THE PERCEPTION OF A DERIVED CONTRAST IN SCOTTISH ENGLISH

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ABSTRACT

This paper reports on ongoing experiments related to the perception of atypical phonological contrasts. It was hypothesized that the quasi-phonemic status of a derived contrast in Scottish English would induce atypical responses, yielding behavioural correlates with intermediate values between phonemicity and allophony. The results show that some of the Scottish participants produce identification slopes that are quite similar to the French allophonic control group while other Scottish listeners show more phonemic responses.

Keywords: Gradient Phonemicity Hypothesis, perception, derived contrasts

1. INTRODUCTION

Many phoneticians and phonologists take it for granted that a difference between two speech sounds can only reflect either a phonemic contrast (i.e. two categories) or allophonic variation (within one category). However, now and then, some authors have cast doubt on the strict categorical view [2, 7, 12]. Evidence from many languages in the world blatantly shows that among the entities analysed as phonemes, some constitute better candidates to phonemicity than others. The predictability criterion, according to which if the occurrence of a sound can be predicted from the phonological context, then this sound is an allophone, and if it is not predictable at all, then the sound is a phoneme, is commonly applied in a binary fashion. However, [2] convincingly argued that the occurrence of a sound can be more or less predictable. Therefore, if predictability determines phonemicity, and if predictability is gradient, then it is not too far-fetched to hypothesize that phonemicity could be gradient too. We introduce the Gradient Phonemicity Hypothesis (GPH), according to which the nature of the difference between two sounds in a language cannot be satisfactorily accounted for by the strict binarism underlying the phoneme concept. We contend that the relationship between two sounds is better described as belonging to the fuzzy set of phonemic contrasts with a certain degree of membership. We believe that this degree can be computed from various behavioural correlates collected during perceptual experiments.

Scottish English provides a perfectly-suited phenomenon to begin testing our hypothesis experimentally. Contrary to most accents of English, the vowel system of Scottish English does not make use of phonological length [3, 11]. However, closer attention reveals that some duration-based contrasts do emerge due to morphological conditioning. For example, the past morpheme <ed> causes the vowel in the word *brewed* to be appreciably longer than its counterpart in *brood*. Similarly, *kneed/need* and *sighed/side* (with additional vowel quality variation in the latter) are known to be distinct in many speakers of Scottish English.

Derived contrasts constitute a puzzle for linguists because, as [5] remarks, structuralists would count them as phonemes while generativists tend to regard them as mere allophones.

This paper is a preliminary report on an ongoing series of perceptual experiments whose aim is to provide empirical information on the cognitive status of atypical contrasts such as the derived contrasts attested in Scottish English mentioned earlier. Because such contrasts are morphologically conditioned, and given their low functional load, our intuition is that their behavioural correlates could exhibit values that are intermediate between those of fully-fledged phonemic oppositions and those elicited by allophones.

2. EXPERIMENT

The experiment reported here is a labeling task involving stimuli varying in duration on a quasi-continuum between *brood* and *brewed*. Native speakers of French and Scottish English performed the task. French being a language without

phonological length, the inclusion of French participants was meant to provide 'baseline' data on the perception of the duration of speech sounds.

2.1. Participants

The participants were 21 students from the University of Glasgow (ECO) and 19 students from the University of Lyon (FRA). The Scottish participants were paid, and most of the French received course credit for their participation.

2.2. Stimuli

From previous recordings involving 15 speakers from Glasgow, we had determined that typical duration values for the vowels in *brood* and *brewed* were approximately 70 and 175 ms respectively. One occurrence of the word *brewed* spoken by a male speaker was selected, vowel boundaries were identified as the limits of the steady-state portion of the formant pattern, and the vowel was time-compressed or expanded, and resynthesized with the Praat program, which yielded 12 stimuli whose vowel duration ranged from 40 to 205 ms in 15-ms steps. All stimuli were presented in the same carrier sentence (*He said the word…*) since speech rate is known to alter [8] both the location of category boundaries and their internal structures. Each trial started with a 150-ms beep (300-Hz sine-wave) which was meant to focus participant's attention; then, the sentence was played after a 500-ms silent chunk.

2.3. Procedure

The Scottish part of the experiment took place in the recording studio at the Glasgow University Laboratory of Phonetics. The French experiment was carried out in a sound-attenuated booth at Laboratoire Dynamique Du Langage, Lyon. For both locations, the experiment was run with the same equipment: two laptop computers with relative output level equalized by means of an oscilloscope, and high-quality headset with TDH-39 earphones and Peltor noise-attenuating cups. The experiment was implemented as a Matlab standalone executable. At the beginning of the experiment, a synthesized /a/ with varying intensity was played and the method of adjustment was used to determine individual thresholds of hearing. Then all stimuli for the rest of the experiment were automatically adjusted so that their RMS intensity was 50 dB above threshold. This procedure was meant to provide a comfortable output level for all participants and to detect potential slight hearing deficiencies.

The French experiment started with a training phase during which participants were told to listen to *brood* (70 ms) and *brewed* (175 ms) in order to become familiar with what we called a 'short word' and a 'long word'. Once they felt confident that they had learned the difference between short and long, they were asked to move on to the experiment itself. They were prompted to decide as quickly as possible whether the word at the end of the carrier sentence was short or long. Then, they were asked to rate the goodness of the stimulus on a 1-7 scale.

The Scottish experiment started with the recording of a short text designed to elicit derived contrasts. This procedure was chosen in order to estimate, for each participant, whether this contrast was present or absent of her production system. Then, the listening part was similar to that of the French experiment except that Scottish participants were asked to decide whether the word was *brood* or *brewed*. The screen prompts were written in the participants' native language. The 12 stimulus levels were presented 40 times in random order varying from a participant to the next, yielding a total of 480 trials.

2.4. Analysis

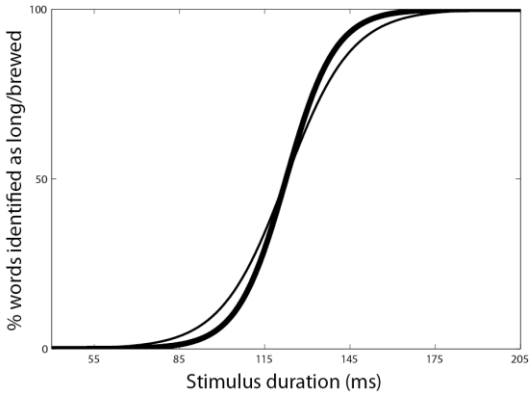
Logistic functions – relating the proportion of stimuli identified as long (FRA)/*brewed* (ECO) – were fitted to individual datasets with the *Palamedes* toolbox [9] in order to determine the slope and the threshold of the identification function. The threshold corresponds to the point where the identification reaches 50%. A visual inspection of the results led to regard participants ECO22 and FRAFF as outliers in terms of slope for the former and threshold for the latter. As it turned out, their values lied outside the mean +/- two standard deviations interval computed from their group for the parameter in question. They were therefore removed from the rest of the analysis. A one-way ANOVA with Native Language as factor was conducted on Slope, and another one with Threshold as the dependent variable. Then, given the substantive variation in the Scottish data in terms of goodness ratings, identification functions, and speech production, individual data were closely inspected in an attempt to group the participants according to specific patterns of results. Goodness ratings,

which were min-max normalized, would be expected to display a typical V-shaped curve if stimulus duration were plotted horizontally against goodness score. That is minimal goodness scores are expected for intermediate durations, and the further away from this intermediate point, the closer to the prototype of *brood* or *brewed*, and the higher the goodness. On the basis of the shape of goodness ratings, 3 groups were identified: Scottish-2 ('2 prototypes'; n = 9), with maximal (100%) or near maximal goodness scores given to both ends of the duration continuum, Scottish-1 ('1 prototype'; n = 7), with maximal goodness assigned to just one end of the continuum while the maximum score at the other end barely reached 60%, Scottish-3 (n = 4), with two participants showing a sawtooth pattern, and two participants whose scores increased monotonically as a function of duration. Scottish-3 were discarded, and we concentrated on whether the apparent existence of 1 vs. 2 prototypes could predict the steepness of the identification curve. A one-way ANOVA with factor Group (French, Scottish-1, Scottish-2) was computed on slope.

3. RESULTS

The statistical analyses showed a significant effect of Language on Slope $F(1,36) = 10.28$, $p = .0028$, but not on Threshold. As can be seen from Figure 1, the slope of the identification function is steeper for Scottish than French participants.

Figure 1: Identification function for Scottish (thick line) and French (thin line) participants.



With Group (Scottish-1, Scottish-2, French) as the factor, and Slope as the dependent variable, the ANOVA showed a significant main effect of Group: $F(1,31) = 14.25$, $p < .0001$. Post-hoc tests revealed significant differences between Scottish-2 and the other two groups, but not between Scottish-1 and French. The results are displayed in Figures 2 and 3.

Figure 2: Identification function for Scottish-1 (dashed line), Scottish-2 (thick line) and French (thin line) participants.

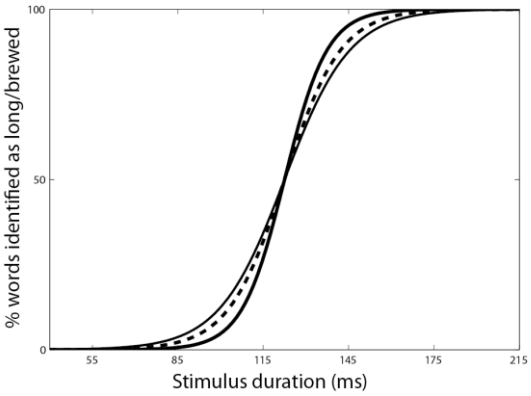
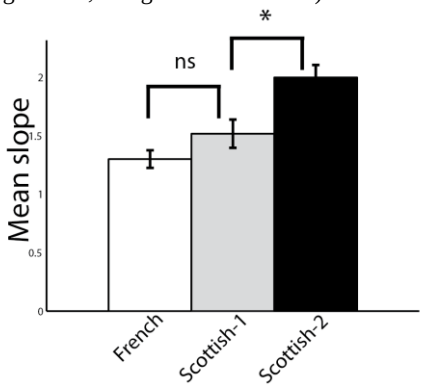


Figure 3: Comparison of mean slopes between Scottish-1, Scottish-2, and French participants (ns: non-significant; *: significant .05 level).



4. DISCUSSION

This study was a preliminary test of the Gradient Phonemicity Hypothesis. Our goal was to investigate whether the 'intermediate' linguistic status of a derived contrast in Scottish English triggered intermediate behavioural correlates. Identification curves were steeper in Scottish participants, which entails that the precision of the boundary between *brood* and *brewed* was, as expected, higher in the Scottish group. However, after inspecting individual goodness ratings, we were able to split the Scottish group into two subgroups: Scottish-1, with one prototype, and Scottish-2, with two prototypes. The analysis showed that the slopes in Scottish-1 participants were probably not different from those observed in French subjects. Scottish-2 had steeper slopes than French and Scottish-1 participants. We therefore tentatively suggest that the perception of the *brood*/*brewed* contrast in the Scottish-1 group was

allophonic while it was more phonemic in Scottish-2 participants. Note that preliminary inspection of the production data does not seem to indicate that the likely presence of the contrast in production predicts group membership.

The slope of the identification curve was implicitly accepted as a correlate of phonemicity: the steeper the slope, the more phonemic the contrast. The rationale for this claim stems from developmental studies involving labeling tasks, where the steepness of the response curve has often been equated with the presence of a reliable phonemic contrast in participants [1, 13]: the steeper the slope, the more reliable or fully-developed the contrast.

Our experimental paradigm has often been used in the literature on categorical perception (CP) [10, 13]. However, the term 'categorical perception' has been avoided here because it is highly connoted and often refers to the extent to which identification predicts discrimination. This, of course, does not apply to our study. A question related to this is how come our response curves are so steep considering that vowels have long been known to be perceived almost non-categorically? Firstly, our task is by no means similar to a standard CP task with continua of isolated vowels, often varying on the spectral dimension. Vowels in word context are known to be perceived more categorically [10]. Secondly, the nature of the task itself (labeling words, rather than vowels for Scottish participants) may have favoured steeper slopes, as the type of task can modulate correlates of CP [4].

Another objection could be that the steepness of the slope is a by-product of the durational step between successive stimuli. This is unlikely: our step size – 15 ms – is smaller than the one – approx. 20 ms – used successfully in a study on phonological quantity in Finnish [14], and it is smaller than the just-noticeable difference established by [6] .

As pointed out earlier, this study is only preliminary. A more conclusive version will include the perception of a linguistically well-established phonemic contrast based on duration, such as the TRAP-START opposition in some accents in the north of England [3]. This will allow a more thorough test of the Gradient Phonemicity Hypothesis with 3 types of duration-based differences: allophonic for French listeners (*brood*/*brewed*, in the current article), phonemic for northern English listeners (TRAP-START), and quasi-phonemic (*brood*/*brewed* in the current article) with Scottish participants.

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