

The Influence of Psycholinguistic Variables on Articulatory Errors in Naming in Progressive Motor Speech Degeneration.

PLATFORM PRESENTATION ONLY

Abstract

We describe an analysis of speech errors on a naming task in a man with progressive speech degeneration. Early assessment indicated naming impairments with no significant phonological or semantic impairment. To examine naming and the factors that influence speech errors, we selected 210 words varying in lexical and phonetic variables and conducted logistic regression analysis on speech error types. No significant naming errors were found. The only significant predictor of articulation errors was phonemic length and the only error type predicted was phone omissions. Results suggest that the sound omissions in naming are caused by motor speech impairment unrelated to lexical factors.

Introduction

Progressive speech deterioration occurs either in combination with progressive language/cognitive impairments or as relatively pure speech impairments (e.g., Cohen *et al.*, 1993; Brousolle *et al.*, 1996; Silveri *et al.*, 2003; Ricci *et al.*, 2008), that are not dysarthric nor (par)aphasic conditions.

Naming problems are common in progressive aphasia and can have a variety of causes arising at semantic, lexical, phonological and/or phonetic levels and a range of psycholinguistic variables can impact on access (Ellis & Young, 1998). Our participant (C.S.) had a progressive speech impairment, but was also reported to have some significant anomia earlier in the progression. However, his 'anomia' may have been due to mis-classification of articulatory errors. To test if C.S. had lexical access impairments, and to test the hypothesis that his articulatory errors in naming were associated with lexical access, we conducted logistic regression analyses on the occurrence of errors in confrontation naming of 210 words varying in frequency, imageability, age of acquisition (AoA), phonemic and syllabic length.

Method

C.S. was aged 62, right-handed man at the time of testing. He obtained a First Class degree in chemistry from Manchester University, England, and was Head of Chemistry in a well-known British public (i.e. 'private') school for 21 years before early retirement because of increasing speech problems, first noticed in 1992.

Neurological investigation in 1995 included neuropsychological screening, CT scan, EEG, EMG and nerve conduction examinations that were all normal. In November, 2000 slightly brisk reflexes and flexible planter responses were noted. MRI scanning in March, 2001 revealed some mild non localised atrophy considered normal for his age and EEG was normal. MRI in October, 2003 showed significant generalised, bilateral atrophy, more prominent in left frontotemporal area, increased in left frontal dorsomedial regions, suggesting a predominantly fronto-temporal degeneration.

By August, 2002 longitudinal testing had been completed of intelligence, perception, memory, language and action/gesture (details in Table 1 in Code *et al.*, 2006). The tests of naming reported here took place in January, 2002.

Extensive testing (see Code *et al.*, 2009) showed intact phonological, grammatical and semantic systems (agrammatic agraphia and sentence processing impairments emerged some months later), and 'naming' impairments noted before this investigation began. But, this anomia is confounded by speech initiation and articulatory errors and some may have been due to unrecognised motor speech problems before this investigation. LT, ST memory and perceptual processing and IQ were unimpaired. Executive impairment and impulsivity were noted with significant limb, buccofacial and ocular motor apraxia.

C.S. died in December, 2007, and post mortem confirmed Pick's disease. MRI scans and autopsy information can be seen in Code *et al.* (2009).

We selected 210 nouns varying in frequency, imageability, age of acquisition (AoA), phonemic and syllabic length. Testing was audio-recorded.

Speech was analysed by two experienced speech scientists with the aid of PRAAT analysis software (version 4.0.26). All phone omissions, additions or substitutions¹ and initiation delays were recorded.

Results

Table 1 shows a summary of initial testing of speech by February 2002. Screening on the Motor Speech Examination (Wertz *et al.*, 1984) and the Dabul Apraxia Test (Dabul, 2000) revealed a range of impairments.

C.S. produced just 8 naming errors on the 210 pictures with 78 articulatory errors consisting of 29 additions, 26 substitutions and 16 omissions, with 30 initiation delays. Table 2 shows the numbers of each kind of error type. This firstly confirmed that his 'naming' impairment probably was due to articulatory rather than lexical access difficulties and we concluded that C.S. did not have significant lexical access impairment.

Logistic regression examined if any of the dependent lexical variables predicted the occurrence of any form of speech errors, the independent variables. The only variable to predict errors was phonemic length, and the only error type predicted was phone omissions ($\beta=.642$; Wald=7.257; $p=.007$), with none of the other error types predicted by the lexical variables. Omissions occurred significantly more often in C.S.'s naming with phonemically longer words.

Discussion

C.S. produced more substitutions and additions than omissions, but the substitutions and additions were not predicted by the regression analysis. Why does word length predict omissions, but not substitutions and additions? Studies have identified additions (e.g., Rosenbek *et al.*) and substitutions (e.g., Itoh & Sasanuma, 1984) as common in apraxia of speech. Why omissions occur and are predicted by the regression analysis is perhaps relatively clear: it is easier for a compromised speech mechanism to omit a phone in a word, especially a longer word, than to struggle to produce the whole word, whereas inserting an additional phone should be harder for an apraxic speaker. However, phone additions too are features of apraxic speech. We interpret these additions as motor speech errors: C.S. tends to add sounds to words in a range of naming, reading and repetition tasks, and schwa-like intrusions account for many of his additions and many are concerned with splitting up clusters, which is independent of word length. Rosenbek *et al.* (1984) show that such intrusions should not be considered 'phonemes', but transitions that are 'intervals of continuous articulatory change' (p.17), which coincides with our view of C.S.'s intrusive schwas. Schwa-like intrusions for C.S. are compensatory aiding his production of ongoing speech. Classification of errors into substitutions are problematic (e.g., Itoh & Sasanuma, 1984) as they are often interpreted as phonological rather than phonetic errors. For C.S. substitutions often occur where he didn't properly align certain gestures (e.g. /m/ to [b] where the nasal gesture was uncoupled, and in voicing errors, and these too can be independent of length, a probable reason that substitutions were not predicted by phonemic length.

¹ The term 'substitution' here covers any incorrect realization, not solely phonemic substitutions; see discussion below.

Listeners make errors when they perceive speech, and many studies of AOS have employed perceptual methods where investigators' own perceptual systems make decisions on the speech they hear and many have not been well controlled for what is known as *phonemic false evaluation* (PFE) (Buckingham & Yule, 1987). Perceivers tend to classify phones in terms of categorical perception (MacNeilage, 1982) - the strong tendency to classify a phone as belonging to one or another phonetic category and to ignore features that do not contribute to categorical perception. Trained phonetic listeners too are subject to categorical perception. Buckingham and Yule (1987) reviewed the implications of PFE and suggest that it is an automatic property of the cognitive system, and listeners cannot help perceiving categorically. This can lead listeners to falsely evaluate an intended phoneme, especially where a failure of motor control produces a switch in an acoustic cue. PFE may account for a significant proportion of the phonemic substitutions reported in the literature.

The category of substitution is not well motivated because using it when errors are to do with motor planning and/or execution conflates the source and effect distinction (see Ball and Müller 2002): classifying an error as a substitution (i.e. as phonemic) is only saying that it 'sounds' like the sound is a separate phoneme to the target. It is usually not possible to state that the speaker deliberately chose to use a sound from another phoneme. Even when we hear what appears to be a substitution, the speaker may have produced a covert contrast. Thus, the speaker may maintain separate gestures for the two sounds, but to the listener the sounds appear merged. For example, both English /s/ realized as a dental sibilant and as a lateral fricative would be classed as distortions, even though the first is close to the target whereas the second is not even an English sound.

We found no evidence for impaired phonology in extensive testing and conclude that C.S.'s speech errors on a naming task varying in lexical and phonetic variables suggest that errors arise as a result of compromise to speech programming/planning.

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Table 1. Summary of results of initial investigations of speech production.

| | |
|---|---|
| <i>Motor Speech Examination (Wertz et al, 1984)</i> | No significant motor or sensory loss; some possible spastic dysarthria. Prosodic disturbance. No dysphagia. <u>Problems initiating laryngeal & oral movement</u> |
| <i>Boston Rating Scale Profile of Speech Characteristics (each rated 1-7)</i> | Melodic Line: 4 (short phrases) Phrase length: 4 (4-5 words) Artic Agility: 3-4 (could be normal in familiar words/phrases) Grammar Form: 4-5 (ltd but correct) Paraphasia: 7 (absent) Word Finding: 5 (proportional to fluency) |
| <i>Dabul Apraxia Test Diadochokinetic (ddk) rate</i> <i>Alternating ddk rate</i> | 2/3 repetitions; some voicing of voiceless stops; some vowel substitutions. Little or no groping/searching. increasing initiation problems & pausing with progress through automatic counting series. Increasing initiation problems |
| <i>Dabul naming & repeating 3 syllable words</i> | Errors increased with length; intrusive schwa, between clusters; devoicing +voice & voicing -voiced fricatives/stops; some vowel distortions; anticipation of phones; increasing errors on repetition. Some problems with control of voicing and co-ordination of laryngeal with oral articulation |
| <i>Grandfather Passage Reading Aloud</i> | Significant initiation problems; pausing <u>between</u> words/phrases; Time 180 secs. (normal = 46 secs) |
| <i>Picture Description</i> | 30 words (including 4 occurrences of the automatism yes) in 51 secs. |
| <i>Phonemic Processing</i> <i>Written word phonological processing</i> | PALPA 1-3 Auditory Discrimination, No Errors Auditory discrimination word/ nonword No Delay: 32/32 Delay (5 Sec.): 30/32 Filled Delay: 32/32 PALPA 15 Rhyme Judgement, 55/60 correct Test 1 & 2 Rhyme Judgement, No Errors PALPA 28 Homophone judgement, 59/60 correct Pseudohomophone judgement, 49/50 correct Regular words, 49/50 correct Irregular words, 50/50 correct |

Key: PALPA=Psycholinguistic Assessment of Language Processing in Aphasia (Kay et al., 1992)

Table 2. Speech error types produced.

| | Errors | Additions | Substitutions | Omissions | Delays |
|--------|--------|-----------|---------------|-----------|--------|
| TOTALS | 78 | 29 | 26 | 16 | 30 |