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The *rhaeadr* effect in clinical phonology

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Abstract

A distinction is drawn between Crystal's bucket theory of language processing, and an overflow of effects between different linguistic levels in language production. Most of the examples are drawn from Welsh (a language of mutual interest to the author and the honoree of this issue). For that reason, it is proposed that this effect is termed the *rhaeadr* effect (from the Welsh for waterfall). The *rhaeadr* effect is illustrated with the initial consonant mutation systems of Welsh and Irish, and with data from both normal phonological (and morphophonological development), and disordered speech.

Keywords: clinical phonology, interacting effects in communication disorders, Welsh, Irish

Introduction

In the first issue of this journal, Crystal (1987) described a ‘bucket theory of language disability’ aiming to account for interaction between different linguistic levels. Crystal envisaged this to be a psycholinguistic account whereby progress at one level may often accompany a regression at another. Crystal cites a range of empirical evidence supporting interactions between different levels of linguistic organization (e.g. phonology and syntax, phonology and semantics, and so on). He goes into detail on a case where the interactions are between syntax and suprasegmental aspects of speech, and between syntax and semantics (as well as other pairings). He compares these interactions to a bucket, in that we can liken “language processing capacity to a bucket, into which a certain amount of linguistic water has been poured. The bucket gets larger, as the child develops; but in the case of the language handicapped child, there is a series of holes at a certain level. As the child’s language level rises, and reaches the holes, there is a stage when *any* extra water poured into the bucket will cause some of the water already present to overflow via the holes ... An extra ‘drop’ of phonology (syntax, semantics etc.) may cause the overflow of a ‘drop’ of syntax (semantics, phonology etc.)” (Crystal, 1987, 20).

This metaphor, then, is being used to describe the language processing end of speech and language production. However, as noted in Hawkins (1985), Hewlett (1985), and Gibbon (1990), it is important to account for both the perception of disordered speech and its production; or the effect on the listener as opposed to the intent of the speaker. Indeed, in Ball and Müller (2002) we argued for an explicit distinction to be made between these two aspects when describing disordered speech. We can expect, therefore, that – if there are interactions between linguistic levels in language processing – there will be such interactions in the listener’s perception of disordered speech (and also normally developing children’s speech). As the bucket metaphor has

been used to describe the production aspects of interaction, we will use the waterfall image to describe interactions at the listener's end; and, as we are describing Welsh in this article, we will call this the 'rhaeadr effect'. As a simple example from English, we can note an interaction between phonology and morphology, in that, if final consonants are regularly deleted, then suffixes such as plural, possessive, 3rd person present tense, and so on, cannot be marked.

Tone languages offer further examples of this effect. Languages such as Chinese and Thai are those where tone is mainly used to differentiate lexical items that are segmentally identical (Abramson, 2014). In many West African languages, on the other hand, tone has a grammatical function, (e.g. Igbo, Anyanwu, 1998) whereas in others tone may have both lexical and grammatical functions (see Kru described in Zogbo, 1989). As is known from research into acquired neurological disorders with speakers of tone languages (see review in Gandour and Krishnan, 2014), the loss of the ability to produce correct tones will lead to potential ambiguity at the level that tone operates. So, for languages where tone differentiates lexical item, lexical ambiguity is possible; for those where tone has a grammatical function, then disruptions to the tonal system may cause grammatical breakdown. Thus, a problem at the suprasegmental speech production level, cascades over into the lexis and/or the grammar.

We will argue here that the Celtic languages offer great scope for the *rhaeadr* effect due to the special nature of their phonology and grammar.

Welsh

Welsh is a member of the Brythonic branch of the Celtic group of the Indo-European language family. According to the 2011 census, Welsh is spoken by 562,016 people in Wales, representing 19% of the population over 3 (Office for National Statistics, 2011). This represents a decrease of around 1.5% since the 2001 census and takes the percentage of Welsh speakers back to what it was in the 1991 census after a small increase in 2001.

Mutations

For the purposes of the *rhaeadr* effect, the aspect of Welsh that is most interest here is the system of initial consonant mutation. Mutations are phonological changes to word-initial consonants that are triggered by a range of morphosyntactic contexts. Initial consonant mutations are common to all the Celtic languages (see the discussion of Irish below), and are historical remnants of processes once triggered by phonological contexts, which contexts have subsequently been lost during various sound changes. A full account of mutations and the environments that trigger them is given in Ball and Müller (1992; see also Thomas 1996 for a full account of Welsh grammar), but we give a short description of them here. There are three main sets of consonants changes: soft mutation (SM) or lenition, nasal mutation (NM) or nasalization, and aspirate mutations (AM) or spirantization. Table 1 shows the changes in orthography and phonology.

{Table 1. about here}

Common triggering environments for these mutations are as follows:

SM: feminine singular noun after the article, after the numeral *un*; adjective following feminine singular noun; word following *ei* ‘his’, *dy* ‘your’ sing.; words following a range of common prepositions; verbs following a range of preverbal particles (e.g. marking questions, statements, negatives); items following a range of numeral forms (e.g. *dau/dwy* ‘two’, *ail* ‘second’); adjectives following the complementizer *yn* (but not verbs); direct object of an inflected verb (but not of a periphrastic construction), and adverbials of time, among numerous others.

NM: words following *fy* ‘my’; nouns following the preposition *yn* ‘in’; various set expressions with numerals and time expressions.

AM: words following *ei* ‘her’; words following a range of prepositions (*â*, *gyda* ‘with’, *tua* ‘towards’); words following various negative particles; words following the numerals *tri* ‘three’ masc., *chwe* ‘six’, and the adverb *tra* ‘very’.

A feature called pre-vocalic aspiration (PVA) by Ball and Müller (1992) can also occur in some contexts, and here an /h/ is added to vowel-initial words, for example, following *ei*, *ein*, *eu* ‘her, our, their’.

We can see how some of these mutations interact across linguistic levels in the following tables (examples are shown orthographically, but the phonological representations can be ascertained from the examples in Table 1.

{Table 2. about here}

While incorrect mutation usage will produce a morphological error (i.e. confusion of grammatical gender), it could be argued that this would not produce a semantic confusion. However, Thomas (1996) provides a list of nouns whose meanings differ dependent upon their gender. The commonest of these is *de* which means ‘south’ when masculine and ‘right’ (as opposed to ‘left’) when feminine, thus *troi i’r de* means ‘turn to the south’, whereas *troi i’r dde* means ‘turn to the right’.

{Table 3. about here}

Table 3 demonstrates that (for words with mutable initials at any rate), incorrect mutation usage may result in semantic ambiguity in terms of the intended possessor, as well as producing incorrect forms morphologically.¹

{Table 4. about here}

As can be seen in Table 4, mutation usage also spills over into the morphology-syntax interface where (on occasion) words that are not otherwise marked as to their class are distinguished via mutation in specific syntactic contexts. A clearer example of syntactic usage is shown in Table 5 where we look at the marking of direct objects of inflected verbs.

{Table 5. about here}

¹ This is usually mitigated in colloquial speech by the addition of postposed pronouns which clarify the intended possessor: *ei gath ef*, *ei chath hi*, *eu cath nhw*; *ei hafalau hi*, *eu hafalau nhw*, etc.

The correct syntax of inflected verb phrases requires soft mutation on the direct object. As the examples in Table 5 illustrate, there are potential ambiguities of the mutation is omitted; thus another example of the *rhaeadr* effect where phonology overflows into syntax.

Our final example illustrates sentence semantics. Welsh has a set of presentential particles that indicate statement versus question, and positive versus negative (and combinations thereof). As discussed in Ball (1988), in spoken Welsh these particles are often omitted, but their mutation reflexes are retained. In many instances it is only the mutation reflex (or that reflex coupled with prosody) that will indicate the sentence type. In Table 6, we show some of the particles in both literary and spoken forms.

{Table 6. about here}

These examples have shown that the phonological changes of initial consonant mutation in Welsh may overflow the phonology and impact morphology, syntax, and both lexical and grammatical semantics and the interfaces between. Figure 1 shows the *rhaeadr*, or waterfall, from the phonetic level through the phonology, morphophonology, to the lexis on one hand, and the syntax on the other, ultimately affecting lexical and grammatical semantics for Welsh, derived from problems with the timing of vocal fold activity.

{Figure 1 about here}

However, for this to be important from the clinical point of view, we need to examine both normal and disordered phonological development in Welsh.

Normal Phonological Development of Welsh

Munro, Ball & Müller (2007), based on Munro, Ball, Muller, Duckworth and Lyddy (2005), described a study into the acquisition of Welsh phonology. These sources provide details for the date of acquisition of particular consonants of Welsh at the 75% accuracy level. However, more interesting from the point of view of this account is the description of what are termed *phonological processes*, which we shall term here ‘patterns’. These patterns display the substitution tendencies of children acquiring the phonology of Welsh typically.

In terms of the consonant mutations, we need to look at patterns involving voice in initial consonants (SM), the stop-fricative distinction (SM and AM), and the nasal-oral distinction (NM). No patterns are reported concerning this last distinction (as might be expected from the study of normal phonological acquisition in other languages), so no *rhaeadr* effect would be expected here.² Interestingly, the pattern of ‘stopping’ is described as occurring very rarely. These patterns are based on Harrison and Thomas (1975), and are drawn from a small number of children. Looking at the data on consonant acquisition, it would appear that some of the fricatives are not fully acquired until after age 3;0 or 3;6 (e.g. /θ/ and /ð/). Further, these data start at age 2;6, so stopping of fricatives may well occur with some target fricatives and at ages

² This of course does not mean that NM will be used at a young age, as mutations themselves have an acquisition pattern that we refer to later.

younger than 2;6. Fricative stopping would clearly overflow the phonology and affect the ability to signal SM on voiced plosives, and AM on voiceless ones. Ball, Müller and Munro (2006) do note the use of fricative stopping with target /ð/.

Munro, Ball & Müller (2007) describe a pattern of voicing, whereby target initial voiceless consonants are realized as voiced. Examples given include: *pen* ‘head’ /pɛn/ → [pɛw]; *castell* ‘castle’ /'kastɛl/ → ['dasdɛ]; *ci* ‘dog’ /ki/ → [gi]; *ti* ‘you [sing]’ /ti/ → [di]; *coch* ‘red’ /kox/ → [gox]; *pedwar* ‘four [masc]’ /'pɛdwar/ → ['bɛdwah]. This pattern would clearly indicate a possible overflow from phonology and disturb the marking of SM on voiceless plosives.

Munro et al. (2005) describe the use of a velar fronting pattern, and a range of substitution patterns with target lateral fricatives and the voiced and voiceless trills. These last two also enter into the SM mutation system, so there is possible interference here too between the phonology and the mutations.

There have been few studies on the normal acquisition of the mutation system in Welsh. Ball and Thomas (2012) report that studies have found a continual progression across age (4;6 – 9 years) in relation to children’s productive command of Soft Mutation (SM) after certain triggering prepositions. Other contexts for SM and the other two mutation systems do not show such progression, however and the authors feel this may indicate a change in progress (see also Awbery, 1986). It may well be that the lack of information on mutation usage under the age of 4;6 is a result of the *rhaeadr* effect; until the onset stop and fricative system is fully established,

it is not possible to know whether mutations are being used or whether substitution patterns are still in operation. It would be most interesting to look at the beginnings of the mutation system, however, in children between the ages of 3;6 and 4;6.

Disordered Speech in Welsh

There are also few published studies of disordered speech in Welsh, and those studies that do exist are almost exclusively on child disordered speech. One investigation that did study phonological difficulties in Welsh/English bilingual children, was that by Munro (1985). Munro gave detailed accounts of two children: Nigel and Rhodri. Nigel's phonetic inventory was extremely limited, as seen in Table 7.

{ Table 7 about here }

Rhodri, on the other hand, had a larger phonological system, shown in Table 8.

{ Table 8 about here }

Having no stops or fricatives, word initially (or indeed elsewhere) demonstrates the *rhaeadr* effect. Nigel could not mark SM or AM even if he wished to, as he lacked the phonetic capability to produce either the radical (i.e., unmutated consonant) or the mutation reflexes. Technically, he

could produce the reflexes of NM at the labial and apical positions but, as he could not produce the radical forms, a listener would not know if NM was truly in operation. Nevertheless, as Nigel's usual realization of initial plosives was [ʔ], it could be argued that NM was at least a feasible explanation were any initial labial or apical plosives realized as nasals.

Rhodri had a fuller inventory and the contrastive phones in his word initial system were [p], [b], [t], [d], [m], [n], [f], [v], [l], [w] and [ʔ].³ Velars were not fully established in word initial position (but were in word final); apart from this Rhodri did have control over fortis-lenis pairs, thus one aspect of SM could be marked. He did not, however, have productive control over the full range of fricatives, meaning that the SM reflexes of /d, g/, and the AM reflexes of /t, k/ would be missing (Rhodri exhibited fricative simplification to the labiodental position).

It would be interesting to investigate possible *rhaeadr* effects with speakers with acquired motor speech disorders, though a search of the literature suggest that no such studies have yet been published. The typical weak articulations of many speakers with dysarthria could well obscure the distinction between stops and fricatives (thus affecting aspects of both SM and NM), and the typical phonation control problems often encountered in apraxia of speech could also affect SM. Finally, the problems with the oral-nasal distinction in various types of acquired speech disorders could affect the ability to signal NM.

³ The vertical brackets denote contrastive phones, i.e. this speaker's 'phonemes' (Grunwell, 1985).

Irish

Irish, like Welsh, has initial consonant mutations. However, the systems differ. There are two main mutation types traditionally termed ‘lenition’ and ‘eclipsis’. With lenition, radical stops become fricatives. Usually the place of articulation is unaffected, but coronal consonants (due to the loss of dental fricatives in Middle Irish) move further back to the palatal or velar positions. Lenition also affects the bilabial nasal and certain fricatives. Eclipsis involves the voicing of radical voiceless stops (and the voiceless labiodental fricative), and the nasalization of radical voiced stops. Mutation triggers include gender, case, possessives, numerals, and syntax (e.g. relative clause markers may be omitted in colloquial speech leaving the mutation as marker of the clause type). For more details of the triggering contexts, see Ó Baoill (2010).

Table 9 shows the changes involved in both lenition and eclipsis in both orthography and IPA symbols. The system is somewhat complicated by the fact that many consonants exist with both palatalized and velarized pairs, and we show these pairs in Table 9. There are various ways in which this difference is shown in the orthography, but Table 9 shows only the simple orthographic form, unmarked for palatalization or velarization.

{Table 9. about here}

Studies of speech disorders in Irish are even more difficult to find than those in Welsh. There are, however, some studies of normal acquisition. Perhaps the most detailed of these that concentrates on phonology is Brennan (2004), an added factor is that this study was designed to

give speech-language pathologists normative data against which to assess possible speech sound disorders in Irish-speaking children. Twelve children between the ages of 1;0 and 3;0 took part in this investigation and, among other analyses, phonological substitution patterns were charted. The following patterns would all interact with the ability to mark one or other of the two mutation types:

Initial consonant deletion. This was noted with the mutable consonants /k, g, f, s, ʃ/, but was found less often than final consonant deletion.⁴ There is clearly an example of the *rhaeadr* effect here; no initial consonants, no initial consonant mutation.

Stopping. Brennan (2004) notes that this pattern was rarely found, with just target apical sibilants affected (realized as apical plosives). As /s/ only enters the lenition mutation system this pattern would have a minimal *rhaeadr* effect.

Voicing. This pattern applied widely, with target initial voiceless consonants being realized as voiced. Although mostly found in children under 3;0, it did persist variably after that age. Clearly, with aspects of eclipsis requiring the voicing of radical voiceless plosives, this pattern has *rhaeadr* effect possibilities, in that words will appear to be marked for the mutation (correctly or incorrectly) when, in fact, this is simply an artifact of the developmental phonological pattern.

⁴ Interestingly, initial consonant deletion is rarely reported as a naturally occurring pattern in phonological development cross-linguistically. Indeed, Bowen (2009) calls it a ‘red flag’ for speech sound disorders if found in English.

It might of course be argued that these interference patterns being normal phonological development and initial consonant mutation marking are not important if children of the age ranges reported in Brennan (2004) are not attempting mutations anyway. However, the study shows that use of both mutation types can be found in the children in the 2;0 – 3;0 age ranges, increasing thereafter (though examples of overgeneralization are also reported).

Conclusions

I got to know Tom Powell through a shared interest in clinical phonology, and also a shared background in Welsh as a second language. This article, therefore, is partly a reflection of these interests. It is also, however, an attempt to balance the bucket theory of language processing with a comparable theory of language production. The *rhaeadr* effect is not only for marking the effect of phonetic/phonological patterns on the realization of lexical, morphological, and syntactic features, as concentrated on above. One could also imagine an overflow between a purely morphological deficit (i.e. not due to phonological disruption) and syntax (for example a failure to marked case in languages where fixed order is not mandatory, or in pro-drop languages); or when syntax errors overflow into sentence semantics, and so on. Whether or not *rhaeadr* survives as a term, the concept is surely a useful one and, who knows, the term might just survive to join the limited number of Welsh words that have gained a wider currency.

Statement of Interest

The author reports no conflict of interest.

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Tables

<i>radical</i>		<i>SM</i>		<i>NM</i>		<i>AM</i>	
orthography	IPA	orthography	IPA	orthography	IPA	orthography	IPA
p	p	b	b	mh	m ^h	ph	f
t	t	d	d	nh	m ^h	th	θ
c	k	g	g	ngh	ŋ ^h	ch	χ
b	b	f	v	m	m		
d	d	dd	ð	n	m		
g	g	deleted	--	ng	ŋ		
m	m	f	v				
ll	ɭ	l	l				
rh	r ^h	r	r				

N.B. Unfilled boxes mean that the mutation does not changes the radical in these cases

Table 1. Initial Consonant Mutations in Welsh

	<i>Radical</i>	<i>Mutated form and mutation</i>
noun gender; marking feminine	cath, 'cat'	y gath, 'the cat' SM
noun gender; marking feminine	cath	un gath, 'one cat' NM
noun gender; marking feminine	cath	cath fawr, 'big cat' NM
noun gender; marking masculine	ci 'dog'	y ci, 'the dog' no mutation
noun gender; marking masculine	ci	un ci, 'one dog' no mutation
noun gender; marking masculine	ci	ci mawr, 'big dog; no mutation

Table 2. Noun gender

	<i>Radical</i>	<i>Mutated form and mutation</i>
masculine singular possessor	cath, 'cat'	ei gath, 'his cat' SM
feminine singular possessor	cath	ei chath, 'her cat' AM
plural possessor	cath	eu cath, 'their cat' no mutation
masculine singular possessor	afalau	ei afalau 'his apples' no PVA
feminine singular possessor	afalau	ei hafalau, 'her apples' PVA
plural possessor	afalau	eu hafalau, 'their apples' PVA

N.B. *ei* and *eu* are usually pronounced the same in colloquia Welsh (/i/).

Table 3. Possessives

	<i>Radical</i>	<i>Mutated form and mutation</i>
yn as complementizer	tenau, ‘thin’	mae Ieuan yn denau ‘I. is thin’ SM
yn as verbal aspect marker	teithio, ‘travel’	mae Ieuan yn teithio ‘I. is travelling’ no mutation
yn as preposition	Talybont, place-name	mae Ieuan yn Nhalybont ‘I. is in Talybont’ NM
yn as complementizer	byw ‘alive’	mae Llinos yn fyw ‘Ll. Is alive’ SM
yn as verbal aspect marker	byw ‘live’ (verb)	mae Llinos yn byw ‘Ll. Is living’ no mutation
yn as complementizer	caer ‘castle, city’	mae ef yn gaer ‘it is a castle’ SM*
yn as preposition	Caer ‘Chester’	mae ef yng Nghaer ‘he is in Chester’ NM

*Admittedly, this example would not represent colloquial usage.

Table 4. Usages of *yn*

	<i>Radical</i>	<i>Mutated form and mutation</i>
Personal name as subject	cathod ‘cats’	gwelodd Ieuan gathod ‘I. saw (some) cats’ SM
Pronoun as subject	cathod	gwelodd ef gathod ‘he saw cats’ SM
Pro-drop at subject	cathod	gwelodd gathod ‘he saw cats’ SM
intransitive usage	cathod	gwelodd cathod ‘cats saw’ no mutation
intransitive usage	ef	gwelodd ef ‘he saw’ no mutation

Table 5. Direct objects of inflected verbs

<i>sentence type</i>	<i>literary</i>	<i>spoken</i>
positive statement	gwelodd Llinos y gath	gwelodd Llinos y gath*
negative statement	ni welodd Llinos y gath	welodd Llinos mo'r gath
positive question	a welodd Llinos y gath?	welodd Llinos y gath?
negative question	oni welodd Llinos y gath?	welodd Llinos mo'r gath?

*Alternate spoken forms use a positive statement particle followed by SM: *fe welodd .../mi welodd ...*

Table 6. Presentential particles

				ʔ
m		n		
				h
w	ʋ	l	j	
m ^ɹ *				

Table 7 Welsh Phonetic Inventory for Nigel

p b		t d	k g		ʔ
m		n			
		l			
	f v			x	
		ɬ			
	ʋ				

Table 8 Welsh Phonetic Inventory for Rhodri

<i>radical</i>		<i>Lenition</i>		<i>Eclipsis</i>		
orthography	IPA	orthography	IPA	orthography	IPA	
p	p ^v	ph	f ^v	bp	b ^v	velarized
	p ^j		f ^j		b ^j	palatalized
t	t ^v	th	h	td	d ^v	velarized
	t ^j		h		d ^j	palatalized
c	k	ch	x	gc	g	velarized
	c		ç		ʝ	palatalized
b	b ^v	bh	w	mb	m ^v	velarized
	b ^j		v ^j		m ^j	palatalized
d	d ^v	dh	ɣ	nd	n ^v	velarized
	d ^j		ɟ		n ^j	palatalized
g	g	gh	ɣ	ng	ŋ	velarized
	ʝ		ɟ		ɲ	palatalized
m	m ^v	mh	w			velarized
	m ^j		v ^j			palatalized
s	s ^v	sh	h			velarized
	ʃ		h			palatalized
f	f ^v	fh	deleted	bhf	w	velarized
	f ^j		deleted		v ^j	palatalized

N.B. Unfilled boxes mean that the mutation does not change the radical in these cases

Table 9. Initial Consonant Mutations in Irish

Figure Title

Figure 1. The *rhaeadr* effect in Welsh of disruptions to vocal fold timing.