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Multilingualism and acquired neurogenic speech disorders

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Abstract. Acquired neurogenic communication disorders can affect language, speech, or both. Although neurogenic speech disorders have been researched for a considerable time, much of this work has been restricted to a few languages (mainly English, with German, French, Japanese and Chinese also represented). Further, the work has concentrated on monolingual speakers. In this account, I aim to outline the main acquired speech disorders, and give examples of research into multilingual aspects of this topic. The various types of acquired neurogenic speech disorders support a tripartite analysis of normal speech production. Dysarthria (of varying sub-types) is a disorder of the neural pathways and muscle activity: the implementation of the motor plans for speech. Apraxia of speech on the other hand is a disorder of compilation of those motor plans (seen through the fact that novel utterances are disordered, while often formulaic utterances are not). Aphasia (at least when it affects speech rather than just language) manifests as a disorder at the phonological level; for example, paraphasias disrupt the normal ordering of segments, and jargon aphasias affect both speech sound inventories and the link between sound and meaning. I will illustrate examples of various acquired neurogenic speech disorders in multilingual speakers drawn from recent literature. We will conclude by considering an example of jargon aphasia produced by a previously bilingual speaker (that is, bilingual before the acquired neurological damage). This example consists of non-perseverative non-word jargon, produced by a Louisiana French-English bilingual woman with aphasia. The client's jargon has internal systematicity and these systematic properties show overlaps with both the French and English phonological system and structure. Therefore, while she does not have access to the lexicon of either language, it would seem that she accesses both the French and English phonological systems.

Keywords: multilingualism, acquired neurogenic disorders, aphasia, apraxia of speech, dysarthria

Introduction

Speech disorders (as opposed to language disorders) are generally deemed to fall into several categories, for example: developmental, acquired neurogenic, genetic, results of surgery and other. Ball (2016) describes these types in detail but we will look briefly at each one here in turn. In each case, Ball (2016) provides further details and references.

Developmental

Various sub-types of speech disorder are found under this heading: articulation disorder (e.g., sibilant and rhotic problems, among others), motor speech disorders in children, childhood dysarthria, childhood apraxia of speech, phonological disorder (consisting of phonological delay, phonological deviancy-consistent, and phonological deviancy-inconsistent). See Howard (2013) and Bowen (2015) for further details, and Ball (2016) for discussion of different classifications for child speech disorders.

Genetic

Speech sound disorders with a genetic origin fall into two broad groups: cleft lip and palate and genetic syndromes. Cleft lip and palate can be subdivided into various types depending on which parts of the lip and palate are affected.

Genetic syndromes include Down, Williams, Fragile-X, Noonan, and Cri-du-chat (see Stojanovik, 2013, for references to these and other syndromes).

Results of Surgery

Surgical intervention to treat, for example, cancer can have effects on speech. In particular, we can note laryngectomy – leading to the adoption of esophageal or tracheo-esophageal speech or the use of external devices to produce a noise source, and glossectomy – the partial or total removal of the tongue (see Bressmann, 2013, for further details).

Other

Speech disorders also occur with the following other disorders of communication: hearing impairment (this primarily affects prosody but eventually also has an effect at the segmental level); voice disorders (primarily affects phonation, but may also exhibit problems with resonance and supralaryngeal articulatory settings); disorders of fluency (stuttering and cluttering have a primary effect on prosody, but often also result in problems at the segmental level).

Acquired Neurogenic Disorders

We have left to last this category as it is the main focus of this account, and thus will be described in greater detail than the previous varieties. The main types of acquired neurogenic disorders are: aphasia, apraxia of speech (AoS), and dysarthria. We will look at each of these in turn.

Aphasia

As non-fluent aphasia often co-occurs with Apraxia of speech, we look here at fluent aphasia. Fluent aphasia may show phonemic paraphasias, that is, incorrect phoneme use, or incorrect phoneme placement. So, the disorder is at the phonological level. Examples include ‘pat’ for *cat*; ‘tevilision’ for *television*, ‘fafter’ for *after*. Extreme forms may result in *jargonaphasia,* that is, the production of fluent, connected, but apparently unmonitored speech that is non-comprehensible and often characterized by the use of nonwords (Marshall, 2006).

Apraxia of Speech

This disorder is at the phonetic planning level, and people with AoS may be able to produce formulaic speech with little problem, but novel utterances demonstrate errors. Childhood Apraxia of Speech (CAS) includes a developmental variety, where no discernible neural insult can be found, although the symptoms are similar to the acquired variety.

The impairments include: slow speech rate, distortions to consonants and vowels, prosodic impairments, and inconsistency in errors (Jacks & Robin, 2010). Other features often noted are: articulatory groping, perseverative errors, increasing errors with increasing word length and increasing articulatory complexity, difficulties initiating speech.

Dysarthria

Various sub-types of dysarthria are recognized: flaccid, spastic, hypokinetic, hyperkinetic and ataxic (see Ackermann, Hertrich, & Ziegler, 2013). Dysarthria is a neuromuscular disorder at the level of motor implementation. The different types of dysarthria have differing effects on respiration (commonly short breaths only are possible); phonation (harsh, strained or breathy voice qualities), resonance (hypernasality found in several types), articulation (general imprecision), and prosody (rate may be slow, pauses may be excessive).

Acquired neurogenic speech disorders and multilingualism

Paraphasias and Multilingualism

We consider here only acquired neurogenic speech disorders in bi- and multilingual speakers, rather than cross-linguistic studies. Although there has been considerable research into language impairments in bilinguals with aphasia, there is much less known about acquired speech impairments in such speakers. However, there is work on phonemic paraphasias in bilinguals from South Africa, for example, Odendaal and Van Zyl (2009); Theron, Van der Merwe, Robin and Groenewald (2009); Kendall, Edmonds, Van Zyl, Odendaal, Stein and Van der Merwe (2015).

Odendaal and Van Zyl (2009) collected phonemic paraphasias from three bilingual English/Afrikaans speakers with aphasia. They found similar examples of errors in both languages. Error types were mostly substitutions, then deletions, then additions in both languages, and most errors occurred on high frequency words, again in both languages. Word length played no part in predicting errors, but there were more errors in the speakers' L2 in complex linguistic tasks, but not in simple ones.

Theron et al. (2009) reported that the English-Afrikaans bilinguals using phonemic paraphasias in their study had more difficulty in L2 than in L1. They were more interested in investigating durational features than in comparing the types of paraphasia between languages, however.

Kendall et al. (2015) looked at four Afrikaans/English bilinguals with aphasia and analysed errors in confrontational naming tasks in the two languages. This study is only peripherally relevant for our purposes as many of the errors were semantic (rather than phonological) and little detail is provided on the types of phonological error. Three of the four speakers performed significantly worse in their L2, but that there was little difference in proportion of error types between the speakers' languages.

Bhan and Chitnis (2010) report on a Telugu-English bilingual with subcortical aphasia. Their client produced phonemic paraphasias in both languages, as well as neologisms, semantic paraphasias, circumlocutions, etc. Typical phonemic paraphasias were found in both languages, though the authors do not compare or contrast the aphasic features between the languages.

AoS and Multilingualism

Laganaro and Overton Venet (2014) review the handful of studies into AoS and bi/ multilingual speakers. They describe work on Afrikaans-English bilinguals (Van der Merwe & Tesner, 2000; Theron et al., 2009). These confirm parallel impairments, and increased consequences for the lesser used language noted above. Laganaro and Overton Venet (2014) also report their own study on a Swedish-French bilingual with similar results.

The authors constructed pseudowords of three types: syllable types common to both French and Swedish, syllable types common to French, and syllable types common to Swedish. Further, all categories contained both high and low frequency occurring types. Accuracy was best on high frequency type 1 words; it was worst on low frequency type 1 words.

The observation that frequency of use summed across languages influence accuracy suggests both shared motor plans (i.e., used for both L1 and L2), and common gestural scores used in late bilinguals for common/similar phonological patterns across the speaker's languages. It also supports the importance of frequency of use as expounded in Bybee's (2001) model of a usage-based phonology.

Dysarthria and Multilingualism

Lee and McCann (2009) is one of very few studies on bilinguals with dysarthria. The authors examined the use of phonation therapy with two Mandarin-English bilinguals with flaccid dysarthria. Phonation therapy concentrates on establishing breathing patterns to improve the amount of air flow for speech and, as Mandarin is a tone language, improved phonation is needed to signal tones and thus improve the intelligibility of their spoken output. Indeed, Lee and McCann reported that their clients' intelligibility in Mandarin improved after phonation therapy, and that accuracy of tone production also improved. Intelligibility improvement was minimal in the speakers' English.

The studies reviewed above have highlighted the urgent need for more research in bi- and multilingual speakers with acquired neurogenic disorders of speech. In the next section, we turn to an example of bilingual jargonaphasia as one step towards this goal.

A case of bilingual jargonaphasia

We describe here phonological aspects of a case of bilingual jargonaphasia. This section is closely based on Müller and Mok (2012); the case was also described in Ball and Müller (2015).

Introduction

Perecman and Brown (1981) present a case study of phonemic jargon produced by KS, a man aged 74 at the time of the study, whose first language was German, who had acquired Argentinian Spanish as a second language in his early twenties, and had been a US resident and speaker of American English since his mid-twenties. While the sound inventory of KS's jargon represented "virtually every phoneme of standard English and German" (Perecman & Brown, 1981, p. 185), the frequency distributions in the jargon differed markedly from those in German and English norms. According to Perecman and Brown, KS's vowel inventory and distribution would suggest a German rather than an English vowel system (and, we may note, is suggestive of a Spanish vowel system, as well; Perecman and Brown do not discuss possible Spanish influence on KS's jargon).

Ms H, on whose speech output we report here, was 78 years old at time of data collection, and had experienced a left hemisphere CVA approximately nine months previously. Her first and second languages are French and English, respectively. English was her dominant language premorbidly, as regards frequency and domains of language use. She used French mainly with relatives and close friends of her own generation. Her education, as well as premorbid literacy practices, had been exclusively in English. Her husband is also a French speaker; their four children do not speak French, but have good conversational comprehension.

According to the Western Aphasia Battery (Kertesz, 1982) criteria, Ms H's scores are consistent with a classification of Wernicke's aphasia. Assessment was only carried out in English (as was language therapy), since no speech-language pathologist with sufficient fluency in French and experience in French-language assessment was available.

Sound inventories

The data analysed here represent an opportunistic sample, in that they consist of recordings of language therapy sessions made available to the authors by the clinician working with Ms H (all necessary permissions for the recording and use of the data for research purposes were obtained). Data were transcribed phonetically and below is an example of three attempts by Ms H to repeat the utterance 'hand me the nail polish':

(a) [tyː iː kɑːm *(whispered:* t^{h}y *)* fœlŭ^{h} ˈdɛn deˈde *(taps nail polish bottle)* fɒːˈse

(b) [njuː lɪt tʃu feɪˈfjo edeˈfɔʁ n̩fəˈbɛn frenˈdju^{h} ɛtˈfe^{h} pəˈsel^{j} *(2 syllables)* dendru ɛ̃ˌsedeˈdru^{h} ˈmijɛl^{ɣ}]

(c) [ˈwːʌn ˈtʃu dædˈjudĭ ˈhɔɹt ˌdɹɔfːɑˈbɛs]

Listener impressions recorded anecdotally were that (a) and (b) sounded more French than English, whereas (c) sounded more English. This would seem to derive from the differential use of both specific vowels and consonants in the three utterances, for example, front rounded vowel in (a), a nasal vowel in (b), and examples of approximant [ɹ] in (c).

In order to compare Ms H's speech output with her two premorbid languages, inventories of consonants and vowels were drawn up, as well as lists of syllable types, phonotactic possibilities, and stress patterns. Ms H's mainly used oral monophthongs and, although she did in fact use a number of nasal vowels ([, , , ,]), these occurred much more rarely than their oral counterparts. Diphthongs occurred very rarely too: [aɪ, a] were used twice each, and [eɪ, eə, o] once each. As can be seen in Table 1, Ms H's vowel inventory overlaps with both the French and English vowel inventories, and shows significant rank correlations with both. Of the 29 vowels in Ms H's jargon, 15 are shared with

English, and 14 with French. The Spearman rank correlations between H's vowel inventory and English and French are r_s=0.386 (p=0.0265), and 0.581 (p<0.01) respectively (N=32 for both).

Table 1. Monophthong inventory

Front vowels			Mid	Back vowels
i	y	ɪ		u
e	ø			o
	œ			
			ɚ	
			ə	
æ			ʌ	ɒ
				ɑ
			a	

Ms H's consonant inventory is shown in Table 2. This inventory incorporates sounds that map onto virtually all contrastive consonants of English and French, the exception being the French /ɥ/ (also a rare consonant in French). Segments that have no counterpart in either French or English are of marginal occurrence in H's jargon ([ɟ] occurs twice, and [x] and [ç] once). Of the five most frequently occurring categories in H's jargon, [t, s, d, "r", m], three, [t, "r", s] are also in that group in English, and the same three [t, "r", s] in French. There is of course a significant overlap between the French and English consonant systems both as regards the segment inventories and in terms of their relative frequency of occurrence (r_s=0.701; N=25; p<0.01). The Spearman rank correlations between Ms H's consonants and English and French norms are r_s=0.721, and r_s=0.748, respectively (N=28, p<0.01 for both).

Table 2. Consonant inventory

Labial			Apical/Laminal			Dorsal		Glottal
p, b			t, d		ɟ	k, g		
m			n			ŋ		
			r					
			ɾ					
				tʃ, dʒ				
w	f, v	θ, ð	s, z	ʃ, ʒ	ç	x	ʁ	h
			ɹ		j			
			l					

Syllable types were classified as 'string-initial' and 'string-final' (where the term 'string' is employed rather than 'word' as, being jargon, it was not obvious where word boundaries occurred or whether one could sensibly use the term 'word' anyway). String-initially, #C- was used 65.9% of the time, #V- 22.9%, and #CC- 11.2%. String-finally, the percentages were: -V# 63.5%, -C# 33.8%, -CC# 2.7%. The restrictions on numbers of consonants in clusters are reminiscent more of French than of English, nevertheless the actual clusters used (see Müller & Mok, 2012, for details) do cover many English and French possible types.

Syllable counts and stress assignments are shown in Table 3. One- and two-syllable strings together greatly outnumber strings of three or more syllables in the data, with a slight preference for di- over monosyllabic strings (χ^2=12.24; df=2; p<0.05). String-final stress predominates, in both two- and three-syllable strings (strings with four or more syllables do not occur in sufficient numbers to show a clear pattern) and, again, this suggests perhaps a more French than English patterning, and it could well be these prosodic characteristics that contribute to listeners' perceptions of a French accent.

Table 3. Syllable counts and stress assignment

N syllables	**1**	**2**	**3**	**4+**
	39.51%	43.48%	13.85%	3.51%
Stress patterns:				
Two syllables	Σ'Σ	ΣΣ'	other*	
	77.36%	14.47%	8.18%	
Three syllables	ΣΣ'Σ	Σ'ΣΣ	'ΣΣΣ	other*
	66.67%	17.65%	7.84%	7.84%

Comparative notes

The ratio of consonants to vowels in Ms H's output is 56.79% to 43.21%. These figures are very close to those given for French by Wioland (1985), 56.5% consonants and 43.5% vowels, respectively. For English, a somewhat higher proportion of consonant use is reported, 61.44% for consonants, and 30.56% for vowels (Ball & Müller, 2005). The almost complete absence of string-initial three element clusters from our data is interesting, which in English occur in some high-frequency words. Ms H's use of C+[j] clusters intersects with both French and English phonotactics. With the exception of a single string-initial [df], we have found no sound combinations that would violate both English and French phonotactic constraints.

The clear preference for string-final stress is reminiscent of French rhythmical patterns, in which phrase-final stress predominates. Therefore, it is tempting to assume that Ms H's jargon is constructed within a French rhythmical structure. However, phrase-final stress is also encountered in English, most typically in sequences of monosyllabic content words preceded by one or more unstressed function words ('at night', 'in the dark'), so this is not conclusive.

Conclusion

Ms H's jargon shows no systematic relationship between sound and meaning; and some of the few instances of possible real words are doubtful. In addition, no recognizable segmental or syllable-by-syllable relationship can be identified between Ms H's jargon and target words or sentences.

Ms H's jargon does, however, have internal systematicity: There are clear preference patterns in terms of segment frequencies, and sequential properties. The systematic properties of Ms H's output show overlaps with both the French and English phonological system and structure. While Ms H does produce some segments that are not part of either contrastive system, these are marginal in occurrence. Therefore, while she does not have access to the lexicon of either language, she accesses both the French and English phonological systems; her jargon shows a greater overlap with both French and English at the segmental level than French and English with each other.

It is of course quite usual that bilinguals access two language systems simultaneously and produce bilingual speech. It is therefore not surprising that the global difficulties with lexical retrieval of persons producing nonword jargon would lead to output that intersects with both contributing phonologies, but is not separable into discrete chunks of, in our case, “French” or “English” jargon.

Conclusion

The small number of studies available for review in the earlier part of this paper, together with the fascinating results from the case of bilingual jargonaphasia described later, highlight both the need for much more research in multilingualism and acquired neurogenic speech disorders, and the rewards that such research will bring.

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