Regularity and lexical diffusion in phonological change

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Abstract

There has been a tension in the historical linguistics literature between two different accounts of phonological change: regular Neogrammarian sound change and lexical diffusion. This chapter provides a summary and analysis of this debate, but also problematizes previous theoretical interpretations. First, we introduce the historical background to the debate about the regularity of sound change, and then discuss the evidence for lexical diffusion and for Neogrammarian change. We answer some questions about diffusion: when it occurs, how it spreads, and whether it eventually leads to regularity. We then move on to a more theoretical perspective of sound change, discussing the relationship of Neogrammarian change and diffusion to synchronic phonological theories, particularly stratal models and exemplar theory.

1.1 Historical background

When a language undergoes a sound change, what part of the language actually changes: does a sound change happen because the speaker modifies individual words? Or does it happen because something about the phonology of the language is altered, such as the realization of a particular phonological category? If the first is true, we should see sound changes taking place by *lexical diffusion* (Chen and Wang 1975, Cheng and Wang 1977), where a change gradually moves through the lexicon word by word in a way not itself conditioned by phonology. If the second, we should see sound changes applying abruptly to all words in the lexicon at once, conditioned by some phonological property - in other words, we should see regular sound change.

The idea that sound change is regular is most closely associated with the Neogrammarians, a group of philologists active in Europe during the 1870s. The Neogrammarian position was stated clearly by Osthoff and Brugmann (1878): "… every sound change, inasmuch as it occurs mechanically, takes place according to laws that admit no exception" (translation from Lehmann 1967: 204, cited in Labov 1981).

There are various ways to read this view: as a factual claim about sound changes, as a *definition* of sound change, or just as a working assumption for the goals of historical and comparative linguistics. For the latter purpose, the Neogrammarian mindset had an early victory with Karl Verner's (1877) analysis of Germanic stops. At least since an essay by Rasmus Rask in

1811/1818, it had been known that Proto-Germanic stops correspond in a chain-shifted way to stops in the other Indo-European languages, by the rule later known as Grimm's Law: PIE *$p\ t\ k\ k^w$ > *$f\ \theta\ \chi\ \chi^w$, *$b\ d\ g\ g^w$ > *$p\ t\ k\ k^w$, and *$b^h\ d^h\ g^h\ g^{wh}$ > *$\beta\ \eth\ \gamma\ \gamma^w$.

It became clear that not all stop correspondences between Germanic and the rest of Indo-European would fit neatly into this pattern - there were some instances of *$\beta\ \eth\ \gamma\ \gamma^w$ corresponding to IE *$p\ t\ k\ k^w$, superficially contradicting Grimm's Law. But Verner noticed that these apparently irregular correspondences were in exactly those instances where the PIE consonant was preceded by an unaccented vowel. He proposed Verner's Law: a voicing of *$f\ \theta\ \chi\ \chi^w$ > *$\beta\ \eth\ \gamma\ \gamma^w$ after an unaccented vowel, taken to occur later in history than Grimm's Law. Explaining a puzzling case of apparent irregularity in terms of the action of two regular sound changes vindicated the Neogrammarian view that sound laws admit no exception.

In total, the Neogrammarians recognized three categories of change: regular sound change, analogy, and borrowing. If a change is apparently non-Neogrammarian - 'irregular' - and could not be explained by a Verner-style analysis in terms of interacting regular sound changes, then the Neogrammarian view was that it must either be analogical to other forms in the language or the result of borrowing from speakers of another language or dialect. In a way, the literature on lexical diffusion that we will come to later respects this Neogrammarian typology: as Kiparsky (1995) commented, we can view diffusion as not really a kind of sound change at all, but a kind of analogy. It's in this sense that the Neogrammarian *Ausnahmslosigkeit der Lautgesetze* ('exceptionlessness of sound laws') could be treated as a definition of 'sound change', if we view sound change and diffusion as different mechanisms.

The alternative to the Neogrammarian view was summarized by the slogan *chaque mot a son histoire* ('each word has its own history'), which Campbell (1998: 212) attributed to the early Neogrammarian-skeptic Hugo Schuchardt. In this view, associated with the 'wave theory' that treats historical change as moving in waves of innovation, the Neogrammarian idea of a sound change applying to every appropriately-shaped form in the language should be replaced by a picture in which each word can either join or resist a wave of change. Schuchardt (1885: 58; translated by Vennemann and Wilbur 1972) summarized a precursor to the lexical diffusion position: "Rarely-used words drag behind; very frequently used ones hurry ahead. Exceptions to the sound laws are formed in both groups." In Normandy French (Bynon 1977: 181), for example, the usual French shift of *$k > ʃ$ failed to apply except to a handful of items such as *chaîne* 'chain'. Dialectologists and etymologists with the *chaque mot* view treated this as a failure of Neogrammarian regularity, where a full explanation of the *$k > ʃ$ shift would depend not on a single sound change applying to the French lexicon as a whole, but on an individual explanation for why each word did or didn't undergo the change (see section 2.1 for one possible explanation).

1.2 Evidence for lexical diffusion and for Neogrammarian change

Today, the existence of lexical diffusion is usually not questioned. However, one finds that the role of anything other than Neogrammarian sound change is downplayed significantly in the

literature. As we have seen, the Neogrammarians themselves attributed a lack of regularity to the independently-required phenomena of analogy and dialect borrowing. We can expand the latter to include borrowing from any other variety than the one in question, be it a dialect, sociolect, ethnolect etc. Such attitudes to lexical diffusion are still found today in some works: for example, Joseph and Janda (2003: 115) stated that apparently diffusing changes "are actually epiphenomenal, being the result of already-needed mechanisms of analogical change and dialect borrowing" (cited in Phillips 2006: 124).

Lexical diffusion could also be reduced to an age of acquisition effect, illustrated here with a hypothetical example.[1] A child is born in a situation where young speakers have an innovative sound change X > Y which is not found in speakers of the previous generation. The child's parents therefore only use X, and the child acquires X in words learnt from their parents. But as the child grows up and learns new words from their peer group, these words have undergone the sound change X > Y and so the child acquires Y in these words. The end result is that a sound change X > Y has affected only some of the words in which X > Y could apply. However, no actual diffusion has taken place, as the distribution of X and Y arose as a consequence of the age of acquisition of individual words. In a way, this type of situation also involves contact between two different varieties, but age of acquisition effects do not obviously involve borrowing, so they are not subsumed under dialect borrowing here.

Despite these explanations, which seek to derive lexical diffusion patterns from other factors, we take the position in this chapter that lexical diffusion does exist, and is at least partly independent from the factors outlined above. We do not deny that analogy, borrowing and age of acquisition effects can lead to situations where a sound change has not applied regularly. However, we do recognise a role for lexical diffusion which does not arise from these forces alone. This section considers one example of what we consider to be a lexically diffusing change, and we will spend some time on ruling out alternative explanations.

The example comes from Tyneside English, and concerns the process which Wells (1982) called T-to-R, and which Carr (1991) dubbed 'weakening'. In a fairly small set of words, /t/ is optionally realised as [ɹ] intervocalically, merging with the rhotic /ɹ/ phoneme (Buchstaller et al. 2013: 91), so that *shut up* may be pronounced [ʃʊɹʊp] (Wells 1982). Wells described T-to-R mainly in phrases, and noted that T-to-R is only applied word-internally "very occasionally" (Wells 1982: 370). Subsequent studies of this phenomenon have confirmed this general picture (Carr 1991, Docherty et al. 1997, Broadbent 2008, Buchstaller et al. 2013, Honeybone 2015 and others).

Comparing the more recent literature with that from the early 1990s, it is clear that the later literature found that T-to-R is possible in a greater number of words than was previously known. Thus, Docherty et al. (1997) considered the words reported to undergo T-to-R in Carr (1991), but also reported the change in a number of words not presented by Carr, including *putting* and *bottom*. And in 2013, Buchstaller et al. wrote that: "It seems, however, that the previously reported set of

[1] We are not aware of age of acquisition being used to explain lexical diffusion previously. However, age of acquisition is well known to affect a range of linguistic phenomena, including performance in word reading (Zevin and Seidenberg 2002) and spoken word recognition (Garlock, Walley, and Metsala 2001).

words may need to be expanded, at least for Tyneside English" (Buchstaller et al. 2013: 115). They mentioned as examples the words *cut*, *shot*, and *regret*, all of which allowed T-to-R for the speakers they consulted. The increasing set of words which undergo T-to-R also involves new contexts where T-to-R was previously thought to be limited or impossible. This includes nouns (*(a) bit (of)*; Carr (1999) claims that nouns except for *(a) lot (of)* do not undergo it), and words with tense/long vowels before the /t/ (*caught, meet, eat, bought*; Wells (1982) claimed that a preceding short vowel is part of the environment). It thus seems clear that the scope for T-to-R is expanding, not only lexically, but also morphosyntactically and phonologically.

Tyneside English T-to-R thus seems like a good candidate for a lexically diffusing rule. However, before we conclude that this is the case, we should first consider the alternative explanations of analogy, borrowing from other varieties, and age of acquisition effects. The analogy-based explanation suffers from a number of drawbacks when applied to the T-to-R case. A fuller discussion of lexical diffusion as analogy is found in section 3, where we discuss in particular the implementation of Kiparsky (1995). We therefore leave discussion of some points until that section, and focus here on one of the critiques of this approach which is independent of implementation. Phillips (1998a, 2006) provided an argument against lexical diffusion as analogy based on the types of frequency effects involved. It is well known that the words which undergo T-to-R are all high-frequency words, and this correlation has been shown to be statistically significant (Buchstaller et al. 2013). But analogical levelling typically applies to low-frequency words first (Bybee 2002, Phillips 2006, De Schryver, Neijt, Ghesquière and Ernestus 2008); for example, in morphosyntactic change, irregular verbs which become regular tend to be of very low frequency. These regularizations rarely affect high-frequency verbs such as 'to be', 'to see', 'to do' etc. So it does not seem that the mechanism of analogy can explain how the T-to-R change is diffusing through the lexicon. We will have more to say about changes based on high and low frequency in section 2.2.1.

How did varieties where T-to-R is lexically restricted first come about? Could this be explained through contact between two different varieties? Such an explanation relies on contact between one variety which has no T-to-R, and another which has consistent T-to-R.[2] The former would then borrow from the latter, such that the end result is a mixed variety where some words undergo T-to-R and others do not. Borrowing has the potential to explain the fact that high-frequency words are the ones which are affected first. Words like 'not' and 'put' are ones which speakers without T-to-R are very likely to hear pronounced with [ɹ] by the T-to-R speakers. They can then be subject to borrowing between varieties. By contrast, lower-frequency words like 'knot' and 'pit' are less likely to be heard with [ɹ] by speakers without T-to-R; they are therefore likely to retain their non-rhotic pronunciation. However, after many decades of studies of T-to-R in a large number of locations across Northern England, it is clear that only a small set of words is ever affected (though the set may vary between dialects; see Wells 1982, Carr 1991, 1999, Docherty et

[2] Once varieties with lexically restricted T-to-R exist, they could of course borrow individual words from each other, such that the set of words undergoing T-to-R may either shrink or expand due to contact. But here we are concerned with whether the creation of these varieties in the first place could be due to contact rather than diffusion.

al. 1997, Asprey 2008, Broadbent 2008, Clark and Watson 2011, Buchstaller et al. 2013 and Honeybone 2015 among others). There are no varieties with consistent T-to-R. As this was a necessary assumption for our contact-based argument, it does not seem possible to explain the fact that T-to-R is restricted to only a small part of the lexicon by means of contact between varieties, typically termed dialect borrowing by the Neogrammarians.

The final explanation for T-to-R that we will consider is diffusion as an age of acquisition effect. Recall from the beginning of this section that age of acquisition effects rely on the sound change in question being innovative, and not found in older generations of speakers. An additional assumption is that what we have treated as a frequency effect is actually primarily an effect of the age at which the words are acquired, with high-frequency words typically being acquired early on (see Phillips 2015 for discussion of the potential confound between frequency and age of acquisition). Both of these assumptions appear to be incorrect. Docherty et al. (1997) presented a variationist study of T-to-R, including its rate of application in groups divided based on age and social class. They concluded that the highest rate of application of T-to-R is found in working-class speakers, and especially old working-class speakers, with younger middle-class speakers showing much lower rates of T-to-R. Petyt (1985) also observed that T-to-R is used more by older speakers. The age-based effect is thus the precise opposite of what the Age-of-Acquisition account predicts. It also does not seem to be the case that the recent additions to the set of words undergoing T-to-R — like *regret*, *cut*, *shot* — have an early age of acquisition in common with each other.

We are therefore led to conclude that T-to-R in Tyneside English represents a genuine case of lexical diffusion. There are several alternative interpretations of the data which do not involve diffusion, all of which make different, clear predictions, and/or rely on different sets of assumptions. Fortunately, the amount of previous research on T-to-R allows us to test whether these are reasonable, and in every case, the answer appears to be negative. Analogy makes the incorrect prediction that low-frequency words are affected first, the opposite of what the data show. Dialect borrowing is not viable, as there are no varieties where T-to-R is applied consistently to all word-final /t/s. Finally, an explanation based on age of acquisition makes the incorrect prediction that younger speakers are leading the T-to-R change, while the available evidence suggests that the opposite is true, with older speakers more likely to use T-to-R.

Having established that lexical diffusion exists, we will now ask whether Neogrammarian-style sound change also exists, or whether all changes diffuse, only at different rates. As Labov (2010: 261) commented, there has been more discussion in the literature of cases involving lexical diffusion than those involving Neogrammarian change; but this is more of a selection bias than a fact about sound change. Just as ‘man bites dog’ is news in a way that ‘dog bites man’ isn’t, historical and comparative linguists will assume every sound change is regular unless there is evidence to the contrary: “the finding that a given change follows a regular Neogrammarian path is not a publishable result” (Labov 2010: 259). To know whether lexical diffusion really is the only route for a sound change to take hold in the lexicon, we would need to look in more detail at the changes claimed to be Neogrammarian rather than just assuming it by orthodoxy.

It turns out that, even under more careful examination, there is evidence for instantaneous, lexically-regular sound changes. Janson (1983) describes the areal shift from apical [r] to uvular [ʀ] in both the Romance and Germanic languages of western Europe as a genuinely Neogrammarian change. From Nauton's (1957) dialectological description of Massif Central French, we see no evidence of diffusion - both [r] and [ʀ] exist as variants throughout the region, conditioned roughly by [r] being more common for older speakers and [ʀ] being an innovation in younger speakers. No lexical conditioning is found for any speakers. Janson came to the same conclusion from Foldvik's (1979) description of the [r] > [ʀ] shift in Scandinavia, where we see no lexical diffusion at any point in the spread from Norwegian cities into the surrounding countryside.

Labov (2014) argued for a similar lack of evidence for lexical diffusion in the raising of /eɪC/ in Philadelphia English. Using the FAVE program for automatic alignment and measurement of vowel tokens, Labov et al. (2013) categorized some 56,748 tokens of /eɪ/ in the Philadelphia Neighborhood Corpus, a database of sound files collected from speakers with dates of birth between 1888 and 1992. A multiple regression analysis found evidence for social conditioning by age, gender, and ethnicity, and phonological conditioning by the features of the consonant /C/, but no good evidence for any conditioning by frequency. Labov concluded that the raising of /eɪC/ in Philadelphia applied to the whole lexicon at once, rather than to any progressively increasing subsets that we might interpret as lexical diffusion.

2.1 How can we reconcile Neogrammarian change with lexical diffusion?

Given the apparent existence of both Neogrammarian change and lexical diffusion, Labov argued for a view of the grammar that involves both (1981: 304; quoted in Janson 1983): "We have located Neogrammarian regularity in low-level output rules, and lexical diffusion in the redistribution of an abstract word class into other abstract classes. I do not propose to resolve the original confrontation into a simple dichotomy - that here words change, there sounds change. I have exhibited two polar types, and have analysed the clusters of properties that created these types. The whole array of sound changes will undoubtedly show many intermediate combinations of these properties of discreteness, abstractness, grammatical conditioning, and social conditioning."

Labov proposed that regular sound change comes from gradual phonetic change, at the level of the phonetic component of the grammar. Lexical diffusion, on the other hand, comes from abruptly substituting one phoneme for another on a word-by-word basis. More accurately, Labov points out, this happens on a stem-by-stem basis; there are apparently no examples of a sound change diffusing through identical environments in the forms of a single paradigm. As an example of (in this case, incomplete) diffusion resulting from substitution of whole phonemes, Labov cites Bonebrake's (1979) discussion of the lexically irregular change from [x] to [f] in the history of English, giving *cough*, *laughter* but *dough*, *daughter*. Rather than being encoded in the phonetic component, a discrete change like [x] > [f] happens when the learner sporadically assigns some words to a new phonological category. On the other hand, Labov's own example of

affrication/spirantization of postvocalic stops in Liverpool English *is* a gradient change, and so is encoded in the phonetic component and behaves like a Neogrammarian change. It is no coincidence, he commented, that a similar leniting shift like Grimm's Law was the Neogrammarian sound change *par excellence*.

As Bermúdez-Otero (2013) described, this gives us a mirror-image picture of Neogrammarian change and lexical diffusion. Neogrammarian change is phonetically gradient but lexically abrupt, in the sense that a change will apply to the whole lexicon at once, but with potentially only a small phonetic difference from the previous generation. Lexical diffusion is lexically gradient but phonetically abrupt: a change diffuses through the lexicon word by word, but because the change involves substituting phonemes for other phonemes, each word undergoes a discrete jump from one articulation to another. Labov (1994: 542) gave a sociolinguistic correlate for each of these descriptions: while Neogrammarian change ('change from below') should be below the level of social awareness, lexical diffusion ('change from above') should be above the level of social awareness and subject to conscious analogy.

This makes a prediction that, out of the four logically possible combinations of 'lexically gradient/abrupt' and 'phonetically gradient/abrupt', only two should exist: we shouldn't see changes that are phonetically abrupt and Neogrammarian, or changes that are phonetically gradient and spread by lexical diffusion. If we believe Janson's analysis mentioned earlier, the first of these predictions is suspect: the change in western Europe from apical [r] to uvular [ʀ] is phonetically abrupt, given that it involves a discrete change in place of articulation, but the evidence both from France and from Scandinavia is that it applies in a Neogrammarian way to the whole lexicon at once.

There have been some attempts to show that the second position is false. One case study comes from Bybee (2002), who gave the example of the deletion of word-final, post-consonantal /t/ and /d/ in American English, in forms like *just* or *child*; Labov (1972) showed that this rule varies by consonantal environment, by grammatical class, and by social status. The study by Bybee (2000) on Chicano English speakers in Los Angeles found that /t/ and /d/ deletion does in fact vary according to frequency, with high-frequency words more likely to lose /t/ or /d/ in this environment than low-frequency ones. Naïvely, the deletion of a whole consonant has been assumed (e.g. by Labov 1994) to be a discrete process; but Bybee argued that this change in the case of English is phonetically gradient, where the length of the consonant can vary continuously. Losiewicz (1991) found that the length of a final stop /t/ or /d/ in the past tense of a verb covaries with the frequency of the verb, suggesting that we are seeing a phonetically gradient change conditioned by frequency. The evidence is clear enough that consonant deletion can be phonetically continuous; but to be a counterexample to Labov's prediction, we need hard evidence that the change is diffusing. The studies by Bybee and Losiewicz showed that deletion is conditioned by frequency, but this in itself is not evidence for lexical diffusion (as opposed to a static but lexically-defined synchronic pattern).

Other studies have complementary flaws. Krishnamurti's (1998) study of s > h > Ø in Gondi gave ample evidence for diffusion. Discussing s > h in particular, Krishnamurti claimed that "there

is no evidence" for it being phonetically abrupt (1998: 211). However, this is also the only argument given for s > h being phonetically gradual. While we do not doubt that debuccalisation could be gradual, this has not been shown to be the case for s > h (or h > Ø) in Gondi; and so, like Bybee's example, Krishnamurti's is not a strong counterexample to Labov's prediction.

One case study that we believe does give strong evidence for both phonetic and lexical gradualness comes from Ogura's (1987) discussion of the history of English, cited in Phillips (2006). Ogura shows that the effect of the Great Vowel Shift on the Middle English high vowels /i:/ and /u:/, which is to diphthongize them to /aɪ/ and /aʊ/ respectively, happened by lexical diffusion. In the case of /u:/ the effect of word frequency is clear in that more frequent words with /u:/ are more diphthongized at each stage; Phillips claimed, based on her own analysis, that we also see some frequency effects for /i:/. Because the evidence comes from the historical record, and because we know the Great Vowel Shift did reach completion in some varieties, Ogura's study gave evidence for diffusion in a way that Bybee's did not. The change is also known to be phonetically gradual, unlike Krishnamurti's example; Ogura listed a range of phonetically intermediate variants at each stage. We conclude, along with Phillips, that the Great Vowel Shift in English is a problematic example for Labov's prediction that diffusing sound changes should always be phonetically abrupt.

2.2 Which words are the first to undergo diffusion, and why?

As discussed by Phillips (2015), there is a perception in some of the literature on sound change that lexical diffusion must somehow be random, unpredictable or irregular. For example, Labov (2014: 31) wrote that "[l]exical diffusion is defined by arbitrary and unmotivated selection." We instead take the position that there are factors which can determine which words are affected first, and how the change diffuses through the lexicon. This section examines some of those factors with case studies from the literature, and considers the mechanisms whereby they can govern the diffusion. The factors discussed here are frequency, part of speech, and what will loosely be termed cultural significance.

2.2.1 Frequency

In section 1.2 we saw an example of diffusion affecting high-frequency words first, in our case study of T-to-R in Tyneside English. There are many other documented cases of lexical diffusion with this kind of frequency effect, including the above-mentioned change s > h > Ø in Gondi (Krishnamurti 1998). Janson (1977) also reported that the small set of words in Stockholm Swedish which allow word-final /d/ deletion have high frequency in common. This case is particularly interesting, as the d > Ø change is no longer diffusing in modern Stockholm Swedish (in fact, the change is reversing; see section 2.3). Thus, not all of the words which undergo the change are high-frequency words today. One example is *vedbod* 'shed for firewood', which allows /d/ deletion for all of Janson's consultants, as well as for the present first author, who is a native speaker of

Stockholm Swedish. The change began in pre-industrial times, and while 'shed for firewood' may have been of relatively high frequency at a time when log fires were the main source of heating, it is no longer one of the 100,000 most frequent words in the language (PAROLE corpus, Språkbanken). As the change is no longer productive, the frequencies are those of a previous stage of the language.

Bybee (2003) discussed why high-frequency words can become the initial or only targets of diffusing sound changes. Fowler and Housum (1987) observed that the second repetition of a word in a discourse is durationally shorter than the first. Words of high frequency, which are thus more likely to be repeated within discourses, are more likely to be reduced, and this can provide the seed of reductive sound change. Note that all of the changes cited above as targeting high-frequency words are ones which involve reductions and deletions. The change T-to-R is not obviously a reduction in synchronic terms, but diachronically it is believed to have arisen by means of intervocalic tapping of /t/ and /d/ (Honeybone 2015). Phillips points out that in general, changes based on high frequency also affect words which are especially frequent for some speakers. For example, in the Ormulum, which was written by a monk, the words *priest*, *heaven*, and *devil* pattern with other words of high frequency (Phillips 1984: 330).

Bybee viewed this connection between high frequency and reductive changes as an important one, arguing that "only sound changes that are articulatorily motivated affect high frequency words first" (de Schryven et al. 2008: 7, citing Hooper 1976 and Bybee 2001, 2002). We do not doubt the existence of the mechanisms she proposes, but we wish to note that situations can arise where even non-reductive changes could be the subject of lexical diffusion based on high frequency. High-frequency words being shorter than low-frequency words does not only mean that they will be more likely to be reduced articulatorily. A shorter duration makes the recognition task more difficult for the hearer, and thus makes sound changes based on misperception or reanalysis of an ambiguous input more likely. Not all such sound changes have to be reductive, as exemplified by metathesis. Metathesis is most common with features which are realised over a larger phonetic domain than the segment, leading to reanalysis of the underlying location of the feature on the part of the hearer (Blevins and Garrett 1998, Blevins 2004). For this reason, it would not be surprising if we found cases where a metathesis process is diffusing, affecting higher-frequency words first.

There are also sound changes where neither articulatory reduction nor perceptual reanalysis seems to be involved, and yet diffusion based on high frequency is found. One example is /æ/-tensing before voiceless fricatives in Philadelphia, where Labov (1994) reported that only common (and monosyllabic) words are affected. Both the articulatory and the perceptual accounts would predict centralisation in these short high-frequency words. How, then, is the change [æ] > [eːᵊ] (using the transcription from Labov 1981) to be understood? We would like to suggest that this may arise due to contact between different closely-related varieties. Some speakers had tensing quite generally before voiceless fricatives, described as the "Philadelphia core pattern" by Labov (1981: 285). Others without tensing in this environment acquired it from the fricative-tensing speakers and only heard and acquired the tense vowels in the words they heard from those speakers. The words they tended to hear were of course more likely to be common, high-frequency

words rather than uncommon, low-frequency ones. It would presumably be possible for speakers who are exposed to tense vowels before voiceless fricatives to infer a general rule applying to all words. However, tensing in Philadelphia is already well known to exhibit lexical exceptions consistent across very many speakers, e.g. unexpected tensing before voiced stops in the three words *mad, had, glad*, and not in similar words such as *sad* (Labov 1981: 286). The fact that lexical exceptions already exist may have favoured item-by-item acquisition of the tense/lax contrast rather than a general rule being inferred.

It has also been reported that there are lexically diffusing changes where low-frequency words are those which are affected first (see Hooper 1976 and Bybee 2003 for discussion). One oft-cited example is the unrounding of the mid front rounded /ø/ vowel in Old English, studied using The Ormulum as a corpus by Phillips (1984). We believe, however, that such apparent cases of diffusion do not actually involve diffusion at all, much like the apparent diffusion of /æ/-tensing discussed above, if our contact-based explanation is true. Both the effects as well as the proposed mechanisms by which such apparent diffusions occur are identical with those of analogy. This is far from a new observation, and these diffusions were explicitly called "analogical change" by Bybee (2002: 269). Kiparsky (1995) also argued, presumably based in part on cases like these, that all lexical diffusion can be accounted for using analogy (see sections 1.2 and 3 for discussion of this position). Accounting for at least low-frequency diffusions with analogy is the only explanation found in the literature known to us. Nevertheless, they have often been called, somewhat misleadingly, lexical diffusion by some authors (including Bybee 2002 and Phillips 2006, 2015). The treatment of these changes as analogical makes a number of predictions. As the proposed mechanism is analogical levelling, there must already be a category in the language which serves as the analogical base for the levelling. In other words, all diffusing changes based on low frequency should be neutralising changes, such as the /ø/ > /e/ change in Old English, where the language already had an /e/ phoneme. We do not expect any non-structure-preserving changes to diffuse by beginning with low-frequency words and gradually spreading to words of increasingly higher frequency. A possible counterexample is the k > ʃ shift in Normandy French discussed in section 1.1, which began with the words for 'candle', 'song' and 'chain' rather than more frequent words such as *chambre* 'room'. However, this change seems to have involved dialect contact, with Normandy French having /k/ in all positions but borrowing words from Standard French, which had ʃ in all positions (Bynon 1977). It seems likely that the words borrowed from a prestigious variety of a language into a less prestigious one should be prestige vocabulary, which tends to be lower in frequency. The case is thus not a counterexample, because of the potential confound between prestige vocabulary and frequency of use. We are not aware of any other counterexamples to this prediction, nor any proposed mechanisms for sound change which would lead to the creation of such counterexamples.

2.2.2 Part of speech

A number of lexically diffusing changes have been reported to affect only one part of speech, often function words. Examples argued to work this way include a voicing rule in Palu'e which applies preferentially to "the small set of bound grammatical morphemes" (Donohue 2005: 427), and pre-nasal raising of /ɑ/ in Old English, which "affected both the most frequent words and function words and adverbs first" (Phillips 2015: 367). We do not find the Palu'e data entirely convincing, as there are only two bound morphemes reported to undergo the change, such that it is very difficult to establish if there really is a robust word-class effect. Cases like the Old English one seem to show the effect more unambiguously.

What are the mechanisms by which a specific part of speech is targeted by sound change? In at least some cases, reanalysis appears to be involved. Pre-nasal raising in Old English may have affected highly frequent words first. But many frequent words are function words and adverbs (14 of the 20 most frequent words according the the Oxford English Corpus), which could have led to a reanalysis on the part of speakers in the early stages of the change, forming the hypothesis that function words and adverbs can undergo the sound change independently of frequency. This mechanism is the one proposed in Honeybone (2015) to account for the fact that tapping of /t, d/ was reanalysed as T-to-R rather than T-and-D-to-R; he notes that of the ten most frequent words ending in /t/ and the ten most frequent words ending in /d/, the /t/-final words are in general more frequent than the /d/-final ones.

Hooper (1976), Bybee (2002), and Phillips (1984, 2006, 2015) have argued that one sometimes finds the opposite relationship between function words and frequency in lexical diffusion. The Old English unrounding of /ø/ affected function words and adverbs first, but otherwise began with the *least* frequent words. As we do not believe that this change represents a genuine case of lexical diffusion (see 2.2.1 above), we will not discuss this case in great depth. However, we suggest that perhaps two changes were involved: an initial unrounding in function words and adverbs, which then spread through the lexicon by analogical levelling. Therefore, it seems that the cases where genuine lexical diffusion is involved, and where grammatical information is relevant, can be explained using the mechanisms proposed in this section.

We have seen explanations for usage-based influences on the spread of sound change, and how these may allow us to understand diffusion based on part of speech. We will now turn to cases where sociocultural factors control the spread of the change rather than grammatical ones.

2.2.3 Cultural significance

There are a few diffusing sound changes where none of the explanations we have investigated so far help us characterise which words are affected. The words undergoing the change all have in common a special cultural significance to speakers of the language. Perhaps the clearest case is reported in Yaeger-Dror (1996), on changes to the /ɛ/ phoneme in Montreal French. It is initially difficult to see any pattern in the targets, which include words for 'mother', 'presbyterian', 'ice box', and 'war.' However, Yaeger-Dror had a hypothesis which we believe is on the right track and elaborate on here, namely that all of the words are somehow connected to "the old days". It is

relevant to note that the sound change began with older speakers. We are suggesting that the reason these words are affected is because speakers relate them to objects, people and events which form an important part of their identity, and which differentiate speakers with the sound change from those without it. The application of the sound change, and in these particular words, thus represents a way for speakers to make a sociolinguistic statement about their identity. Dividing the affected words into semantic categories, one finds kinship terms, words related to the church, and other words related to objects and events which are less significant in Montreal now than they once were. The latter category includes the words for 'ice box' (now replaced by refrigerators) and 'war' (used to refer to World War I). Since the mid-20th century, church attendance in Montreal has decreased significantly (Gill 2003), placing church-related terms in the same category of words which have lost some of their significance. The inclusion of kinship terms is somewhat surprising, but it seems likely that terms like 'mother' and 'father' are related by the older speakers leading this sound change to their childhood, and to people who may no longer be alive. Speakers thus have two linguistic variables, the sound change and their lexis, which they can use to identify as part of a group, and to differentiate themselves from other speakers. The additive effect of combining the two would be an even more effective linguistic marker of group affiliation, and it appears to be in these culturally significant words that the sound change has been acquired by other speakers, independently of whether or not they form part of the social group in question. Note that we are not necessarily claiming that some speakers had the sound change in all items, and that it was only acquired by subsequent generations in some words. It seems more likely that the sound change was phonetically gradual to begin with, but was more pronounced in words which also functioned as markers of sociolinguistic identity. Later generations reanalysed the gradual changes as discrete, and only the words where the phonetic cues to the sound change were the easiest to perceive were seen as possible undergoers. Further sociolinguistic work on sound changes of this type will hopefully shed light on whether the hypothesis from Yaeger-Dror (1996) which we have expanded on here is plausible as a general explanation.

2.3 Does diffusion eventually lead to regularity?

The previous section discussed what happens as a change begins to diffuse through the lexicon. This section focuses on the later stages of lexical diffusion. On the one hand, one might expect diffusing changes to begin to affect more and more words, such that the end result is that the entire lexicon has been affected. On the other hand, there is a large literature on diffusing sound changes which stop diffusing and become unproductive, or even ones which reverse such that increasingly few words are affected. This section discusses these different outcomes of lexical diffusion, concluding that while diffusing changes tend to eventually run to completion in the absence of outside influences, there are many mechanisms by which a sound change could stop before diffusing to all possible target words, or even begin to reverse.

There are well-studied sound changes where diffusion has eventually spread through the entire lexicon, so that the result looks Neogrammarian. As was discussed in section 1.3, this has

led some authors to conjecture that regular sound change does not exist. Among these sound changes, we can mention s > h > Ø in Gondi, which has run to completion in some dialects (Krishnamurti 1998), and some of the sound changes we have already examined, such as unrounding of /ø/ in Old English (Phillips 1984), leading to the absence of an /ø/ phoneme in modern varieties of English. Some seem to regard this pattern of diffusion as the default; for example, Wang (1969: 17) said that it "seems frequently to be the case" that changes run to completion. The mechanisms whereby a sound change can continue to diffuse until it is complete are fairly well-known, and have been modelled in simulations by Wedel (2007). Wedel's implementation relies on speakers having a bias towards previously experienced forms, which creates a positive feedback loop. As more words undergo a sound change, the bias becomes stronger, leading to even more words undergoing the change and so on.

Others instead see this development as unexpected: "[M]ore often than linguists have thought, a phonological rule peters out toward the end of its life span, or is thwarted by another rule competing for the same lexemes" (Chen and Wang 1975: 256). Indeed, some changes appear to have stopped completely, such as the loss of Proto-Oceanic *R. This change has affected various parts of the lexicon of many daughter languages, but does not appear to be productive (François 2011). The same goes for the split of Middle Chinese tone 3 in Cháozhōu Chinese, one of the most well-known cases of lexical diffusion (Chen and Wang 1975, Cheng and Wang 1977). There is also at least one well-documented case where a sound change has reversed over time, namely d > Ø in Stockholm Swedish (Janson 1977; see also section 2.2). We will suggest a number of mechanisms for these developments, beginning with the Cháozhōu case.

One way in which a sound change can stop diffusing is that the rate at which it is spreading is too slow for speakers to realise that the input and output of the change are connected. In the case of a diffusing change X > Y, each generation will acquire some words with X and some words with Y. If the change is productive, they will also probably acquire some words where both X and Y can be used, assuming that it takes some time before a new Y variant is used consistently. In such situations, there is no problem for the change to continue spreading, as the relationship between X and Y is synchronically observable at each step of the change. Indeed, Krishnamurti (1998) saw it as a prerequisite for diffusion that speakers are able to set up a (lexically specific) synchronic rule X > Y. We agree with the general spirit of this proposal; if speakers acquire 50% of *X words with X and 50% with Y, and there is no variation, how would they know that previous generations underwent an incomplete change *X > Y? In these cases, the change would stop diffusing and the language would gain a phonemic X-Y contrast. This is what we believe happened in the Cháozhōu tone split, which may have diffused for several centuries before becoming unproductive; Late Middle Chinese was spoken in the 12th century (Pulleyblank 1984: 62), and Chen and Wang's (1975) Cháozhōu data are from the modern variety. However, we do not believe that a synchronic rule is necessarily required for every generation. Any evidence that X is changing to Y over time is sufficient, and such evidence includes observing that one's grandparents use Xs in some words where one uses Ys oneself. In fact, it may be exactly that type of observation of differences between generations which is necessary for a change X > Y to diffuse further, as it

establishes the direction of the change. In Krishnamurti's scenario, there may be synchronic variation between X and Y, but this does not tell speakers whether it is X > Y or Y > X which is diffusing.[3] Thus, while we agree with Krishnamurti that each generation needs evidence that X is changing to Y from their input, we do not see X~Y variation for some words within individual speakers as sufficient evidence.

However, this is not the only proposed mechanism for sound changes stopping. Another one is proposed by Wang (1969), relying on the notion of rule competition. Two rules are said to compete with each other if applying them in a different order diachronically would produce different outputs for some words. If X > Y is in the process of diffusing through the lexicon, the innovation of a competing rule X > Z might reach some words before X > Y has had the chance to affect them. This leaves what Wang calls residue, i.e. words which could have been affected by X > Y but which were not. Wang's original work was rather tentative, and he explicitly says that "definitive proof of this conjecture [his theory of competing changes – SA, OS, BV] must await case studies with careful and detailed documentation" (Wang 1969: 20). It also seems to us that the end result of two competing changes is not what we would prototypically call an incomplete sound change. Using again the hypothetical example with X > Y and X > Z, the end result of these changes competing could indeed be one where X > Y has not applied to all words with X. But under Wang's account, these words are precisely the ones where the change has been blocked by application of X > Z. In other words, all Xs have changed into something else, be it Y or Z. This is different from the Cháozhōu tone split, where some Xs changed to Y but others remained as X. With this said, it is true that in order to arrive at an irregular split where X > {Y or Z} depending on the word, some incomplete sound change must have occurred. Thus, we do not doubt that the mechanisms proposed by Wang could lead to incomplete sound changes. However, we are still not aware of any case studies showing this effect of rule competition, which may well be due to the rarity of two separate lexically diffusing changes affecting different parts of the lexicon at the same time within one speech community.

When it comes to reversals of sound changes, we see the main mechanism as changes in the social status of speakers for whom the sound change has advanced the furthest.[4] The d > Ø change in Swedish appears to have precisely this signature. Between the beginning of the change in the 17th century[5] and today, a vast majority of Swedish speakers became literate. This development brought with it a stigmatisation of colloquial pronunciations which were not reflected in the standard orthography, such as the deletion of /d/, which is not written in the standard language, with vanishingly few exceptions. As far as d > Ø is concerned, its social status is perhaps

[3] It is logically possible that a failure to infer the direction of change could be responsible for reversals of sound changes. We are not aware of any reversing sound changes where this is a plausible mechanism.

[4] Wedel's model discussed above also works in a parallel fashion in reverse, providing, as is noted by Wedel (2007: 151), "evolutionary pathways towards regularity *and back again*" (emphasis added). This seems, perhaps unexpectedly, unable to explain reversals of sound changes in any great detail. Wedel's model is capable of modelling X > Y followed by Y > X at a later stage in the language, but does not capture scenarios where a language midway through an X > Y sound change stops and begins to change Ys back into Xs.

[5] Chen and Wang (1975: 262) point to cases of deletion as early as the 14th century, but Janson (1977: 255) makes it very clear that these early changes did not affect Stockholm Swedish.

seen most clearly in early pronunciation dictionaries, where /d/-less forms are always assigned "to one of the lower levels of style" (Janson 1977: 257). It seems likely that the lower status of Ø pronunciations favoured forms with /d/, such that more of these forms survive now than might otherwise have been the case. Some might not be convinced that what are essentially spelling pronunciations could successfully reverse an ongoing sound change several centuries old. However, the link between literacy and d > Ø proposed here is more indirect. Our proposal is simply that literacy made pronunciations with Ø less prestigious, and that this change in social status biased speakers when choosing whether to apply the (always optional) d > Ø process.

As this is the only case known to us of a sound change reversing on a word-by-word basis, it is not possible to say whether this is the only source of reversals. However, this explanation seems to be the best one available for this particular change, given the historical and sociolinguistic context in which it took place.

3.1 How does phonological theory account for Neogrammarian change?

Both regularity and diffusion have been addressed by theoretical phonologists with regard to their implications for the architecture of the grammar: what sort of grammar do we need to explain both types of sound change? As part of a wider debate about the relationship between synchrony and diachrony, the question is how a synchronic theory of phonology can explain the stages of sound change in process that we see in the historical record.

Within an 'amphichronic' worldview that recognizes both synchronic and diachronic explanations for phonological facts, Bermúdez-Otero (2013) argues that the existence of regular change - Neogrammarian sound change - is explained by a *modular* grammar. A module (Fodor 1983) is an autonomous part of the mind that performs its own computation independent of any other modules, with its own alphabet; transfer of information between modules can strictly only take place at an interface. In a classic modular architecture (e.g. Halle and Vergnaud 1987), the morphological component only has access to the output of the syntactic component (and not to the semantic component); the phonetic component only has access to the output of the phonological component (and not to the morphological or syntactic components); and so on. Each component has its own representational system: syntax deals with hierarchical structures, phonology deals with discrete bundles of phonological features and association lines, and phonetics deals with continuous articulatory and acoustic space.

Bermúdez-Otero's argument was that Neogrammarian sound change is explained by the fact that, in a strict modular feed-forward architecture, the phonetic module of the grammar only has access to the output of the phonological module. A phonetic change cannot be encoded in the grammar with reference to any lexical or syntactic information, because the phonetic module cannot express any dependence on the lexicon or on the syntactic module. If phonetics has access only to (surface) phonological representations, then a sound change encoded in the phonetics can only ever be conditioned by properties of those surface representations.

3.2 How does phonological theory account for lexical diffusion?

If we believe Bermúdez-Otero's theoretical explanation for why sound changes can only refer to phonologically defined sets of surface representations, and not to lexical information, then we are faced with a puzzle: to explain how they *do* refer to lexical information. We have seen evidence for lexical diffusion, and so any theoretical description of phonological change will have to provide a synchronic account of the learner's grammars at each point during the sound change, such that the sound change applies in a way only sensitive (or apparently only sensitive) to some particular set of words at a time.

Labov's (1981) synchronic account of diffusion, as we commented above, was to treat diffusing sound changes as analogical substitutions of one phoneme for another in words affected by the change. Effectively, this means moving lexical diffusion from one category of the Neogrammarian typology of change (see section 1.1) into another; rather than a sound change in the sense the Neogrammarians understood it, diffusion is actually a type of analogical levelling. Treating diffusion as analogy is a spiritually Neogrammarian solution to an apparent problem for Neogrammarian views of sound change.

Kiparsky (1995) argued for a similar solution to Labov's in spirit, but within the framework of Lexical Phonology and Morphology ('LPM'; see Kiparsky 1982, 1985). The issue with word-by-word substitution of phonemes, Kiparsky argued, is that this substitution itself has nothing to do with phonology, so Labov's account allows for a sound change to diffuse through the lexicon in phonologically unpredictable ways. Instead, it seems to be the case that diffusion can be constrained by phonology. One example of this comes from the Philadelphia æ-tensing rule mentioned earlier, described by Labov (1981). In Philadelphia, /æ/ tenses before "-f, -s, -θ, -n, -m" in closed syllables (Kiparsky 1995), but is diffusing to include i) open syllables and ii) contexts before /d/ and /l/. We see no diffusion of tensing into other phonological contexts - before voiceless stops, for example - which would be unexpected if diffusion takes place by lexical analogy that makes no reference to phonology.

Instead, Kiparsky explained the phonological conditioning of the diffusion of æ-tensing in Philadelphia by proposing that what's actually being extended analogically is the application of an independently existing phonological rule - he achieved this with a technical analysis specific to LPM. The main distinguishing feature of LPM from earlier theories of generative phonology is that LPM imposes a division of the rules of the grammar into two components. The lexical component, ordered first, involves strictly structure-preserving rules interwoven with processes of morphological affixation; the post-lexical component, ordered later, involves potentially non-structure-preserving rules applying to the output of the lexical component.

As one of the various theories of underspecification within LPM, Kiparsky assumed the principle of 'radical underspecification', whereby the grammar only allows one value of each phonological feature to be specified underlyingly. Unspecified feature values are then filled in during the derivation, by default feature-filling rules that apply only in the lexical component of the grammar (and in a way that can be language-specific).

Kiparsky's idea for representing lexical diffusion in the grammar is similar to Labov's, but implemented using radical underspecification within LPM: rather than spreading by substituting phonemes into new words, diffusing sound changes spread by underspecifying the URs of new words. A word with a radically underspecified UR is then input to a default feature-filling rule, and this rule is the sound change that appears to be spreading irregularly. In the case of Philadelphia æ-tensing, Kiparsky took the diffusing rule to be the addition of the feature [+tense], with [-tense] values being specified underlyingly. Diffusion of tenseness corresponds to this feature-filling rule expanding its environment to include open syllables and contexts before /d/ and /l/, with concurrent underspecification of vowels in those environments. This explains the phonological conditioning of the spread of æ-tensing, in a way that Labov's account did not: the new contexts for tensing are phonologically conditioned because they are an analogical extension, within the grammar, of the old contexts.

3.3 Does lexical diffusion require a rich lexicon?

The existence of lexical diffusion has been argued by some to support phonological theories with a rich lexicon. We use the term 'rich lexicon' here to denote storage of all word forms that a speaker has heard, often based on a set of phonetically-detailed exemplars rather than abstract underlying forms. Based on the patterns of diffusion which are found (see section 2.2), lexical representations have been argued to include not only phonetic detail, but also information about word and context frequency (Bybee 2002). It is worth emphasising just how important this debate is for linguistic theory. If the lexicon is enriched with representations of phonetic detail, frequencies of use, and polymorphemic word forms, a large number of widely held assumptions in phonology and morphology must be revised. These include the existence of underlying forms, of phonological processes of the type which are the bread and butter of many phonological theories, and of morphemic decomposition. A number of assumptions about how speakers reason about language would also need to be rejected, including the desire to have as little redundancy as possible in the lexicon, and to attribute generalisations to the application of rules which are independent of the individual words to which they apply. Indeed, some of the literature has used diffusion to argue that these widely held assumptions are flawed (Bybee 2002, Phillips 2006, Booij 2008). If there are diffusing changes which take into account the frequency of phrases in which they occur, rather than just word frequency, this also has potentially wide-reaching consequences for theories of syntax. Such changes seem to suggest that we would need to store entire phrases as wholes, along with frequency information, rather than building these phrases from their constituent words. This stands in stark contrast to generative theories of syntax (Chomsky 1957, 1995), where non-idiom multi-word phrases are built rather than stored.

Needless to say, far from everyone accepts that these assumptions about the workings of phonology, morphology and syntax need to be abandoned. One example of an attempt to explain the same range of empirical data without a rich lexicon is found in Kiparsky (1995). As we have already seen, Kiparsky uses phonological underspecification to encode the fact that a word can be

the input to a diffusing rule. What is diffusing is not the process itself, but gradually, more and more words gain specifications for the relevant feature. This provides a way of encoding the information that some words undergo a change while others do not, without requiring lexically-specific phonological processes.[6] However, we doubt whether Kiparsky's theory is capable of accounting for all of the attested cases of lexical diffusion. We noted in sections 2.2.1 and 3.2 that Kiparsky's theory relied on analogical levelling, which is known to affect low-frequency words first. But many diffusing changes affect high-frequency words first, which, as Phillips (2006, 2015) pointed out, seems to be inconsistent with Kiparsky's theory. Kiparsky is also very explicit about what is required as the analogical base for a diffusing change: "According to the present proposal, the prerequisite for lexical diffusion is a context-sensitive structure-building lexical rule and its starting point is an existing site of neutralization or partial neutralization of the relevant feature in lexical representations" (Kiparsky 1995: 324), and: "The model for /…/ analogical regularization is the existence of a systematic context /…/ where length [the relevant phonological feature in this example –SA, OS, BV] is systematically predictable, which is extended on a case-by-case basis." (Kiparsky 1995: 321). These conditions, it seems, are not met by all diffusing changes. The T-to-R case discussed at length in section 1.2, for example, has no "systematic context" in phonological terms where the application of T-to-R is predictable. There appear to be favouring contexts, such as monosyllabic words with lax vowels, but even in this core environment the change is not found in more than a fraction of the possible words. The same is true of the s > h > Ø changes in Gondi, which began with three common words, rather than with a core phonological environment (Krishnamurti 1998: 197).

However, even if Kiparsky's particular implementation is not correct in all details, it may still be the case that a rich lexicon is not needed. All of the explanations for frequency-based diffusion in section 2.2 are in essence diachronic in nature. They provide mechanisms whereby the frequency of words in one generation can affect the acquisition of those words by the next generation, and none of them rely explicitly on the existence of a rich lexicon synchronically, in the minds of those speakers participating in the sound change. The diachronic nature of the explanation is especially clear in the case of d > Ø in Swedish. In section 2.2 we noted that the frequencies which conditioned the application of this deletion were those of the Swedish spoken many centuries ago. Words which were highly frequent then, but which now have a very low frequency, still trigger d > Ø in modern Swedish. If the process had instead been dependent on a rich lexicon, we would expect such words to no longer trigger the process. The change must therefore be encoded synchronically as affecting an entirely arbitrary set of words, and even access to rich lexical representations would not change this.

The argument in the beginning of this section about phrasal frequencies still seems to present a challenge to generative theories, however. Even if the triggering environment is defined diachronically rather than synchronically, we still need a way to represent the fossilised remnants

[6] This is an advantage especially for theories like Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1993), where the constraints used to derive surface forms are assumed to be universal, and therefore cannot encode information about an arbitrary set of words in a specific language.

of that change in synchronic terms. This seems to require that speakers store phrases, such that rules can target them. However, we are not aware of any lexically diffusing changes which spread based on phrasal frequency. T-to-R is often described as applying in common phrases (as in Wells 1982), but studies of this change have shown that it is just as likely to apply in *get around* as in *get Ethel* (Buchstaller et al. 2013). The frequency effect in T-to-R is thus word-based, applying in *get around* because of the frequency of *get* rather than that of *get around*. A possible counterexample is reduction of the word *don't*, which Bybee and Scheibman (1999) report as more common and more extreme "in the contexts in which *don't* occurred most often" (Bybee 2002: 287). But although some of the reductions involved (vowel reduction to schwa and t/d deletion) may be lexically restricted, Bybee presents no evidence that they are diffusing, i.e. spreading gradually through the lexicon (cf. section 2.1). Alba's (2003) results on hiatus resolution based on phrasal frequency in New Mexican Spanish are subject to the same critique. It should also be pointed out that in some theories, rules can alter the properties of words in context, such that *don't* may indeed have different phonological properties in the context *I* ____ *know* than elsewhere. One such theory is Distributed Morphology, which uses post-syntactic readjustment rules to accomplish this (Halle and Marantz 1993).

One promising candidate for a diffusing sound change which requires a rich lexicon has been discussed by Phillips (2006; see also references therein). The sound change is the ongoing stress shift for verbs in *-ate*, where disyllables increasingly receive final stress, and trisyllables initial stress. Thus, earlier *stágnate* may now also be pronounced *stagnáte*, and earlier *demónstrate* is now *démonstràte*. This change is "affecting the *most frequent* words first" (Phillips 2006: 41, emphasis in original; see also Phillips 1998b), and this seems to be based on word frequency rather than stem or morpheme frequency. A verb like *commentate* patterns with other very low-frequency verbs like *auscultate, extirpate and sequestrate*, unaffected by the high frequency of morphologically related words like *comment*. However, here again we see that the plausible explanations for this sound change do not rely on a rich lexicon synchronically. Phillips suggested that the *-ate* suffix is in the process of losing its status as a suffix, so that speakers access words like *stagnate* as wholes. This leads to default stress, which for bisyllabic verbs is on the final syllable (Sereno 1986). The reanalysis is proposed to affect high-frequency words first because they tend to develop meanings which are less predictable from those of their bases (see also Bybee 2003). This increased semantic distance makes the reanalysis of the *-ate* form as an independent whole more likely. The diffusion itself, then, involves the reanalysis of historically related forms as unrelated because they are too distant semantically (compare Booij's 2008 discussion of Dutch *bijdehand* 'bright', which has lost its formal connection to the etymon *hand* 'hand'). That semantic distance is more likely to arise diachronically in high-frequency words, leading to the frequency effect observed by Phillips. At no stage does this explanation assume that speakers have a rich lexicon.

It is also common for theories with rich lexicons to include phonetically detailed exemplars in the lexicon rather than abstract underlying forms. It has been argued that there is evidence for this inclusion from lexical diffusion; Bybee writes that "[c]hange that is both phonetically and

lexically gradual presents a serious challenge to theories with phonemic underlying forms" (Bybee 2002: 261). We saw one convincing example of this type of change in section 2.1, namely the diphthongisation of high vowels as part of the Great Vowel Shift. It follows that speakers must be able to represent gradiently different degrees of diphthongisation on a word-by-word basis. Exemplar Theory (as in Bybee 2001) manages this successfully, while traditional generative models of phonology (as in Chomsky and Halle 1968) do not. However, we do not agree with Bybee that this entails the rejection of phonemic underlying forms. Booij (2008: 487) articulates this position clearly: "A necessary preliminary remark is that the issue of 'storage versus computation' with respect to a specific regularity of a language, is not a matter of 'either … or'. The conclusion that a particular linguistic form must be stored in the lexicon does not preclude the existence of a rule that accounts for most or all of the properties of that form." Booij (2008: 487). While this possibility is not commonly discussed in the phonology literature, it may be noted that a very similar combination of two theories is found in some models of morphology. For example, in the Dual-Route Race Model (Baayen, Dijkstra and Schreuder 1997), morphologically complex regulars may be either retrieved from memory (storage) or constructed from their constituent morphemes (computation). Perhaps debates in phonology between proponents of exemplars and phonemes could also benefit from consideration of such hybrid models.

Our answer to the question of whether patterns of diffusion require a rich lexicon is thus a 'yes' in some places and a 'no' in others. We have pursued the idea that the frequency effects which are found in diffusing changes do not necessarily require representations of frequency in the lexicon. The fact that some sound changes target high-frequency words is a pattern which can arise diachronically without making reference to individual speakers whose lexicons contain frequency information. In this sense, the study of lexical diffusion is of limited use to phonological theories concerned with synchronic descriptions. However, as is often the case, there are ways in which the study of diachrony informs synchronic theorising in important ways. We have argued, following work by Bybee, that lexically and phonetically gradual sound changes do not appear to be straightforwardly accounted for by traditional generative models of phonology. We disagree with Bybee's argument that this should lead us to abandon underlying forms, but it seems that a generative lexicon must be expanded to include storage of forms closer to the phonetic surface as well.

4 Conclusion

Work on the question of Neogrammarian and diffusing sound changes has been carried out for over a century. We believe that this work has convincingly shown that both types of changes exist. We considered T-to-R in Tyneside English as an example of a lexically diffusing sound change, and believe that examples of Neogrammarian changes include the shift from an apical to a uvular rhotic in parts of Western Europe, as well as changes to the /eɪ/ diphthong in Philadelphia. There are several theories attempting to explain why we sometimes find Neogrammarian changes and sometimes diffusing ones. We have not suggested any new mechanisms here, but it seems as if

Labov's theory that Neogrammarian changes are phonetically gradient while diffusing changes are phonetically abrupt may be a tendency rather than a universal pattern.

We have also covered a number of factors controlling the spread of a diffusing change, and argued that these include (at least) high word frequency, part of speech, and cultural significance. We do not believe that diffusion based on low word frequency exists, treating proposed cases as analogy instead; in this we follow earlier analyses, in practice if not in terminology. In addition, diffusing sound changes can either run to completion, stop diffusing, or even reverse. Modifying a proposal by Krishnamurti (1998), we have proposed that a change X > Y can only continue to diffuse if speakers are able to infer from their input a connection between the two sounds X and Y, as well as the direction of the change.

We have also discussed the ways in which lexical diffusion has been used as an argument for debates in phonological theory. We have surveyed Kiparsky's (1995) theory within the framework of Lexical Phonology and Morphology, as well as several proposals within usage-based phonology (Bybee 2002, Phillips 2006, Booij 2008). We do not believe that Kiparsky's solutions are general enough to account for all lexical diffusion. Contra Kiparsky's predictions, not all diffusing changes begin with a core phonological environment where the change is exceptionless, and not all of them behave like analogy. However, we also believe that many of the arguments for usage-based phonology do not consider that the data can also be explained diachronically without what we have called a rich lexicon. An exception to this is our conclusion that storage of phonetic forms in addition to phonemic ones appears to be necessary to account for the existence of lexically and phonetically gradual sound change. It seems likely to us that the continued careful study of regularity, sound change and diffusion carried out since the 19th century will have an important role to play in settling these and other theoretical debates in phonology.

5 Bibliography

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