 6.7.

In addition, parents of the children who participated in the study (*n*=31) were given a short background questionnaire to complete, based on their child's exposure to the experimental accents. All children were exposed to the Cork accent multiple times a week. Nineteen children were reported to have *no* contact with either Indian or American accented speakers, and 12 children were reported to be exposed to an American and/or Indian accent ranging from less than once a week to multiple times a week. In addition, parents reported that all children had family and teachers with Cork accents and only two children had relatives or school friends with an American or Indian accent.

Sentence stimuli

Speakers were individually recorded reading the instructions for the sentence comprehension task aloud in a sound attenuated speech-recording studio. Sentence stimuli were recorded at a sampling frequency of 44.1 kilohertz. Speakers also read three story excerpts aloud from the children's book *Diary of a Wimpy Kid* (Kinney, 2007). For the sentence stimuli, speakers were instructed to speak at a comfortable loudness level, and Praat speech processing software (version 5.4.02) was used to modify the volume or intensity of the sentence stimuli across the three speakers to between 65 and 67 dB. Speaking rate was calculated in syllables per second (sps). In order to minimise any influence of speaking rate on sentence comprehension, measures were taken to match the speaking rates across speakers as closely as possible. This study utilized the subjective method in controlling speech rate, a method in which a speaker consciously varies his or her rate. The speech stimuli were recorded a number of times in order to have utterances of comparable duration. Care was taken to vary the speech rate only to the point where it still sounded natural for the speaker. The final average speaking rates were: 3.7sps for the Cork speaker, 3.61sps for the North

American speaker, and 3.43sps for the Indian English speaker. Variability in speaking rate between speakers ranged from 2% to 7%, with the Cork speaker producing the instructions 7% faster than non-native speaker.

Sentence comprehension task

An adapted version of the Token Test for Children (McGhee, Ehrler & DiSimoni, 2007) was used as the experimental task in this study. This task was also used in the accent comprehension studies by Allen et al. (2016), Frizelle et al. (2017), and O'Connor and Gibbon (2011). Throughout the task, instructions increase in length and complexity and require the child to manipulate plastic tokens differing in size, shape and colour. Using the same syntax and vocabulary as the original Token test, an extra 23 instructions were added, increasing the total number of test instructions to 69 in the adapted version. These 69 instructions were divided into three different blocks, with each block being presented in one of the three experimental accents. The instructions in each block were matched in terms of vocabulary, level of difficulty and length (the number of syllables). An example of the test instructions is given in table 2. Each block of 23 instructions comprised of four sections, with each section increasing in length and difficulty. These sections were presented in order of difficulty (i.e. not randomised), to reflect assessment administration in a clinical setting. All children heard a total of 69 instructions, with block 1 presented in the first accent, block 2 presented in the second accent and block 3 presented in the third accent. The order of the accent presentations was counterbalanced across children.

Table 2. Examples and number of instructions per section within each block in the sentence comprehension task.

Section	No. of instructions	Example of instruction
1	5	Touch the large white square
		Touch the small blue circle
2	5	Touch the blue square and the red circle
		Touch the red circle and the yellow square
3	5	Touch the large white square and the large red circle
		Touch the small green square and the large blue square
4	8	Put the blue circle on the red square
		Touch the white square after you touch the white circle but before you point to the yellow square

Procedure

Children were assessed over three sessions. The standardised assessments and hearing-screen were completed in the first and second sessions and the experimental sentence comprehension task was completed in the third session. Before administering the sentence comprehension task, children's knowledge of the test vocabulary was assessed, and all children were successful in naming the test tokens. The sentence comprehension task was administered through a Microsoft PowerPoint slide show presentation using audio files stored on the computer. Sixty-nine pre-recorded instructions were played via speakers attached to a Dell Latitude E5420 laptop. To encourage children to listen, they were simultaneously shown an image of an ear which was displayed on the laptop screen. The layout of test materials is shown in figure 1.

Figure 1. Image of test materials – Materials laid out for each participant to complete the sentence comprehension task.

In order to facilitate the participants' familiarization with each accent, they were exposed to a short story excerpt, adapted from *Diary of a Wimpy Kid* (Kinney, 2007). A short exposure period is also recommended by Nathan et al. (1998), so that the child becomes familiar with the new phonological system prior to the testing period. A story excerpt was presented in the test accent, prior to the block of instructions. Therefore in summary, participants were presented with a story excerpt, three trial instructions and 23 test instructions in accent 1; a story excerpt, three trial instructions and 23 test instructions in accent 2; and a story excerpt, three trial instructions and 23 test instructions in accent 3. The sentence comprehension task was scored using a binary scoring system. The instructions were scored in real time by the researcher. In order to check the reliability of scoring and allow off-line scoring of missed responses, a small video camera was used to record children's movement of the tokens. Three children's responses (10% of total participants) were randomly selected for re-analysis. An intra-rater reliability agreement rating of 96% was found, and an inter-rater reliability measure was obtained by an additional speech and language therapist, with an agreement rate of 94%.

Results

Children's total performance scores are presented in table 3. Children with SSD as a group achieved lower performance scores on the sentence comprehension task than the TD participants, and this group difference was greatest with the North American and Indian English accents. When combining performances of all children (*n*=31) on the experimental task, children scored highest with the Cork accent (*M*=12.71, *SD*=3.58), marginally lower with the North American accent (*M*=12.68, *SD*=3.497) and lowest with the Indian English accent (*M* =12.097, *SD*= 2.797).

Table 3. The mean (M) and standard deviation (SD) for both groups of children (SSD & TD) on the sentence comprehension task with each accent separately and with all accents combined (averaged overall ability).

Measure	**SSD (*n*=15)**		**TD (*n*=16)**	
	M	*SD*	*M*	*SD*
Cork Total	12.6	3.72	12.81	3.56
North American Total	11.87	2.64	13.44	4.08
Indian English Total	11.47	2.77	12.69	2.77
Total Averaged Overall ability	11.98	2.74	12.98	3.17

Note. SSD = speech sound disorder, TD = typically developing.

An accent difference score was obtained for each participant by calculating the difference in sentence comprehension scores between the control accent (i.e. the Cork accent) and the regional/non-native accent. These results are presented in figure 2. No clear pattern is evident across the accent pairing or groups.

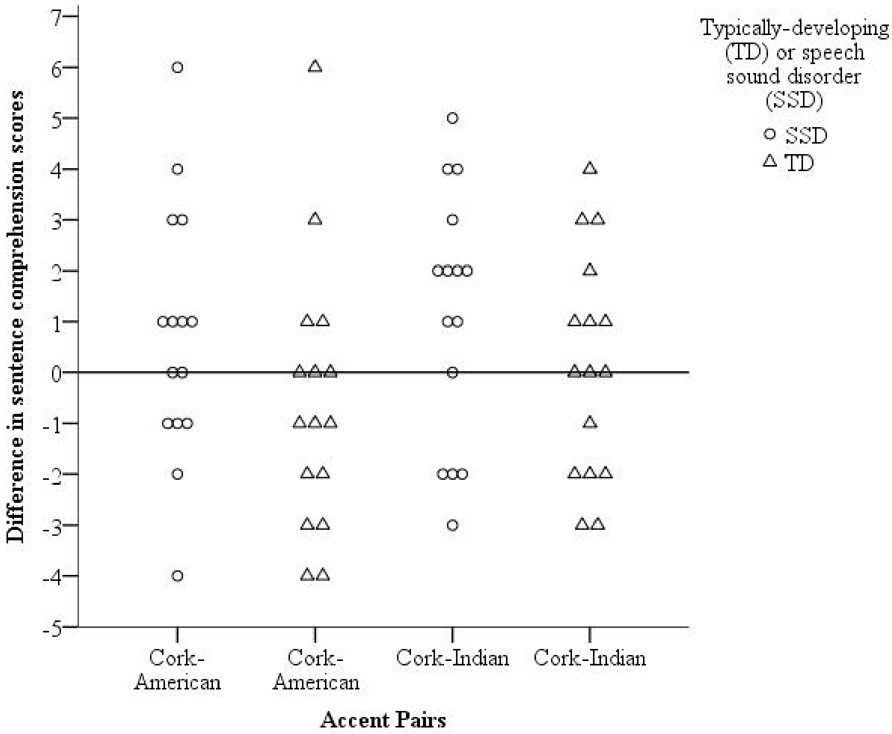

Figure 2. Difference in total sentence comprehension scores between the Cork accent and the North American accent (Cork-American), and between the Cork accent and the Indian English accent (Cork-Indian) in children with speech sound disorder (SSD; *n*=15), typically developing children (TD; *n*=16).

The sentence comprehension data was normally distributed for both groups. Correlation coefficients were similar across the three accent conditions (r= 0.73, 0.76, 0.65, p< .001). The linear mixed model procedure in SPSS was used to analyse the repeated measures data, with individual subject as the random factor and accent and group as the fixed factors. A Likelihood Ratio test was used to compare nested models and Compound Symmetry fitted the data adequately. Results showed that there were no significant group differences for total sentence comprehension scores (F (1,29)= 0.88, p= 0.36). This indicates that children with SSD and TD children did not significantly differ in their sentence comprehension ability. This test also showed that the total scores in each accent were not significantly different (F (2,58)= 1.16, p= 0.32), demonstrating that there was no significant effect of accent on sentence comprehension for all participants. Additionally, the interaction between accent and group was not significant (F (2,58)= 1.19, p= 0.31), indicating that the non-significant accent effect did not change depending on group type (i.e. whether children had SSD or were TD). Therefore, to answer our research questions; there was no significant difference in children's ability to understand sentences spoken in a local, regional and non-native accent and children with SSD and a TD language-matched control group did not differ in their ability to process different accents.

Discussion

In this study we investigated whether there was a significant difference in the ability of children with SSD to understand sentences spoken in a local, regional and non-native accent (i.e. is there any accent effect), and if any potential accent effect was greater for children with SSD than a group of language-matched control children. We hypothesised that children's receptive language would be negatively impacted by the unfamiliar accents and this impact would be greater in children with SSD. Our results showed no significant effect of accent on language comprehension in children with SSD or children with typical development. Closer inspection of individual performances showed that that approximately 50% of participants in each group had the highest total sentence comprehension score in one or more of the non-local accents. In fact, 19 children performed either equally well with the Cork and North American accents, or performed best with the North American accent; while 14 of the participants performed either equally well with the Cork and Indian English accents, or performed best with the Indian English accent; and only nine children out of the total 31 participants performed best with the Cork accent over both of the other accents. These results indicate that individually many children did not demonstrate accent comprehension difficulties. This result contradicts the study's hypotheses, and contrasts with the majority of research carried out in the area of accent comprehension with children and adults (e.g. Adank et al., 2009; Nathan et al., 1998; Van Heugten et al., 2015).

In particular, our results are in contrast to those reported by Nathan and Wells (2001), the only other published study examining accent comprehension in children with speech difficulties. Nathan and Wells used an unfamiliar and familiar regional accent in a receptive lexical decision task with children with speech impairment aged 5 to 6 years, but showed that these children had significant difficulties with an unfamiliar regional accent and the TD participants did not. Differences in task type may account for the conflicting outcomes. Unlike Nathan and Wells' (2001) research, the current study used more high frequency lexical items that were repeated throughout the task (differences in task design and stimuli are discussed further below). In addition, Nathan and Wells used two participant groups matched on chronological age rather than language ability, and notably the group with speech impairment had significantly lower language scores than the TD group.

The role language ability plays in children's comprehension of different accent is also relevant based on the results reported by Frizelle et al. (2017). This study revealed that children with LI aged 5;0 to 8;11 years and a younger control group of TD children (matched on receptive language ability) had significantly greater difficulty comprehending sentences presented in a regional Irish accent than in their own local accent or in a neutral Irish accent. Additionally, there were no significant differences evident between the two groups of participants (i.e. children with LI and TD children performed at a similar level). Importantly, Frizelle et al. (2017) found that receptive language skills and phonological short-term memory were highly significant in accounting for children's ability to process accent variation. This finding along with the results from the current study (showing that two groups of children who were language-matched performed similarly on a measure of accent comprehension), lends support to the idea that receptive language ability plays a role in the comprehension of accented variation in speech. Furthermore, many researchers have reported a developmental trend in accent comprehension (see Harte et al., 2016 for a recent review), which again is suggestive of a relationship between language ability and accent comprehension skills. Consequently, if general language skills play a key role in the comprehension of different accents, non-local accents may possibly have a greater impact on sentence comprehension in children with lower levels of language ability than in children with superior language skills. Participants in the current study had language skills within or above the average range, which may account for the non-significant accent effect found.

However, it is important to consider alternative explanations for our findings of a non-significant accent effect. Firstly, the sample size was relatively small, with 15 participants with SSD and 16 control participants. While this is not an unusual participant number in studies with children with speech impairments (e.g. Bird & Bishop, 1992; McNeill, Gillon & Dodd, 2009; Rvachew, 2007), and studies examining accent comprehension in children (Mulak et al., 2013; Nathan & Wells, 2001; Van Heugten et al., 2015) it is possible that a larger population size might have revealed different results. The need for a larger sample size is also relevant when you consider the highly variable results in individual performances.

Secondly, the lack of a significant result may be due to certain aspects of the experimental design. For example, the current study and the study by Nathan and Wells (2001), which both found no significant accent effect with one or more of their participant groups, used tasks with a reduced lexical search. The sentence comprehension task (adapted version of the Token Test for Children; McGhee et al., 2007) utilised in the current study used vocabulary that was familiar to all participants, had little variability in the items, and had a predictable syntax. More importantly, the task involved the manipulation of tokens, which provided the children with visual cues. Equally, the word comprehension task used by Nathan and Wells (2001) required children to decide if a pre-recorded word matched a presented picture and to answer "yes" or "no", providing children with a phonological and visual reference. Therefore, both tasks provided an immediate visual context, which might have facilitated children's access to their own phonological representations in a highly constrained task. Researchers have shown that more high- than low-predictability contexts, (Holt & Bent, 2017) and stimuli with accompanying visual scenes or semantic contexts (Creel et al., 2016) can facilitate accent comprehension ability. However, many accent studies with children use word or sentence repetition tasks (e.g. Nathan et al., 1998), requiring a wider lexical search and no visual cue to aid access to phonological representations.

The type of vocabulary used in speech stimuli is another factor that may impact children's performance on the sentence comprehension task. According to Creel and Seubert (2015), children's ability to comprehend different accents can be more difficult when children are required to make finer phonetic discriminations. The familiar and high-frequency vocabulary used in the current study (e.g. small/large, blue/green/red/yellow/white, circle/square) was highly contextually supported and less likely to be mistaken for another token (i.e. phonologically distinct vocabulary items), even when presented in the non-native accent. Several authors who have found contrasting results to the current study, such as Bent (2015) and Nathan et al. (1998), used word and sentence repetition tasks, which may have included words that were phonologically similar if presented without any context. Therefore, children in the current study may have performed differently to these participants due to the predictable nature of the vocabulary used and the fact that fine phonetic discriminations were not required.

Thirdly, the role of short-term accent exposure or accent adaptation may have influenced the outcome of the study. White and Aslin (2011) found that 18 to 20-month-old children could accommodate a novel accent after approximately one minute of priming containing the same vowel shifts. Additionally, Bent and Frye (2016) discovered that 6- and 9-year-old children understood Mandarin-accented sentences better after participating in a sentence repetition training phase than those who did not. Frizelle et al. (2017) also found a potential adaptation effect in their study, in which children with LI used an identical sentence comprehension task to the current study. They found a significant accent effect in the early section of their comprehension task, which contained the simplest instructions, and not in the later and more difficult sections. It is possible that the increased difficulty of the later sections masked the accent effect, but another possibility is that children began to normalise the accented speech to their own phonological representations. In keeping with the study by Frizelle and colleagues, participants in the current study heard a read story excerpt for approximately 60 seconds and three trial instructions before carrying out the first section of the comprehension task. This may have been sufficient for the children in the current study to adapt to each accent. Therefore, we might consider it likely that children in the current study could adapt to the accented speakers after a short period of time.

Finally, the outcome of this study (i.e. no significant accent effect) suggests that if we interpret the ability to process accent variation as a measure of the precision or flexibility of children's phonological representations, then we could conclude that children with SSD may not exhibit specific deficits with their phonological representations as measured in the current study's task. This conclusion is in contrast to findings by Sutherland and Gillon (2005), who found that children aged between 3 and 5 years with moderate and severe SSD not only had significantly greater difficulties forming new phonological representations but also had more difficulty with accessing precise phonological representations than TD children matched on age and receptive language ability. Moreover, Bird and Bishop (1992) found that children aged 5;0 to 6;03 years with specific SSD failed to identify phoneme constancy across different word contexts, in comparison to non-verbal and age-matched controls. The experimental task used by Sutherland and Gillon (2005) involved mispronunciation detection and non-word learning using picture pointing while Bird and Bishop (1992) used phoneme matching tasks. All of the aforementioned tasks are very different to the task used in the current study, in relation to both comprehension level (single word vs. sentence level) and speech stimuli (non-words and mispronunciations vs. natural accent variation). While both studies did have several practise items (i.e. speaker familiarisation period) and some visual supports, it is likely that a task more similar to that used clinically using real speakers at sentence level proved less difficult for children with SSD than a less contextually supported experimental task using single words that are phonetically similar.

As previously discussed, the current study's results contrasted with the majority of studies in the area of accent comprehension; however, comparable results were found to Nathan, Stackhouse et al. (1998) in terms of phonological representations in SSD. Based on an auditory lexical decision task, using a very similar group of participants to the current study (4- to 5 year-old-children with specific SSD), Nathan, Stackhouse et al. (1998) also found that children with SSD and TD children did not significantly differ in their speech discrimination skills, their lexical decision making or the precision of their phonological representations. It was only when language skills (receptive and/or expressive language difficulties) were taken into account that group differences occurred. In contrast to the children with specific SSD, Nathan, Stackhouse et al. (1998) found that children with combined SSD and LI significantly differed from the TD group on the auditory-lexical decision task, highlighting the important role of language ability in speech and phonological processing.

In sum, the current study showed that children with specific SSD do not have difficulties comprehending sentences spoken in an unfamiliar regional or non-native accent during a relatively simple sentence comprehension task comprising familiar vocabulary. Moreover, their ability to process accent variation does not differ to children who are receptively language matched and typically developing. These results lend further support to the premise that language level plays an important role in children's ability to process accent variation.

Acknowledgments

The authors thank the recorded speakers, teachers, SLTs and children and parents who contributed to the study, in addition to the Health Research Board Ireland who funded the study.

Declaration of Interest

The authors report no conflicts of interest. This research MSc project was funded by the Health Research Board Ireland, research grant HRA_POR/2012/68.

References

Adank, P., Evans, B., G., Stuart-Smith, J., & Scott, S. K. (2009). Comprehension of familiar and unfamiliar native accents under adverse listening conditions. *Journal of Experimental Psychology: Human Perception and Performance, 35*(2), 520–529. doi: 10.1037/a0013552

Ainsworth, S., Welbourne, S., & Hesketh, A. (2016). Lexical restructuring in preliterate children: Evidence from novel measures of phonological representation. *Applied Psycholinguistics, 37*(4), 997–1023.doi:10.1017/S0142716415000338.

Allen, E., O'Leary, D., & Gibbon, F. (2016). The effect of an unfamiliar accent on typically developing children's comprehension of spoken sentences. *Journal of Clinical Speech and Language Studies*, *22*, 29–45.

Bent, T. (2015). Development of perceptual flexibility. In The Scottish Consortium for ICPhS 2015 (Ed.), *Proceedings of the 18th International Congress of Phonetic Sciences* (paper 705, pp. 1–5). Glasgow, UK: The University of Glasgow. Retrieved from http://www.icphs2015.info/pdfs/Papers/ICPHS0705.pdf

Bent, T., & Frye, J. (2016). Perceptual adaptation to nonnative speech by school-aged children. *The Journal of the Acoustical Society of America, 140*(4), 3218. doi: http://dx.doi.org/10.1121/1.4970145

Best, C. T., Tyler, M. D., Gooding, T. N., Orlando, C. B., & Quann, C. A. (2009). Development of phonological constancy: Toddlers' perception of native- and Jamaican-accented words. *Psychological Science*, *20*(5), 539–542. doi: 10.1111/j.1467-9280.2009.02327.x

Bird, J., & Bishop, D. (1992). Perception and awareness of phonemes in phonologically impaired children. *International Journal of Language & Communication Disorders*, *27*(4), 289–311. doi: 10.3109/13682829209012042

Bruce, C., To, C., & Newton, C. (2012). Accent on communication: The impact of regional and foreign accent on comprehension in adults with aphasia. *Disability & Rehabilitation*, *34*(12), 1024–1029. doi: 10.3109/09638288.2011.631680

Creel, S. C. (2012). Phonological similarity and mutual exclusivity: On-line recognition of atypical pronunciations in 3-5-year-olds. *Developmental Science*, *15*(5), 697–713. doi: 10.1111/j.1467-7687.2012.01173.x

Creel, S. C., Rojo, D. P., & Paullada, A. N. (2016, June). Effects of contextual support on preschoolers' accented speech comprehension. *Journal of Experimental Child Psychology*, *146*, 156–180. doi: 10.1016/j.jecp.2016.01.018

Creel, S. C., & Seubert, E. (2015). Children's early perceptual and late-emerging social sensitivity to accented speech. In *Proceedings of the 37th Annual Meeting of the Cognitive Science Society* (paper 91, pp. 1–6). Pasadena, California: Cognitive Science Society. Retrieved from https://mindmodeling.org/cogsci2015/papers/0091/paper0091.pdf

Dodd, B., Hua, Z., Crosbie, S., Holm, A., & Ozanne, A. (2002). *Diagnostic Evaluation of Articulation and Phonology (DEAP)*. London, UK: Pearson.

Fowler, A. E. (1991). How early phonological development might set the stage for phoneme awareness. In S. A. Brady, & D. P. Shankweiler (Eds.), *Phonological processes in literacy: A tribute to Isabelle Y. Liberman* (pp. 97-117). Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Frizelle, P., Harte, J., Gibbon, F., & Fletcher, P. (2017). Investigating the effect of regional native accents on sentence comprehension in children with language impairment. *International Journal of Speech-Language Pathology*. Advance online publication. doi: 10.1080/17549507.2017.1293734

Haase, T., & Pratschke, J. (2012). *The 2011 Pobal HP Deprivation Index for small areas (SA): Introduction and reference tables*. Retrieved from https://www.pobal.ie/Publications/Documents/Introduction%20and%20Reference%20Tables.pdf

Harte, J., Oliveira, A., Frizelle, P., & Gibbon, F. (2016). Children's comprehension of an unfamiliar speaker accent: A review. *International Journal of Language & Communication Disorders*, *51*(3), 221–35. doi: 10.1111/1460-6984.12211

Hickey, R. (2004). The phonology of Irish English. In B. Kortmann, & E. W. Schneider (Eds.), *Handbook of varieties of English: Phonology* (Vol. 1, pp. 68–97). Berlin: Mouton de Gruyter.

Holt, R. F., & Bent, T. (2017). Children's use of semantic context in perception of foreign-accented speech. *Journal of Speech, Language and Hearing Research*, *60*(1), 223–230. doi: 10.1044/2016_JSLHR-H-16-0014

Jeffries, E. (2015, June). Pre-school children's identification of familiar speakers and the role of accent features. *York Papers in Linguistics Series 2*, *14*, 15–40.

Kinney, J. (2007). *Diary of a Wimpy Kid*. New York: Amulet Books.

Leonard, L. B. (1985). Unusual and subtle phonological behavior in the speech of phonologically disordered children. *Journal of Speech and Hearing Disorders, 50*(1), 4–13. doi: 10.1044/jshd.5001.04

McGhee, R. L., Ehrler, D. J., & DiSimoni, F. (2007). *Token Test for Children* (2nd ed.) (TTFC – 2). Texas: PRO-ED Inc.

McNeill, B. C., Gillon, G. T., & Dodd, B. (2009). Phonological awareness and early reading development in childhood apraxia of speech (CAS). *International Journal of*

Language & Communication Disorders, *44*(2), 175–192. doi: 10.1080/13682820801997353

Mulak, K. E., Best, C. T., Tyler, M. D., Kitamura, C., & Irwin, J. R. (2013). Development of phonological constancy: 19-month-olds, but not 15-month-olds, identify words in a non-native regional accent. *Child Development, 84*(6), 2064–2078. doi: 10.1111/cdev.12087

Nathan, L., Stackhouse, J., & Goulandris, N. (1998). Speech processing abilities in children with speech vs speech and language difficulties. *International Journal of Language & Communication Disorders*, *33*(1), 457–462. doi:10.3109/13682829809179468

Nathan, L., & Wells, B. (2001). Can children with speech difficulties process an unfamiliar accent? *Applied Psycholinguistics*, *22*(3), 343–361. doi: 10.1017/S0142716401003046

Nathan, L., Wells, B., & Donlan, C. (1998). Children's comprehension of unfamiliar regional accents: A preliminary investigation. *Journal of Child Language, 25*(2), 343–365. doi: 10.1017/S0305000998003444

O'Connor, C., & Gibbon, F. (2011). Familiarity of speaker accent on Irish children's performance on a sentence comprehension task. *Journal of Clinical Speech and Language Studies*, *18*, 1–17.

Raven, J. C. (2008). Raven's – Educational: CPM/CVS. London: Pearson Assessment.

Rvachew, S. (2007). Phonological processing and reading in children with speech sound disorders. *American Journal of Speech-Language Pathology*, *16*(3), 260–270. doi: 10.1044/1058-0360(2007/030)

Rvachew, S., & Grawburg, M. (2006). Correlates of phonological awareness in preschoolers with speech sound disorders. *Journal of Speech, Language and Hearing Research*, *49*(1), 74–87. doi: 10.1044/1092-4388(2006/006)

Panday, P. (2015). Indian English pronunciation. In M. Reed, & Levis, J. M. (Eds.), *The handbook of English pronunciation* (pp. 301–319). UK: John Wiley & Sons.

Pickering, L., & Wiltshire, C. (2000). Pitch accent in Indian-English teaching discourse. *World Englishes*, *19*(2), 173–183. doi: 10.1111/1467-971X.00167

Stackhouse, J., & Wells, B. (1997). *Children's speech and literacy difficulties: A psycholinguistic framework*. London: Wiley.

Sutherland, D., & Gillon, G. T. (2005). Assessment of phonological representations in children with speech impairment. *Language, Speech, and Hearing Services in Schools*, *36*(4), 294–307. doi: 10.1044/0161-1461(2005/030)

Trudgill, P., & Hannah, J. (1982). *International English: A guide to varieties of standard English*. London: Edward Arnold.

Van Heugten, M., & Johnson, E.K. (2016). Toddlers' word recognition in an unfamiliar regional accent: The role of local sentence context and prior accent exposure. *Language and Speech*, *59*(3), 353–363. doi: 10.1177/0023830915600471.

Van Heugten, M., Krieger, D. R., & Johnson, E. K. (2015). The developmental trajectory of toddlers' comprehension of unfamiliar regional accents. *Language Learning and Development, 11*(1), 41-65. doi:10.1080/15475441.2013.879636

Walley, A. (1993). The role of vocabulary development in children's spoken word recognition and segmentation ability. *Developmental Review*, *13*(3), 286–350. doi:10.1006/drev.1993.1015

Wells, J. C. (1982b). *The Accents of English volume 2: The British Isles.* Cambridge, UK: Cambridge University Press.

Wells, J. C. (1982c). *The Accents of English volume 3: Beyond the British Isles.* Cambridge, UK: Cambridge University Press.

White, K. S., & Aslin, R. N. (2011). Adaptation to novel accents in toddlers. *Developmental Science*, *14*(2), 372–384. doi: 10.1111/j.1467-7687.2010.00986.x

Wiig, E. H., Secord, W. A., & Semel, E. (2006). *Clinical Evaluation of Language Fundamentals–Preschool 2* (UK Standardisation) *(CELF-P2 UK).* London: Pearson Assessment.

Wiltshire, C. R., & Harnsberger, J. D. (2006). The influence of Gujarati and Tamil L1s on Indian English: A preliminary study. *World Englishes*, *25*(1), 91–104. doi: 10.1111/j.0083-2919.2006.00448.x