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AN EXAMINATION OF THE POTENTIAL OF MODAL ENHANCEMENT TO IMPROVE SPEECH-LEARNING IN THE DEAF/HEARING IMPAIRED CHILD

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INTRODUCTION

Published figures suggest that the profoundly deaf population of the UK is approximately 50,000 (i:1,000), of which 12,000 are school children (British Deaf Association, 1992). A number of teaching techniques exist which are designed to accommodate the speech learning needs of the deaf/hearing impaired individuals. They range in complexity and vary in the approach taken, yet the fundamental link between them is the attempt to compensate or substitute for a degraded sensory input. This paper outlines some of the characteristics of modal encoding and considers how they may be employed to reinforce speech-learning. The information covered represents part of an initial stage in a programme of research into modal enhancement funded by *Visible Sound Limited.*

The acquisition of speech skill may be viewed as a process of associative priming where both cognitive visual (imagery) and acoustic (phonetic) features of a stimulus act as priming and encoding cues. The physical registration of speech stimuli occurs within separate sensory (modal) channels which form a sensory memory acting as components of Short Term Memory (STM). Speech learning in the deaf/hearing impaired child is characterised by a degraded ability to represent modal items within this sensory memory. The essential role of this processing stage, in the promotion of speech learning, is to establish a sensory signature of sufficient definition to enable elaboration at the next level of translation. In brief, the function of sensory memory is to maintain a stimulus's sensory signature when the stimulus is no longer physically present.

Any reduction in the quality of sensory representation (eg acoustic cues), will create a reduced sensory base leading to problems of both encoding and, in this case, the production of speech sounds.

MODAL ENHANCEMENT FOR SPEECH LEARNING

MODAL ENHANCEMENT TECHNIQUES AND OBJECTIVES

How have existing teaching techniques responded to the problems of a reduced sensory base?

There are many versions of basically the same technique, which is to elaborate either the visual or tactile channel and to then use the stimuli to mark out segments of speech. For example some techniques use visual feedback which translates the spectral quality of sound into graphic displays. This feedback permits the individual learner to modify their speech output relative to the changes in the graphic display, such as those used in the IBM Speech Viewer series. While, other approaches have adopted a tactile channel of stimulation which, through various forms of vibrating contact pads, can be used to identify and again mark out the physical signature (eg amplitude pattern) of speech.

The nature of the problem of representation will vary with the severity of hearing impairment. Except in the case of the profoundly deaf, both visual and acoustic representation will play a major role. For example vibrotactile aids are designed to extract and create an enhanced sensory register of speech features that are fundamentally both pre-categorical and categorical analyses. This is achieved through the transmission of Frequency, Intensity and Duration to a particular site on the skin. These enhanced features translate into cues for detection and directed attending, rhythm, syllabic stress and pattern duration (Weisenberger, 1989). This marking out of stimuli is achieved by extracting the amplitude envelope of an incoming acoustic waveform and then to use this envelope to modulate the amplitude of a broad band vibratory-carrier.

Both single and multi-channel versions of vibrotactile stimulators are available and appear to have separate strengths. The work of Carney and Beacher (1986), investigated the relative merits of single and multi-channel models using three tasks involving suprasegmental aspects of speech: syllable number, stress, and intonation pattern, in single words and sentences of varying duration. The results showed that single channel versions provided better cues for identifying the number of syllables and syllable stress but that the multi-channel versions better enabled the identification of intonation patterns. The motivation for the development of within modal enhancement strategies stems from the fact that rates of teaching speech acquisition are slow.

MODAL ENHANCEMENT FOR SPEECH LEARNING

The visual modality has a greater potential for the development of sensory enhancements, which have prompted a range of computer based graphics applications. The Speech Viewer (1 and 2) both contain displays designed to substitute sensory inputs in order to allow the user to register deviations from the target sound. These deviations can then be represented in a variety of formats. The power of within modality enhancement (by multiple versions within the same code) is likely to be derived from the capacity of the Iconic sensory register to retain multiple inputs for at least three seconds (Cowan, 1984) thereby consolidating the information available for categorical analysis. Indeed the precategorical nature of this, and for that matter, the echoic (acoustic encoding equivalent) register is a defining attribute of these registers (Crowder and Morton, 1969). In Figure 1 can be seen the within modal enhancement of precategorical stimuli shown against the negative effects of mixed modal input where the change in modality at the end of a serial recall task (towards the period of recency effect) attenuates the existing modal representation. This is said to occur at a 'precategorical' stage where the modality of the stimulus is the primary encoding cue.

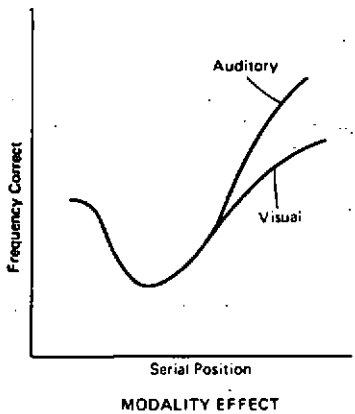

Figure 1 Impact of Cross-Modal attenuation

MODAL ENHANCEMENT FOR SPEECH LEARNING

The ability of teaching techniques to provide enriched sensory environments for the deaf/impaired learner is likely to be based upon the ability of a system to maximise the precategorical space available, while not risking interference effects from other modes. The improved segment marking attained by the single channel compared to the better intonation patterning of the multi-channel is indicative of the needs to map out the changing set of modal capacities built around specific speech processing needs.

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