Tonal Center of Gravity Predicts Variation in the Interpretation of Rising and Falling Intonation in American English

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Background

Pierrehumbert and Hirschberg (1990)
Farkas and Bruce (2010)
Farkas and Roelofsen (2017)

Falling and rising declaratives in American English typically convey either an **assertion** or a **question**, respectively

Jeong (2018)

Shallow rises are more likely than steep rises to convey an assertion, but is this a phonological contrast or phonetic variation?

Barnes et al. (2012;2021)

Tonal Center of Gravity reflects the weighted overall pitch for a time span

Experiment Task

We recruited participants from Prolific (n=110, Exp1:56 and Exp2:54)

Participants judged declarative utterances on whether the speaker was asking them something (=question) or telling them something (=assertion)

Other utterances:
Gavin's on broadway
Megan's a grandma
Ryan's in greenview
Joey's from Bronville

Stimuli cross a 5-step **accentual pitch** continuum with a 5-step **ending pitch** continuum, which they hear 5 repetitions of (total trials=125)

Schiefer & Batliner (1991)
Steffman et al. (2021)

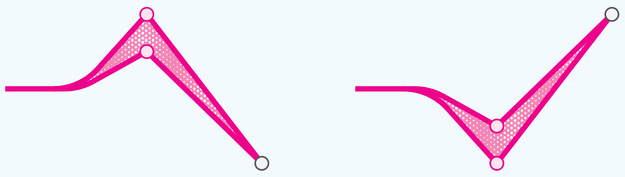
To avoid order effects, participants count aloud by 2s between each trial

Questions

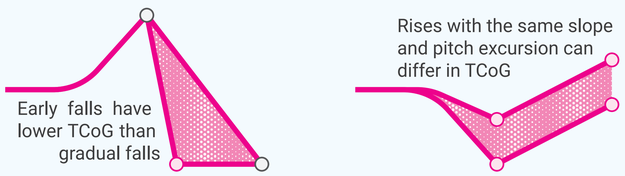
Which part of the contour do people attend to for interpreting assertions/questions?

Is it only about where it falls/rises **towards**?

Or does it matter where it falls/rises **from**?



Is there a role for the **overall trajectory**?



Models

We test three models on the probability of Telling responses to assess the contribution of pitch accent and edge tone scaling and the holistic contour via TCoG and excursion

Scaling Model
*% Telling ~ Acc.F0 * End.F0*
*+(1|utterance) + (1+AccF0*EndF0|subj)*

TCoG Model (+Shape)
*% Telling ~ TCoG * ContourShape*
+(1|utterance) + (1+TCoG|subj)

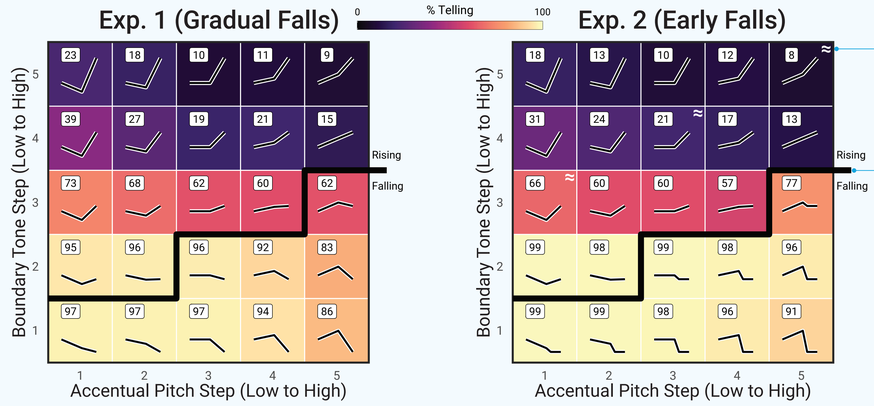
Excursion Model (+Shape)
*% Telling ~ F0Excursion * ContourShape*
+(1|utterance) + (1+F0Slope|subj)

F0 measures are transformed to semitone scale from 90 Hz (the midpoint of the accentual pitch continuum)

Results

Question/Assertion interpretation is driven by variation in **ending pitch**, not accentual pitch: higher ending pitch is less likely to receive a Telling response

Effect of accentual pitch is in the opposite direction than predicted: higher accentual pitch is less likely to receive a Telling response, not more likely



Cells with ≈ have equivalent pitch excursions and slopes between the two pitch targets

Shape: **Rising** if ending pitch is greater than accentual pitch, otherwise **Falling**

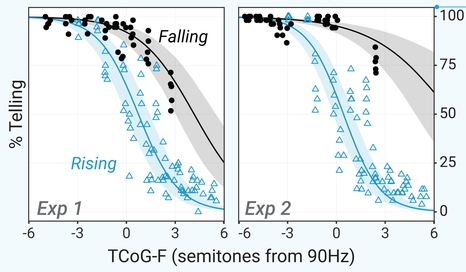
Counterintuitive negative effect of accentual pitch predicted by TCoG: **higher accentual pitch raises TCoG and yields lower % Telling responses**

Early falls have much lower TCoG than gradual falls, counteracting the raised TCoG from the accentual pitch and yielding lower % Telling responses

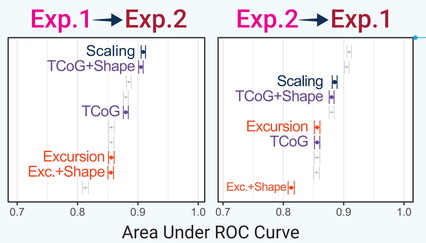
We compare model performance by **training** models on **one experiment** then **testing** them on **the other**

The **Scaling** model is the best model overall, but the **TCoG** model performs nearly as well when contour shape is added; the **Excursion** model does not improve with shape

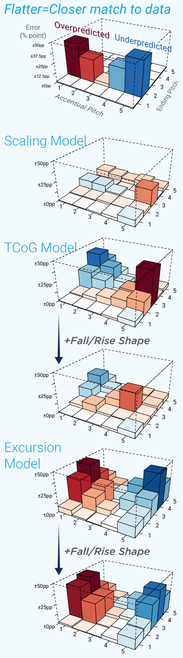
Responses Modeled by TCoG



Empirical proportions for each continuum step (/25) for each utterance (/5) with 95% credible interval from Bayesian Logistic Mixed Effects Model



Differences between the predicted % Telling and empirical data shown as 3D heatmap
Flatter=Closer match to data



Conclusions

Responses well-captured by AM theory, represented through the Scaling model, but the counterintuitive accentual pitch effect is better captured using TCoG

No evidence that H* contributes to assertive interpretation, **pitch accent scaling does not affect interpretation of edge tone meaning**

Variation in response behavior between gradual and early fall shapes is straightforwardly predicted by Tonal Center of Gravity