Opacity does not always lead to recoverability: Counterbleeding in Canadian English

One of the hallmarks of traditional counterbleeding opacity is that it preserves a contrast, although the surface contrast is different from the underlying contrast. For example, in the classic interaction between Canadian raising and intervocalic flapping, the diphthongs [aɪ, aʊ] are raised to [ʌɪ, ʌʊ] before voiceless consonants, but intervocalic voiceless /t/ is realized as a voiced flap [ɾ]. The result is an apparent vowel height contrast on the surface that actually reflects an underlying contrast between /t/ and /d/, as in *writing* and *riding* in (1).

(1) Underlying /t-d/ contrast	wr/aɪt/ing	r/aɪd/ing
Vowel raising	ʌɪt	---
Flapping	ʌɪɾ	aɪɾ
Surface vowel height contrast	wr[ʌɪɾ]ing	r[aɪɾ]ing

Phonologists have long proposed that one potential benefit of opaque interactions is that they preserve some underlying contrast, thus helping the listener recover correct representations (Kaye 1974; Gussman 1976; Łubowicz 2003; Mielke, Hume, & Armstrong 2003). However, this recoverability has not been tested. This paper presents the results of two experiments testing whether listeners can use their knowledge of phonologically opaque processes to determine underlying representations. Based on the results of these experiments, we argue that recoverability is not a clear consequence of opacity.

Both experiments tested whether native Canadian-English speaking participants could accurately judge the underlying identity of an intervocalic flap using the height (raised or unraised) of a preceding diphthong. In Experiment 1, 44 university-student participants heard cartoon aliens use nonce words to describe novel actions, as in Figure 1 (this experiment was originally designed for children). They were asked to respond whether the second alien's statement was correct. In experiment 2, we simplified the task: 42 university-student participants participated in a same-different task where they heard the pairs of auditory stimuli from Experiment 1 and were asked to judge whether the words came from the same paradigm or different paradigms. In both cases, experimental stimuli consisted of three sets of nonce words: 10 transparent pairs with unraised vowel before /d/ ([smaɪɾɪŋ ~ smaɪd]), 10 opaque pairs with raised vowel before /t/ ([krʌɪɾɪŋ ~ krʌɪt]), and 20 unambiguous control pairs ([vækɪŋ ~ væk]). In half the trials, the pairs matched, and in the other half, they mismatched (e.g., *[smaɪɾɪŋ ~ smʌɪt], *[krʌɪɾɪŋ ~ kraɪd, or *[vækɪŋ ~ vɛk]). Because vowel height is entirely predictable based on the underlying voicing of the following consonant, a transparent or opaque

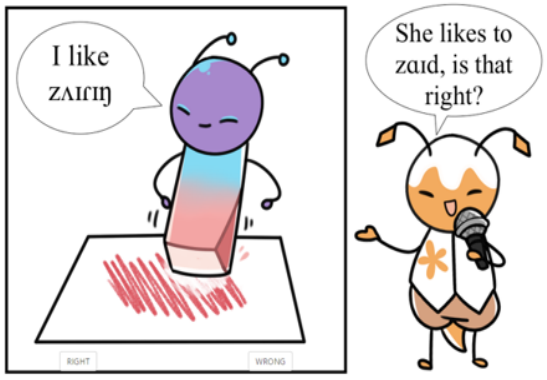

Figure 1 Sample Experiment 1 task; the participant was asked to click "right" or "wrong" in response to each prompt.

mismatch always mismatched in vowel height as well as stop voicing, making a mismatch theoretically easy to identify.

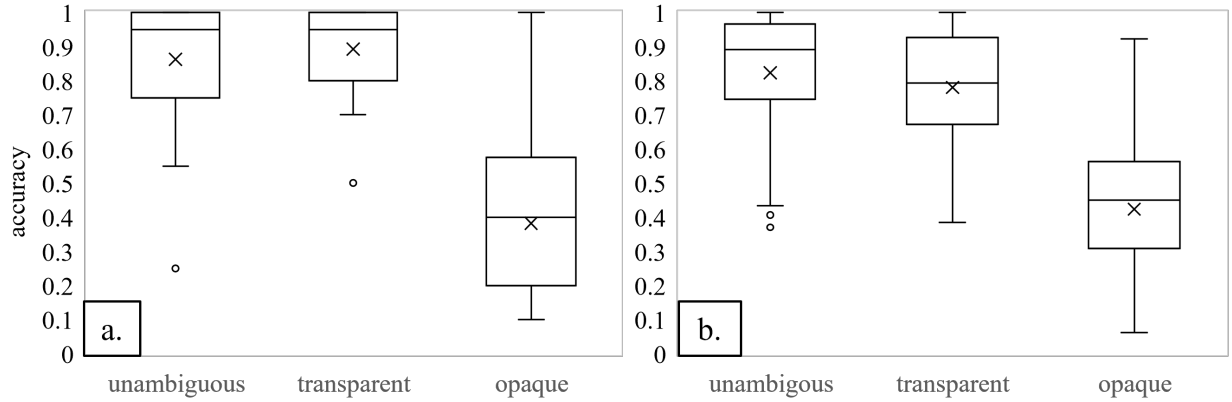

Figure 2 Boxplot results showing accuracy for each trial type in Experiment 1 (2a) and Experiment 2 (2b).

Results are displayed in Figure 2a,b. In Experiment 1 (Figure 2a), participants were nearly at ceiling accuracy when judging unambiguous and transparent forms, which did not differ in their overall accuracy, $z = 0.79$, $p = .428$. However, their judgments of opaque forms were significantly less accurate than both transparent ($z = 5.56$, $p < 0.001$) and unambiguous ($z = 7.6$, $p < .001$) forms. This result was essentially replicated in Experiment 2 (Figure 2b), in spite of the simpler design. In Experiment 2, participants were significantly less accurate in the transparent trials than they were in the unambiguous trials, $z = 1.99$, $p = .0469$, and they were significantly less accurate in opaque trials than in either unambiguous trials ($z = 6.91$, $p < .001$) or transparent trials ($z = 4.41$, $p < 0.001$).

In sum, participants were unable to use vowel height to determine the identity of a flap, even though vowel height is an entirely reliable cue to the source of the flap and is consistent across the paradigm. Moreover, in Experiment 2, participants' responses to transparent and opaque trials indicated that they interpreted the flap as a /d/ in 67% of trials, rather than the intended 50%. Participants seemed to take the (voiced) flap at its acoustic face value, interpreting the surface voicing as the result of an underlying voiced /d/.

One potential interpretation of these data is that listeners had not had sufficient experience with the nonce words and their uninflected forms to access a representation based on a different surface contrast. Our next step in this line of experimentation is to test participants' ability to use vowel height to identify a flap in real words like *writing* and *riding*, to see if the existing lexical representation can help participants make the phonological connection.

References

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