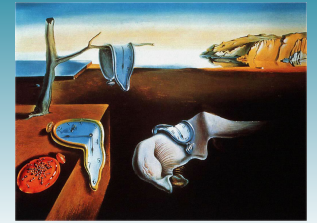




5aSC30: Dynamic pitch and pitch range interact in distortions of perceived duration of American English speech tokens

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Introduction

- Duration measures have been considered key to the study of prosodic boundary size
- Increased pre-boundary lengthening and pause duration are correlated with stronger prosodic boundaries in production and perception (Wightman et al 1992; Lehiste et al 1996; inter alia)
 - Edges of prosodic groups are also known to be marked by pitch features, namely phrase tones and reset
 - Phonetic measures of pitch and timing features are typically taken independently

However, pitch and timing are known to interact in perception

- Pitch has been shown previously to affect perceived duration, of both filled and silent intervals

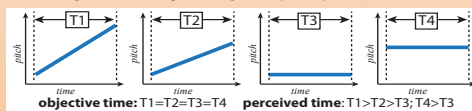
How might dynamic pitch affect perceived duration in prosodic boundary-like contexts?

Background

Perception of time can be systematically affected by a range of contextual factors (Brown, 2008), including pitch (Hoopen, 2008).

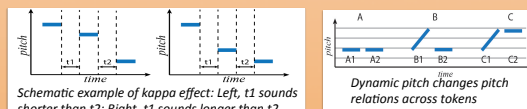
1. Dynamic pitch and scaling differences affect perceived duration of filled intervals

- Vowels with dynamic pitch perceived as longer than those with static pitch (Lehiste, 1976; Yu, 2010; Cumming, 2011; inter alia)
- Vowels with higher pitch perceived as longer than those with lower pitch (Yu, 2010)
- Non-speech tone glides with greater pitch change velocity heard as longer than than tone glides with lesser pitch change velocity (Henry, 2011)



2. Pitch differences between tones or speech across silent intervals (The auditory kappa effect):

- Silent intervals bounded by tones of closer pitch are perceived as shorter than those of more widely differing pitch in both speech (Brugos & Barnes, 2012) and nonspeech contexts (Cohen et al, 1953, 1954; Shigeno, 1993; MacKenzie, 2007; inter alia)



3. Comparing dynamic pitch intervals to level pitch intervals necessarily introduces differences in pitch across intervening silence

Question: How to overcome this confound in order to explore effects of dynamic pitch on perception of duration in speech?

Answer: Manipulate relative scaling along with dynamicity directly.

Methodology

Stimuli: all manipulations of a single base file of spoken word "blue"

- crossed 3 continua of manipulations:
 - 5 durations (between 300 and 500 ms)
 - 3 f0 contour manipulations (plateau and 2 rises)
 - 4 pitch ranges for each contour

Presentation & Task:

- Targets paired with flat f0 standards at 5 durations
- Presented in 2 orders: target first and standard first
- 600 trials, randomized for each subject
- 20 subjects responded via designated keys on laptop
- Asked of presented pair: **Which sounds longer?**

Hypothesis: increased pitch dynamicity will lead to increases in perceived duration.

- But how will effects of relative scaling on duration perception interact with dynamicity?

Results

- Responses for all 20 subjects • 10,757 trials • Graphs separated by presentation order
- Show proportion of responses "target longer" by time difference between target and standard

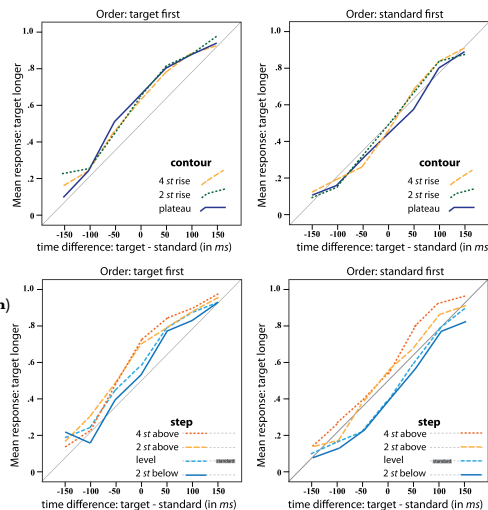
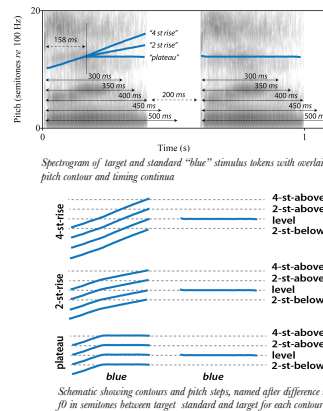
- Graphs show strong effect of time: more responses "target longer" when the target was, indeed, longer
- Presentation orders also show difference: target heard as longer more often when presented before standard in both sets of graphs

Results by f0 contour (top)

- (for all pitch steps collapsed)
- Lines overlap → degree of dynamicity was not reflected in responses

Results by pitch step (bottom)

- (for all f0 contours collapsed)
- Lines separate → scaling differences affect responses
- Higher pitch steps heard as longer than those level or lower than standard



Analysis

Mixed-effects logistic regression: model (N = 10757, log-likelihood = -5553)

- Dependent variable: response ("target longer" or "standard longer") • Subject included as a random effect
- Fixed Factors: time difference, pitch step, contour and presentation order

Main effects:

time difference: Wald Z = 47.65, p < .001

pitch step: 3 steps all differed from "level":

- 4 st above: Wald Z = 5.75, p < .001 • 2 st above: Wald Z = 5.96, p < .001 • 4 st below: Wald Z = -2.66 p < .01

presentation order: Wald Z = -12.90 p < .001

Step "2 below" and "standard first" order → more responses "standard longer"

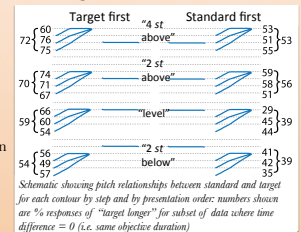
No significant effect of contour: Rising contours did not differ significantly from plateau:
2 st-rise Wald Z = 1.53 p = 0.12719; 4 st-rise Wald Z = 0.31 p = 0.76026

Discussion

- Degree of dynamicity did not straightforwardly affect perceived duration
- Scaling differences between standard and target did

- higher tokens tended to be heard as longer (cf Yu, 2010)
- Tendency for first token to be heard as longer, especially when discontinuous with second

Some previous findings showing effects of dynamic pitch on perceived duration may be magnified by the kappa effect → Scaling differences in stimuli may likewise have led to some previous null results (See Cumming, 2011, for overview)



Conclusions

- Objective duration ≠ perceived duration
→ pitch relations can distort perceived duration

- Listeners may be responding to perceived prosodic distance that integrates information from timing (filled and silent intervals) and pitch (pitch slope and pitch jumps across silent intervals).

Measures of prosodic boundary strength should not rely exclusively on objective duration.

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