A Model of Underspecified Recognition for Phonological Integration: English Loan Vowels in American Norwegian

David Natvig
University of Wisconsin-Madison
david.natvig@wisc.edu

Abstract
Using loanword data from Haugen (1953), this paper investigates variation in vowel integrations of English loanwords in the Norwegian among 19th century Norwegian immigrants to the United States, as first-language Norwegian and second-language English speakers. Previous research, most notably Flege (1995), has argued that speakers make use of L1 categories that are the most similar to the integrated L2 sound. In contrast, this research argues that the “most similar,” as well as less similar but attested, L1 integrated phonemes can be understood through the Lahiri and Reetz (2002) Underspecified Recognition model, where phonetic features of L2 input sounds are mapped onto hierarchically organized L1 distinctive features (i.e., Dresher, 2009).

Keywords
loanwords – vowels – phonology – English – Norwegian

1 Introduction
A number of studies have investigated the relationship between phonological contrasts and second language phenomena, including the acquisition of L2 sounds (Brown, 1998), as well as loanword integrations (Herd, 2005). The purpose of this article is to investigate the variation in integrated Norwegian vowels from English loanwords into American Norwegian, a heritage language spoken largely in the American Midwest. Loanword data from Haugen (1953) indicate that English vowels are not integrated with a one-to-one mapping of
the English to the Norwegian vowel. Instead, multiple Norwegian vowels appear in English loans. I argue that the selection of the well-formed candidates falls out from the association of the phonetic features of English vowels to underspecified phonological representations of Norwegian vowels (i.e., Dresher, 2009) through a three-way mapping condition: match, mismatch, or no mismatch (Lahiri and Reetz, 2002: 638). This approach contrasts Flege’s (1995) Speech Learning Model (SLM) that argues for phoneme-to-phoneme matching from the L1 to the L2 based on sound similarities. That multiple Norwegian phonemes correspond to a single English phoneme in loanwords provides clear evidence that the pairing of similar phonemes across languages is insufficient to explain the patterns in the data. Further, the present evaluation of loanwords supports the hierarchy of Norwegian vowel contrasts, and provides a clear direction for further investigation into the organization of contrastive features within Norwegian vowel systems.

This paper is structured as follows: In section 2, I discuss theoretical issues with respect to loanword phonology and language contact, along with a summary of the relevant socio-historical and linguistic background of American Norwegian as a heritage language. In section 3, I present the feature geometry and phonology theory I adopt, including a contrastive hierarchy (Dresher, 2009) of English vowels (Purnell and Raimy, 2015). I then argue for a Norwegian contrastive hierarchy, and outline the theory of Underspecified Recognition (Lahiri and Reetz, 2002). I use this model to analyze English loanword data in American Norwegian in section 4, and argue that the phonological structure of Norwegian vowels presented in section 3 supports these data. I also discuss implications that bear on the studies of phonological borrowing, loanwords, and language contact situations. I conclude in section 5.

2 Loanword Phonology and Language Contact

In this section I examine relevant research on second language and loanword phonology and language contact, and how they relate to Norwegian as a heritage language in the United States. Throughout the analysis proposed in this paper, I view the English loanwords into American Norwegian presented in Haugen (1953) as representative of early stages of bilingualism, where L1 Norwegian immigrants are exposed to English words through contact with English speakers, and are beginning to learn English as their L2. At this stage of Norwegian-English bilingualism, Norwegian is the linguistically dominant language, and the source for the imposition of phonological structure (see below). As members of these communities increase their proficiency in English,
the linguistic dominance relationship changes, and makes different predictions regarding the direction of linguistic transfer, especially among contemporary American Norwegian speakers, who may no longer be linguistically dominant in Norwegian. Because I analyze loan vowel integrations with respect to Norwegian dominance, Haugen’s (1953) data provide a comprehensive account of English and Norwegian vowel correspondences closest to the time of Norwegian immigration in the United States, and to the earliest English contact for Norwegian speakers. I, therefore, leave integrations in contemporary heritage speakers to future study (see section 2.2).

2.1 Loanword Phonology and Language Contact

The study of loanword phonology relates directly to second language research in that integrations of L2 sounds, both present in and absent from L1 phonologies, provide insights into the organization of the phonemes in language. Early studies focused on the primacy of the L1—that the patterns of L2 sounds correspond to the L1 phonological system (see Eckman, 2004), where L2 speakers adopt the L2 sounds that are contained in their L1 grammars. L2 sounds that have no representation in the L1 grammar, or sounds that are difficult for L2 speakers, are approximated to the closest (similar) L1 sound. Flege’s (1995) SLM, for example, posits that L2 learners use L1 phonetic categories for similar L2 sounds and have to learn new categories for different L2 sounds. There are, however, no formal criteria for determining similarity (Eckman, 2004: 517). Moreover, models that operationalize concepts such as difficulty and similarity largely make these predictions using the phonological inventories or phonetic categories of the L1.

In contrast to approaches that employ concepts of ‘difficulty’ and ‘similarity,’ Brown (1998) finds that speakers can produce L2 segments absent from the L1 by reorganizing phonological features available for L1 contrasts. Building on Brown (1998), in a study of English loanwords in Polynesian languages, Herd (2005) demonstrates that neither the phonemic inventories themselves, nor the closeness of an L1 sound to an L2 sound, accounts for the relationship between the two. For example, Tongan integrates English non-interdental fricatives (/s z ʒ ʃ tʃ dʒ/) as /s/; interdentals /θ ð/ are integrated as /t/ (Herd, 2005: 93–94). Herd (2005) argues that this pattern results from Tongan contrasting /s/ and /t/ in terms of the feature [strident], not [continuant], which contrasts the stop /p/ from fricative /f/ (92). Non-strident /θ ð/ are integrated as non-strident /t/, and strident /s z ʒ ʃ tʃ dʒ/ are incorporated as strident /s/. The consonants selected for English loanwords result from the features present within a language. Furthermore, Chang (2015) finds that even though L2
learners show some access to the L2 phonology, the categories that they create for L2 sounds are the products of their L1 categories. Moreover, Eckman and Iverson (2015) argue that L2 categories are predictably selected with respect to L1 phonological structure. I follow this line of reasoning and analyze the integration of English loan vowels into American Norwegian as processing English phonetic features through Norwegian phonological categories.

A loanword analysis is necessarily a study of the interactions between languages in contact. The structural integration of vowels from loanwords examined in this study implies a contact situation where one language is linguistically dominant (i.e., the speaker is more proficient) with respect to the other (Van Coetsem, 1995: 70, cited in Winford, 2005: 376). Here, L1 (dominant) Norwegian speakers borrow words from their L2 English, imposing their Norwegian phonological structure onto the English sounds. Van Coetsem (1988) argues for a difference between borrowing and imposition in terms of the types of speaker agentivity employed in the transfer of linguistic material from the source language (SL) to the recipient language (RL). Both types of transfer are evident in the early integration of English loan vowels into American Norwegian: the borrowing of English lexical items, and the imposition of the Norwegian phonological system on those new words. In each case, the Norwegian speaker is the agent of the transfer; the source language, however, is different. In borrowing words, the source language is English; the direction of transfer is from English (SL) to Norwegian (RL). The transfer of the Norwegian (SL) phonological system onto the borrowed lexical items from English is an example of source language agentivity, which “tends to involve mainly phonology and grammatical features” (Winford, 2005: 377). Furthermore, Winford (2005: 377) argues that with imposition, or SL agentivity, the SL is the dominant language of the speaker. I assume Norwegian linguistic dominance and the imposition of Norwegian (SL) phonological structure onto English (RL) loanwords throughout this analysis, where the Norwegian speakers do not accommodate to the incoming English vowels through the assembly of Norwegian phonological features (e.g., Brown, 1998). I argue that the perception of phonetic features from the English source (signal) is interpreted though Norwegian phonological categories (integration). This interpretation, then, provides the sets of Norwegian vowels available for loanword integrations that account for the variation in the correspondences between English and Norwegian vowels present in Haugen’s (1953) data. I will now briefly outline the social, historical, and linguistic background of Norwegian as an immigrant language in the United States, and discuss current research on American Norwegian.
2.2 **American Norwegian**

The first Norwegian immigrants to the United States came in 1825 from near the city of Stavanger, in southwestern Norway (Flom, 1909: 46). Over the following hundred years, roughly 750,000 Norwegians, mostly from rural districts, emigrated from across southern, western, and eastern Norway to the United States. In fact, “Norway lost ... a number nearly equal to her total population in 1800” due to immigration (Haugen, 1953: 29). They settled predominantly in the midwestern states of Wisconsin, Minnesota, and North and South Dakota (Flom, 1909; Haugen, 1953); Wisconsin was the primary region of Norwegian settlement from the 1840s until the Civil War (Lovoll, 1999: 51). Approximately seventy-two percent of the immigrants to the Midwest settled in small agricultural districts and towns (Flom, 1909: 33) with varying degrees of isolation from other immigrant, and English-speaking, communities. Regardless of the Norwegian American communities’ isolation from speakers of other languages, Norwegian immigrants saw English as a necessity for success in the New World (Blegen, 1940: 72; Haugen, 1953: 37–39). They often sent their children to English-speaking schools, and many Norwegians began learning some English before leaving Norway (Blegen, 1940: 73–74). While Norwegian remained the language of the home and of the community, English would replace Norwegian in economic or official domains (Haugen, 1953). This state of English-Norwegian bilingualism was relatively stable until the beginning of the 1900s, when English overtook Norwegian as the language of the home and community (Haugen, 1953: 52).

The immigrants in these communities demonstrated varying degrees of English proficiency, but despite clear attempts on the part of Norwegian immigrants to learn English “there unquestionably was a considerable period of transition [from Norwegian to English] marked by relatively slow progress” (Blegen, 1940: 74). Therefore, there was a period of time with relatively stable linguistic dominance in Norwegian, before subsequent generations became more dominant in English. Because the degree of L2 proficiency a bilingual speaker has affects the types of influences that one language will have on the other (Van Coetsem, 1988; Winford, 2005), speakers who are Norwegian dominant are more likely to impose Norwegian structure (e.g. phonology, syntax) on loanwords than bilinguals who are more English dominant. I assume Norwegian dominance in this analysis, so English loanwords in contemporary American Norwegian are excluded because these speakers are likely to be either English dominant, due to the widespread use of English as the primary language in the United States, including American-Norwegian communities, or the dominance relationship is unclear in that speakers may, more or less, be equally dominant in each language, as demonstrated in Allen and Salmons
(2015) with respect to American Norwegian speakers’ phonetics and phonology of obstruent laryngeal features.

In addition to shifts in linguistic dominance, immigrant languages undergo changes not present in the baseline language/dialect with respect to the lexicon (Annear and Speth, 2015), phonology (Hjelde, 1996, 2015), morphology (Hjelde, 2015), and syntax/semantics (Brown and Putnam, 2015; see also Montrul, 2012; Benmamoun, Montrul, and Polinsky, 2013; Putnam and Sánchez, 2013; and Westergaard and Anderssen, 2015, for discussions on changes in heritage grammars, including attrition and incomplete acquisition). Changes in phonological structure, along with changes in linguistic dominance, will produce different integrations for loanwords: different phonological structure selects different integration candidates (see sections 3 and 4.2) and increased English dominance is likely to produce more English-like vowels (Van Coetssem, 1988, 1995; Winford, 2005).

A final complication with respect to loanwords is that they may be borrowed and adapted, and spread throughout the community and to younger speakers, with imposed Norwegian phonological structure (see also Johannessen and Laake, 2015, for a discussion of interdialectal borrowing of Norwegian forms). Later generations of heritage speakers may adopt more English-like vowels in loanwords as a result of increased English proficiency compared to the previous generation of speakers. Additionally, loanwords may be imported into the American Norwegian vocabulary with vowels that reflect the phonological impositions of a previous generation (cf. Haugen, 1950). To understand the processes that underlie the production of loanwords, we must have a full account of how, when, and where Norwegian speakers come in contact with the English words that they borrow, along with how those words are transmitted within the communities and across communities. This type of investigation is outside the scope of this paper; the analysis I put forward addresses the initial transfer of English words onto the Norwegian phonology. The model of Underspecified Recognition (i.e., Lahiri and Reetz, 2002) of speech sounds mapped onto the phonological system (see 3.5 below) presented here assumes that integrated sounds result from phonological imposition, in that these sounds will reflect the phonological structure of the linguistically dominant language.

3  Phonological Theory

To analyze the phonological structure of Norwegian vowels, I assume representations based on contrastive hierarchies of distinctive dimensions (Avery and Idsardi, 2001; Dresher, 2009; Purnell and Rainy, 2015). In the following
subsections, I discuss the feature geometry I adopt, present a theory of phonological contrast (i.e., Dresher, 2009), including contrastive hierarchies of English and Norwegian vowel systems, and outline the Underspecified Recognition model (Lahiri and Reetz, 2002) I use to analyze English phonetic features interpreted through Norwegian phonological structure

3.1 Feature Geometry

The present analysis of the Norwegian vowel system assumes a two-way distinction of both height and place based on a contrastive feature hierarchy of articulatory dimensions (Avery and Idsardi, 2001; Purnell and Raimy, 2015). Within this model, phonological features are dimensions, organized as antagonistic pairs of articular gestures (Avery and Idsardi, 2001; see Fig. 1). Dimensions that are specified in the phonology are implemented with a gesture in the phonetics; which gesture completes the dimension, and in which phonological environments, is language-specific (Avery and Idsardi, 2001). The conversion from phonological dimensions to phonetic gestures is represented in Fig. 2. It should be noted that dimensions may be completed with the opposite gestures presented in Fig. 2, depending on language-specific phonological alternations, and that not all languages require all the gestures provided to specify their vowel inventories. Vowels may be specified with the dimensions Tongue Root (TR), Tongue Height (TH), Tongue Thrust (TT), and Labial (LAB).

In languages, such as English and Norwegian, that have three phonological

![Figure 1](https://example.com/figure1.png)  
*Avery and Idsardi (2001) Model of distinctive features for vowels: Dimensions, gestures, and phonetics (modified from Purnell and Raimy, 2015: 526).*
heights, two distinct height dimensions are required: one that specifies high vowels and one that specifies low vowels. High vowels, therefore, are specified with \texttt{TH} and completed with the gesture [high]; vowels specified for \texttt{TR} and completed with the [RTR] gesture are low because a retracted tongue root lowers the body of the tongue (Purnell and Raimy, 2015: 534). Because \texttt{TH} refers to whether the tongue is high or low, completed with the gestures [high] or [low], it may contrast the high vowels or the low vowels, respectively, depending on phonological alternations within a language, i.e., whether [high] or [low] is present in phonological rules, or whether the high or the low vowels show mid variants, which suggests the unspecified set (Hall, 2011). Mid vowels are not specified for height dimensions. \texttt{TT} indicates the forward or backward position of the tongue, either completed as [front] or [back], respectively. Finally, \texttt{LAB} manipulates the shape of the lips, and contrasts round and non-round vowels.

### 3.2 The Contrastive Hierarchy and Vowels

I adopt the feature geometry above as the contrastive dimensions within a language-specific hierarchy through the application of the Successive Division Algorithm (SDA; Dresher, Piggot, and Rice, 1994; Dresher and Zhang, 2005; Dresher, 2009). Contrast between distinctive sets of segments is marked by specifying one member for a dimension, leaving the other member unspecified for that dimension (Dresher, 2009; Purnell and Raimy, 2015). This process is repeated to each set until all phonemes are distinct (i.e., all sets have just one member). For example, English low vowels are specified for \texttt{TR} and contrast with non-low vowels, which are unspecified for this dimension (Purnell and Raimy, 2015). The members of a group of contrasting segments, in addition to the hierarchical organization of the dimensions and their completions, rely on language-specific phonological processes, such as which dimensions are active in phonological rules (Iverson and Salmons, 1995; Dresher and Zhang, 2005; Dresher, 2009), the phonetic variation of a segment or set of segments (Hall, 2011), and evidence of mergers or near-mergers of phonemes (Purnell...
and Raimy, 2015), which Oxford (2015) argues occur as the result of a loss of contrast at lowest level of the hierarchy. Within Dresher’s (2009) model, only contrastive dimensions are represented in the phonology; additional phonetic features, however, may appear in surface forms as predictable/redundant features that enhance phonological contrasts (Hall, 2011).

I assume the contrastive hierarchy and completions of dimensions argued in Purnell and Raimy (2015) for English, and extend their analysis to the phonological structure of Norwegian vowels, as presented primarily in Kristoffersen (2000), but with reference to Venås (1977), Endresen (1988), and Sandøy (1996). I only present the hierarchies for long vowels in both languages. Unlike English, all Norwegian vowels can be long or short (see section 3.4 for further discussion). Short vowels are also either lax, and/or lower than long vowels (Kristoffersen, 2000: 17). Long and short vowels are contrastive in Norwegian (Vanvik, 1972; Venås, 1977; Sandøy, 1996; Kristoffersen, 2000; Skjekkeland, 2005; Hanssen, 2010), for example tak [tʰɑːkʰ]1 ‘roof’ and takk [tʰɑkʰ] ‘thank you.’ Every vowel phoneme can be either long or short, assigned during stress calculations (Kristoffersen, 2000: 14). I follow Purnell and Raimy’s (2015) analysis of long and short vowels in English in that short and long vowels are mapped onto one and two timing slots, respectively (cf. Selkirk, 1990; Ringen and Vago, 2011). I assume the same contrastive hierarchy for the long and short vowels, and only present one hierarchy for Norwegian vowels. The short/long contrast in Norwegian vowels is relevant for their correspondence with English short vowels in loanwords, but not for the analysis of contrastive Norwegian vowel dimensions.

3.3 English

For English vowels, Purnell and Raimy (2015) argue that what have traditionally been referred to as ‘lax’ and ‘tense’ vowels are ‘short’ and ‘long’, where short and long vowels are mapped onto one and two timing (x) slots, respectively (Purnell and Raimy, 2015). Within this model, the English system consists of eight long vowels /i e æ u o ɔ ʌ a/, and three short vowels /ɪ ɛ ʊ/; [ə] is an unstressed allophone that lacks phonological specification (Purnell and Raimy, 2015). The contrastive hierarchy for English long vowels is represented in Fig. 3.

---

1 The laryngeal stop contrast in Norwegian is that of aspirations vs. unaspirated, voiceless, or partially voiced (Kristoffersen, 2000: 22). I follow Iverson and Salmons (1995) in assuming an underlying specification for aspiration (Glottal Width in Avery and Idsardi, 2001) for the ‘voiceless’ stops, leaving the ‘voiced’ stops unspecified (i.e., /pʰ/~/p/). This distinction does not affect the vowel analysis put forward in this paper.
below (Purnell and Raimy, 2015: 533). At each step in the SDA a contrastive dimension specifies a set of phonemes against an unspecified set, represented with Ø in the contrastive hierarchy.

Vowels with the TR specification are completed with the [rtr] gesture, contrasting the low vowels /æ a ɔ/ from the non-low vowels /i e u o ʌ/. The next application of the SDA contrasts the front vowels /i e/ from /u o ʌ/ and /æ/ from /a ɔ/ with the TT dimension, completed with the gesture [front]. The TH dimension, completed with the gesture [high], then contrasts the high vowels from the mid vowels: /i/ from /e/, and /u/ from /o ʌ/. Finally, LAB completed with [round] contrasts /o/ from /ʌ/, and /ɔ/ from /a/. The short vowels are specified with the same dimensions as their long counterparts, but are mapped onto one timing slot. A summary of the contrastive vowel dimensions for long vowels and their completions in English is outlined in Table 1.

![Contrastive hierarchy for English long vowels.](image)

**Table 1** Dimensions and completions for English vowel phonemes (Purnell and Raimy, 2015: 533).

| Dimension | Completion | /i/ | /e/ | /æ/ | /u/ | /o/ | /ɔ/ | /a/ | /ʌ/ |
|-----------|------------|-----|-----|-----|-----|-----|-----|-----|-----|
| TR        | [rtr]      | √   |     | √   |     |     |     |     |     |
| TT        | [front]    |     | √   |     | √   |     |     |     |     |
| TH        | [high]     |     |     | √   |     |     |     |     |
| LAB       | [round]    |     |     |     |     | √   |     |     |
3.4 Norwegian
Norwegian immigrants to the United States emigrated from various regions in Norway, and the dialects they spoke reflect this regional diversity (Haugen, 1953: 345, see section 2.2). There has, however, been little systematic investigation into how broad patterns of dialectal variation in surface vowels relate to a more general Norwegian phonological system. For example, most Norwegian dialects have the low, front vowel /æ/ (Venås, 1977; Endresen, 1988; Sandøy, 1996), but Kristoffersen (2000) argues that /æ/ is a marginal phoneme in “Urban Eastern Norwegian” (UEN), showing at least a partial merger with /e/. Because UEN is the dialect that has been studied in the most phonological detail, I take UEN as a starting point for the positions of the vowels in the vowel space, as well as for my discussion of Norwegian vowel contrasts. However, I also incorporate descriptions of Norwegian vowels from a variety of sources (i.e., Venås, 1977; Endresen, 1988; Sandøy, 1996). While it is not the goal of this paper to survey all the dialectal variation in Norwegian vowels, I propose a contrastive hierarchy for a general Norwegian vowel system that accounts for many dialectal differences, as well as a system that accurately captures patterns of loan vowel integration in the heritage language (see section 4.3).

Assuming that /æ/ is generally a phoneme in Norwegian, since a front vowel lower than /e/ (either /æ/ and /e/) is present in descriptions of most dialects (Venås, 1977; Endresen, 1988; Sandøy, 1996), I assume that Norwegian has nine vowel (monophthong) phonemes that are contrastively long and short (Endresen, 1988: 86; Kristoffersen, 2000: 14). Measurements of the first and second formants, adapted from Kristoffersen (2000: 17), of the short and long phones for each phoneme are presented in Fig. 4. With the assumption that long and short phonemes have the same phonological specifications, Norwegian has four high vowels (/i y u u/), three mid vowels (/e ø o/) and two low vowels (/æ ø æ/). There are three phonetically back vowels (/u o ø/), three phonetically front vowels (/i y e/), and three phonetically central vowels (/ʉ ø æ/). In terms of /æ/, however, Endresen (1988: 88) places this vowel further front than Kristoffersen (2000) and because there is phonological evidence that it patterns with /e/ (see below), I argue that /æ/ is phonologized as a front vowel. Finally, five vowels are phonetically round (/y u ø o/). I discuss evidence below that only /y u o/ are phonologically specified for lab.

The contrastive hierarchy for the Norwegian vowel phonemes is shown in Fig 5. Unlike English, I posit that TT (completed [front]) first contrasts the front vowels /i y e æ/ from the non-front vowels /ʉ u ø ø ø/. The high vowels in each set are then specified with TH, completed [high], to contrast /i y/ from /e æ/, and /ʉ u/ from /ø ø ø/. TR, completed [rtr], contrasts the low vowels /æ/...
from /e/, and /æ/ from /ø o/. Finally, LAB completed [round], contrasts /y/ from /i/, /u/ from /u/, and /o/ from /ø/. Each vowel’s phonological specifications and the completions for each dimension are provided in Table 2.

The initial TT contrast, followed by TH, places /e/ and /æ/ in the same set; these phonemes are further contrasted with TR at the final application of the SDA that produces distinct phonemes. Because Oxford (2015) and Purnell and Raimy (2015) provide evidence that phonological mergers result from the loss of a contrast at the lowest level of the contrastive hierarchy, this representation accounts for the partial merger of /e/ and /æ/ that leads Kristoffersen (2000:14) to describe /æ/ as a marginal phoneme in UEN. Dialects that retain /æ/ are dialects that maintain a TR specification among vowels specified for TT. An additional merger of /y/ > /i/ is found in some rural Eastern Norwegian dialects.
(Venås, 1977: 24), and likewise indicates the loss of the lowest contrast in the hierarchy in a dialect that is maintained in others. In this example, the Lab contrast among vowels specified for TT and TH is maintained for dialects that retain a /y/ phoneme. Finally, I argue that the back vowels /u o/, but not /ʉ ø/, are specified for Lab, because “rounding positions F2 even closer to F1 and hence enhances the feature [+back]” (Keyser and Stevens, 2006: 51), producing positions in the vowel space that are further back from their unspecified counterparts.2 Rounding for /u/ and /ø/, then, occurs as a redundant feature for non-TR and non-TT vowels, similar to the rounding of English /u/, which is only specified for TH, but is [round] on the surface.3 Having argued for the phonological representations of Norwegian vowels through the application of the SDA and resulting in the contrastive hierarchy in Fig. 5, I present the Underspecified Recognition theory (Lahiri and Reetz, 2001) and discuss how this model relates to phonological representations and vowel integrations.

### Table 2: Dimensions and completions for Norwegian vowel phonemes.

| Dimension | Completion | /i/ | /y/ | /ɛ/ | /æ/ | /ʉ/ | /u/ | /ø/ | /ɑ/ | /ø/ |
|-----------|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| TT        | [front]    | √   | √   | √   | √   |     |     |     |     |     |
| TH        | [high]     | √   | √   |     |     | √   | √   |     |     |     |
| TR        | [rtr]      |     |     |     | √   |     |     |     |     |     |
| LAB       | [round]    |     |     |     |     | √   | √   | √   |     |     |

2 Rice (1999) argues that central vowels should be unspecified for place. Furthermore, D’Arcy (2004) argues for a three-way place contrast: with front and back vowels specified as Coronal and Peripheral, respectively, leaving central vowels unspecified. In the Avery and Idsardi (2001) system, TT [front] corresponds to D’Arcy’s (2004) Coronal, and either TT [back] or LAB [round] to Peripheral, depending on the phonetics/phonology of the language.

3 An anonymous referee points out that Endresen (1988) classifies /ʉ/ as a front vowel. Because /ʉ/ lacks phonological place specifications (here either TT or LAB), it can vary with respect to frontness within the vowel space (Hall, 2011: 17). This process is similar to American English /u/ fronting, where /u/ approaches the phonetic positions of a front vowel, especially among southern speakers (Clopper, Pisoni, and de Jong, 2005: 1672).
and Reetz (2002). They present a three-way matching condition (match, no mismatch, mismatch) for processing features in the signal of a sound with underspecified phonological features (here dimensions). Phonemes with completions of dimensions that match or do not mismatch signal features are activated as integration candidates; phonemes that mismatch features in the signal are ruled out. Instead of a pairwise matching of same or different segments, the organization of Norwegian contrastive dimensions—along with a model that maps English features in the signal to the Norwegian structure—produces a set of viable candidates for phonological imposition/integrations. I continue this line of reasoning in that the hierarchical structure of vowel contrasts in Norwegian determines the set of Norwegian vowels available for English loanwords that describe the variation in integration patterns.

In addition to the ternary matching condition described above, Lahiri and Reetz (2002: 641) introduce a scoring formula, shown in Fig. 6 above, for evaluating how well a phoneme matches the features in the signal. Phonemes with higher scores are better matches than phonemes with lower scores. Any phoneme that is not specified with a dimension completed with a gesture that mismatches a feature from the signal is a viable percept for that phone. I contend that is also the case for language contact and borrowing: that the input is from the \textit{rl} (i.e., the language of the loanword is the recipient of the imposition/integration), which is mapped on to the phonological system of the \textit{sl} (i.e., the language that is the source of the grammatical structure that is imposed).

In what I refer to as the Underspecified Recognition (\textit{ur}) score, the number of features from the signal that match the a phoneme (i.e., the gestures that complete the dimensions) is squared and then divided by the product of the total number of features in the signal and the total number of features in the lexicon. Here, the number of features in the lexicon refers to the number of dimensions that specify a phoneme candidate (see Fig. 5; I include \textit{sonorant} in calculations throughout). Features, then, refer to the phonetic features present in the signal of English phones, where dimensions refer to the phonological features in the contrastive hierarchy for Norwegian vowel phonemes. I assume that in the Avery and Idsardi (2001) model of distinctive features, a match will consist of a feature/gesture that completes the dimension specified.
in the phonology; a mismatch is the opposing gesture. For example, the signal feature [high] will match TH completed [high], and the feature [low] will mismatch TH completed [high]. The features [high] and [low], however, will be a no mismatch for phonemes that are not specified for TH. Furthermore, because TR completed [rtr] specifies low vowels in both English and Norwegian, [high] is a mismatch for phonemes specified as TR. In this way, phonological representations in the form of dimensions indicate both the matching and mismatching features in the signal by means of the opposing gestures for each dimension shown in Fig. 1. In terms of the present analysis, in addition to the TH dimension discussed above, TR matches [rtr] and mismatches [atr]; TT matches [front] and mismatches [back]; and LAB matches [round]. Unrounded vowels are a no mismatch with respect to the LAB dimension. I now turn to an analysis of loanwords from English into American Norwegian that implements the underspecified recognition of English features through Norwegian contrastive dimensions.

4 Loanword Data

In this section I analyze patterns of vowel integrations from English loanwords in American Norwegian, as presented in Haugen (1953). These data were collected primarily in Wisconsin during the 1930s (Haugen, 1953: 326). Even though Haugen (1953) presents some contextual explanations for a number of variations, such as the consonantal environment, spelling pronunciations, and native Norwegian dialect, his analysis is largely descriptive, and more research is necessary to investigate, for example, how pervasive spelling pronunciations were (literacy in English has increased over time), as well as if integrations of English vowels comport with native dialect phonology, or if they reflect patterns more consistent with Norwegian dialect mixing. In spite of these limitations, the integration patterns demonstrate the interaction between English and Norwegian phonological systems.

4.1 Predictions

If the phonological inventory of L1 directly determined the segments available for loanwords adaptions, American Norwegian would exhibit a one-to-one correspondence in loanwords of all English vowels with the exception of /ʌ/ and /ɔ/. English /ʌ/ is unspecified with the exception of [sonorant], the only feature in the signal because it is a mid, central, unrounded vowel and lacks height and place features. No Norwegian phoneme will mismatch /ʌ/ for any
of the dimensions in which they are specified. The data show that /ʌ/ produces the most variation with respect to the Norwegian vowel that is integrated. This is a likely result because no Norwegian vowel can be ruled out through a mismatch, and a number of vowels will produce the same UR score. With respect to /ɔ/, Brown (1998) predicts that American Norwegian should be able to reconstruct this phoneme by adding Labial [round] to Norwegian /ɑ/, however the phonetic detail required to test this hypothesis is lacking in the data.

Both the Norwegian vowel inventory and the phonological representations within the system result in a condition where one might expect an exact correspondence of English to Norwegian vowels. However, the Underspecified Recognition (Lahiri and Reetz, 2002) model that I implement here predicts the possibility of multiple integration candidates for loanword integrations. Based on these considerations, along with an interaction of the English and Norwegian vowel hierarchies, I make the following predictions:

1. Vowel selection will consist of matched and non-mismatched Norwegian dimensions based on the features in the signal of English vowels (Lahiri and Reetz, 2002).
2. Norwegian vowel candidates that have the highest UR scores (see Figure 6, above) will be attested as integrated forms.

In the following subsection, I analyze the integration patterns of the eight long English vowels into American Norwegian.

4.2 Variation in Vowel Integration

Haugen’s (1953) descriptions of the American Norwegian and English vowel correspondences in English loanwords show considerable variation. I outline these patterns with relevant examples of loan vowel integrations from English to American Norwegian, focusing on the eight English long vowels: [ɔ], [æ], [a], [i], [u], [ei], [oʊ], and [ʌ]. The integration of these vowels shows that the Underspecified Recognition model (Lahiri and Reetz, 2002) selects multiple attested integration candidates, in contrast to SLM (Flege, 1995). Furthermore, I focus on the long vowels because short [ɪ], [ɛ], and [ʊ] pattern as their long counterparts [i], [e], and [u], but appear as short Norwegian vowels. Whether the integrated vowel is long or short depends primarily on Norwegian syllable structure: long vowels appear in open syllables or before one consonant at the end of the word; short vowels appear before closed syllables or more than one consonant at the end of the word. This is consistent for all vowels except for [ʌ]; English short (lax) vowels are integrated as short Norwegian vowels.
Because of this regularity, I do not discuss the distinction between long and short Norwegian vowels further. I follow Haugen (1953) and present loanwords in a modified Norwegian orthographic system, which depicts both vowel quality\(^4\) and vowel length.\(^5\)

### 4.3 Integration of the English Long Vowels

I argue that the integrated Norwegian vowels are selected from the Lahiri and Reetz (2002) scoring formula, or ur score (see section 3.5). I use the integration of English loanwords in American Norwegian as examples that illustrate the underspecified recognition of English phones through Norwegian phonological representations. First, I analyze the low vowels [ɔ], [æ], and [a] before discussing the high vowels [i] and [u]. Finally, I present the mid vowels [eɪ], [oʊ], and [ʌ].

English [ɔ] is attested either as Norwegian /ɑ/ or /o/, as in Table 3 below. The loanwords ‘chalk’ and ‘faucet’ each appear with both Norwegian vowels. There are four features in the signal for English [ɔ]: [sonorant], [back], [rtr] (low), and [round]. The ternary decision tree in Figure 7 demonstrates the Norwegian phonemes that mismatch (mm) do not mismatch (ømm) or match (m) the signal features with respect to each Norwegian dimension. For example, the Norwegian dimension tt (completed [front]) mismatches the feature [back] because [front] and [back] are opposite gestures (Avery and Idsardi, 2001; see Fig. 1). Features in the signal that are the same as a dimension's completed gesture are matches; all other features are no mismatches.

| English word | English vowel | Norwegian word | Norwegian vowel |
|--------------|---------------|----------------|-----------------|
| chalk, faucet | [ɔ]           | kjaˈk, faˈsett | /a/ (long)      |
| chalk, faucet | [ɔ]           | kjåˈk, fåˈsett | /o/ (long)      |

\(^4\) Norwegian back vowels underwent the following chain shift: a > o > u > u (Haugen, 1982: 40); the effect on the orthographic system is that [o] is written <å>, [u] <o>, and [u] <u>. Some of the back rounding of /a/ was sporadic, or dialect and context dependent, and short /a/ was lengthened in open environments (Haugen, 1982: 38). These facts contribute to the preservation of /a/ as a phoneme in Norwegian.

\(^5\) Haugen (1953: 420) denotes vowel length by placing a stress marker after the vowel for long vowels and after the consonant or at the end of the syllable for short vowels (cf. long roˈst ‘praised’ vs. short takˈke ‘to thank’ and takk ‘thanks’).
The Norwegian vowels specified for TT (/i y e æ/) mismatch the feature [back] in the signal for [ɔ], leaving the remaining phonemes /u u ø o a/ as no mismatches because they lack a TT specification. Of the latter set, /u/ and /u/ mismatch [RTR] because in both English and Norwegian, [RTR] correlates with the feature [low]. Both /u/ and /u/ are specified for TH, completed with the opposing [high] gesture. Of the remaining candidates /ø o a/, /a/ matches [RTR] through its TR specification, and /o/ matches [round] through LAB.

The three Norwegian vowel candidates that are not ruled out by mismatching features with English [ɔ] are /a o ø/. Table 4 shows the number of dimensions in the phonological representations as well as the number of matches, and the UR scores (Lahiri and Reetz, 2002). Both /a/ and /o/ are specified with two dimensions: each is specified for [sonorant] in addition to TR for /a/ and LAB for /o/; /ø/ is only specified for [sonorant]. The UR score (Lahiri and Reetz, 2002) is calculated for each phoneme assuming four features in the signal for [ɔ]: $2^2/(4 \times 2) = 0.5$ for /a/ and /o/, and $1^2/(4 \times 1) = 0.25$ for /ø/. Both Norwegian phonemes that are attested integrations of English [ɔ], namely /a o/, have the highest UR scores, confirming the hypothesis that vowel candidates with the highest UR scores correspond to the attested variation in loan vowel integrations not possible through the one to one phoneme correspondence of the SLM (Flege, 1995).

With the integration of English [æ], similar to [ɔ], there is variability of the integrated Norwegian vowel (see Table 5). Flege’s (1995) SLM, however, predicts only Norwegian /æ/ as the integrated phoneme because it is the phoneme
most similar to English [æ]. The Norwegian vowels attested in English loanwords with [æ], however, are long and short /æ/, /e/, and /a/, as well as sporadically the diphthong /ei/ as the result of diphthongization in some dialects (Haugen, 1953: 427, 430).

The ternary decision tree for English [æ] is represented in Fig. 8, above. All of the Norwegian TT vowels (/i y e æ/) match [æ] for the feature [front]; the remaining vowels do not mismatch. For the TH dimension, the high vowels /i y u u/ mismatch the [RTR] in the signal and are excluded. The TR vowels /æ a/ match [RTR], and none of the vowels mismatches [round]. The Norwegian phonemes that are not ruled out by mismatches are /æ e a o o/; their UR scores are shown in Table 6.

Of the five Norwegian vowels not excluded, /æ/, /e/, and /a/ are attested in the loanword data (see Table 5, above), and have the highest UR scores: 1 for /æ/, and 0.6667 for /e/ and /a/. Furthermore, short /e/ occurs before two consonants, where short Norwegian vowels are expected. In addition to these three phonemes, the Norwegian diphthong /ei/ is also attested for English [æ]. Because Haugen (1953: 427) states that /e/ undergoes diphthongization before dentals in some dialects, the presence of the diphthong in ‘fanning

---

TABLE 5 Integration of English [æ] (Haugen, 1953: 429).

| English word       | English vowel | Norwegian word        | Norwegian vowel |
|--------------------|---------------|-----------------------|-----------------|
| care, add (inf.), gravel | [æ]           | kæ’r, æ’da, græ’vel   | /æ/ (long)      |
| gravel            | [æ]           | gre’vel                | /e/ (long)      |
| basket, chance    | [æ]           | bes’ket, kjens’        | /e/ (short)     |
| fanning mill      | [æ]           | fei’ningmylla          | /ei/ [æi] (long) |
| tavern            | [æ]           | ta’van                 | /a/ (long)      |

English [æ]: [son], [front], [RTR] (low)
Features in the signal: 3

| TT                | TH                | TR                | LAB               |
|-------------------|-------------------|-------------------|-------------------|
| MM                | MM                | MM                | MM                |
| /æ/               | /æ/               | /æ/               | /æ/               |
| /e/               | /e/               | /e/               | /e/               |
| /a/               | /a/               | /a/               | /a/               |

FIGURE 8 Ternary matching condition of English [æ].
Three Norwegian phonemes are attested for English [a]: /ɑ/, /æ/, and /o/ (see Table 7). The ternary matching condition (Fig. 9) discards the high vowels /i y ʉ u/ through the mismatch of th with [rtr] (low), and the phonemes /ɑ æ/ match [rtr]. All other comparisons of signal feature to phonological dimension result in a no-mismatch. Table 8 shows that Norwegian /ɑ/ and /æ/ have the highest UR scores of the viable candidates, with 1 and 0.667, respectively. Norwegian /o/, on the other hand, has the lowest score of 0.25. Haugen (1953) argues that a minority of speakers use /o/ “in most of the common words spelled with o” (430), which may account for its correspondence with Norwegian å. However, one would also expect attestations of /u/ since this phoneme corresponds with the Norwegian letter <o>. Another possibility is dialectal variation in how Norwegian /o/ is phonologized. There is evidence from Venås (1977) that /o/ patterns with the low vowels in some rural Eastern Norwegian dialects. In such a dialect, /o/ has an additional match with TR, resulting in a
categorized under the same process. Venås (1977: 29) provides evidence of diphthongization before velars (i.e., veg > vẽig ‘road/way’) in the rural Eastern Norwegian dialect of Hallingmål.
score higher than both /ø/ and /e/. I leave individual dialect variation among American Norwegian speakers to future study, but both spelling pronunciation and dialect differences are plausible explanations for attestations of the lowest-ranking Norwegian phoneme for integrations of English [a], especially if it occurred among a minority of speakers and did not represent a general pattern.

Like the low vowels, multiple Norwegian phonemes are attested for high English vowels. With respect to English [i], the data show integrations of both Norwegian /i/ and /y/ (Table 9). Figure 10 indicates that the front vowels /i y e æ/ match the signal feature [front], that the low vowels /a æ/ mismatch and the high vowels /i y u u/ match the feature [high]. Only the low vowels are ruled out through a mismatch; the UR scores for the remaining phonemes are given in Table 10, with attested /i/ and /y/ scoring highest at 0.75, and 0.563, respectively.

| Phoneme | Number of dimensions | Matches | UR Score |
|---------|---------------------|---------|----------|
| /a/     | 2                   | 2       | 1        |
| /æ/     | 3                   | 2       | 0.667    |
| /ø/     | 1                   | 1       | 0.5      |
| /e/     | 2                   | 1       | 0.25     |
| /o/     | 2                   | 1       | 0.25     |

**Table 8. Norwegian vowel candidate scores for English [a].**

| English word | English vowel | Norwegian word | Norwegian vowel |
|--------------|---------------|----------------|-----------------|
| beat (inf.), cheese | [i]             | bi’ta, kji’s | /i/ (long)      |
| reap, treat | [i]             | ry’pa, try’ta | /y/ (long)      |

**Table 9. Integrations of English [i] (Haugen, 1953: 425).**
English [i]: [son], [high], [front], [ATR]

Features in the signal: 4

| MM | ØMM | M | MM | ØMM | M | MM | ØMM | M | MM | ØMM | M |
|----|-----|---|----|-----|---|----|-----|---|----|-----|---|
| /u/ /u/ | /u/ /u/ | /u/ /u/ | /i/ /y/ | /æ/ /æ/ | /æ/ /æ/ | /y/ /y/ | /u/ /u/ | /u/ /u/ | /i/ /y/ | /u/ /u/ |

**Figure 10**  Ternary matching condition of English [i].

**Table 10**  Norwegian vowel candidate scores for English [i].

| Phoneme | Number of dimensions | Matches | ur Score |
|---------|----------------------|---------|----------|
| /i/     | 3                    | 3       | 0.75     |
| /y/     | 4                    | 3       | 0.563    |
| /e/     | 2                    | 2       | 0.5      |
| /u/     | 2                    | 2       | 0.5      |
| /u/     | 3                    | 2       | 0.333    |
| /ø/     | 1                    | 1       | 0.25     |
| /o/     | 2                    | 1       | 0.125    |

**Table 11**  Integration of English [u] (Haugen, 1953: 425–426).

| English word | English vowel | Norwegian word | Norwegian vowel |
|--------------|---------------|----------------|-----------------|
| loose (inf.) | [u]           | lu’sa          | /u/ (long)      |
| euchre       | [u]           | jo’ker         | /u/ (long)      |
| tools        | [u]           | tol’s          | /u/ (short)     |

English [u] occurs as two Norwegian phonemes (/u/ and /u/; see Table 11); the ternary matching condition is presented in Fig. 11. It should be noted that English [u] at the time of initial borrowing was likely a back vowel. Although American English speakers, especially in the south and midlands regions front their /u/ vowels (Clopper, Pisoni, and de Jong, 2005), Wisconsin speakers still maintain a [back] position for /u/ (Jacewicz, Fox, and Salmons, 2011), although some /u/ fronting may be evident among younger speakers. Due to these facts, I stipulate that the feature [back] is present in the source for English [u].
The Norwegian TT specification for /i y e æ/ mismatches English [u] for the feature [back], ruling out the front vowels. Norwegian /a/ mismatches [u] for both [high] and [ATR] through the TR specification for /a/, and /u ø/ match [high]. Finally, /u ø/ match the feature [round] (see Fig. 11). Four Norwegian vowels /u ø ø ø/ are not ruled out through mismatches; their UR scores are presented in Table 12.

The UR score predicts Norwegian /u/ to be the highest-ranking candidate, but both /u/ and /ø/ to rank equally (0.4): each is specified with two dimensions that match the features in the signal. Both /u/ and /ø/ match English [u] with respect to [sonorant], but, as Fig. 5 and Table 2 indicate, the second matching dimension for /u/ (TH) is positioned higher in the Norwegian hierarchy than the second matching dimension for /ø/ (LAB). The selection of Norwegian /u/ over /ø/ suggests that matches higher in the contrastive hierarchy produce more viable integration candidates than matches lower in the hierarchy. Further research is required to develop a scoring formula that ranks matches with respect to their positions in the contrastive hierarchy, and whether or not a ranked score in general makes better predictions for loan integrations than the UR score. With respect to the present data, ranking matches only explains the patterns attested in the integrations of English [u] and [ø].

---

English [u]: [son], [high], [back], [round], [ATR]
Features in the signal: 5

| Phoneme | Number of dimensions | Matches | UR Score |
|---------|----------------------|---------|----------|
| /u/     | 3                    | 3       | 0.6      |
| /uí/    | 2                    | 2       | 0.4      |
| /ø/     | 2                    | 2       | 0.4      |
| /ø/     | 1                    | 1       | 0.2      |

**Figure 11** Ternary matching condition of English [u].

**Table 12** Norwegian vowel candidate scores for English [u].
The integration of English [eɪ] appears to present a counterexample to the three-way matching condition because of the attestation of /æ/ in loanwords, which mismatches [ATR] in the signal. Allen (1976: 22) indicates that the monophthongal [e] and diphthongal [eɪ] and [ɛɪ] variants appear in the Upper Midwest for the /e/ phoneme. A monophthong source vowel, as well as a diphthong, could result in the Norwegian forms steˈbil and meˈka, as well as greps in Table 13. The presence of the other forms in Table 13, however, suggests that the Norwegian speakers were in contact with at least some diphthongal variants. Because analysis of the diphthong requires also the analysis of the monophthong, I analyze the attested Norwegian vowel integrations through the underspecified recognition of the English diphthong [eɪ] as the recognition of [e] in the onset and [ɪ] in the offglide.

As Fig. 12 indicates, /e i y ø u o/ are the Norwegian vowels that do not mismatch any features for English [e]; /ɑ æ/ mismatch [ATR]. Of the vowels not ruled out, the front vowels /i y e/ match the signal for TT. The ternary matching condition to the onset with the UR score (Table 14) then, predicts /e/ to be the most viable candidate for integration. The loanwords presented in Table 13, however, confirm that the full English diphthong is recovered (as Norwegian /æi/), supported by attestations of the Norwegian diphthong /ei/.

The English loans ‘stable’ and ‘make’ both conform to the Norwegian syllabic structure that produces long vowels (I analyze the short vowels in ‘grapes’
below), which are vowels projected onto two timing slots (see Fig. 13, below). In this instance, the three-way matching condition applies to each X-slot, for the onset [e] and the offglide [ɪ]. Table 14 shows that /e/ is the highest ranking-candidate for the first X-slot, followed by /i/. The ternary matching condition of the English offglide [ɪ] is the same for [i] (Fig. 10) but the ur scores for Norwegian phonemes (Table 15) are different due to one less feature ([ATR]) in the signal. Table 15 shows that /i/ is the highest-ranking candidate for the second X-slot with a ur score of 1; /y/ is ranked second, with score of 0.75; and

---

7 The [ATR] feature may be present in the offglide, as it is unclear how it should be interpreted when separating the diphthong into two X-slots since advancing the root of the tongue contributes to the raised diphthong. Because offglides are often transcribed as the lax (short) vowels, I analyze their features as such. The presence of [ATR], however, would not change the ranking of the ur scores.

---

**Table 14** Norwegian vowel candidate scores for English [e].

| Phoneme | Number of dimensions | Matches | UR Score |
|---------|----------------------|---------|----------|
| /e/     | 2                    | 2       | 0.667    |
| /i/     | 3                    | 2       | 0.444    |
| /y/     | 4                    | 2       | 0.333    |
| /ø/     | 1                    | 1       | 0.333    |
| /o/     | 2                    | 1       | 0.167    |
| /ʉ/     | 2                    | 1       | 0.167    |
| /u/     | 3                    | 1       | 0.111    |

**Table 15** Norwegian vowel candidate scores for English [ɪ].

| Phoneme | Number of dimensions | Matches | UR Score |
|---------|----------------------|---------|----------|
| /i/     | 3                    | 3       | 1        |
| /y/     | 4                    | 3       | 0.75     |
| /e/     | 2                    | 2       | 0.667    |
| /ʉ/     | 2                    | 2       | 0.667    |
| /u/     | 3                    | 2       | 0.444    |
| /ø/     | 1                    | 1       | 0.333    |
| /o/     | 2                    | 1       | 0.167    |
/e/ and /ʉ/ are ranked third, with scores of 0.667. However, both /y/ and /ʉ/ are ruled out as the second member of the diphthong because offglides match onsets for phonetic rounding (Kristoffersen, 2000: 14; cf. /ɔi/ > [ɔy]), leaving /i/ and /e/ as the highest-ranking viable candidates. The integration, then, of Norwegian long /e/ for English [eɪ] in steˈbil and meˈka can result either from the integration of /e/ from the onset recovered as a long vowel, or from the selection of /e/ as the offglide vowel. The Norwegian American forms steiˈbil and meiˈka reflect the selection of /i/ as the offglide vowel, which produces the Norwegian diphthong /ei/; both perceptions of English [eɪ] are represented in Table 13. The underspecified recognition of English [eɪ] as Norwegian long /e/ or the diphthong /ei/ is presented in Fig. 13.

The three variants for long Norwegian vowels that appear for English [eɪ] result from the combination of the recognition of phonemes for each X-slot within the diphthong. The integration of Norwegian short /e/ and /i/ for English [eɪ], as in greps/grips ‘grapes’, is the result of choosing (or possibly deleting) one X-slot where Norwegian syllable structure requires a short vowel. Figure 14 illustrates the mapping of the underspecified recognition of the two highest scoring well-formed candidates of the onset (/e i/) and offglide (/i e/) for English [eɪ] onto a Norwegian structure with one vowel slot. The result is either short /e/ or /i/.

The American Norwegian forms maek ‚make’ and staebil ‚stable’ present a problem for the ternary matching condition in that it predicts that /æ/ is ruled out as an integration candidate because of a mismatch of TR (completed [RTR]) with the [ATR] feature in the signal (see Table 9). Because [ATR] is not specified for English /e/, but enhances the contrast between long /e/ and
short /ɛ/, this feature is likely to be gradient and not categorical (Hall, 2011: 18). Integrations of /æ/ for [ei], then, suggest that [ATR] may not be perceived in the signal, which, if the case, would not exclude /æ/. Furthermore, because [RTR] is a correlate for [low] within this representational system, it is possible that only [high] mismatches TR completed [RTR]. In either case, the loanword data indicate that more research is necessary to investigate how [ATR] and [RTR] interact with other features in the ternary matching condition, both as features in the signal and as completed gestures in phonological representations.

English [ʊʊ] is primarily attested as Norwegian /o/ and /u/ in loanwords, but like [ei] there is evidence that the offglide is integrated as a short /ʉ/ (Table 16). I analyze the ternary matching conditions for onset (Fig. 15) and offglide (same as English [u], see Fig. 11) and, like English [u], I assume that the feature [back] is present for [ʊʊ]. Therefore, TT /i y æ/ mismatch [back], TR /ɑ/ mismatches [ATR], and LAB /o u/ match [round]. The UR scores for the four vowels not ruled out are presented in Table 17; /o/ has the highest score of 0.5, followed by /u/ with 0.333. Haugen (1953: 427) states that short /u/ is found

---

**Table 16** Integration of English [ʊʊ] (Haugen, 1953: 427).

| English word | English vowel | Norwegian word | Norwegian vowel |
|--------------|---------------|----------------|-----------------|
| road, stove  | [ʊʊ]          | råˈd, ståˈv     | /o/ (long)      |
| cloak, coat, poker | [ʊʊ]    | kloˈk, koˈt, poˈker | /u/ (long)    |
| gopher      | [ʊʊ]          | gufˈfert        | /u/ (short)     |

English [o]: [son], [round], [back], [ATR]
Features in the signal: 4

---

**Figure 15** Ternary matching condition of English [o].

---

8 Monophthongal English /o/ variants are attested in and around Norwegian settlement in the region (Allen, 1976; Thomas, 2001; Purnell, Raimy, and Salmons, forthcoming). But because there is evidence of integration of the offglide, I analyze this phoneme as diphthongal [ʊʊ].
sporadically in loans such as ‘gopher,’ despite it producing the lowest UR score (0.125). The presence of /u/ as a short vowel is consistent with integrations of [ei] where the offglide is integrated in grips ‘grapes’ (cf. Fig. 14), since /u/ has the second highest score for [ʊ] (cf. Table 12) and a vowel that is attested for integrations of English [ʊ] (Haugen, 1953: 426).

The final English vowel I discuss, and the one that shows the greatest variation in loanwords into Norwegian, is [ʌ]. Because [ʌ] has no features in the signal other than [sonorant], no Norwegian vowel mismatches with the input, and the scoring formula predicts that the least specified vowels will be the most likely integration candidates. This suggests that /ø/ is most viable, followed by /o e u ø a/, then /æ i u/, and finally that /y/ is the least viable (see Table 18 for UR scores). However, [ʌ] can appear as any non-front vowel, as in Table 19.

The data in Table 19 suggest that integrations for [ʌ] are short Norwegian vowels like English /i e ø a/, likely because mean duration measurements of [ʌ]
indicate that it is the shortest of the English long vowels (cf. House, 1961: 1174; van Santen, 1992: 523). Furthermore, Haugen argues that spelling influences the use of /u/ and /o/, but that “most of them can be accounted for by their consonantal environment” (Haugen, 1953: 429). However, many of the same words appear with different Norwegian vowels. Even though consonantal features, both in English and Norwegian, may influence the selection of the Norwegian phoneme, the relatively large amount of variation in integrations of English [ʌ] may also point to dialectal differences in contrastive hierarchies because the unspecified phoneme will always produce the highest UR score. In the phonological representations presented here, /ø/ is the unspecified vowel, but there is evidence that /ø/ is phonologized as a front vowel in some Norwegian dialects (cf. Venås, 1977), which may leave either /o/ or /a/ unspecified, depending on whether Lab specifies /o/ or Tr specifies /a/. While a comprehensive analysis of different contrastive hierarchies across Norwegian dialects is outside the scope of this study, phonological analyses of these dialects, as well as evidence from the dialectal composition of settlements, connected to which form or forms of the loans are present within those communities will provide a more detailed account of how English [ʌ] is integrated into American Norwegian. It remains to be seen whether or not such description of both the language and dialect contact situations in those settlements are recoverable.

Throughout this section, I have argued that the integration of loanwords supports the model of Underspecified Recognition (Lahiri and Reetz, 2002), where phonetic features in the signal of the English word are evaluated through a ternary matching condition with respect to Norwegian underspecified phonological dimensions organized in a contrastive vowel hierarchy. The model proposed here accounts for most of the integrations

### Table 19: Integration of English [ʌ] (Haugen, 1953: 428–429).

| English word                        | English vowel | Norwegian word | Norwegian vowel |
|-------------------------------------|---------------|----------------|-----------------|
| cut (inf.), husk                    | [ʌ]           | katˈta, haskˈ  | /a/ (short)     |
| hunt (inf.), bug, husk              | [ʌ]           | hånˈta, båggˈ, háskˈ | /o/ (short) |
| cut (inf.), husk, justice           | [ʌ]           | køtˈta, høskˈ, jøsˈtis | /ø/ (short) |
| hunt (inf.), husk                   | [ʌ]           | honˈta, hoskˈ  | /u/ (short)     |
| hunt (inf.), justice                | [ʌ]           | hunˈta, jøsˈtis | /u/ (short)     |
analyzed above, and provides avenues for further research to refine this approach, specifically: whether the position of a dimension within a contrastive hierarchy affects the UR score, how the TR dimension interacts with the signal features [high] and [ATR], and how fine-tuned analyses of dialectal phonological contrasts can further our understanding of vowel integration patterns.

5 Conclusion

Haugen (1950) states that “the analysis of borrowing must ... begin with an analysis of the behavior of bilingual speakers” (210). Throughout this paper, I have argued for a particular aspect of bilingual behavior—namely, the perception and interpretation of L2 sounds (specifically vowels) and their mapping onto the phonological structure of the L1. The selection of vowels integrated is understood through a formula that relates the interpretation of the phonetic signal to underspecified phonological representations (Lahiri and Reetz, 2002), and not through the pairing of similar L1 and L2 phonetic categories (Flege, 1995). Lahiri and Reetz (2002) situate Underspecified Recognition in the context of the perception of specified vs. unspecified phonological features, as well as in language change. The present proposal largely accounts for the variation of integrated L1/SL phonemes for L2/RL input sounds, but predicts a limited amount of possible variation based on the set of non-mismatching dimensions derived from hierarchical contrastive representations.

The integration of loanwords provides further support for the Underspecified Recognition model within a different, but related domain. Finally, I show that there are instances where the Lahiri and Reetz (2002) model does not predict an attested integrated vowel. These cases, however, clearly lay out directions for additional research that will refine the model. There are, of course, additional factors in loanword and language contact phenomena that go beyond initial contact situations and the processing of L2/RL sounds with a L1/SL phonology, including increased proficiency in the L2, and real-time differences in the adoption of loanwords in the community. These social factors are indeed fundamental in understanding the nature of the contact between the two languages, but I leave these matters for future research. This structural analysis of loan integrations, however, provides insight into the processes that underlie the early contact between two languages in a bilingual environment, and builds upon related work in language contact, speech perception, and phonological theory.
Acknowledgements

I would like to thank B. Marcus Cederström, Robert Howell, Eric Raimy, Thomas Purnell, Joseph Salmons, and Kirsten Wolf, as well as three anonymous reviewers, for helpful suggestions and comments on earlier versions of this paper. I alone am responsible for any mistakes or errors.

References

Allen, Brent, and Joseph Salmons. 2015. Heritage language obstruent phonetics and phonology: American Norwegian and Norwegian-American English. In Janne Bondi Johannessen and Joseph Salmons (eds.), Germanic Heritage Languages in North America: Acquisition, attrition and change, 97–116. Amsterdam: John Benjamins. Downloadable at https://benjamins.com/#catalog/books/silv.18/ (accessed January 17, 2016).

Allen, Harold B. 1976. The Linguistic Atlas of the Upper Midwest, Vol. 3. Minneapolis, MN: University of Minnesota Press.

Annear, Lucas, and Kristin Speth. 2015. Maintaining a multilingual repertoire: Lexical change in American Norwegian. In Janne Bondi Johannessen and Joseph Salmons (eds.), Germanic Heritage Languages in North America: Acquisition, attrition and change, 201–216. Amsterdam: John Benjamins. Downloadable at https://benjamins.com/#catalog/books/silv.18/ (accessed January 17, 2016).

Avery, Peter, and William J. Idsardi. 2001. Laryngeal Dimensions, completion and enhancement. In T. Allen Hall (ed.), Distinctive feature theory, 41–70. Berlin: Mouton de Gruyter.

Benmamoun, Elabbas, Silvia Montrul, and Maria Polinsky. 2013. Heritage languages and their speakers: Opportunities and challenges for linguistics. Theoretical Linguistics 39.3–4: 129–181.

Blegen, Theodor C. 1940. Norwegian Immigration to America: The American Transition. Northfield, MN: Publications of the Norwegian-American Historical Association.

Brown, Cynthia. 1998. The role of L1 grammar in the L2 acquisition of segmental structure. Second Language Research 14.2: 136–193.

Brown, Joshua R., and Michael Putnam. 2015. Functional convergence and extention in contact: Syntactic and symantic attributes of the progressive aspect in Pennsylvania Dutch. In Janne Bondi Johannessen and Joseph Salmons (eds.), Germanic Heritage Languages in North America: Acquisition, attrition and change, 135–160. Amsterdam: John Benjamins. Downloadable at https://benjamins.com/#catalog/books/silv.18/ (accessed January 17, 2016).
Chang, Charles B. 2015. Determining cross-linguistic phonological similarity between segments: The primacy of abstract aspects of similarity. In Eric Raimy and Charles E. Cairnes (eds.), *The Segment in Phonetics and Phonology*, 199–217. Chichester: John Wiley & Sons.

Clopper, Cynthia G., David B. Pisoni, and Kenneth de Jong. 2005. Acoustic characteristics of the vowel systems of six regional varieties of American English. *Journal of the Acoustical Society of America* 118.3: 1661–1676.

D’Arcy, Alex. 2004. Unconditional neutrality: Vowel harmony in a two-place model. *Toronto Working Papers in Linguistics* 23: 1–42.

Desher, B. Elan. 2009. *The Contrastive Hierarchy in Phonology*. Cambridge: Cambridge University Press.

Desher, B. Elan, Glyne Piggot, and Keren Rice. 1994. Contrast in Phonology: Overview. In Carrie Dyck (ed.), *Toronto Working Papers in Linguistics* 13, iii–xvii. Toronto: Department of Linguistics, University of Toronto.

Desher, B. Elan, and Xi Zhang. 2005. Contrast and phonological activity in Manchu vowel systems. *The Canadian Journal of Linguistics/La revue canadienne de linguistique* 50.1: 45–82.

Eckman, Fred R. 2004. From phonemic differences to constraint rankings: Research on second language phonology. *Studies in Second Language Acquisition* 26.4: 513–549.

Eckman, Fred, and Greg Iverson. 2015. Second language acquisition and phonological change. In Patrick Honeybone and Joseph Salmons (eds.), *The Oxford Handbook of Historical Phonology*, 637–643. Oxford: University press.

Endresen, Rolf Theil. 1988. *Fonetikk: Ei elementær innføring*. Universitetsforlaget AS.

Flege, James E. 1995. Second language learning: Theory, findings and problems. In W. Strange (ed.), *Speech perception and linguistic experience: Issues in cross-linguistic research*, 233–277. Timonium, MD: York Press.

Flom, George T. 1909. *A History of Norwegian Immigration to the United States from the Earliest Beginning down to the Year 1848*. Priv. Print.

Hall, Daniel Currie. 2011. Phonological contrast and its phonetic enhancement: dispersedness without dispersion. *Phonology* 28.1: 1–54.

Hanssen, Eskil. 2010. *Dialekter i Norge*. Bergen: Fagbokforlaget.

Haugen, Einar. 1950. The analysis of linguistic borrowing. *Language* 26.2: 210–231.

Haugen, Einar. 1953. *The Norwegian language in America: A study in bilingual behavior*, Vols. 1–2. University of Pennsylvania Press.

Haugen, Einar. 1982. *Scandinavian language structures: A comparative historical survey*. Minneapolis, MN: University of Minnesota Press.

Herd, Jonathan. 2005. Loanword adaptation and the evaluation of similarity. In Chiara Frigeni, Manami Hirayama, and Sarah Mackenzie (eds.), *Toronto Working Papers in Linguistics* 24: Special issue on similarity in phonology, 65–116.
Hjelde, Arnstein. 1996. Some phonological changes in a Norwegian dialect in America. In P. Sture Ureland and Iaian Clarkson (eds.), Language Contact across the North Atlantic, 283–295. Tübingen: Max Niemeyer.

Hjelde, Arnstein. 2015. Changes in a Norwegian dialect in America. In Janne Bondi Johannessen and Joseph Salmons (eds.), Germanic Heritage Languages in North America: Acquisition, attrition and change, 283–298. Amsterdam: John Benjamins. Downloadable at https://benjamins.com/#catalog/books/silv.18/ (accessed January 17, 2016).

House, Arthur S. 1961. On vowel duration in English. The Journal of the Acoustical Society of America 33.9: 1174–1178.

Iverson, Greg, and Joseph Salmons. 1995. Aspiration and laryngeal representation in Germanic. Phonology 12.3: 369–396.

Jacewicz, Ewa, Robert A. Fox, and Joseph Salmons. 2011. Cross-generational vowel change in American English. Language Variation and Change 23: 45–86.

Johannessen, Janne Bondi, and Signe Laake. 2015. On two myths of the Norwegian language in America: Is it old-fashioned? Is it approaching the written Bokmål standard? In Janne Bondi Johannessen and Joseph Salmons (eds.), Germanic Heritage Languages in North America: Acquisition, attrition and change, 299–322. Amsterdam: John Benjamins. Downloadable at https://benjamins.com/#catalog/books/silv.18/ (accessed January 17, 2016).

Keyser, Samuel, and Kenneth Stevens. 2006. Enhancement and overlap in the speech chain. Language 82.1: 33–63.

Kristoffersen, Gjert. 2000. The Phonology of Norwegian. Oxford: Oxford University Press.

Lahiri, Aditi, and Henning Reetz. 2002. Underspecified recognition. In Carlos Gussenhoven and Natasha Warner (eds.), Laboratory phonology 7, 637–676. Berlin: Mouton de Gruyter.

Lovoll, Odd S. 1999. The Promise of America: A History of the Norwegian-American People. University of Minnesota Press.

Montrul, Silvina. 2012. Incomplete acquisition and attrition of Spanish tense/aspect distinctions in adult bilinguals. Bilingualism: Language and Cognition 5.1: 39–68.

Oxford, Will. 2015. Patterns of contrast in phonological change: Evidence from Algonquian vowel systems. Language 91.2: 308–357.

Purnell, Thomas and Eric Raemy. 2015. Distinctive features, levels of representation and historical phonology. In Patrick Honeybone and Joseph Salmons (eds.), The Oxford Handbook of Historical Phonology, 522–544. Oxford: University Press.

Purnell, Thomas, Eric Raemy, and Joseph Salmons. Forthcoming. Upper Midwestern English. In R. Hickey (Ed.), Listening to the Past. Cambridge, England: Cambridge University Press.
Putnam, Michael T., and Liliana Sánchez. 2013. What’s so incomplete about incomplete acquisition? A prolegomenon to modeling heritage language grammars. *Linguistic Approaches to Bilingualism* 3.4: 478–508.

Rice, Keren. 1999. Featural markedness in phonology: variation. *Glot International* 4.7–8: 3–6.

Ringen, Catherine, and Robert Vago. 2011. Geminates: Heavy or Long? In Charles E. Cairns and Eric Raimy (eds.), *Handbook of the Syllable*, 155–169. Leiden: Brill.

Sandøy, Helge. 1996. *Talemål*. Oslo: Novus forlag.

Selkirk, Elisabeth. 1990. A two root theory of length. *University of Massachusetts Occasional Papers in Linguistics* 14: 123–171.

Skjekkeland, Martin. 2005. *Dialektar i Noreg–Tradisjon og Fornying*. Kristiansand: Høyskoleforlaget.

Thomas, Erik. 2001. *An acoustic analysis of vowel variation in New World English*. Durham: Duke University Press.

Van Coetsem, Frans. 1988. *Loan Phonology and the Two Transfer Types in Language Contact*. Providence: Foris Publications USA.

Van Coetsem, Frans. 1995. Outlining a model of the transmission phenomenon in language contact. *Leuvense Bijdragen* 84: 63–85.

van Santen, J.P.H. 1992. Contextual effects on vowel duration. *Speech Communication* 11.6: 513–546.

Vanvik, Arne. 1972. A phonetic-phonemic analysis of Standard Eastern Norwegian. *Norwegian Journal of Linguistics* 26: 119–164.

Venås, Kjell. 1977. *Hallingmålet*. Oslo: Det Norske Samlaget.

Westergaard, Marit, and Merete Anderssen. 2015. Word order variation in Norwegian possessive constructions: Bilingual acquisition and attrition. In Janne Bondi Johannessen and Joseph Salmons (eds.), *Germanic Heritage Languages in North America: Acquisition, attrition and change*, 21–45. Amsterdam: John Benjamins. Downloadable at https://benjamins.com/#catalog/books/silv18/ (accessed January 17, 2016).

Winford, Donald. 2005. Contact-induced changes: Classification and process. *Diachronica* 22.2: 373–427.