# Perception of Glaswegian rhoticity suffers in challenging listening conditions

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## RESEARCH BACKGROUND

**Rhoticity in Glasgow is changing.** Middle class (MC) speakers are producing more strongly-rhotic variants in words such as *car* and *hurt* [1,2], but working class (WC) speech is undergoing **derhoticisation**, where /r/ is a weaker, pharyngealised variant [1,3].

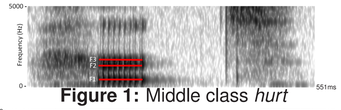


**Figure 1:** Middle class *hurt*

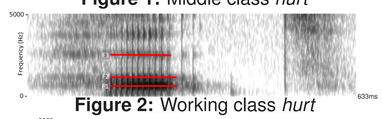


**Figure 2:** Working class *hurt*

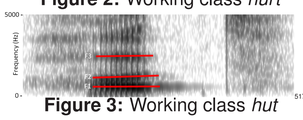


**Figure 3:** Working class *hurt*

A similar place of articulation in **derhoticised** /**r**/ and /ʌ/ (pharynx/uvula) causes perceptual ambiguity in /CʌrC, CʌC/ minimal pairs (Figs.2&3). Previous experiments show listeners' ability to distinguish pairs improves after long term familiarity (residence in Glasgow) [4] and short term learning (5min lab exposure) [5].

This paper tests the ability of Glaswegians (the most 'fluent' listeners) in distinguishing e.g. *hut/hurt* of a **MC talker** & of a **WC talker**, then examines performance under more difficult listening conditions: when the talkers are **mixed**.

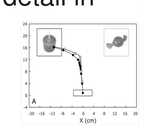
**Research question:**

**How does hearing two talkers together affect /r/ perception?**

In order to answer this question in the greatest detail, mouse tracking was used, as it allows for in-depth analyses such as spatial attraction.

## MOUSE TRACKING

**MouseTracker** [6] records trajectories, allowing competitor strength to be measured [7]. This may highlight detail in the time course of decisions where there are differences between cohort and control conditions [8].



## EXPERIMENT

**Stimuli:** 1xMC & 1xWC Gla. males, wordlist data. Target words: *hut/hurt bud/bird fussed/first* etc.

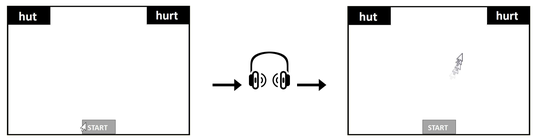
**Design:** 3x 2AFC tasks: 2x blocked by talker (for separate analyses of resp. to Single talkers) & 1x Mixed (analysis of resp. to Mixed stimuli).

Single MC → Single WC → Mixed MC+WC

(Order of Single blocks alternated per participant, for balance)

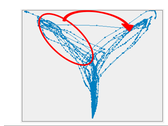
Single blocks: 12 target (+12 distr.) min. pairs
Mixed block: all 24(+24) MC & WC pairs
**Total = 192 trials** (~30min)

**Procedure:** On each trial, 51 native Glaswegians (normal hearing) clicked 'START' to play the word (500ms delay). They were instructed to move the mouse upwards and click the word they heard.

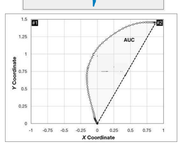



## ANALYSIS

Correct trajectories ending at the top-left were flipped right, for ease of analysis.



**Area Under the Curve** [6] measures spatial attraction to competitor. Area between each trajectory and an idealised straight line calculated, then averaged.




**Discrete Cosine Transformation** defines curves as sinusoid coefficients [9]: k*0*=mean, k*1*=slope, k*2*=curvature etc. This facilitates comparison of differences between components of trajectories, as well as statistically modelling the coefficients.

## RESULTS

**Accuracy:**

*hut/hurt* discrimination replicates [4] & [5]:

- MC = **99.01%**; WC = **90.27%**

**Statistical modelling:**

Mixed Effects Models run in R's lme4 package; best-fit models found with lmerTest's step()

**Area Under the Curve:** Interaction: Pr(>F)=0.01, F=6.02

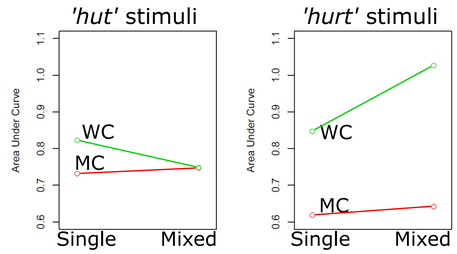



**Figure 4:** Sig. interaction: Class X Block X *hut/hurt*

- **AUC:** Higher = more spatial attraction to incorrect competitor
- Higher AUC for WC than MC stimuli
- Smallest AUC for **MC *hurt*** trajectories in Single block: **easiest stimuli to distinguish from *hut***
- Largest AUC for **WC *hurt*** in Mixed block: **hardest stimuli to distinguish from *hut***
- Larger AUC for all MC stimuli in Mixed block: more difficulty when heard with WC stimuli

**Discrete Cosine Transformation:** Int.: Pr(>F)=0.004, F=8.51

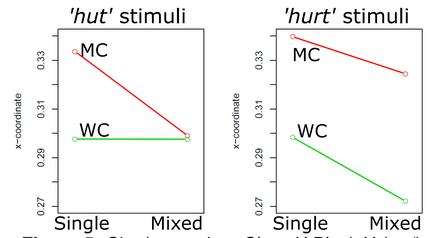



**Figure 5:** Sig. interaction: Class X Block X *hut/hurt*

- **k*0* (mean x-coord.):** Higher = greater/earlier horizontal movement towards correct response
- Earlier movements to correct MC response than to correct WC response
- Earlier movements to correct MC response in Single block than in Mixed block

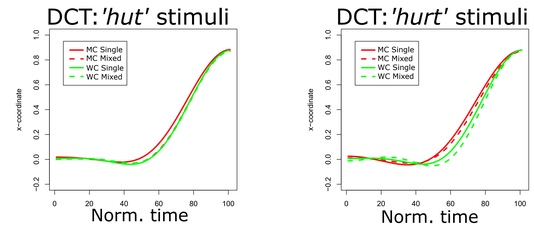



**Figure 6:** x-coords/time, reconstructed from DCT coeffs. k*0*-k*3* (time=0: 'START' clicked, time=100: 'response' clicked)

- Comparison of Figs. 5&6 shows DCT is very effective in describing trajectory patterns

## DISCUSSION

Discrimination is harder with derhoticised /r/. However, even the 'easy' MC stimuli were harder to distinguish when heard alongside WC stimuli.

**Words are harder to distinguish when talkers are heard together**

This shows the difficulty of perceptually switching between speakers with different accents. It also suggests a similar finding as [10 & 11], who found integrated talker & phoneme processing.

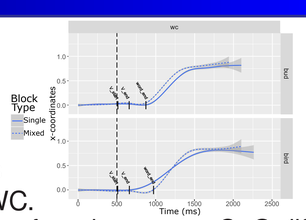
These results could be interpreted under either exemplar or Bayesian approaches to speech perception, as both may attribute greater processing costs to speaker and/or linguistic uncertainty.

## FUTURE RESEARCH

This research will answer another question:

**At what point does the listener decide what word they are hearing?**

Trajectories have been aligned with segment data, enabling real-time comparison of when listeners moved the mouse while hearing stimuli.




**Preliminary indications:** following fricatives, to a greater degree than stops or nasals, facilitate **earlier discrimination** of e.g. *bu**st**/bur**st*** in MC than in WC. Fricatives can carry information about a preceding segment: spectral analyses found a greater CoG difference between MC /r/ & no-/r/ tokens' fricatives (850Hz), than the difference in WC fricatives (350Hz).

## REFERENCES

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