The role of non-phonetic factors in phonetically conditioned sound change
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1 Introduction

Language is not static, but rather varies from person to person, from place to place, and from time to time. Sound change refers to the process in which sounds in a language change across people, places, and times. Sound change is key to many fields of research. Historical and comparative linguists discover common ancestry by tracing the patterns of sound change across different languages. Anthropologists and evolutionary biologists use these results to track ancient people’s divergence and migration. Recent sound changes feed sociological studies that examine variation across groups and individuals. Cognitive psychologists and neuro-biologists explore the mechanisms underlying language perception, and why, despite individual differences in language processing, synchronic language can be relatively homogeneous.

2 The Comparative Method and the Neogrammarian Principle

The traditional method of examining sound change is the comparative method, in which cognates (i.e., words deriving from the same historical form) are compared across languages, in order to reconstruct how the original sounds changed to produce the resulting sounds. Example (1) shows a sound change whereby the Old English (OE) $c$ developed into $ch$. By comparing cognates, we find that the $c$ in these words developed from an original $k$ sound. (2) lists words where this hard $c$ (i.e., $k$ sound) was retained in English, comparable to the similar sound in related languages.

(1) English church OE circe German Kirche Danish kirke
English chest OE cest German Kiste Dutch kist

(2) English corn OE corn German Korn Danish korn
English cow OE cu German Kuh Danish ko

This preliminary analysis does not explain why OE $c$ sometimes remained a hard $c$ (i.e., $k$), while other times it developed into $ch$. A closer examination of (1) and (2) reveals that the change from hard $c$ into $ch$ was a phonetically conditioned sound change - i.e., a sound change triggered by a nearby sound, such as a following vowel. When OE $c$ occurred before $i$ or $e$ (vowels that are pronounced in the front of the mouth), the vowel’s property of front-ness spread to the $c$, moving
it to a more front position in the mouth, making it \textit{ch}. This resulted in a \textit{sound split}, where \textit{c} became \textit{ch} before front vowels \textit{i} and \textit{e}, and remained hard \textit{c} before back vowels \textit{u o} and \textit{a}.

The foundation of the comparative method is the assumption that phonetically conditioned sound change does not have exceptions. Any apparent exception must be the result of some other sound change, borrowing from another language or dialect, or analogical re-shaping based on the influence of an associated word. The \textit{Neogrammarian Principle}, as this assumption is known, has not only proven useful in reconstructing ancient languages and establishing relationships among languages, but has also served as a strict test for thoroughness in linguistic analysis, ensuring that all exceptions are accounted for by one of these mechanisms, when possible.

Ex. (3) illustrates some analogical exceptions to the generalization illustrated by (1) and (2). We expect the word \textit{chosen} to have developed a hard \textit{c} from OE \textit{coren}, like the words in (2); however, \textit{ch} occurs in all the modern past and present tense forms of \textit{choose}, though the present tense form alone is explained by an OE front vowel. Such exceptions are attributed to \textit{analogical leveling}, whereby language users ‘level out’ pronunciation differences across related words so that different forms of the same root word have a similar phonetic shape. Similarly, the forms \textit{charve: corven} were leveled in favor of the hard \textit{c} to yield \textit{carve: carved}.

\begin{flushleft}
(3) \hspace{1cm} \text{English } \textit{choose} - \textit{chosen}; \hspace{1cm} \text{OE } \textit{ceosan} \hspace{1cm} \text{pron. } \textit{cheosan} \hspace{1cm} \text{past } \textit{coren} \hspace{1cm} \text{pron. } \textit{koren} \\
\hspace{1cm} \text{English } \textit{carve} - \textit{carved/carven}; \hspace{1cm} \text{OE } \textit{ceorfen} \hspace{1cm} \text{pron. } \textit{cheorven} \hspace{1cm} \text{past } \textit{corfen} \hspace{1cm} \text{pron. } \textit{korven}
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\section{An alternative theory}

One impediment to a unified interdisciplinary theory of sound change is the heuristic outlined above that treats phonetically conditioned sound change and analogy as categorically separate. The goal of this dissertation is to show that the same mechanism is at work for both types of sound change. Analogical changes are the result of generalizations based on associations between sounds and non-phonetic conditions, such as lexically or semantically related word-forms, while phonetically conditioned sound change results from associations among sounds.
Listeners form associations between sounds and linguistic contexts, and use such associations to anticipate sounds using linguistic information such as phonetic environment (e.g., Beddor 2009, Connine & Darnieder 2009). For example, listeners take into account their experiential knowledge that *t* sounds different in different environments, such as *top, trap, and pat*. If a mismatched variant is heard, it causes a processing delay because it is unexpected. Listeners also use variation as a source of extra-linguistic information, including physiological (e.g., age, sex) or social (e.g., dialect, social status) factors (e.g., Kraljic, Brennan & Samuel 2008; Maye, Aslin, & Tanenhaus 2008). If the speech and perceived identity of the talker don’t match, a listener has greater difficulty in processing, while positive matches facilitate ease of communication. These associations allow efficiency in processing speech, but may also lead to sound change.

4 Methods
To test the claim that sounds may be associated with non-phonetic contexts, in the same way as phonetic contexts, I propose a series of three experiments, using perceptual learning to simulate the mechanism of sound change. *Perceptual learning* occurs when an ambiguous sound in a word is perceived as the normally occurring sound in that word. With repeated exposure listeners incorporate the ambiguous sound into a mental representation for the original sound, changing the sound category (e.g., Samuel 2001, Norris, McQueen & Cutler 2003). Perceptual learning closely mimics sound change, as it induces a gradual change in the perception of a sound.

The targeted sound in this laboratory-controlled sound change is the *t* in the context of *tw-* (as in *twin*). Experiment 1 uses perceptual learning to shift listeners’ perception and production of the target sound toward the training condition variant. One group hears *tw-* words pronounced with a *retracted* (further back in the mouth) variant that sounds like *chw-*; and another group hears a *fronted* (more towards the front of the mouth) variant that sounds like *tsw-* . This first experiment will determine if the perceptual learning technique is effective at changing perception and/or production, so that participants will accept the sound-change pronunciation on which they
are trained. If training succeeds, the chw- group will accept the ch sound as a variant of t before w, while the tsw- group will accept ts as a variant of t before w. In comparison, the control group, which hears words with a normally pronounced tw-, should be less willing to accept the variant pronunciations. Experiments 2 and 3 expose listeners to both variants, so as to induce a sound split using non-phonetic contexts. Participants in experiment 2 will associate one variant with female talkers and the other with males. Participants in experiment 3 will associate one variant with one grammatical category and the other variant with another category.

Each of the proposed experiments has the same protocol: before training, participants read aloud a set of target words that are recorded, and rate the familiarity of each word. Then, in a vocabulary-learning task, participants are exposed to both unfamiliar and familiar words, which are pronounced with the training variant of the tw-sound, to facilitate perceptual learning of this new sound. Next, participants in all conditions complete a lexical decision task, in which they decide whether the stimulus they hear is a real word or a nonsense word. Accuracy and response times (RT) are measured for each variant, with the assumption that higher accuracy and faster RT indicate easier processing. Participants then read the words aloud again, so that changes in pronunciation can be examined. Finally, they complete an identification (ID) task, in which they must decide whether an ambiguous stimulus is the word chew, too, or tsu. The ID task is designed to measure changes to the perceptual category for t. Experiments 2 and 3 include an eye-tracking task that measures how quickly participants identify the target word and how often they look at a competing word beginning with sw- or ch- depending on which variant they hear.

5 Expected results
The training conditions in experiment 1 are expected to affect speech production, so that the front (tsw-) group will have a more front pronunciation, and the retracted (chw-) group will have a retracted pronunciation of tw- after training, relative to their initial production. Participants in experiment 2 should pronounce tw- more like the training variant for their gender. Participants in
experiment 3 should pronounce different variants based on grammatical category. In experiment 1, the \textit{chw}- group should show faster RTs in the lexical decision task for words with the \textit{chw}- variant, and the \textit{tsw}- group should have faster RTs for words with \textit{tsw}-. The control group is expected to have slower RTs and higher rejection rates for words with both variants. Both training groups will show a perceptual shift in how they perceive the \textit{t} sound. Preliminary results for the identification task show differences by training condition for perception of \textit{t}, so that the \textit{tsw}-trained group accepts more instances of \textit{tsu} as \textit{too}, and the \textit{chw}-trained group perceives more instances of \textit{chew} as \textit{too}. These results suggest not only that the perceptual learning method is effective at training a phonetically conditioned perceptual sound change, but also that the change in \textit{t} is robust enough to be associated with other sounds (as \textit{u} is different from \textit{w}). The rest of the data from experiment 1 is being prepared for analysis, and data-collection for experiment 2 will begin in November. The lexical decision task in experiments 2 and 3 should produce faster RTs for words with the same variant and association (gender or word class) as presented in the training. Experiment 2 participants should respond faster to \textit{chw}- produced by men, if trained in this condition, and more slowly to \textit{chw}- by women, as they would expect women to use \textit{tsw}-. In experiment 3, listeners should respond faster to \textit{chw}- in verb-type words if they are trained in this condition, and vice-versa. In the eye-tracking, participants should focus on competing \textit{ch}-or \textit{sw}- words more often if the variant and association do not match the training condition. All these results would demonstrate association of a sound variant with non-phonetic factors in the same manner as an association with phonetic factors, providing evidence for the claim that there is one mechanism underlying both phonetically conditioned sound change and analogy, namely the ability of the mind to form generalizations from associations between sound and context. Removing the barrier between sound change and analogy clears the path for an updated theory of sound change that will allow us to examine language \textit{in situ}, in the minds of language users.
6 References


