Are norms for percent consonant correct and the age of acquisition of phonemes in the Irish DEAP valid for a sample of typically developing children in Limerick?

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Are norms for Percent Consonant Correct and the age of acquisition of phonemes in the Irish DEAP valid for a sample of typically developing children in Limerick?

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Abstract

This paper reports a normative study on the phonological development of Irish English-speaking children. Speech samples of 56 children, aged between 3; 00 and 5; 11 years were randomly chosen from pre-schools and schools in Limerick and analysed to obtain normative data. The phonology assessment from the Diagnostic Evaluation of Articulation and Phonology (DEAP) is an assessment of speech widely used for assessment by Speech and Language Therapy (SLT) clinics and by researchers throughout Ireland. However data for the norms were collected in Dublin and Galway only, which may not be representative of the country as a whole. This would have implications for research and clinical practice. This study was carried out to inform a larger study of children with speech sound disorders in Limerick. The study found that the age of acquisition of phonemes differed to those reported in the Irish DEAP. No differences in norms and age of acquisition of phonemes between high and low SES were found. A significant difference in the age range 4; 06-4; 11 between the DEAP Percentage of consonant correct (PCC) scores and this study was found. This signifies that PCC in the Irish DEAP for that age group was invalid for this study, however due to the small sample size; the DEAP can be considered a valid tool to be used in local clinical settings.

Key words: Speech Sound Disorders, Speech, Assessment, Standardisation

Introduction

Aim of research

To establish whether norms for PCC and the age of acquisition of phonemes in the Irish DEAP are valid for a sample of typically developing children in Limerick.

In clinical assessment of children's phonology, the accessibility of normative data is critical to provide a measure to which a child's performance can be compared (Dodd et al, 2009; Peña and Spaulding, 2006). Normative data should be representative of the population and consider sociolinguistic elements.

Research shows that children with Speech Sound Disorders (SSD) display delayed developmental error patterns (or phonological processes) (Baker and McLeod, 2011; Dodd *et al*. 2003). This research project has been undertaken to gain an understanding of speech sound development in normally developing children through a comparison of Irish normative data of the Diagnostic Evaluation of Articulation and Phonology Assessment (DEAP) to normative data.

The DEAP is an assessment of speech widely used for assessment by SLT clinics and by researchers throughout Ireland (Dodd *et al*. 2002). However data for the norms were collected in Dublin and Galway only, which may not be representative of the country as a whole. This would have implications for research and clinical practice. This study was carried out to inform a larger study of children with speech sound disorders in Limerick and North Tipperary.

Children with Speech Sound Disorders (SSD)

Children with SSD can be classified in terms of their speech errors (Dodd, 2005). An SSD can be described as a "significant delay in the acquisition of articulate speech sounds" (Lewis *et al*. 2006, p.1294). Dodd's classification of speech sound disorders is described in the literature as; articulation disorder, phonological delay, consistent phonological delay and inconsistent phonological delay (Dodd, 2005).

The prevalence of SSD is the quantity of cases in a population at a specific time (Law *et al.* 2000). Prevalence varies in the research. Approximately 5% of the primary school population is characterised by children with SSD and this amounts to 70% of Speech and Language therapists' caseloads (Fox *et al.* 2002). Broomfield & Dodd (2004a, 2004b) detailed information regarding referrals which indicated that of 1100 children assessed over one year in Middleborough Primary Care trust, 320 had a speech and language disability. Their results showed that 57.5% of these children had a phonological delay, 20.6% displayed consistent non-developmental error patterns, 9.4% made inconsistent errors on the same word and 12.5% had an articulation disorder. Based on this study, the estimated national incidence rate of referrals of children with speech and language impairment per year is 85000-90000 children (14.6% of births). However, in a review of many studies Law *et al*. (2000) made the point that prevalence rates were different across studies. The prevalence of SSD was shown to vary from 2.3% to 24.6% and the prevalence of combined speech and language was shown to range from 4.56% to 19.0%.

The nature of SSD is complex, and the literature shows that it is a heterogeneous impairment; however, comprehensive information about children with SSD is limited in literature (Shriberg *et al*. 1999).

Speech Sound Assessment

Standardised assessments are extensively used in clinical settings. They are an important tool for speech and language therapists in the differential diagnosis of children with speech sound impairments. The purpose of phonology assessment in Speech and Language Therapy is to catalogue the speech sounds in a child's speech, by collating information from speech samples and analysing it using standardised assessment tools (Williams, 2006). They are advantageous to clinicians as they assist with the identification of SSD and help with planning intervention.

Kamhi (1992) and Fey (1992) both recommend that formalised assessment ought to classify where the speech deficits are occurring in a child's system; perceptual, cognitive-linguistic or articulatory. The majority of current formalised assessments include cognitive-linguistic and articulatory however lack perceptual analysis (Williams, 2006). Locke's Sound Production-Sound Perception Tasks allow the child to perceive their own spoken productions with the productions of the same word in their surroundings. The Goldman-Fristoe-Woodcock test of auditory discrimination broadly assesses a child's ability to discriminate sounds; however it may not accurately correlate a child's perceptual abilities with their speech sound errors. According to Williams (2006), this unreliability of perceptual testing may be due to the maturational ability of speech discrimination.

Standardised assessments may not represent a child's linguistic ability as they may display a cultural bias. If dialectal features are not taken into account during formalised assessment, research has indicated that overall scores will be lower and a false diagnosis may be identified (Goldstein and Iglesias, 2001; Cole and Taylor, 1990). The majority of standardised assessments used within clinics are not considered time-efficient and usually depend on one sample of elicited single-word trials of children's speech.

Many clinicians are motivated by using phonetic analysis in their assessments and according to Kamhi (1992), the relevance of an explanatory account of a child's SSD provides clinicians with information about the level of where the deficits are occurring in a child's phonological system, along with descriptive accounts of the child's sound system. Standardised assessments can be useful in the identification of a child's SSD through a comparison with normative data.

Normative data

Normative data is valuable as it provides a contrast with a clinical population with which the performance of a child can be compared (Dodd *et al.* 2009, Peña and Spaulding, 2006). However, the composition of the normative group is significant, as different variables can affect the diagnostic process in a clinical setting (Peña and Spaulding, 2006). Normative data should entail a sufficiently large sample, be demonstrative of the entire population, and be considerate of sociolinguistic factors (Dodd *et al*. 2003)

Speech sound development can be examined phonetically and phonemically. Examination of the *production* of speech sounds provides a phonetic analysis and the *use* of speech sounds provides a phonemic analysis (Dodd *et al*. 2003). The majority of prior research has been done on phonemic analysis and children's speech is typically studied in terms of the degree of accuracy of their production with an analysis of the amount of children who attained that level of accuracy in a specific age group (Dodd *et al*. 2003).

Investigations of gender differences in speech production variability show that girls perform better than boys (Dodd *et al*. 2003). No gender differences were found in younger age groups, however, in the older age group, females performed better than males in the phonological accuracy measures (Dodd *et al*. 2003). Citing Moore, Holm *et al*. (2007) describe substantial differences in the speech production of females at 18 months, in comparison to males of the same age. Burt *et al.* (1999) showed no gender variation in the analysis of 4 year olds speech. Several hypothesises have been postulated regarding the gender variances in speech development, mostly relating to maturational effects (Hyde and Linn, 1988).

A number of investigations on the impact of Socio-economic status (SES) on speech sound development support the discussion that linguistic variation can be ascribed to SES (Robertson, 1998; Burt *et al.* 1999). Walker *et al.* (1994) report in a longitudinal study that children being from a low SES impacted upon academic achievement on standardised assessments. Burt *et al*. (1999) reports similarly and shows evidence of poor phonological awareness abilities in children from a low SES.

Several studies show the effect of a deprived linguistic environment on the speech and language development of children with low SES (Walker *et al*. 1994; Hart and Risley, 1995). Walker *et al.* (1994) propose that low SES children might be at a disadvantage, being from the type of environment that does not assist them in focusing on the features of a language. Citing Hart and Risley, Dodd *et al*. (2003) reference the long-term negative effects on academic success of children with a low SES.

Dodd *et al.* (2003) found no SES effect on any age group in their normative study of 684 children aged between 3:0 and 6:11 years old. Citing Law, Dodd *et al*. (2003) explains that there are many variables that may affect SES and that low scores on formalised assessments may be attributed to other factors, which may account for the evidence base claims that linguistic variation can be attributed to SES.

Irish Dialect

Hiberno-English is the dialect of English used in Ireland. General characteristics from Hickey (2004) include;

-Rhotacisation of /ɹ/ post-vocalically

- The rhotacisation can be a post alveolar tap [ɾ] in some accents

- /t/ is produced as a fricative instead of a plosive

- /θ/ and /ð/ can appear as a dental fricative or a dental stop [t̪ʰ] and [d̪]

-Consonant clusters ending in /j/ often change;

-/dj/ becomes /dʒ/

-/tj/ becomes /tʃ/

Ireland is divided linguistically into mainly two sections; the north and the south (Hickey, 2004). Specific dialectal variations of Hiberno-English in the mid-west are;

-The raising of the /ɜ/ to /ɪ/ before nasals

-Tense, raised articulation of /æ/ (evidenced also in the East)

-Considerable range of intonation (only in the south and south-west)

Assessment and intervention might be influenced by dialect, as dialectal features can impact on how clinicians might analyse the results of a formalised assessment.

Standardisation and Diagnostic Evaluation of Articulation and Phonology (DEAP)

The DEAP is an assessment standardised for differential diagnosis of SSD on a population of children aged between 3;0 and 6;11. It includes 6 assessments and used in the United Kingdom, Australia and Ireland. A total of 306 children were assessed in Galway and Dublin during 2006 and 2009. It has recently been standardised for an Irish population (Leahy *et al.* 2011).

The DEAP is a valuable clinical aid as it affords precise assessment of speech sound production, which is a critical part of a formalised speech sound assessment. Using the DEAP's diagnostic screen is a fast way of identifying the need for further investigation of a child's speech (Dodd *et al*. 2002).

Limitations in the DEAP study are the low sample size per age group and the lack of geographical representation throughout the population. For the Irish standardisation, 306 children were sampled between the ages of 3:0 and 6:11 with a maximum amount of 50 children selected per age group. Reduced sample size can be less representative of a population leading to inferior validity of an assessment as research states that 100 children per age group should be the minimum selected (Friberg, 2010). This sample was taken from only two regions in the country; Dublin and Galway, meaning that there is not a fair representation of dialectal variance of the Irish population.

Conclusion

The standardization of formal assessments (such as the DEAP) should include dialectal variations, as research has shown that working from a dominant dialect and not accounting for dialectal features will impact on diagnosis and can lead to incorrect target selection in therapy (Goldstein and Iglesias, 2001; Cole and Taylor, 1990).

Although the categorization of the development of error patterns (or phonological process) is recognized in the research, few studies have focused on determining the age of acquisition of these patterns in normally developing children's speech (Dodd *et al*. 2003). Broomfield and Dodd (2004 b) and Stackhouse and Wells (1997) suggest that further work is necessary to detect these patterns in normally developing children.

Due to the lack of norming research available, a comparison of Irish normative data of the DEAP with normative data assisted in gaining an understanding of speech sound development in normally developing children however further research is recommended.

Research questions

1. Are the norms of the DEAP assessment of speech valid for local data?
2. Is the order and age of acquisition of phonemes the same as in the Irish DEAP sample?
3. Are there differences in norms and the order and age of acquisition of phonemes between high and low SES children?

Method

The Participants

60 typically developing English-speaking children from Limerick city aged between 3;0 and 5;11 years were recruited for this research. Four children were excluded from the research; one was bilingual and the remaining 3 provided insufficient usable data due to low sample size within the age-group 5;6-5;11. The sample consisted of 26 males and 34 females and children were recruited from schools and pre-schools in Limerick city. The schools were selected randomly by the assessors and the school principals acted as gatekeepers. A mix of participants from Delivering Equality of Opportunity in schools (DEIS) and non-DEIS schools were recruited. A letter of invitation was sent to schools and pre-schools explaining the purpose of the research. All participants' parents were provided with an information sheet, explaining the research, and a letter of consent to sign. Inclusion criteria were: monolingual English speakers, within the age range of the study: 3;0 to 5;11 years. Exclusion criteria were: no known speech or language difficulties or attendance at Speech and Language Therapy, no sensory or intellectual impairment or previous behavioural difficulties reported.

The assessors

Four speech and language therapy (SLT) post-graduate students in the final year of the Masters of SLT in the University of Limerick (UL) tested children for collection of normative data. There was a period of training when the assessors were observed by an SLT on the first day of data collection, in order to ensure consistency of assessment and scoring. The assessors received guidance on elicitation methods, dialectal information and scoring the results of assessments. The assessors divided into pairs for assessing.

Procedure

Each participant was assessed individually on one occasion for 40-60 minute long sessions. They were assessed in a quiet room in their school or pre-school. Rapport was established with each participant and maintained throughout testing, to ensure comfort and collaboration of participant. At each assessment, two assessors were present, one administering and scoring the assessment, and the other recording scoring reliability. Each

session was audio recorded using a Dictaphone to ensure that the transcription was reliably recorded. On occasion where transcriptions differed, the recording was replayed and assessors mutually agreed on an answer. On completion of the assessments, assessors evaluated and scored the data together initially as a group and subsequently in pairs. Procedures followed were in accordance with the ethical principles outlined by UL ethics policy.

Materials

All children were assessed with a standardised speech assessment and a battery of novel cognitive assessments. The latter battery was part of another study which is reported elsewhere.

The Phonology Assessment

The standardized speech assessment used was the Diagnostic Evaluation of Articulation and Phonology (DEAP) (Dodd *et al.* 2002). This test is standardised on the Irish population and assesses children's articulation and phonological speech development. The Diagnostic screen and the phonology assessment were both carried out. The diagnostic screen required the participants to name 10 coloured pictures twice to check for consistency of word production. An informal conversation was carried out between the two trials. Consistency was calculated based on a comparison of the words produced on two trials. If the participants produced more than 40% of the 10 words differently, they were considered to be inconsistent, and a Speech and Language Therapy referral was recommended to the parents.

The phonology assessment required the participants to name 50 coloured pictures. Each word elicited was phonetically transcribed by two assessors and developmental and non-developmental error patterns were identified. Developmental and non-developmental error patterns are explained in Appendix 1. An error pattern occurred when there was a difference between an adult and child's production of a word (Dodd *et al.* 2003). A developmental error pattern such as *fronting* was acknowledged if it occurred on more than five occasions (with the exception of weak syllable deletion, which was two occurrences). A

non-developmental error pattern such as *backing* was acknowledged if it occurred on one occasion

Measures and analysis

Phonemic inventory

Each participant's phonemic inventory was established by the assessors. The normal age of acquisition of a phoneme was considered to be the age at which the phoneme was included in the inventory of 90% of children at that age. Non-dialectal phonetic differences, such as a lisp, were considered an error. A measure of 90% was used because research shows that speech sound disorders occur within 3 and 10% of the normal population (Enderby and Phillipp, 1986).

Error Patterns

Error patterns were identified following analysis of the participants' assessments. For a process to be considered present, 5 examples of its use must be shown, except in the case of Weak Syllable Deletion (WSD), where 2 examples suffice to establish this process as being present.

Dialectal differences

All participants' dialectal differences were established following analysis of assessments. These features are normal for dialect and thus not counted as errors when calculating PCC or processes.

- Stopping of dentalised fricative /ð/→[d]
- Stopping of dentalised fricative /θ/→[t]
- Rhotacisation of post-vocalic /ɹ/

Quantitative measures

Percent consonants correct (PCC): the percentage of correctly produced consonants divided by the number of elicited consonants from the DEAP Phonological Assessment. Inter-rater reliability for transcription and analysis of data was calculated between different assessors. The audio recordings of 6 children (10.7% of the sample) were transcribed. Each recording was reanalysed by a different assessor. The agreement was calculated based on PCC. Kappa measure agreement 0.91, p=.117 signifying a very good agreement.

Results

Characteristics of the sample

The preliminary statistical analysis observed the effect of age, gender and SES. The total number of sample participants was 56; with a mean of 2.23 and a standard deviation of 1.362. The participants comprised 34 males and 22 females with Table 1 presenting the number of participants per age group. The youngest age group was 3;00-3;05 and the oldest was 5;00-5;05. Table 2 presents the normative sample by SES with 39.3% of the sample categorised as DEIS. 10 children were found to have a speech sound disorder in the sample.

Table 1: *Normative sample by age*

Age Group	Number	Percentage of sample
3;00-3;05	8	14.3
3;06-3;11	10	17.9
4;00-4;05	11	19.6
4;06-4;11	15	26.8
5;00-5;05	12	21.4
Total	56	100.0

Table 2: *Normative sample by socio-economic status (SES)*

DEIS	Number	Percentage of sample
NO	34	60.7
YES	22	39.3
Total	56	100.0

Comparison of local norms to DEAP norms

PCC of the DEAP norms and PCC of the local norms based on standard scores are presented in Table 3. A Kruskal-Wallis test of variance between PCC norms revealed significant differences in four age groups of PCC in the DEAP norms. The DEAP PCC χ^2 (5, n=56) =11.781, p=.019 and PCC in the local norms χ^2 (5, n=56) = 8.073, p=.089. A Post Hoc Mann Whitney test indicated significant differences in PCC in the DEAP between the following groups 3:0-3:05 and 4:06-4:11, p=0.011; 3.06-3.11 and 4.06-4.11, p= 0.006. Bonferroni adjustment value was 0.0125. This signified that PCC in the Irish DEAP for age group 4:06-4:11 was invalid for this study.

Table 3 *Comparison of local norms to DEAP norms*

Scaled Score		17	16	15	14	13	12	11	10	9	8	7	6	5	4	3
Age Group 3;00-3;05																
PCC	Irish norms: DEAP	97-100	95-96	94	93	92	91	90	88-89	85-87	78-84	72-77	66-71	56-65	0-55	
	Norms: This study						92-98	89-91	86-88	82-85	79-81	76-78	72-75	68-71	66-67	0-65
Age Group 3;06-3;11																
PCC	Irish norms: DEAP	98-100	97	96	95	94	92-93	90-91	89	87-88	82-86	78-81	73-77	70-72	68-69	0-67
	Norms: This study						90-98	86-89	82-85	77-81	73-76	69-72	64-68	59-63	56-58	0-55

Scaled Score		17	16	15	14	13	12	11	10	9	8	7	6	5	4	3
Age Group 4;00-4;05																
PCC	Irish norms: DEAP					100	98-99	97	92-96	88-91	85-87	81-84	77-80	73-76	69-72	0-68
	Norms: This study						94-99	92-93	89-91	86-88	83-85	81-82	77-80	74-76	72-73	0-71
Age Group 4;06-4;11																
PCC	Irish norms: DEAP					100	99	97-98	93-96	91-92	88-90	85-87	82-84	81	78-80	0-77
	Norms: This study						95-100	93-94	91-92	88-90	85-87	83-84	80-82	77-79	75-76	0-74

Scaled Score		17	16	15	14	13	12	11	10	9	8	7	6	5	4	3
Age Group 5;00-5;05																
PCC	Irish norms: DEAP					100	99	97-98	94-96	92-93	90-91	86-89	83-85	81-82	80	0-79
	Norms: This study						98-100	97	95-96	93-94	92	91	89-90	87-88	86	0-85

Table 4: *Mean PCC and SD by age group*

The mean scores and standard deviations of each age group for each measure are presented in table 4. No significant difference on any measure in Kruskal Wallis analysis was reported.

Age Group	N	Mean	Std. Deviation
Whole Group	56	90.78	9.3337
3:00-3:05	8	88.35	10.2175
3:06-3:11	10	84.83	12.9873
4:00-4:05	11	90.791	8.6091
4:06-4:11	15	92.26	7.9775
5:00-5:05	12	95.5	4.3599

Table 5: *Mean PCC and Standard deviation of each age group by gender*

The mean scores and standard deviations of the participants by gender are presented in table 5. No significant difference on any measure in Kruskal Wallis analysis was reported.

Age Group	Gender	N	Mean	Std. Deviation
3:00-3:05	Male	3	83.267	4.6307
	Female	5	91.4	11.8729
3:06-3:11	Male	5	83.9	15.0592
	Female	5	85.76	12.2704
4:00-4:05	Male	4	93.95	5.8358
	Female	7	88.986	9.8002
4:06-4:11	Male	3	92.533	8.4949
	Female	12	92.192	8.2371
5:00-5:05	Male	7	95.529	5.1765
	Female	5	95.46	3.4753

PCC of each age group by DEIS in years

As the distribution of children from DEIS schools was uneven across six month age groups, analysis of differences by SES was done across year groups, as this provided a more even distribution. In the age group 3, there were 13 DEIS children, in the age group 4 there were 9 DEIS children and in the age group 5 there were no DEIS children. No significant difference on any measure in Kruskal Wallis analysis was reported.

Age of Acquisition of phonemes by 90% of children

Table 6 presents the phonemic inventory for each child within each age group. The normal age of acquisition of a phoneme was considered to be the age at which the phoneme was included in the phonemic inventory of 90% of children at that age. Acquisition of a phoneme is defined as two occurrences of the phoneme in the correct position anywhere in the sample. For practicality, the data is presented in the original 6 month age groups.

Variability in production of phonemes

The following data showed reversals in production of particular phonemes which can imply phonological regression or sampling error according to Smit *et al.* (1990);

- Nasal /ŋ/ was acquired by the age group 3;06-3;11 however absent from age group 4;00-4;05
- Affricates /tʃ/ and /dʒ/ were acquired by the age group 4;00-4;05 however absent from the age group 4;06-4;11

Table 6: *Age of Acquisition of phonemes by 90% of children*

Age		Present	Absent
3;00-3;05	Plosive	P, b, t, d, k, g	
	Nasal	m, n	Nasal ŋ
	Fricative	f, h,	Fricative v, s, z,ʃ,θ,ð Affricate tʃ, dʒ
	Approximate	w, l,	Approximate ɹ
3;06-3;11	Nasal	ŋ	Fricative v, s, z,ʃ,θ,ð Affricate tʃ, dʒ Approximate ɹ
4;00-4;05	Fricative	ʃ	Nasal ŋ Fricative v, s, z,θ,ð Approximate ɹ
	Affricates	tʃ, dʒ	
4;06-4;11	Nasal	ŋ	
	Fricatives	v, s	Fricative z, θ,ð
	Approximate	ɹ	Affricate tʃ, dʒ
5;00-5;05	Affricates	tʃ, dʒ	Fricatives z, θ,ð

Comparison of age of acquisition of phonemes between the DEAP and local norms

Table 7 presents the differences in age of acquisition of the Irish DEAP and the local norms. Various phonemes were acquired earlier in the local norms in comparison to the DEAP norms; /ɹ/ was acquired at 4;06-4;11 however not until 5;00-5;05 in the DEAP norms, /k/ was acquired at 3;00-3;05 however not until 3;06-3;11 in the DEAP norms, /tʃ/ was acquired at 4;00-4;11 however not until 5;00 in the DEAP norms.

Various phonemes were acquired later in the local norms in comparison to the Irish DEAP norms; /ŋ/ was acquired at 3;00-3;05 in the DEAP norms however not until 3;06-3;11 in the local norms, /s/ was acquired at 3;00-3;05 in the DEAP norms however not until 4;06-4;11 in the local norms, /v/ was acquired at 3;00-3;05 in the DEAP norms however not until 4;06-4;11 in the local norms.

Table 7: *Comparison of age of acquisition of phonemes between the DEAP and local norms*

Age	Present DEAP	Present Local	Absent DEAP	Absent Local
3;00-3;05	p, b, t, d, g, m, ŋ, f, v, s, z, h, w, l,	p, b, t, d, k, g, m, f, h, w, l	θ,ð, ʃ, tʃ, dʒ,k, ɹ	θ,ð,ŋ, v, s, z, ʃ, tʃ, dʒ, ɹ
3;06-3;11	k, dʒ	ŋ	θ,ð, ʃ, ɹ	θ,ð, v, s, z, ʃ, tʃ, dʒ, ɹ
4;00-4;05	ʃ	ʃ, tʃ, dʒ	θ,ð, ɹ	ŋ, v, s, z, θ,ð, ɹ
4;06-4;11		ŋ[1], v, s, ɹ	θ,ð, ɹ	z, θ, ð, tʃ,dʒ
5;00-5;05	tʃ, ɹ	tʃ, dʒ[2]	θ,ð	z, θ, ð

[1] This phoneme was acquired at age 3;00-3;05 but absent from age4;00-4;05
[2] These phonemes were acquired at age 4;00 -4;05 but absent from age 4;06-4;11

Table 8: *Age of suppression of developmental error patterns*

Table 8 presents the phonological error patterns[3] that occurred regularly in the sample. More than 10% of children in each age group were required to exhibit the error pattern on at least 5 occasions (twice for weak syllable deletion). In comparison to the development of error patterns in the Irish DEAP, the local norms differ on various error patterns; gliding in the local norms was present up until age group 4;06-4;11 and up until age group 5;06-5;11 in the Irish DEAP norms. Cluster reduction was present up until age group 3;06-3;11 in the local norms and present until 4;06-4;11 in the Irish DEAP norms. WSD and fronting were present for both the Irish DEAP and the local norms until age group 3;06-3;11. Stopping and deaffrication were present in the local norms up to the age group 3;06-3;11 and were not present in the Irish DEAP.

Age group	Gliding	Cluster reduction	Fronting[4]	WSD[5]	Stopping	Deaffrication	Voicing
3;00-3;05	X	X	X[6]				
3;06-3;11	X	X	X[7]	X	X	X	
4;00-4;05	X						
4;06-4;11	X						
5;00-5;05							

[3] Refer to appendix 1 for an outline of developmental error patterns
[4] Includes fricative and velar fronting
[5] X represents the presence of the error pattern in that age group
[6] Velar fronting only
[7] Velar fronting only

Use of non-developmental error patterns

14 children from the sample were using non-developmental error patterns[8]; 1 child used initial consonant deletion, 5 children used affrication and 8 children used backing. However not all of them fit the criteria for a diagnosis of SSD. 4 of these children had PCC's which were within normal limits and were considered to have normal phonological development as outlined in Roberts *et al.* (1990).

[8] Refer to appendix 1 for an outline of non-developmental error patterns

Common distortion of alveolar fricative

Percentage of all children using dentalised fricative with a distributed air flow for /s, z/ (lisp). 37.5% of children were lisping /s/ and 21.4% children were lisping /z/. A large section of the sample substituted /z=s/ and /z/ with a dentalised fricative with distributed air flow.

For /z/ this was 12.5 per cent of children aged 3;00 to 3;05, 30% of those aged 3;06-3;11, 27.3% of those aged 4;00-4;05, 13.3% of those aged 4;06-4;11 and 25.0% of those aged between 5;00-5;05. The lower age group is low due to stopping of /s/ previously.

For /s/ this was 12.5 per cent of children aged 3; 00 to 3; 05, 50% of those aged 3;06-3;11, 36.4% of those aged 4;00-4;05, 40.0% of those aged 4;06-4;11 and 41.7% of those aged between 5;00-5;05.

Use of dialectal features

Percentage of all children using stopping of dentalised fricative /θ/ *and /ð/.*

33% of children were stopping /θ/ and 20% of children were stopping /ð/.

For /θ/ this was 62.5 % of children aged 3;00 to 3;05, 70% of those aged 3;06-3;11, 63.6% of those aged 4;00-4;05, 53.3% of those aged 4;06-4;11 and 50.0% of those aged between 5;00 -5;05.

For /ð/ this was 37.5 % of children aged 3;00 to 3;05, 40% of those aged 3;06-3;11, 27.3% of those aged 4;00-4;05, 40.0% of those aged 4;06-4;11 and 33.3% of those aged between 5;00 -5;05.

Percentage of all children using rhotacisation of post-vocalic /ɹ/

83.9% of all children were rhotacising /ɹ/ post-vocalically. This was 75 % of children aged 3;00 to 3;05, 80% of those aged 3;06-3;11, 81.8% of those aged 4;00-4;05, 86.7% of those aged 4;06-4;11 and 91.7% of those aged between 5;00 -5;05.

Discussion

The speech samples of 56 Irish English-speaking children were collected and analysed to gain normative data. These children were aged between 3;00 and 5;11 years old. Various elements of speech sound development were investigated; the developmental path of PCC, the phonemic acquisition of sounds (the age at which children acquired speech sounds) and the age at which children presented with error patterns. Dialect was also examined.

It was anticipated that phonological abilities mature with age and this proved to be correct. Gender was predicted to have an effect on speech sound development. It was anticipated that girls would have higher PCC than boys however no significant difference was found. Socio-economic status (SES) was predicted to impact on speech sound development with children from lower SES expected to have inferior phonological abilities in comparison with children from higher SES. A significant difference in the age range 4; 06-4; 11 between the DEAP PCC scores and this study was found. This signifies that PCC in the Irish DEAP for that age group was invalid for this study, however due to the small sample size; the DEAP can be considered a valid tool to be used in local clinical settings. The impact of SSD, age, gender and SES on speech sound development will be discussed individually.

Age

Phonological skills mature with age; children produce more accurate speech and fewer error patterns (Dodd *et al*. 2003). Investigating performance in six monthly age groups presented a stable progression of speech sound accuracy.

Variability in production was found with this sample, where some phonemes were acquired by younger but not older children. As discussed in Smit *et al.* (1990), this reversal is difficult to account for as it implies that children display phonological regression at substantially older ages than stated previously. A proposed explanation is that it is due to either group variation or sampling error. In these data, group-to-group variation occurred for a number of sounds; nasal /ŋ/ and affricates /tʃ/ and /dʒ/.

The age and order of phoneme acquisition was different in this study in comparison to the Irish DEAP. This could be accounted for because of the small sample size or because of the variation within age groups of this study.

Gender

This study discovered that gender had no overall impact on speech accuracy. Research suggests that gender tends to impact on speech sound acquisition after the age of 5;06 and that girls acquire sounds a year sooner than boys (Dodd *et al.* 2003). If this is the case, then it would account for the lack of gender division in this study, as the highest age group was 5;00-5;05. More up-to-date research suggests variability in acquisition patterns between gender and age and report differences in age ranges 4;00, 4;06 and 6;00 years (Smit et al. 1990). One possible explanation for the lack of significant gender difference in this study is the small sample size. A further large scale study might provide results more in line with gender norms.

Socio-economic status

Socio-economic status did not have an impact on phonological accuracy of any age group. In the age of acquisition of speech sounds, Smit *et al*. (1990) reported no link between SES and acquisition of sounds. Research indicates that SES can impact on other areas of language such as vocabulary (Bates *et al*.1994). Elements that may be associated with low SES are reduced quality of linguistic exposure, decreased experience of reading books and reduced interpersonal communication. According to Bishop, as cited in Dodd *et al.* (2003), the link between speech and language impairment and SES is negligible. It is considered to be more probable that a combination of elements add to speech and language deficits.

Speech sound disorders

This study attempted to eliminate children with SSD from participating in the assessment. It was stated as part of the exclusionary criteria that children with previous speech and language therapy concerns could not participate. However, of the 56 participants, 10 were reported to have a SSD.

It was noted that 4 children in the study displayed unusual processes however did not fit the profile of SSD as their PCC was within normal limits. This indicates that there is a clear requirement for further research into the use of unusual error patterns by children. Previous studies have predominantly looked at the occurrence of common phonological processes and neglected to look at the use of unusual error patterns (Roberts *et al*. 1990). Some

researchers account for this by suggesting that these unusual processes are also displayed by children who are considered to have normal phonological development. An alternate suggestion could be that all children use these unusual processes during their development but that they persist in children with SSD (Roberts *et al*. 1990).

Dialect

In this study, the majority of children were using some form of dialectal variation. These features are normal for the Limerick dialect and consequently were not counted as errors when calculating PCC or processes.

- Stopping of dentalised fricative /ð/→[d]
- Stopping of dentalised fricative /θ/→[t]
- Rhotacisation of post-vocalic /ɹ/

It may not be entirely representative of different dialects to use normative data, in spite of some clinical benefit to using it. Dialects can use a wide variety of language; therefore a child's linguistic ability may not be represented in formalised assessment. This is especially important in assessment of younger children given that current research dictates best practice to be early intervention. To date, research on dialects has focused exclusively on the differences between it and more frequently spoken dialects. In the case of this study, standard scores were representative a child's ability as dialectal features were considered when analysing assessments. In the case they were not taken into account, overall scores are shown to be lower and a false diagnosis may be identified.

Conclusion and recommendations

As no significant difference between the DEAP PCC scores and this study were found, the DEAP can be considered a valid tool to be used in local clinical settings.

Limitations to the study include; the small sample size and participants from DEIS schools (low SES) were not evenly distributed among age groups.

Further research should entail a larger sample size and contain children with speech sound difficulties, in order to be representative of the population. There is a strong requirement for studies that examine the usage of unusual phonological processes by children whose speech is considered to be normally developing.

Validity is the degree to which a test measures what it is invented to measure. It would be useful to assess concurrent validity with another reliable assessment.

Clinical Implications

The DEAP is a reliable speech assessment and allowances for SES should not be made in clinical assessment of local children.

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Appendix 1

Definitions of developmental error patterns

Error Pattern	Explanation	Example
Gliding of liquids	The liquid consonants /l/ and /ɹ/ are substituted by glides [w] or[j]. In this example, the /ɹ/ in /ɹabit/ is replaced by [w].	/ɹabit/→[wabit]
Velar Fronting	A velar consonant, Is substituted by a consonant produced at the front of the mouth. /k/ is replaced by [t], /g/ is replaced by [d], and /ŋ/ is replaced by [n].	/ɛg/→[ɛd]
Palatal Fronting	The fricative consonants /ʃ/ and /ʒ/ are substituted by fricatives that are made further forward on the palate. /ʃ/ is replaced by [s] and /ʒ/ is replaced by [z].	/ʃip/→[sip]
Cluster reduction	One part of a consonant cluster is deleted.	/spaɪdə/→ [paɪdə]
Weak syllable deletion	An unstressed syllable is deleted	/ʌm'bɹɛlə/→[bɹɛlə]
Stopping of fricatives and affricates	A fricative consonant -/f/, /v/, /s/, /z/, /ʃ/, /ʒ/, /θ/, /ð/ or /h/- or an affricate consonant /tʃ/ or /dʒ/ is replaced by a stop – [p], [b], [t], [d], [k] or [g].	/van/→[ban] /dʒam/→[dam]
Prevocalic voicing and postvocalic devoicing	A voiceless sound is replaced by a voiced sound -/p/→[b] A voiced sound is replaced by a voiceless sound -/g/→[k]	/pɹam/→[bam] /pɪg/→[pɪk]
Deaffrication	An affricate is replaced by a fricative-/ tʃ/→[ʃ] or /dʒ/→[dz]	/wɒtʃ/→[wɒʃ] /bɹɪdʒ/→[bɹɪdz]

(Bowen 1998; Dodd *et al.* 2003)

Definitions of non-developmental error patterns

Error Pattern	Explanation	Example
Initial consonant deletion	Deletion of a word-initial consonant	/lɛg/→[ɛg]
Medial consonant deletion	Deletion of a word-medial consonant	/fɛðə/→[fɛhə]
Backing	A front sound is substituted by a sound produced at the back of the mouth-/t/ is replaced by [k], /d/ is replaced by [g], /s/ is replaced by [ʃ]	/dɒg/→[gɒg]
Affrication	Stops are replaced with fricatives or affricates-/t/ is replaced by [s], /d/ is replaced by [dʒ]	/dɒg/→[dʒɒg]
Intrusive consonant	An extra consonant is inserted before another consonant	/dʌk/→[dʌŋk]

(Bowen 1998; Dodd *et al.* 2003)