Research Report

Identification of phonological processes in preschool children's single word productions

Key words: phonology, speech development, preschool, typical development

Structured abstract

Background

Speech and language therapists (SLTs) often refer to phonological data norms as part of their assessment protocols in evaluating the communication skills of the pre-school child. There is a variety of norms available and although broadly similar, differences are embedded within their definitions of mastery of the adult target system.

Aims

The aim of the study was to compare phonological processes present in the single word productions of 94 West of Scotland preschool children with published normative data relating to typical ages of elimination of phonological processes.

Methods and Procedures

The 94 children, grouped into four 6-month age bands from 3.1 to 4.11 years, named 78 pictures. Their responses were broadly transcribed and then analysed for phonological processes.

Outcomes and Results

Presence of velar fronting, stopping of affricates and [s] reduction in the dataset was found to mirror previous research. However, there was a lower than expected incidence by age groups of palato-alveolar fronting, stopping of fricatives and obstruent cluster reduction.

Conclusions and Implications

SLTs frequently rely on phonological normative data as part of their assessment and management of children with speech delay. Evidence from children recruited from typical mainstream nursery classes indicates that there are distinct differences between what would be expected of them with reference to normative data for some phonological processes and what they produce. U.K. Clinical guidelines (RCSLT, 2005) recommend consideration of both acquisition of phonemes and presence of phonological processes when assessing and planning intervention. However, differences in development and occurrence within processes in relation to phonological development may have implications for clinicians' decision-making. Further research is proposed in relation to the extent to which phonological norms contribute to such clinical decision-making.

What is already known on this subject

English speaking children tend to acquire speech sounds according to a well researched and published sequence in terms of phonetic and phonological development. Within these datasets, typical patterns exist that are used to assist the SLT to distinguish between those children who are developing speech typically, and those who are not. SLTs use normative guidelines to assist their clinical decision making, taking into account other areas including impact, environment and communicative intent for example.

What this study adds

Differences were identified within the cohort studied for three categories of processes (fronting, stopping and cluster reduction) when compared to current normative guidelines. The study illustrates the complexities involved in making comparisons to the available normative data.

Background

Speech and language therapists (SLTs) rely on phonological data norms in assessing and diagnosing children's speech and in choosing intervention targets. Since the 1970s, the contribution of linguistic knowledge has been fundamental in shaping the profession's understanding of the typical rules associated with normal speech development (Ingram, 1976; Grunwell, 1981). Normative data have been presented as phonological processes derived from single word productions (Grunwell, 1981, 1985, 1987) and speech sound acquisition guidelines derived from connected speech samples (Shriberg, 1993). These various datasets have been used to analyse speech development and contribute to individual case management.

Phonological processes or phonological patterns are descriptions of the predictable simplified productions typically found in young children's speech when they are learning to talk. Phonological processes fall into two categories; substitution processes where sounds are replaced and syllable structure processes where the structure of the syllable changes via the inclusion or exclusion of sounds (Ingram, 1976). The presence of persisting processes beyond the ages at which they are thought to resolve may signal speech delay. Other error-types such as backing, initial consonant deletion, vowel distortions or atypical substitutions may indicate disordered or deviant development (Dodd, 2005).

In analysing children's phonology, both independent and relational analyses should be carried out on single word and conversational speech samples (Stoel- Gammon, 1988). An independent analysis provides an account of a child's consonant and vowel inventories, syllable shapes and syllable stress patterns. Relational analysis provides a

comparison between a child's system and an idealised version of the adult target phonology using percentage of consonants correct (PCC), and phonological process analysis (Williams, 2003). The main purpose of analysis in assessment is to evaluate how severe any delay is in the child. There are a number of clinical protocols available to help clinicians establish whether a delay exists including for example, Phonological Assessment of Child Speech (PACS) (Grunwell, 1985), Diagnostic Evaluation of Articulation and Phonology (DEAP) (Dodd, Hua, Crosbie, Holm and Ozanne, 2002) and Percentage of Consonants Correct- Revised (PCC-R) (Shriberg, Austin, Lewis and McSweeny 1997). Children's speech is analysed extensively in research through single word, connected speech and conversational speech samples. However clinicians in the UK usually evaluate children's speech using published assessments that are designed to provide a single word sample (Joffe and Pring, 2008).

Presence of phonological processes and phonetic errors are only two of many factors to be considered in decisions about therapy (Powell, 1991). A number of authors have provided guidance on commonly occurring phonological processes and the ages at which these typically resolve (Grunwell, 1985, 1987; Roberts Burchinal and Footo, 1990; Dodd, Holm, Hua and Crosbie, 2003). Speech sound acquisition has also been studied in relation to the age at which sounds are mastered in typical development (Prather, Hendrick and Kern, 1975; Ingram, 1989; Smit, 1986; Shriberg and Kwiatkowski, 1994).

The Metaphon Resource Pack (MRP) (Dean, Howell, Hill & Waters 1990) contains a Screening Assessment that includes 29 pictures from which 44 monosyllabic words

are elicited. It has been designed to provide opportunities to identify several phonological processes in a short timeframe (15-25 minutes). A further 25 pictures of 26 polysyllabic words are available to the assessor to supplement monosyllabic data. The MRP includes analysis sheets to aid identification of phonological processes in elicited samples. However, not all the error types listed can be classified as phonological processes; for example, fricative simplification [Θ] → [f].

Further assessment using Process-Specific Probes is recommended within the MRP to supplement information from the Screening Assessment. These Process-Specific Probes contain additional pictures to supplement description and analysis of phonological processes. The Process-Specific Probes are designed to be used to establish baseline productions for comparison following a period of intervention (Dean et al. 1990).

The present investigators were given permission from the original authors to update picture stimuli from the original Metaphon Screening Assessment (Dean ,2006, personal correspondence) as the pictorial stimuli were developed over 20 years ago. The investigators set out to evaluate whether a new set of pictures could be used to provide a spontaneous single word sample, avoiding the need to cue, prompt or ask children to imitate words. In undertaking pilot testing of the new picture pack with children, we analysed the children's phonological processes as presented within the single word data.

SLTs define phonological delay with reference to the presence of phonological processes that would be seen in younger children (Joffe and Pring, 2008). They base

their assessments on screening tools such as STAP (Armstrong and Ainley, 1988) which provide single word samples (Joffe and Pring, 2008). When analysing single word samples, SLTs refer to a variety of published data sources (e.g. Grunwell 1985, 1987, Dodd et al. 2003) to make comparisons, with differences in the size and composition of the datasets making cross study comparisons rather difficult.

For example, one of the difficulties in relating the data to clinical decisions with confidence has been that some original samples were small. Grunwell's summary of phonological processes in the PACS Developmental Assessment (Grunwell, 1985) has been a reference point for clinicians since it was published. The data studies on which it appears to be based were Ingram's work (1976): a collection of case studies, and Anthony et al.'s (1971) sample of 187 children.

Other authors (e.g. Howell & Dean, 1994; Bowen, 1998) have cited Grunwell's norms (1981, 1985, 1987, 1997) in their discussion of phonological processes. However the same norms have been interpreted in different ways resulting in SLTs accessing different interpretations of what is essentially the same data. For example, consonant harmony could be expected to be eliminated before the age of 3 years (Grunwell, 1987, 1997) or by approximately 4 years (Bowen, 2009 citing Grunwell, 1987).

In a more recent study, Dodd et al. (2003) collected phonological data from a large national sample of 684 English-speaking children in the UK. The sample included children who had speech and language difficulties and was therefore more likely to be representative of the general population. By including children with speech and language difficulties, the data generated could be expected to include some examples

of higher ages for suppression of phonological processes than Grunwell's normative data cited above. McLeod and Bliele (2003) have reviewed and summarised data for phonological development for English speaking children from a number of studies including Grunwell (1981, 1987) and Dodd (1995).

A second problem for clinicians in applying normative data has been the way that some data have been presented. For example, speech sound acquisition charts are susceptible to misinterpretation if they are presented as graphs indicating changes over time. As Lof (2004) notes, Sander's 1972 norms for speech sound acquisition may be read by clinicians as developmental progressions, when the data actually demonstrate production mastery from 50% to 90%. Prather et al. (1975) show their data for phonetic mastery in a similar way.

The third area of difference is how different studies combined or separated data ranges within phonological processes. For example, Roberts et al. (1990) and Dodd et al. (2003) included both velar and palato-alveolar fronting in the same data set ("fronting"). However, velar fronting and palato-alveolar fronting were considered separately by Grunwell (1987). Similarly, Roberts et al. (1990) and Dodd et al. (2003) included stopping of fricatives and affricates in one data set ("stopping") where other authors separated them (e.g. Grunwell 1987). Cluster reduction was reported as combined data by Dodd et al. (2003), but distinction was made between [s] cluster combinations and obstruent + approximant cluster combinations by Grunwell (1987). Table 1 illustrates the differences between these two widely referenced datasets.

< insert Table 1 about here>

The effect of combining phonological processes into an age related "age of process elimination" may affect clinical decisions. For example, where a child aged 4;5 presents with cluster reduction a clinical decision based upon Dodd et al. (2003) may be to "watch and wait" (see Table 1). Another clinician may decide to intervene, as the PACs developmental assessment (Grunwell, 1985) indicates that cluster reduction is eliminated by around 3;0 to 3;6. Mastery of cluster productions is considered to be complex in nature (McLeod, Van Doorn and Reed, 2001) and distinction may be made between clusters that begin with an obstruent and those that do not. In this context it may be important to decide which clusters to target first.

Aims

The aim of the study was to compare the phonological processes present in the single word productions of 94 West of Scotland preschool children with published normative data relating to typical ages of elimination of phonological processes.

Methods & Procedures

Participants

94 children between 3;1 and 4;11 years old from three local authority nursery schools provided the speech data presented in this paper. The local authority is the 8th [out of 32] most deprived in Scotland (Renfrewshire Council, 2008) and the three nurseries were located in an area of mixed private and rented housing. Specific information regarding socio-economic status was not gathered from the participating families at the time of recruitment to the study. As this was the case, the original sample was entirely inclusive. There were two children for whom speech and language therapy

services were already involved and one further child who was referred for speech and language therapy assessment as a result of participating in the study. Table 2 indicates the number of children in each of four 6-month age ranges who were recruited to the study.

< insert Table 2 about here>

Ethical considerations

Ethical permission had been granted by the local authority education department to invite parents of children in its nursery schools to consent to their children participating in the study. Informed consent was granted by parents. Children gave assent to participate on the day the recording was made using an age appropriate form. Both procedures had been approved by the local authority and University ethics committee.

Stimuli

The original items from the Metaphon Screening Assessment were modified and extended to include a range of phonemes in different word positions in 78 monosyllabic and polysyllabic words. The word list (see Appendix) was constructed to contain at least 5 examples of each of the 13 processes considered in the original assessment. A speech and language therapist who was experienced in eliciting data from children through drawings prepared 30 hand drawn colour pictures to illustrate the target words. The pictures were presented in a ring-binder to allow children to turn each page themselves and thus maintain interest.

Procedures

A record form was produced showing the target words that corresponded with each picture, with space for phonetic transcription of the child's production and additional coding to indicate whether or not the child produced the target word with prompting (Pr) or by imitation (I).

A quiet room was made available in the nursery schools where each child was able to work through the stimuli individually without distraction. A Sanyo TRC-2050C audio tape recorder was used to record individual productions in the event that on-line phonetic transcription was too distracting. Each sample was transcribed live and then checked against the recording to ensure intra-observer accuracy. Thirty percent of the sample was randomly chosen for re-transcription by the authors from the tape-recordings and inter-observer agreement on broad phonemic transcription was calculated using Cohen's kappa (Cohen, 1960). Agreement of > 0.90 was found between transcriptions indicating excellent agreement (Fleiss, 1981 as cited in Robson, 1993).

In all cases, the children were asked to name the pictures by a speech and language therapist. Suitable encouragement and positive feedback such as praise and stickers were made available to maintain the children's enthusiasm.

Analysis

The children's responses were analysed for phonological processes. A phonological process was considered to be present if it appeared 5 times in a child's single word sample to enable direct comparison with Dodd et al (2003). Presence of an age

appropriate phonological process in each age group was defined where more than 10% of the children in an age band used that process, following Dodd et al.'s (2003) criteria.

For each age range, the number of children who used an error pattern in each of the relevant target words was evaluated and a percentage calculated. All the data were rechecked against the original transcriptions by each author (i.e. on two occasions) to ensure accuracy. Where a child did not produce the target word this was coded as missing data and not included in subsequent analyses.

Three children within the dataset had some involvement with speech and language therapy services before or as a result of the study. These children had error patterns that fell within Dodd's category of consistent non-developmental phonological disorder (Dodd, 2005). Their speech was characterised by non-developmental processes including backing and initial consonant deletion, and by atypical substitutions and vowel distortions. Their data were removed from subsequent analyses.

Results

Table 3 shows the age at which the remaining children (n = 91) in the sample met the criterion for presence of phonological processes as sampled by the revised pictures following the original MRP Screening Assessment.

<insert Table 3 about here>

The presence of 7 phonological processes is similar to those from Grunwell (1987) and Dodd et al. (2003). However, differences were found to occur for three processes; stopping (e.g. between stopping of fricatives and stopping of affricates), fronting (e.g. between fronting velars and fronting palato-alveolars) and within the cluster reduction process (e.g. between [s] cluster reduction and obstruent-cluster reduction), and these are reported below. In the charts that follow, comparison is made between Grunwell's (1987) expected age at which a phonological process is eliminated in typical development and that of Dodd et al. (2003) in relation to the findings from the reported investigation.

< insert Figure 1 about here>

Stopping of fricatives was present in none of the children in the sample which was considerably earlier than 3;6-3;11 (Dodd et al 2003) and 4;0-4;6 (Grunwell, 1987). By contrast although stopping of affricates decreased in occurrence from age 3;0, this process continued to be present in around 10% of children from 3;6.

< insert Figure 2 about here>

Palato-alveolar fronting was present in less than 10% of the children from the age of 3;0 which is considerably earlier than the suggested age of 4;0 – 4;6 (Dodd et al. 2003) and 4;6 from Grunwell (1987). Velar fronting was present in less than 10% of children from around 3;6 (somewhere between 3;0 – 3;6 (Grunwell, 1987) and 4;0-4;6 (Dodd et al. 2003).

< insert Figure 3 about here>

Reduction of obstruent + approximant clusters was present in less than 10% of children from around 3;10, similar to the range of 3;6-3;11 (Grunwell, 1987) but earlier than 4;6-4;11 (Dodd et al. 2003). Reduction of [s] clusters continued to be present in more than 10% of the children in this sample until the age of around 4;2 which was slightly later than the obstruent + approximant clusters but earlier than the combined data of Dodd et al. (2003).

Discussion and Implications

Analysis of the data gathered illustrates some of the complexities that exist in interpreting normative data that have been highlighted above. Problems arise in identifying whether a phonological process could be expected to be present where there are two distinct patterns in the normative data, especially where the two are rather disparate. Although both Dodd et al. (2003) and Grunwell (1987) suggest that a 6 month period is acceptable to account for individual differences in development, larger differences between the norms may affect management decisions. By combining two similar processes into one category some clinically relevant information may be lost. For example, clinicians may want to consider whether a child aged 3;6 is stopping fricatives or affricates to inform their intervention planning.

The presence of phonological processes beyond expected developmental norm ages is only one factor in assessment and diagnostic decisions. Clinicians may be more concerned about how patterns of phonological delay or disorder impact on intelligibility when deciding whether or not to intervene.

Caution must be exercised when interpreting findings from a relatively small group of participants using single word data. A further limitation of the study was that there were fewer children in the youngest age group sampled but it could be argued that this group is least likely to be offered intervention for speech delay.

Comparison of existing norms and data generated from the study showed differences in the age at which three commonly occurring phonological processes would no longer be expected to be present in most children's speech. There may be specific advantage when planning intervention in considering some phonological processes in more detail: for example separating stopping fricatives from stopping affricates, separating fronting velars from fronting palato-alveolars, and the different cluster combinations.

Clinicians decide on the extent to which a child's speech patterns are distinguishable, or otherwise, from what would typically be expected for his or her age using screening tools such as the type in this study. A screening tool is a valuable element in assessment if it enables clinicians to distinguish between common phonological processes and to identify those children for whom further investigation is warranted. Reference is also made to normative data in relation to intervention planning.

The target words that were used within this study were devised in order to revise the Metaphon Screening assessment (Dean et al. 1990). Further exploration of the phenomena found within this sample could be tested with a larger pool of target words designed to test the various phonological processes highlighted here.

Connected speech sampling would provide further data on phonological process development in a longitudinal study.

The findings from this small scale study are most relevant in relation to clinical decision making. RCSLT Clinical guidelines point out that therapists need to consider the state of the development of the child's speech in relation to phonological processes (RCSLT, 2005). Thus for an individual child, full evaluation of the child's communication skills is required. Decision making will depend on other factors including skills, impact, opportunities and support. The evidence presented within this paper in relation to phonological processes is therefore only one part of the decision making process. Published norms have been based on small data sets or use varying criteria to differentiate phonological processes. How norms might be interpreted by clinicians could vary considerably which may be an area for future research.

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Appendix

Revised Metaphon Screening Assessment word list

cup	thumb	bread	towel
spoon	finger	house	cat
green	watch	door	sleeping
red	ring	window	chair
go	foot	chimney	chips
stop	toe	smoke	sausage
knife	snake	garden	salt
fish	van	path	crab
kiss	fast	tree	spider
glasses	girl	car	legs
flower	stairs	bridge	jacket
butterfly	yellow	train	zip
nose	blue	digger	badge
mouth	big	sheep	letter
rabbit	washing	plane	stamp
carrots	sock	sky	scissors
seven	trousers	sun	umbrella
teeth	pyjamas	cloud	elephant
leaf	shirt	bath	
hand	jam	splash	

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Table 1. Comparison of phonological process ages of suppression data (Dodd et al 2003 and Grunwell 1987)

	AGE RANGE	2;0–2;5	2;6-2;11	3;0–3;5	3;6-3;11	4;0-4;5	4;6-4;11	5;0 +
Author	**Phonological Process**							
Dodd et al (2003)	Fronting							
Grunwell (1985)	Velar fronting							
	Palato-alveolar fronting							
Dodd et al (2003)	Stopping							
Grunwell (1985)	Stopping fricatives							
	Stopping affricates							
Dodd et al (2003)	Cluster reduction							
Grunwell (1985)	Cluster reduction							

Table 2. Number of participants in each 6-month age range by gender

6-month age range	♀	♂
3;00 - 3;05	4	7
3;06 - 3;11	16	11
4;00 - 4;05	14	11
4;06 - 4;11	19	12

Table 3. Age at which each error pattern was found to be present in more than 10% of the children in the sample

Process	3;0-3;5	3;6-3;11	4;0-4;5	4;6-4;11
Context sensitive voicing				
Weak syllable deletion				
Initial consonant deletion				
Final consonant deletion				
Consonant harmony				
Palato-alveolar fronting				
Velar fronting				
Devoicing				
Stopping of fricatives				
Obstruent + approximant cluster reduction				
/s/ cluster reduction				
Stopping of affricates *				
Gliding				
/❄/ to /↗/				
* Note that for stopping of affricates 8% of children aged 4;0-4;5 presented with this process while 12.9% of children aged 4;6-4;11 presenting a nonlinear progression in this cross sectional data				

Figure 1. Occurrence of stopping of fricatives and stopping of affricates

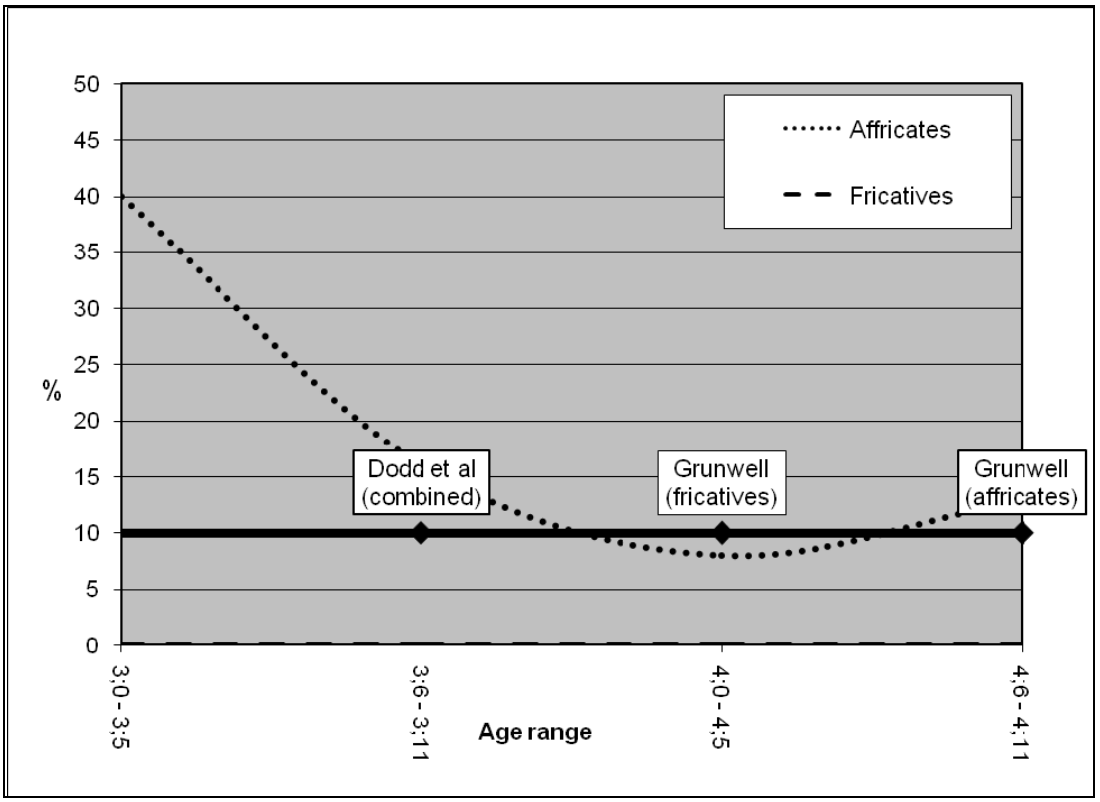

Figure 2 Occurrence of fronting of velars and fronting of palato- alveolars.

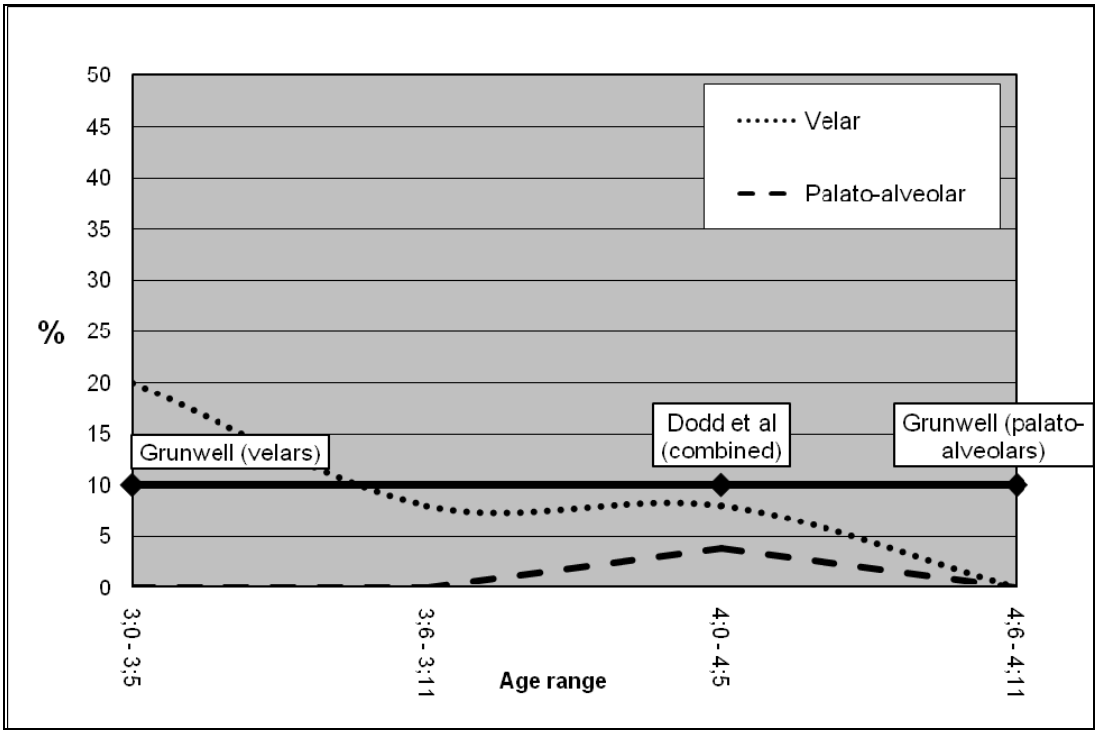

Figure 3 Occurrence of [s] cluster reduction and obstruent + approximant cluster reduction