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Predicting Mergers in New Dialect Formation

Kajsa Djärv
University of Pennsylvania

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Abstract
This paper considers the application of Yang's (2000, 2002, 2009) model of phonological change and population dynamics to the case of competing mergers in the formation of New Zealand English, as described by Peter Trudgill and colleagues. Trudgill (1986 *et seq*) argues for the deterministic nature of change in the specific case of contactinduced change referred to as New Dialect Formation, such that given sufficient knowledge about the linguistic features represented among the speakers of the different contact-varieties, it is possible to predict with a high degree of certainty the features which will survive into the new dialect. Specifically, Trudgill argues that the features that are in a majority in the input mixture will survive at the expense of its competitors. He accounts for exceptions to this generalization, the focus of this paper, in terms of linguistic pressures such as markedness. The aim of the current paper is twofold. First, Yang's model predicts exactly the proportion of merged speakers necessary for a given merger to be successful in a competing grammar situation. Thus, we use the case of phonological mergers in the formation of New Zealand English as a case study to test Yang's model. Second, the model can help us better understand the complexity of the dynamics of New Dialect Formation. Here, we test the hypothesis that New Dialect Formation is in principle no different from other types of language change, in the sense that the acquisition-based mechanisms driving language change are the same across all learners. Specific to New Dialect Formation, we argue, is the unique demographic situation through which the variation is introduced that forms the child's primary linguistic data, the basis for his or her first language.

Predicting Mergers in New Dialect Formation

Kajsa Djärv*

1 Introduction

Recent work on language variation and change has made increasing progress through the application of mathematical and computational methods. Yang (2000, 2002, 2009) models language acquisition and change within a 'Darwinian' model of grammar competition. His model situates empirical facts about structure, learning and the linguistic environment, within a mathematically motivated model of language transmission. The current paper considers the application of Yang's (2009) model of phonological change and population dynamics to the case of competing mergers in the formation of New Zealand English, as described and analyzed by Peter Trudgill and colleagues. Trudgill (1986 *et seq*) argues extensively for the deterministic nature of change in the specific case of contact-induced change typically referred to as New Dialect Formation, as observed in a number of Southern Hemisphere Englishes, including New Zealand English. Trudgill argues that given knowledge about the linguistic features represented among the speakers of the different contact-varieties, it is possible to predict with a high degree of certainty the features which will survive into the new dialect. Specifically, he argues that the features that are in a majority in the input mixture will survive (at the expense of its competitors). He accounts for exceptions to this generalization, the focus of this paper, in terms of linguistic pressures such as markedness.

The aim of the current paper is twofold. First, the variational model in Yang 2000, 2009 makes predictions for the outcome of New Dialect Formation. Specifically, the model predicts exactly the proportion of merged speakers necessary for a given merger to be successful in a competing grammar situation. Thus, I use the case of phonological mergers in the formation of New Zealand English as a case study for Yang's model. Second, Yang's model can help us better understand the complexity of the dynamics of New Dialect Formation. Here, we test the hypothesis that New Dialect Formation is in principle no different from other types of language change, in the sense that the acquisition-based mechanisms driving language change are the same across all learners. Specific to New Dialect Formation, as acquisition-mediated change, is the unique demographic situation through which variation is introduced and which forms the basis for the child's linguistic environment. In section 2, I present Trudgill's analysis of New Dialect Formation in New Zealand. In section 3, I present Yang's (2000, 2009) learning model and the predictions it makes for the competing mergers and non-mergers in the formation of New Zealand English. Section 4 describes the present study, and section 5 presents the results. Section 6 concludes with some implications of this study.

2 New Dialect Formation in New Zealand

The term New Dialect Formation (henceforth: NDF) refers to the process by which a new dialect emerges as the result of a large number of speakers of different mutually intelligible dialects being brought together to form a new, 'mixed' dialect. Much discussed cases of NDF involve so called New Towns (such as Milton Keynes and Livingston in the UK) or large-scale migrations of speakers of different dialects of a language, to countries previously not settled by speakers of the language, as in the British colonies in New Zealand and Australia. The account given here for NDF in the case of New Zealand follows the description of Trudgill (1986) and Trudgill, Gordon, Lewis, and MacLagan (2000) (henceforth, Trudgill *et* al. 2000).

Although the migration of English speakers to New Zealand started in the early 1800's, significant numbers of speakers only started arriving in New Zealand around 1840. The majority of speakers however, arrived between 1860-1900, to the effect that the non-Maori population grew from 80,000 to 470,000 in the years between 1860-1900. The demographic make-up of English

*Thanks to Charles Yang, University of Pennsylvania, for helpful feedback and discussion.

speakers in New Zealand before 1881 is given in Table 1, using census figures cited in Trudgill et al. 2000:303.

Region	**Percentage speakers**
England	49%
Scotland	22%
Ireland	20%
Australia	7%
Wales	1%
North America	1%

Table 1: English-speaking immigrants in New Zealand before 1881, from Trudgill et al (2000).

A central observation made by Trudgill (1986 *et seq*) is that New Zealand English and other Southern Hemisphere varieties, such as the Englishes of Australia, South Africa, the Falkland Islands, and Tristan da Cunha were formed during roughly the same historical period by comparable input populations. These varieties share a significant number of linguistic features. This observation lends credence to the claim that the outcome of NDF is predictable given the distribution of features in the input dialects. Trudgill (1986) identifies three chronological stages in NDF. Stage 1 is described as a period of "rudimentary levelling". This stage (in New Zealand approximately 1840-60), involved the initial contact of adult immigrants. During this stage, certain linguistic features were lost, due to accommodation between speakers of different dialects. Stage 2, which in New Zealand lasted approximately until the beginning of the 20th century, is characterized by the "extreme variability" in the grammars of the first generation of native speakers of the emerging dialect, both at the level of intra- and inter-speaker variation. Trudgill attributes this to the fact that there is no single peer dialect for children to acquire, and thus considerable freedom for learners to select features from the linguistic environment: "[A]t the second stage, there was often a kind of supermarket of vocalic and consonantal variants that they could, as children, pick and choose from and put together into new combinations." (Trudgill et al. 2000:310). Stage 3 is described as "further levelling" and involves the focusing of the new dialect into a "stable, crystallized variety" (Trudgill et al. 2000:307). The interesting question which Trudgill raises, is why some specific features of the input dialects (and not others) should survive into the new dialect, and why the same features were successful across *different* new dialects. The answer offered by Trudgill et al. (2000) is that the features or variants which are in the majority in the input mixture will survive at the expense of its less frequent competitors. Thus, this analysis of NDF differs from alternative accounts, such as Lass's (1990) theory of *Swamping*, or the more sociolinguistically oriented analysis by Gordon et al. (2004). Trudgill et al. (2000) do however identify some exceptions to their *majority rules*-principle. For instance, a number of British dialects at the time had a split between *schwa* and the KIT-vowel in unstressed syllables (Lass 1990), so that for example *Rose's* and *roses* or *Lenin* and *Lennon* had different vowels in the final syllable. According to Trudgill et al. (2000: 86), only about 32% of the input population would have had the merger, thus making it a minority-feature in New Zealand English.[1] Nonetheless, it was the merger (to schwa), rather than the split, that survived in the new dialect. Trudgill et al. appeals to markedness, claiming that "[t]he large minority [Old New Zealand English] informant figure of 32 % at the second stage of development, we can suggest, was high enough for it to replace other forms at the third stage on the grounds of its unmarkedness." (2000:311). Similarly, the FIR-FUR-FERN split, common in Scottish English, they claim was lost, primarily because of its minority status, but also due to a principle of *simplification*. Further, they invoke the generalization (due to Labov 1994), that mergers tend to survive at the expense of non-mergers in contact situations. Nonetheless, a number of the mergers discussed by Trudgill et al. (2000) did *not* survive into the new dialect. For instance, the FOOT-STRUT merger, they claim was lost in New Zealand English because it occurred at Stage 1 with a frequency below the "necessary

[1] This is based on the assumption of *apparent time*, see below.

threshold" (2000:311). In the following section, I show that Yang's (2000, 2009) model can make more nuanced and precise the notions of 'simplicity' and 'critical threshold'.

3 Modeling Language Change

3.1 Grammar Competition and Fitness

This section briefly present Yang's (2000, 2009) model.[2] For the exact mathematical proofs and a more in-depth discussion of the model, I refer the reader to these papers. Yang analyzes language change in terms of (Darwinian) Natural Selection, as changes in the distribution of grammars in a population over successive generations of learners. Here, I follow Yang in using the term 'grammar' to refer to any linguistic system, including morphosyntax and phonology. The space of grammars may be constrained by Universal Grammar, or provided by the linguistic environment. The selectional fitness of a grammar is understood as its advantage over its competitor grammars. In Yang 2000 (building on insights from Bush and Mosteller 1951), this is formalized as the *penalty probability* c of a grammar G. That is, the proportion of input tokens s in a learner's linguistic environment π that are incompatible with G. Here, $\rightarrow$ denotes 'G can successfully parse s':

$$c = \Pr(G \nrightarrow s \mid s \in \pi)$$

The linguistic environment π at a given time is defined in terms of the composition of grammars A and a, which are compatible with the same context of use, and are available to the learner with probabilities pA and qa (where p + q = 1). Thus, when confronted with some linguistic input s, the child acquiring her target language will entertain A and a as competing hypotheses for interpreting s, with probabilities pA and qa. Depending on the fitness of A and a, p and q will be updated according to the following learning algorithm L (illustrated for A, but the same applies to a):

$$\text{if } A \rightarrow s \text{ then } p' = p + \gamma q$$
$$\text{if } A \nrightarrow s \text{ then } p' = (1 - \gamma)p$$

Yang shows that, given the penalty probabilities C_A and C_a of A and a in π, and a sufficiently small learning rate γ, the child will acquire A and a with the following distribution:

$$\lim_{t\to\infty} p_t = \frac{C_a}{C_A + C_a}, \lim_{t\to\infty} q_t = \frac{C_A}{C_A + C_a}$$

In a monolingual environment then, the child will acquire the target grammar with probability 1, since the penalty probability of the target grammar is 0. However, when variation is introduced into the linguistic environment, as in the case of language contact, so that both A and a are available to the learner with different penalty probabilities, she will converge on a distribution of A and a. Thus, language change follows a variational process whereby the composition of grammars (in terms of their probabilities of use) in a linguistic environment changes, as it gets updated for each new generation of learners:

$$\pi' = L(\pi)$$

Note that whether a given grammar can in fact parse the input is an empirical fact relative to specific cases. In Yang 2000, $G \rightarrow s$ is defined in terms of the syntactic compatibility of G with s. However, $G \rightarrow s$ can also be understood in psycholinguistic or phonetic terms, as discussed next.

3.2 Predicting Mergers

We asked above what ratio of merged-to-non merged speakers is, necessary for a given merger to win out over its competitors in a contact situation. Yang (2009) uses his model to examine Johnson's (2007) conjecture, that a merger will be acquired by a generation of learners when there

[2] All equations and rules stated here are the borrowed from Yang 2000, 2009. All errors and mistakes are, of course, my own.

is a *critical mass* of merged speakers represented in the linguistic environment. (Similar to Trudgill et al.'s claim about NDF.) The variational model of language change outlined above predicts that a grammar will win over its competitors in a contact situation, given that its fitness, defined in terms of its penalty probability, is greater than its competitors'. To estimate the probability of success in the case of competition between a merged and a non-merged grammar, Yang (2009), drawing on Labov (2009), takes the processing load associated with homophone processing as a measure of fitness. Here, I briefly review Yang's motivation for using homophone processing as a measure of fitness. Swinney (1979 *et seq*) shows that in lexical processing, initial lexical activation is based purely on phonological form, with contextual cues such as structure and meaning getting integrated only at a later stage in the processing. Furthermore, Caramazza et al. (2001) shows that homophone processing is sensitive to frequency-effects, in that the more frequent homophone has a shorter activation time. The less frequent homophone therefore faces processing delays compared to the more frequent one. Yang (2009) thus takes the fitness of a merged grammar to be the processing load involved in hearing the less frequent homophone in a minimal pair involving the merger, which forces the hearer to reanalyze the input as the appropriate item given contextual disambiguation. He shows that the fitness of a merged grammar can be estimated from the sum of the frequencies of all minimal pairs in a language affected by the merger, which can be given by a corpus. For instance, for the FOOT-STRUT merger, the penalty probability of the merged grammar is calculated from the total frequency of all homophone pairs ($H = \sum_i(h^i{}_{uh}, h^i{}_{ah})$, where $h^i{}_{uh}$ and $h^i{}_{ah}$ are the frequencies of the ith minimal pair of the FOOT and STRUT variants respectively, and p_0 and q_0 are the probabilities of the two grammars, as given above:

$$c_+ = \frac{1}{H}, \sum_i[(p_0 + q_0)min(h^i{}_{uh}, h^i{}_{ah})], \text{ where } H = \sum_i(h^i{}_{uh}, h^i{}_{ah})$$

For estimating the fitness of the non-merged grammar, Yang (2009) shows that it is necessary to account for the inherent confusability probability of the two variants. (The probability that the hearer will mistake the one variant for the other.) These are taken from independent studies in acoustic phonetics. Hillenbrand et al. (1995) provides a confusion matrix for the vowels in English, and Wang and Bilger (1973) gives one for consonants. We thus get the follow penalty probability for the non-merged grammar:

$$c_- = \frac{1}{H}, \sum_i[(p_0[(1 - \in_{oh})h^i{}_o + \in_{oh} h^i{}_{oh}]] + [q_0(\in_o h^i{}_o + \in_{oh} h^i{}_{oh})], \text{ where } H = \sum_i(h^i{}_o, h^i{}_{oh})$$

As Yang (2009) shows, we can thus derive the critical proportion of merged speakers necessary for the merger to win in a contact situation. Next, we describe the current experiment, which applies Yang's (2000, 2009) model to the merger/split competition(s) in New Zealand English NDF. Specifically, we predict, for each merger reported to have been present in the input, the *critical mass* of merged speakers that would have been necessary in order for the merger to survive in the new dialect. We then ask whether these predictions are borne out, given the historical demographic evidence available.

4 Experiment

4.1 Materials & Participants

The data on the mergers discussed here is primarily taken from Trudgill et al. 2000,[3] and is based on recordings from the Origins of New Zealand English (ONZE) project at the Department of Linguistics at the University of Canterbury at Christchurch. The recordings were made by the Mobil Disc Recording Unit of the National Broadcasting Corporation in New Zealand between 1946-1948. The unit recorded speakers across geographical locations on the North and South Islands of New Zealand. 325 speakers born between 1850-1889 were recorded. Trudgill et al look at a subset of the recorded speakers; 83 speakers from 34 different locations (North and South Islands). The data also includes an acoustic analysis of 10 of these speakers (due to Margaret Maclagan). As mentioned

[3] See also Table 1 in Meyerhoff 2006, which provides a useful overview of the phonological features which made it into in New Zealand English.

above, the data is based on the assumption of *apparent time*, i.e. the assumption that the language of an individual remains relatively stable over her lifespan (cf. Sankoff and Blondeau 2007).

4.2 Mergers

I analyze the following mergers: the VEST-WEST merger, the FOOT-STRUT merger, the FOOT-GOAT merger and the KIT-schwa merger. These mergers are listed in Table 2, together with their UK origin and outcome in the new dialect (as reported by Trudgill et al. 2000). I follow the convention of using Wells' (1982) lexical sets to denote the classes of items affected by the merger. In this section, I briefly review the mergers in question, following Trudgill et al. (2000).

Merger	Input	Outcome
KIT-schwa ɪ, ə	Ireland, East Anglia, West Country (32%)	Merger [ə]
FOOT-GOAT ʊ, əʊ	East Anglia (12%)*	Split
FOOT-STRUT ʊ, ʌ	Northern England (1.2%)	Split
VEST-WEST v, w	Southeastern England (<49%)*	Split

Table 2: Mergers present in the dialects forming the input to New Zealand English, including their UK origins, approximate frequency (* = estimate), and outcome in the new dialect (Trudgill et al. 2000).

First, the KIT-SCHWA merger[4] refers to the merger of ɪ and ə to ə in unstressed syllables. Although New Zealand English has he merger, the majority of speakers migrating to New Zealand from the British Isles did not. Trudgill et al. (2000:311-312) reports that only about 32% of the speakers in the input mixture would have had the merger (speakers from Ireland, East Anglia and the West Country). Trudgill (1986) and Trudgill et al. (2000) claim that because of the unmarkedness of schwa, the large minority of 32% was sufficient for the merger to spread. Second, the FOOT-GOAT merger refers to the merger of ʊ and əʊ to ʊ. This merger was present in East Anglia at the time, but did not survive into New Zealand English (Trudgill et al. 2000:304). The authors do not provide an exact number of merged speakers, but if the merger as primarily an East Anglian feature, the merger could not have been in the majority, since the total number of English speakers constituted only 49% of immigrants (see Table 1). However, further narrowing turns out to be possible: if the FOOT-GOAT merger was a feature of East Anglia only, and the KIT-schwa merger was a feature of Ireland, East Anglia and the West Country, and the KIT-schwa group constituted about 32% of the immigrants in New Zealand during that period, then we can deduce that the East Anglian population made up no more than 32% of the immigrant population. (Provided that the East Anglian speakers with the KIT-schwa merger also had the FOOT-GOAT merger.) Specifically, if all Irish speakers (approximately 20% of all immigrants, see Table 1) had the KIT-schwa merger, then we expect the number of FOOT-GOAT speakers to be closer to 12% (32%–20%).

Third, the FOOT-STRUT merger refers to the merger of ʊ and ʌ to ʊ. This merger was (and still is) a widespread feature of Northern English dialects. However, only just over 1% of all speakers had the merger, according to Trudgill et al. (2000). Following McKinnon (1997), they explain the absence of the merger with the fact that most of the immigrants in New Zealand came from Warwickshire, Gloucestershire, Oxfordshire, Devon, Cornwall, Hampshire, Surrey, Sussex, Kent, Essex, Middlesex and London. Out of these, only Warwickshire has the merger (Trudgill et al. 2000: 306-7).

Finally, the VEST-WEST merger is the merger of v and w to w word-initially. According to Trudgill et al. (2000:304), although the merger was common in southern English dialects in the 19th century, it did not survive in the new dialect. Note however, that the merger *did* survive in other colonial Englishes, such as the dialects of Tristan da Cunha and the Bahamas (Trudgill et al. 2000:304). Unfortunately, Trudgill et al. does not provide more specific figures about its frequency

[4] Also referred to as the Weak Vowel Merger.

in the input mixture. As above, however, we can infer that since the total of English speakers made up 49% of the immigrants (Table 1), and the merger was confined to Southern England, no more than 49% of the population would've had the merger.

Trudgill et al. (2000) also discuss the FERN-FIR-FUR merger. This is the merger of the short stressed vowels ɛ and ɪ, ʌ to ɜ before r (the NURSE vowel). Only Scottish English did *not* have the merger. Unfortunately, Trudgill et al. do not give an exact figure, but from the census figures in Table 1, we can again infer that if the split was confined to Scotland, about 78% of immigrants (100%–22%, Table 1) would've had the merger. Indeed, the merger *did* survive in New Zealand English. However, this merger is more complicated than the others, not because it involves a three-way merger *per se*, but because the merger does not go to any of the phonemes in the split system. Thus, we leave this merger aside for the remainder of the paper.

4.3 Methods

To derive the penalty probability of the merged (M+) grammars and the critical mass of merged speakers necessary for the different mergers to be successful, we ran a script[5] on a list of words containing all minimal pairs in English, listed with their token frequencies (from the SUBTLEX-us database, Brysbaert and New 2009). The words were transcribed using the Carnegie Mellon University (CMU) pronunciation dictionary system, and annotated for stress (0 = no stress, 1 = primary stress, 2= secondary stress). Table 3 gives the corresponding IPA and CMU transcriptions for the mergers under discussion.

Merger	IPA	CMU	Example (CMU)
KIT-schwa	ɪ, ə	IH-AH0	it, sofa
FOOT-GOAT	ʊ, əʊ	UH-OW	hood, oat
FOOT-STRUT	ʊ, ʌ	UH-AH1,2	hood, hut
VEST-WEST	v, w	V-W	vee, we

Table 3: Correspondence between the IPA-transcriptions and the CMU pronunciation dictionary.

The SUBTLEX-us corpus did not include v and w. The results for this merger come from Charles Yang, using child-directed speech (CHILDES, MacWhinney 2000). The script took six arguments: the two vowels involved in the mergers (V1, V2), the confusability probability of mis-hearing the first vowel as the second (cV1) and the second vowel as the first (cV2), as well as an upper and lower frequency bound for the lexical items. The confusability probabilities were taken from Hillenbrand et al. (1995) as the probability of the event of a vowel intended by the speaker as V, being misheard by the hearer as V*. Unfortunately, this study neither included diphthongs nor schwa. Hence, we assumed a mutual confusability probability of 0.05 for these vowels. Yang assumed a mutual confusability probability of 0.01 for w and v. Non-words and function words were removed manually from the list of minimal pairs. The search-space also had to be further narrowed to match the phonological conditions on the merger, such as word-initial or pre-rhotic position. Table 4 lists the input to the script.

5 Results

This model, as implemented in the simulation, gives us the penalty probability of the merged grammar, as well as the critical mass (proportion of speakers in the linguistic environment) required for the merger to survive in the new dialect. Yang's results for the VEST-WEST merger only provide the critical mass for the merger to w, which was the direction of the merger in the input to New Zealand English, and thus the relevant numerical value for predicting the outcome in the new dialect. These values, rounded to the nearest two decimals, are listed in Table 5.

[5]Courtesy of Charles Yang, University of Pennsylvania.

Merger	V1	V2	cV1	cV2
KIT-schwa	IH	AH0	0.05	0.05
FOOT-GOAT	UH	OW	0.05	0.05
FOOT-STRUT	UH	AH1,2	1.0	3.2
VEST-WEST	V	W	0.01	0.01

Table 4: Input to script. (*Data from Charles Yang.)

Merger	V1	V2	Penalty Pr M+	Critical Mass V1	Critical Mass V2
KIT-schwa	IH	AH0	0.24	0.59	0.33
FOOT-GOAT	UH	OW	0.12	0.26	0.11
FOOT-STRUT	UH	AH1,2	0.08	4.20	0.37
VEST-WEST	V	W	–	–	0.56*

Table 5: Penalty probabilities for the merged grammars, and the critical mass required for the merger to survive, derived from Yang's (2000, 2009) model.

In order to test whether the predictions made by Yang's (2000, 2009) model are borne out by Trudgill et al.'s (2000) data, we compare the proportion of merged speakers in the immigrant population with the *critical mass* (ratio of merged-to-non merged speakers) predicted by Yang's model to be necessary for the merger to survive in the new dialect. That is, we want to ask whether the critical ratios derived for each merger predict the outcome of the merger in New Zealand English, as given by Trudgill et al. (2000). To this end, Table 6 lists the mergers present in the input, the direction of the merger, the outcome in the New Zealand dialect, the proportion of speakers with the merger (as specified by Trudgill et al. 2000, or as estimated above), and the critical mass of merged speakers necessary for the merger to be successful.

Merger	Direction	Outcome (NZE)	% M+ Speakers	Critical Mass M+
KIT-schwa	ɪ, ə → ə	Merger to ə	32%	33%
FOOT-GOAT	ʊ, əʊ → ʊ	Split	12%*	26%
FOOT-STRUT	ʊ, ʌ → ʊ	Split	1.2%	37%
VEST-WEST	v, w → w	Split	$<$ 49%*	56%

Table 6: Mergers present in the dialects forming the input to New Zealand English, including their UK origins, approximate frequency, and outcome in the new dialect. Data from Trudgill et al. 2000.

In order for the VEST-WEST merger to survive in a situation of contact between merged and non-merged speakers, 56% of the speakers would have had to have the merger. However, we can be fairly certain that no more than 49% of the speakers had it (Section 4.2.). Thus, Yang's (2000, 2009) model predicts that the merger should not have survived in New Zealand English, which is indeed what Trudgill et al. (2000) reports. Further, for the FOOT-STRUT merger to survive, Yang's model gives us 37% as the critical ratio of merged-to-non merged speakers. Since the proportion of merged speakers reported in Trudgill et al. is just over 1%, the model correctly predicts that New Zealand English should not have the merger. The same is true for the FOOT-GOAT merger, which according to Yang's model requires 26% of speakers to be merged in order for it to survive in a contact-situation. Since the proportion of speakers can be estimated to approximately 12%, the model correctly predicts that the merger should not have survived in New Zealand English. Finally, for the KIT-schwa merger to survive, the model predicts that 33% of speakers would have had to have the merger. Trudgill et al. reports that 32% of the speakers did have the merger. Although this is slightly below the predicted ratio for success, it is important to bear in mind that we are dealing with approximations of the linguistic and demographic situation. In the case of Trudgill et al.'s data, the proportion of speakers with the different dialect features is based on a very small sample of speakers, and must therefore be taken as an approximation of the linguistic situation in New Zealand in the 19th century. Also in the present experiment, the exact thresholds derived will depend on the specific corpus used, and on the confusability probabilities assumed. A preliminary version of this experiment by Charles Yang (p.c.), which used the CHILDES corpus for child-directed speech, derived 28% as the critical threshold. Similarly, for the current data, if only a slightly higher mutual confusability probability is assumed (0.1% instead of 0.05%), we also get a lower critical threshold for success, 27%. Note that this uncertainty does not necessarily undermine the methodology or the conclusions drawn with respect to the other mergers. For KIT-schwa, FOOT-GOAT and FOOT-STRUT, the difference between the derived threshold and the reported proportions of speakers is sufficiently large that the results should not be significantly affected by the error rate.

6 Conclusions

Here, we tested the hypothesis that New Dialect Formation is no different from other cases of contact-mediated language change. Specifically, we assumed a selectionist model of language change, where language change is seen as change in the distribution of grammars over successive generations. In fact, on this model, language change presupposes some variation in the input in order for children to acquire a different distribution of grammars than that of their parents. Thus, on this model, there is nothing special about NDF as a case of language-change *per se*, except for the rather exceptional social circumstances under which it occurs. Hence, the difference between NDF and "regular" language change is simply in the amount of variation, and thus the amount of competing grammars present. This is what leads to the situation observed by Trudgill and colleagues in New Zealand, where the features present in the new dialect reflect the distribution of features in the input mixture as a whole, but where the combination of features is very different from the combination of features found in any one input dialect. On this model, we also predict the "extreme variability" of Trudgill et al.'s (2000) second stage of NDF. That is, given the variability of the sample, the sample-size and the sampling-probability, we can predict the direction of acquisition (and thereby change) with a high probability. However, given the probabilistic nature of the learning-model, we can expect a certain amount of randomness in acquisition once a new variant has been introduced into the linguistic environment. Therefore, the model predicts a fair amount of variation in the first generation of learners in NDF, given the amount of variation present in the input.

The central question of this paper however, was whether we can predict, for a given merger, the critical proportion of speakers necessary for the merger to be acquired into the new dialect. The present experiment allows us to answer this question in the affirmative. Moreover, Yang's (2000, 2009) model makes different predictions from Trudgill et al.'s *majority wins*-principle. Specifically, we predict that only for the *vest-west* merger, is a critical mass greater than 50% actually necessary for success. Since the merger *was* in fact successful in the dialects spoken in Tristan da Cunha and the Bahamas (see above), our results make the additional prediction that the proportion of merged speakers in the input mixture for *those* varieties must have been higher than 56%; a prediction that remains to be tested. For FOOT-STRUT and FOOT-GOAT, and KIT-schwa however, a proportion significantly lower than 50% of the speakers is in fact required for the merger to survive.

To summarize, we have used the case of New Dialect Formation in New Zealand as an empirical case study for the variational model due to Yang (2000, 2009). We found that the predictions made by the model were borne out by Trudgill et al.'s (2000) data from New Zealand English. We thus also hope to contribute to the research on the history of New Zealand English, and to the debate over the role of determinism in New Dialect Formation and language change.

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Department of Linguistics
University of Pennsylvania
Philadelphia, PA 19104-6228
kdjarv@sas.upenn.edu