A PHONETIC AND PHONOLOGICAL STUDY OF SO-CALLED 'BUCCAL' SPEECH PRODUCED BY TWO LONG-TERM TRACHEOSTOMISED CHILDREN

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ABSTRACT

Speech spontaneously developed by two long-term tracheostomised children has been clinically designated as 'buccal'. Analysis reveals speaker-specific, non-buccal strategies for setting air in motion, for generating a source of sound to replace normal voice, and for articulating vowels and consonants. The implications for communicating phonological contrasts are discussed.

Keywords: tracheostomy, buccal speech, speech acquisition, pharyngeal speech, pseudo-voice

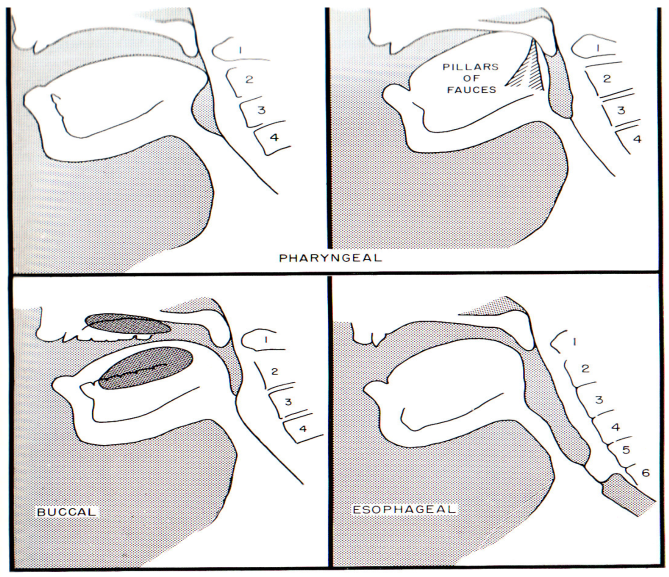
1. INTRODUCTION

There are few published studies reporting on the use of 'buccal' speech by children. The term is used to cover various rare pseudo-voice mechanisms that may be developed spontaneously by children with long-term tracheostomies who cannot use the larynx as a source of sound on the pulmonic airstream. The population of such children has been very small, though recent advances in medicine have resulted in more children surviving with tracheostomies in situ for prolonged periods. Most children with long-term tracheostomies do not need to use pseudo-voice (speech produced by residual anatomical structures that continue to function after tracheostomy) to communicate; rather, they achieve air leak around their tubes, either spontaneously, with manual occlusion, or using speaking valves, to re-direct the flow through the larynx and enable phonation to take place. Consequently little is known about the characteristics of the rare pseudo-voices and studies disagree about the mechanisms involved. Even less attention has been given to the phonetic properties of these pseudo-voices, to their potential for communicating phonological contrasts, and to speech acquisition in children limited to these forms of speech production. This poses a challenge to Speech and Language Therapists (SLTs) who are expected to make a number of important clinical decisions regarding assessment, analysis, advice and intervention. In cases of this kind, there is little published evidence to support them in the decision-making process. The present study addresses these concerns by reviewing the literature that informs our current understanding of the nature of buccal speech, and investigates the phonetic and phonological properties of the spontaneous pseudo-voice, thought to be varieties of buccal speech, produced by two long-term tracheostomised children.

2. REVIEW OF THE LITERATURE

Van Gilse [10] provides an early description of the use of a neo- glottis between cheek and upper jaw, a mechanism termed 'parabuccal' in [3]. The source of sound was air compressed high in the cheek through a 'rima glottidis' composed of the upper alveolar process and the mucosa of the mouth tensed by the buccinator muscle. This description was confirmed as buccal by [11]. A different mechanism, also described as buccal, was reported in [3] for a 17-year-old boy. A source of sound for speech was generated when the side of the tongue contacted the side of the upper alveolar process. Air from the pharynx was pushed through into this constriction by a backward movement of the base of the tongue. His speech was monotonous and formed of 'quacking sounds.' Very few consonants were identifiable and there was little differentiation between vowels, rendering the speech itself frequently unintelligible. [11] argues that this subject used pharyngeal rather than buccal speech.

Figure 1: Illustrations of buccal, pharyngeal, and oesophageal speech. [4]



In [11] we find the most detailed investigation to date into the characteristics of buccal speech, using a somewhat atypical subject: a normal-speaking adult male who taught himself buccal speech during childhood. The study confirms the buccal mechanism described in [10]. Buccal speech is elsewhere described as being like 'Donald Duck' [2]. Some debate exists as to whether such speech should be considered buccal or pharyngeal [11]. The speech of a 12- year old girl using a neo-glottis created between tongue and palate is described explicitly in [12] as pharyngeal. It is suggested that these alaryngeal mechanisms are mostly discovered during non-vocal oral play provided there are no severe oro-motor co-ordination difficulties [2].

3. THE PRESENT STUDY

To investigate the phonetic characteristics and phonological potential of buccal speech two detailed child case studies were conducted. Investigation involved analysing audio and video recordings of controlled clinical speech samples. Qualitative analysis was used to compare and contrast the phonetic properties of the buccal speech produced by the subjects and to assess the potential of their speech for communicating phonological contrasts.

Assuming that speakers were using a buccal mechanism, the main hypothesis posed was that air held in the cheeks would be used as the vibratory source, which would then be manipulated by the articulators to form speech-like sounds.

3.1 Methodology

3.1.1 Subjects

Two male, child subjects (subject D & subject P) were identified as probable buccal speakers by a trained SLT working clinically with both children. Clinical speech samples from D at 13 years of age and P at 9 years of age were used for analysis. Though aetiologies differed, both required tracheostomies after a period of normal speech development. D was tracheostomised at 4;05 years and P at 2;01 years. Both subjects were unable to utilise a pulmonary airstream for speech; D due to the need for a cuffed tracheostomy tube to manage airway secretions and P due to laryngeal scarring.

3.1.2 Recording

The clinical speech sample used for analysis was collected in a well-furnished room on a quiet corridor utilising standard recording procedures for clinical assessment at the subject's treatment centre. Measures were taken to minimise ambient noise and sound reverberation, and to ensure general comfort and appropriateness.

Since spoken communication relies on a combination of acoustic, visual and linguistic information [13], [6], synchronised audio and video recordings were made of the subjects' speech productions, using a DAT machine, a digital video recorder and a uni-directional external microphone.

3.1.3 Assessments

Assessments were selected from the clinical sample to evaluate the oro-motor skills necessary for accurate speech production, to establish the range of different sounds occurring in the subjects' speech and to establish their ability to sequence these sounds at different levels of complexity. The following assessment tools were used:

- Dysarthria Profile [7] sub- sections of facial musculature & diadochokinesis.
- Phoneme level assessment from The Nuffield Centre Dyspraxia Programme [9]. Subjects pronounce individual phonemes (vowels in isolation, consonants before schwa) following an adult model.
- The South Tyneside Assessment of Phonology [1]. Subjects pronounce single words using pictorial cues.
- The sentence elicitation test from 'Revised GOS.SP.ASS (98): Speech assessment for children with cleft palate and/or velopharyngeal dysfunction,' [8]. Sentences focussing on specific sounds are modelled by an adult and repeated by the subjects.

3.1.4 Data Analysis

The recorded speech samples were subjected to auditory, visual and limited acoustic analysis i.e. spectrography, using SFS software [5]. As part of the process, the subjects' pronunciations of the target stimuli were first described and then transcribed where possible symbolically. A trained phonetician checked the reliability of the primary researcher's analysis. IPA symbols were used or adapted where appropriate.Representation was limited by the fact that pulmonic air was not used for any of the speech sounds and that normal laryngeal voice was impossible. Vowel symbols could not be interpreted in the normal way, even when resonant characteristics of the target vowels were recognisable, since the source of sound was pseudo-voice. Consonant sounds, being non-pulmonic, were not consistent with the English targets but were sometimes consistent with sounds for which IPA symbols were available. It is important to note that video data were crucial in informing the descriptions, with the support of the auditory and acoustic analysis.

4. RESULTS

4.1 Airstream mechanisms and sound source

Evaluation of the pseudo-voice production mechanisms suggests that D used an egressive pharyngeal airstream mechanism to produce most of his speech. Sounds consistent with ejectives were used as realisations of target obstruents and nasals. Target vowels and approximants were produced with mainly velar or palatal friction as the source of sound. Subject P mostly used an ingressive oral airstream mechanism for his consonants, and to a lesser extent the egressive pharyngeal airstream. Obstruents and nasals were thus frequently heard as clicks and more rarely as ejectives. The clicks were often accompanied by nasal turbulence; it was hypothesised that P compressed the air in the pharynx and forced it into the nasal cavities through a narrow opening between the velum and pharyngeal wall.

4.2 Contrasts of voice, place and manner

Table 1 summarises subjects’ typical realisations of target consonant phonemes. The two subjects differed in their ability to make place of articulation contrasts, but for both there was evidence of awareness of the target; D usually produced all bilabial targets as bilabial ejectives, while P produced bilabial stops as bilabial clicks. Some place anomalies were nonetheless observed.

For both subjects manner contrasts were severely compromised. Target plosives, affricates and nasals could not be clearly differentiated, and the distinction between stops and fricatives was inconsistently made. The variable amounts of affrication accompanying subject D’s ejective stops could not be systematically related to target manner or voicing distinctions. The symbols [P’, T’, K’] are used to cover this range of variation.

Audio-visual and spectrographic analyses revealed no systematic strategy to mark the voicing contrast for either subject, resulting in no consistent difference between normally voiced and voiceless cognate pairs. Acoustic analysis revealed some differences for D; for example the targets /f/ and /v/ were distinguished by a double burst for the sound used for /v/, but it is hard to be sure that this was a consistent strategy.

Table 1: Summary of consonant target realisations for subjects D and P.

<table>
<tr><th>TARGET</th><th>D’s RESPONSE</th><th>P’s RESPONSE</th></tr>
<tr><td>/p/</td><td rowspan="3">[P’]</td><td rowspan="3">[ʘ]</td></tr>
<tr><td>/b/</td></tr>
<tr><td>/m/</td></tr>
<tr><td>/t/</td><td rowspan="3">[T’]</td><td rowspan="3">[ǀ]</td></tr>
<tr><td>/d/</td></tr>
<tr><td>/n/</td></tr>
<tr><td>/k/</td><td rowspan="2">[K’]</td><td rowspan="2">[!]</td></tr>
<tr><td>/g/</td></tr>
<tr><td>/f/</td><td rowspan="2">[f’]</td><td rowspan="4">[ʘ̪]</td></tr>
<tr><td>/v/</td></tr>
<tr><td>/θ/</td><td>[P’]</td></tr>
<tr><td>/ð/</td><td>[f’]</td></tr>
<tr><td>/s/</td><td rowspan="2">[s’]</td><td rowspan="2">[ǀ]</td></tr>
<tr><td>/z/</td></tr>
<tr><td>/ʃ/</td><td rowspan="2">[ʃ’]</td><td rowspan="4">[!]</td></tr>
<tr><td>/ʒ/</td></tr>
<tr><td>/tʃ/</td><td rowspan="2">[tʃ’]</td></tr>
<tr><td>/dʒ/</td></tr>
<tr><td>/l/</td><td>[C*]</td><td>[ǀ]</td></tr>
<tr><td>/w/</td><td>[ʍ]</td><td>[ʍ]</td></tr>
<tr><td>/j/</td><td rowspan="2">[C*]</td><td>[!]</td></tr>
<tr><td>/r/</td><td>[ʍ]</td></tr>
<tr><td>/h/</td><td>[h]</td><td>[h]</td></tr>
</table>

Key: [P’, T’ K’]: ejective stops with variable affrication
C Unidentifiable consonantal articulation*

Both subjects consistently replaced target voicing in vowels with the friction used as a sound source. Typically this was produced when air from the pharynx was forced through a small space between the body of the tongue and the hard or soft palate. When this friction was carried over to adjacent continuant consonants segment boundaries were indeterminate. Spectrographic analysis, where the amplitude of the signal was sufficient to allow it, revealed some evidence of formant excitation during vowels. Both subjects showed awareness of the monophthong and diphthong targets by making appropriate mouth gestures, such as lip-rounding, allowing broad vowel distinctions to be made and perceived. However, it is hypothesised that the articulations were modified in order to keep the tongue in its raised position to create the turbulence.

5. DISCUSSION

The study reported above of the so-called buccal speech of two long-term tracheostomised children has revealed differences in the strategies adopted to set an airstream in motion and to generate a vibratory source of sound to act as a pseudo-voice. A preliminary assessment has also been made of the extent to which the children were able to articulate English speech sounds in order to communicate linguistic contrasts.

The hypothesis that air held in the cheeks would be used to produce a vibratory sound source was not supported by the researchers' observations for either child. Instead, both were able to use non-pulmonic airstreams attested in natural language (though not used contrastively in English). Many of subject D's consonant sounds, using the egressive pharyngeal airstream mechanism, were consistent with ejective consonants found in natural language. What was more unusual was that the continuous friction noise used as a pseudo-voice was also generated on this airstream between the body of the tongue and the palate. This mechanism was consistent with the pharyngeal speech described in [12]. The need to maintain velar or palatal approximation for the sound source inevitably conflicted with a number of articulatory targets requiring a lower tongue position. Over the years D had acquired considerable fluency with this mechanism and was able to sustain quite long periods of continuous speech. Subject P, by contrast, tended to use the ingressive oral airstream mechanism to produce click sounds as realisations of many of his target consonants. To a limited extent he used a pharyngeal airstream similar to D, but more commonly he was able to generate some nasal turbulence to act as a sound source. This turbulence was of very low amplitude, and his speech generally was quiet and effortful.

Both subjects displayed a reduced inventory of sounds, with difficulties making some place and especially manner and voicing distinctions. Some minor difficulties with tongue and jaw movements were noted for both in the oro-motor examination. Consonant clusters and polysyllabic words were problematic. How far linguistic contrast problems were attributable to phonological delay as opposed to the articulation difficulties outlined remains a matter for further investigation.

Further studies of other paediatric 'buccal' speakers are needed to establish the range of mechanisms used to produce pseudo-voice, and to assess phonetic and phonological development of the long-term tracheostomised children who spontaneously develop some variety of buccal speech. Imaging techniques such as lateral X-ray or videofluoroscopy would enhance the reliability of the qualitative and acoustic analyses. Importantly, some measure of the intelligibility of buccal speakers is needed. Though generally well understood by immediate family members, the speech of both subjects was reported to be largely unintelligible to outsiders, confirming the problems reported for trained and untrained listeners by [2]. The contribution to intelligibility of facial gestures, especially lip movements, also needs evaluation.

IPA resources (including recommendations for disordered speech) were limited when it came to representing symbolically the speech of these subjects. Symbols could be found or devised to represent the non-pulmonic airstreams and some place and manner distinctions, but IPA transcription was less successful in representing the complex activities associated with the vowel articulations. Nonetheless the very limitations of the tool proved useful in helping the researchers home in on problem areas, such as indeterminate segmentation. Evidence from further analytic studies of this small population, and from evaluation of the intelligibility of 'buccal' speech compared with other communication modes available to alaryngeal speakers will inform SLTs in deciding whether spontaneously developed 'buccal' speech is best supported or discouraged.

6. REFERENCES

[1] Armstrong, S., Ainley, M. 1989. *South Tyneside Assessment of Phonology.* UK: STASS Publications

[2] Bleile, K.M. 1993. *The care of children with long-term tracheostomies*. London: Singular Publishing Group, Inc.

[3] Damste, P.H. 1958. Oesophageal speech after laryngectomy. In: Weinberg, B. (eds), *Readings in speech following total tracheostomy.* USA: University Park Press, 21-22

[4] Deidrich, W.M., Yongstrom, K.A. 1966. *Alaryngeal speech.* USA: Charles C Thomas Publishers

[5] Huckvale, M. SFS Speech Filing System, http://www.phon.ucl.ac.uk/resource/sfs/ visited Feb-07

[6] Parker, A. 1999. *PETAL: Phonological Evaluation & Transcription of Audio-Visual Language.* Bicester, Oxon: Winslow Press

[7] Robertson, S.J. 1982. *Dysarthria Profile.* San Antonia: Communication skill builders

[8] Sell, D., Harding, A., Grunwell, P. 1998. 'Revised GOS.SP.ASS (98): Speech assessment for children with cleft palate and/ or velopharyngeal dysfunction.' *International Journal of Paediatric Otorhinolaryngology* 31, 214-230.

[9] The Nuffield Hearing & Speech Centre. 1992. *The Nuffield Centre Dyspraxia Programme.* London: The Nuffield Centre Speech & Language Therapy Department

[10] Van Gilse, P.H.G. 1949. Another method of speech without larynx. *Acta Otolaryng supplement* 78: 109-110.

[11] Weinberg, B., Westerhouse, J. 1971. A study of buccal speech. In: Weinberg, B. (eds), *Readings in speech following total tracheostomy.* USA: University Park Press, 19-25.

[12] Weinberg, B., Westerhouse, J. 1973. A study of pharyngeal speech. In: Weinberg, B. (ed), 1980. *Readings in speech following total tracheostomy.* USA: University Park Press, 27-34.

[13] Yavas, M. 1998. *Phonology development & disorders.* London: Singular Publishing Group, Inc.