Different Speech Styles Promote Different Processing Strategies: Eye-Tracking Evidence

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How do we understand spoken words as quickly and adeptly as we do?

Background

Careful speech and Casual speech are both understood quite well.

How do we understand both styles with no regular breakdowns in communication?

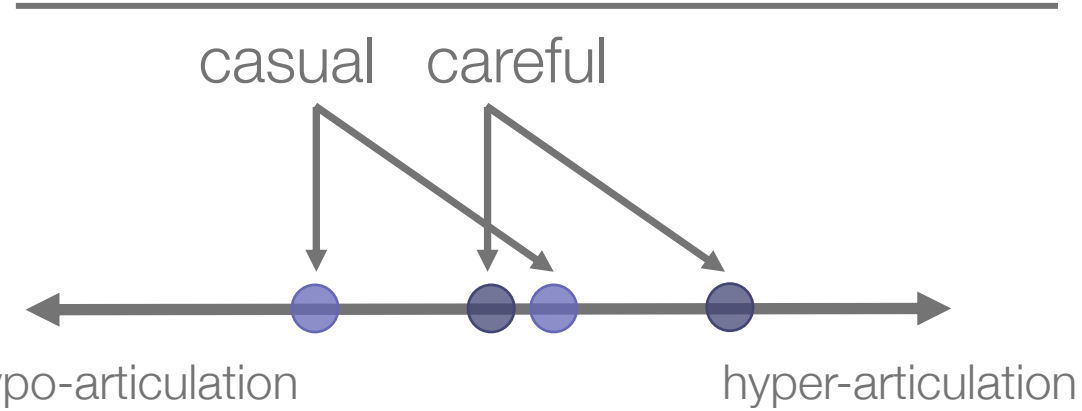
Both styles are *processed* well, but carefully articulated forms are *remembered* better.

Memory representations are weighted.

Speech Styles

Casual/Reduced

- Common
- Used for general, everyday communication



Careful/Hyperarticulated

- Rare
- Used in specific contexts
  - Clarifications
  - New information
  - Loud environments
  - Some child-directed speech

Current Study

Given that memory representations are asymmetrically weighted, we also expect to find processing asymmetries.

Proposal:

Careful speech: Special case; increase attention to *bottom-up* information.

Casual speech: Default; fast use of top-down information – lexical access, associative spread

(Sumner, 2013; Sumner et al., 2014)

Current Study & Broad Predictions

Casual speech:

Fast associative spread

↳ Interference from meaning-based competitors

Careful speech:

Attention allocated to signal-based processing

↳ Interference from phonological form competitors

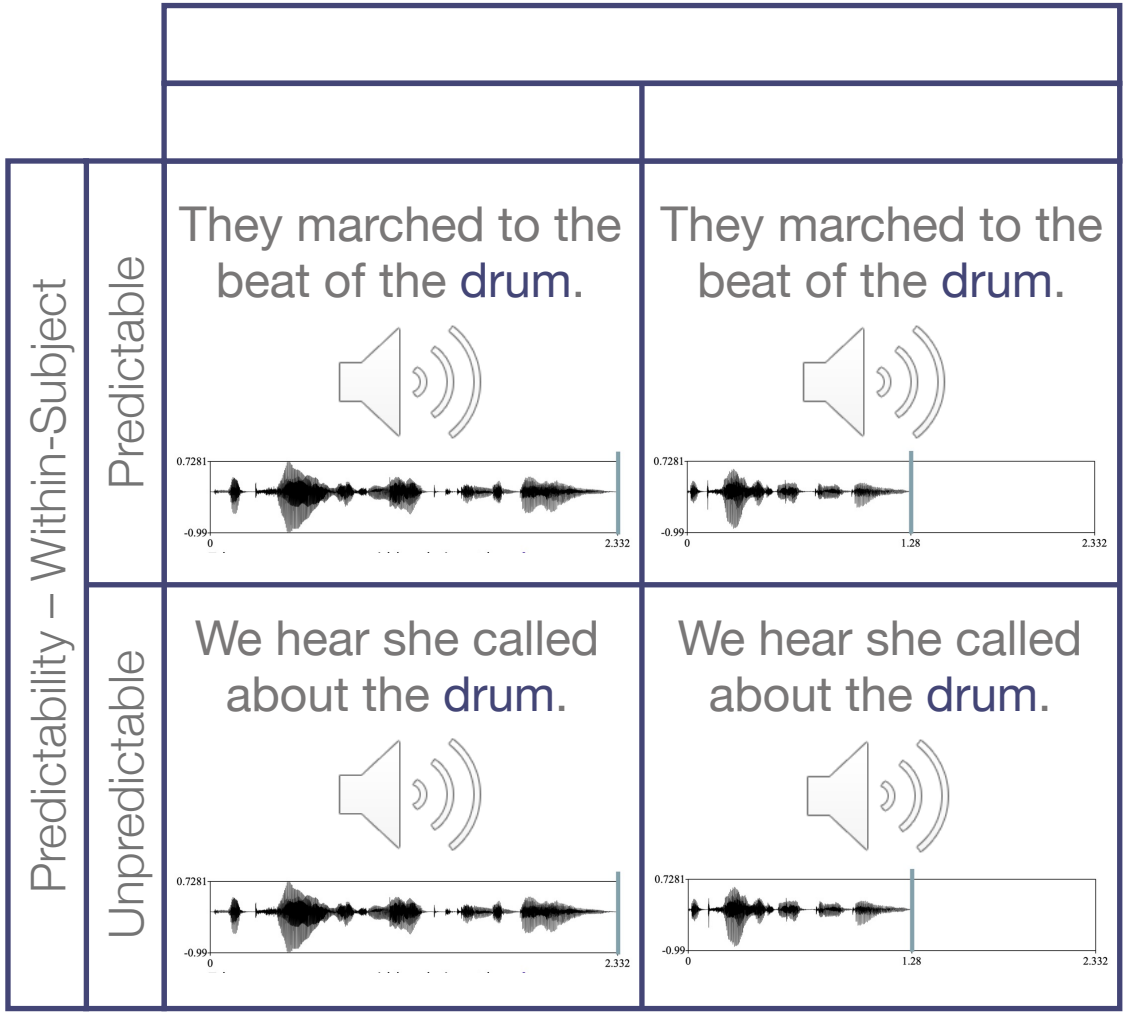
Exp. 1: Meaning-based competition

Exp. 2: Phonological form-based competition

Exp. 1

What does the presence of a meaning-based (semantic) competitor tell us about processing strategies in Careful and Casual speech?

Exp. 1 – Design



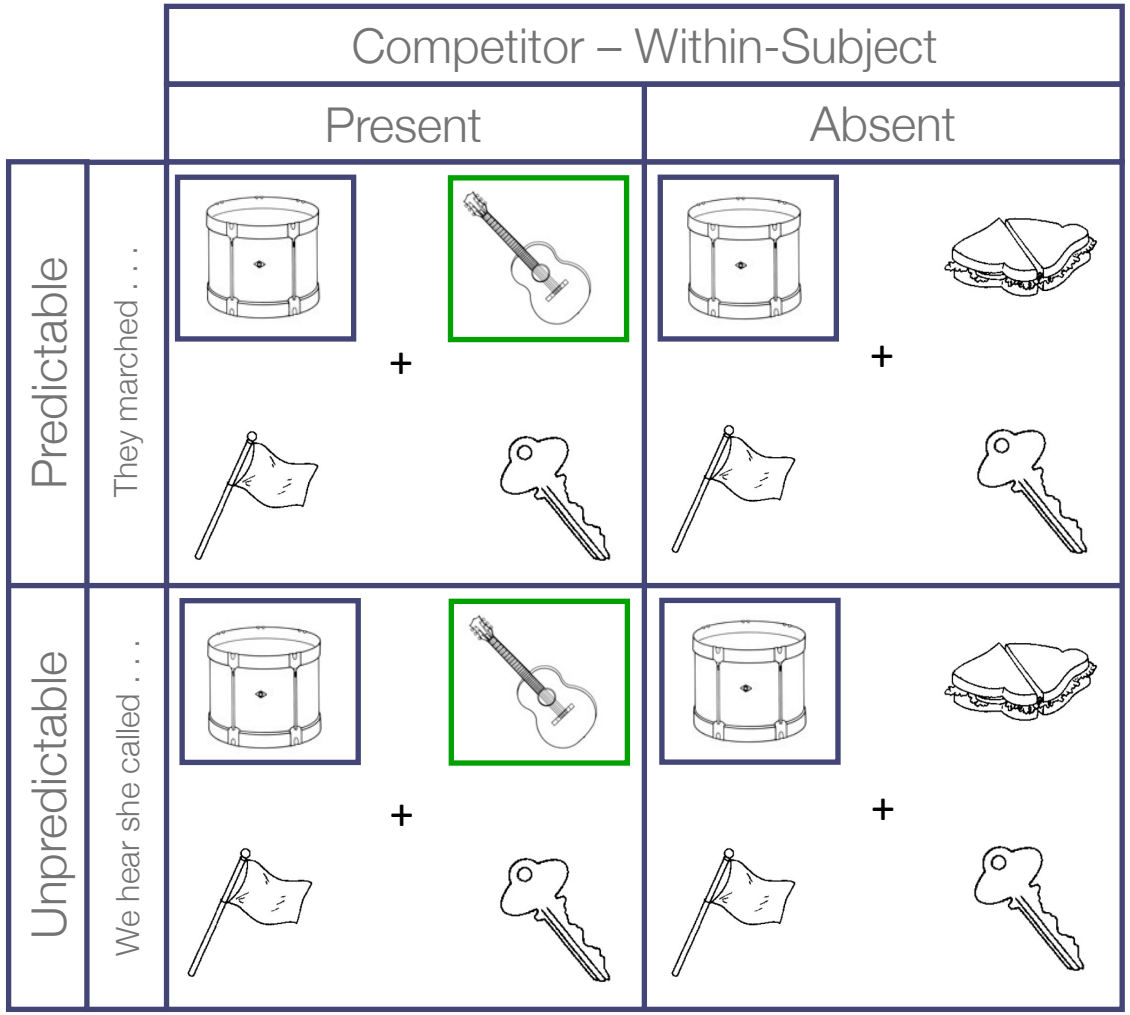
Mean durations: 2185 ms Careful; 1406 ms Casual

Visual world eye-tracking

26 American-English listeners

24 critical, 12 filler sentences from R-SPIN (Bilger, 1984)

Exp. 1 – Design



Target – "Drum"

Semantic competitor – "Guitar"

Between-Subjects:
Speech Style

Within-Subjects:
Predictability
Competitor

Exp. 1 – Predictions

No competitor:

More, earlier looks to target for Predictable than Unpredictable; both Styles

Competitor:

Careful speech: Interference from semantic competitor is subtle and slow.

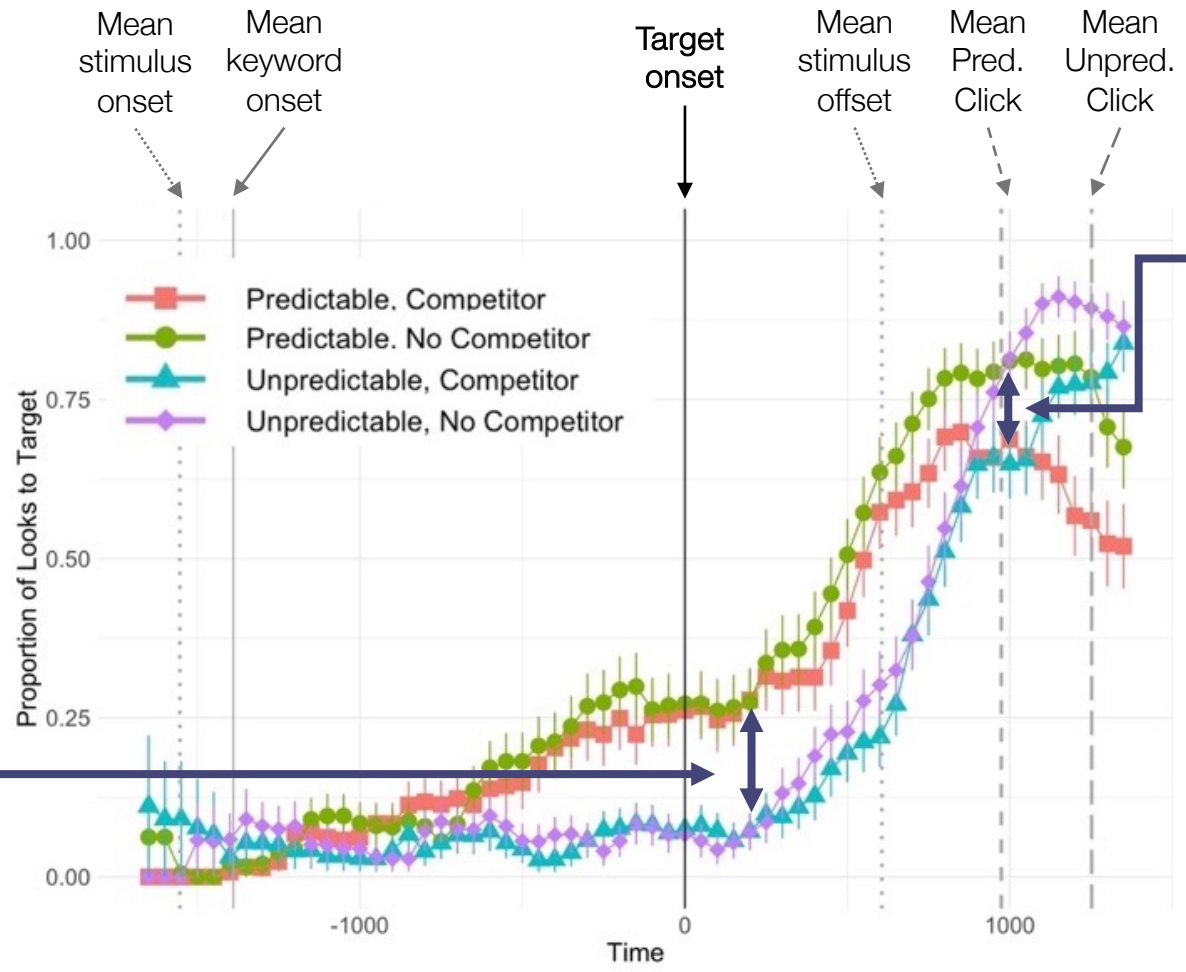
Casual speech: Interference from semantic competitor is robust and early.

Analysis – Gaze

- Fitted three generalized additive mixed models (GAMM) for each Style
  - Predictable vs. Unpredictable; No Competitor
  - Competitor vs. No Competitor; Unpredictable
  - Competitor vs. No Competitor; Predictable

- Significance tests:
  - Chi-squared: Overall difference
  - Parametric term: Diff. in height of two trajectories
  - Smooth term: Diff. between trajectories over time

Exp. 1 Results – Gaze for Careful Speech



More looks: PNC > UNC

*** Overall ($\chi^2(3) = 8.3$, $p<0.001$)
. Parametric ($\beta = -0.68$, $t=-1.9$, $p=0.06$)
** Smooth (edf=6.3, $F=3.4$, $p<0.01$)

Marginal effect: UNC > UC

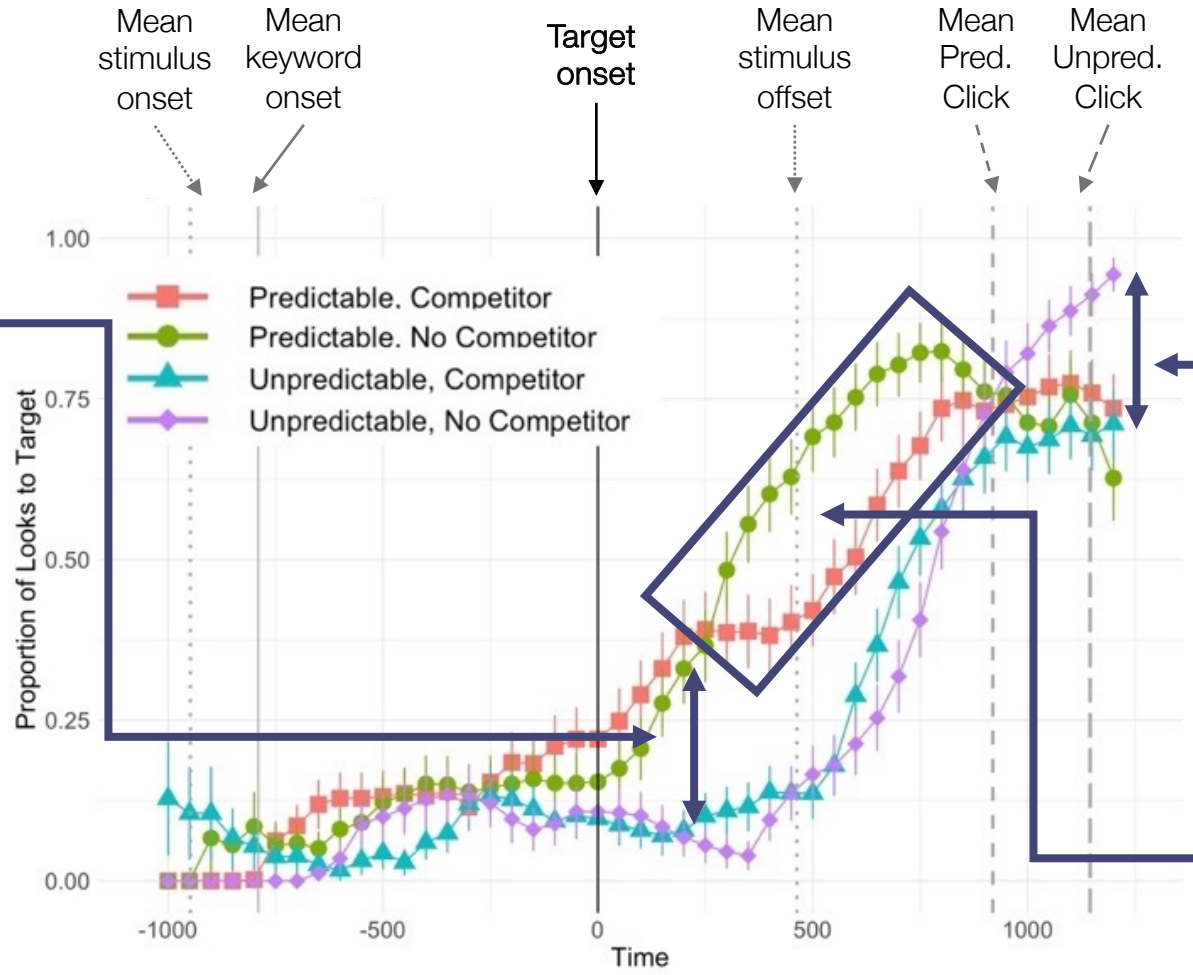
. Overall ($\chi^2(3) = 3.9$, $p=0.05$)
. Parametric ($\beta=0.28$, $t=1.8$, $p=0.08$)
* Smooth (edf=1, $F=4.1$, $p<0.05$)

No effect: PNC = PC

ns Overall ($\chi^2(3)=2.58$, $p>0.1$)
. Parametric ($\beta=0.32$, $t=1.7$, $p=0.08$)
ns Smooth (edf=1, $F=1$, $p>0.1$)

Predictable: *"They marched to the beat of the drum."*
Unpredictable: *"We hear she called about the drum."*

Exp. 1 Results – Gaze for Casual Speech



More looks: PNC > UNC

*** Overall ($\chi^2(3)=12.6$, $p<0.001$)
* Parametric $\beta=-0.83$, $t=-2.3$, $p<0.05$)
*** Smooth (edf=6.1, F=5.9, $p<0.001$)

More looks: UNC > UC

*** Overall ($\chi^2(3)=19.7$, $p<0.001$)
ns Parametric ($\beta=0.05$, $t=0.2$, $p>0.1$)
*** Smooth (edf=4.9, F=8.5, $p<0.001$)

More looks: PNC > PC

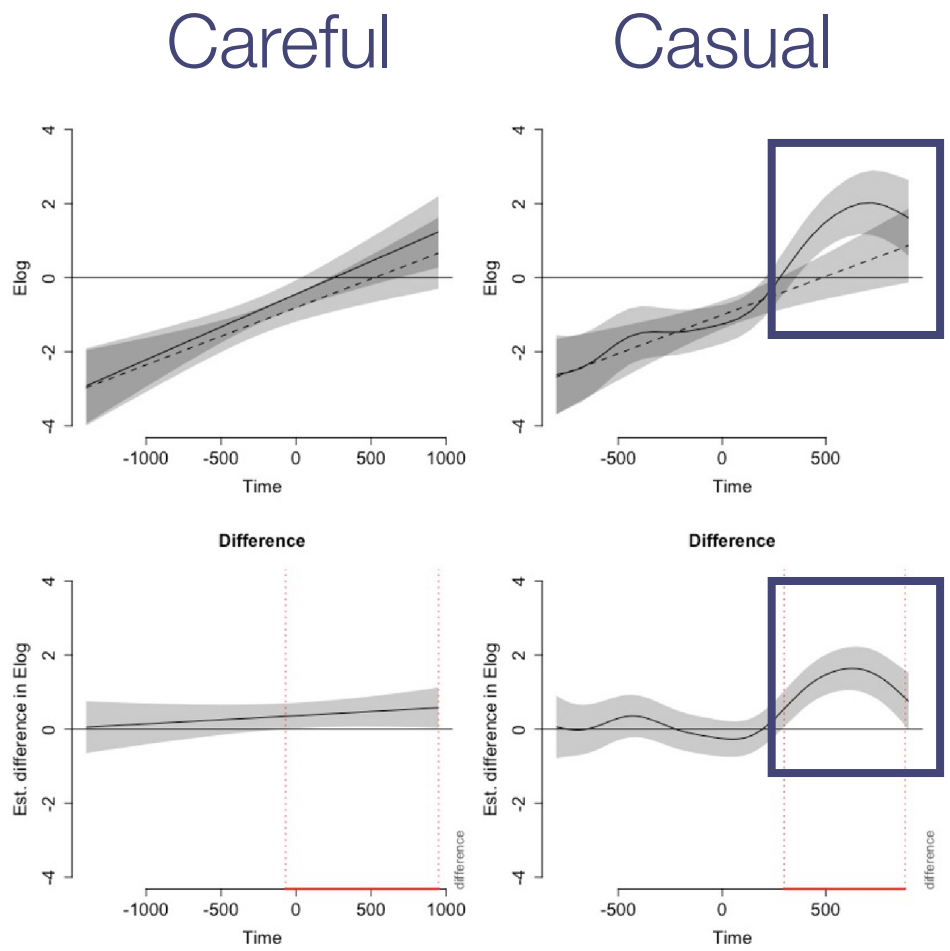
*** Overall ($\chi^2(3)=21.5$, $p<0.001$)
** Parametric ($\beta=0.49$, $t=2.6$, $p<0.01$)
*** Smooth (edf=6.8, F=6.7, $p<0.001$)

Predictable: *"They marched to the beat of the drum."*
Unpredictable: *"We hear she called about the drum."*

Exp. 1 Results – Competitor in Predictable

Fitted trajectories and difference curves:
PNC (solid) vs. PC (dotted)

"They marched to the beat of the drum."



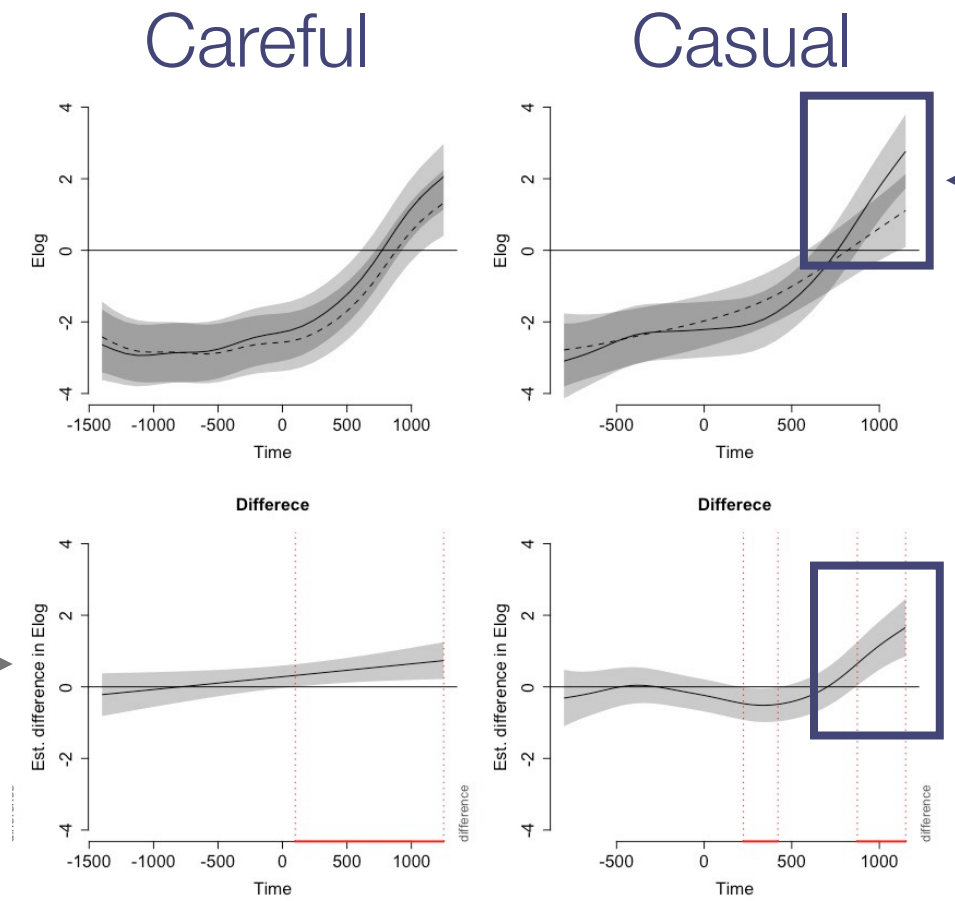
Careful speech:
No interference from competitor

Casual speech:
Interference from competitor 300-900 ms after target onset

Exp. 1 Results – Competitor in Unpredictable

Fitted trajectories and difference curves:
UNC (solid) vs. UC (dotted)

"We hear she called about the drum."



Casual speech: Interference from competitor 800 ms after target onset

Careful speech: Marginal interference from competitor

Exp. 1 – Discussion

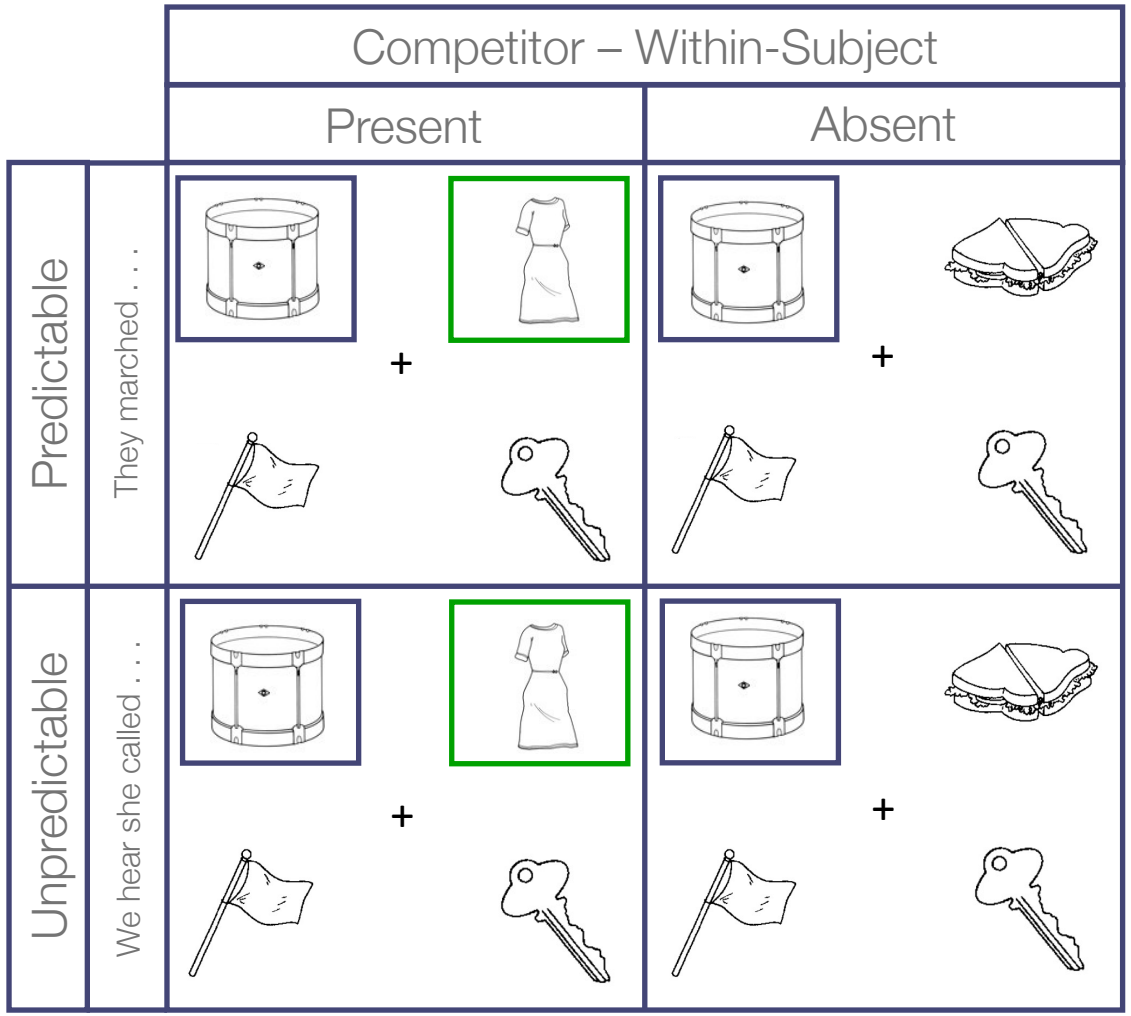
Predictions confirmed:

- More looks to target in Predictable than Unpredictable sentences for both styles.
- Semantic competitor drew gaze in Casual but not Careful condition.

Exp. 2

What does the presence of a phonological form competitor tell us about processing strategies in Careful and Casual speech?

Exp. 2 – Design



Identical to Exp. 1, but with phonological form competitors

Target – "Drum"

Form competitor – "Dress"

24 American-English Listeners

Exp. 2 – Predictions

No competitor:

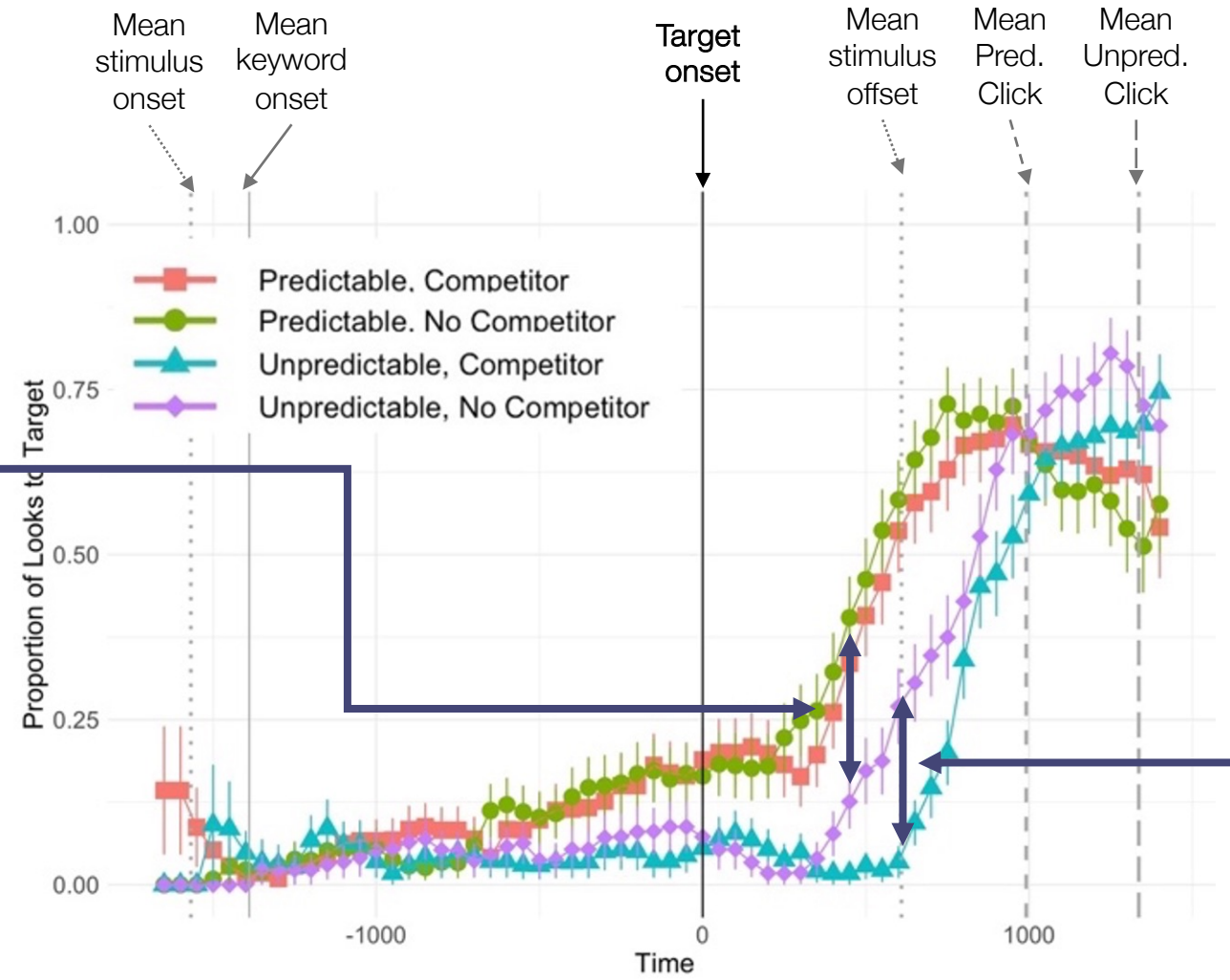
More, earlier looks to target for Predictable than Unpredictable; both Styles

Competitor:

Careful speech: Interference from phonological form competitor is robust.

Casual speech: Interference from phonological form competitor in minimal.

Exp. 2 Results – Gaze for Careful Speech



More looks: PNC > UNC

*** Overall ($\chi^2(3) = 11$, $p<0.001$)
ns Parametric ($\beta = -0.36$, $t=-0.9$, $p>0.1$)
** Smooth (edf=4.98, F=4.4, $p<0.01$)

More looks: UNC > UC

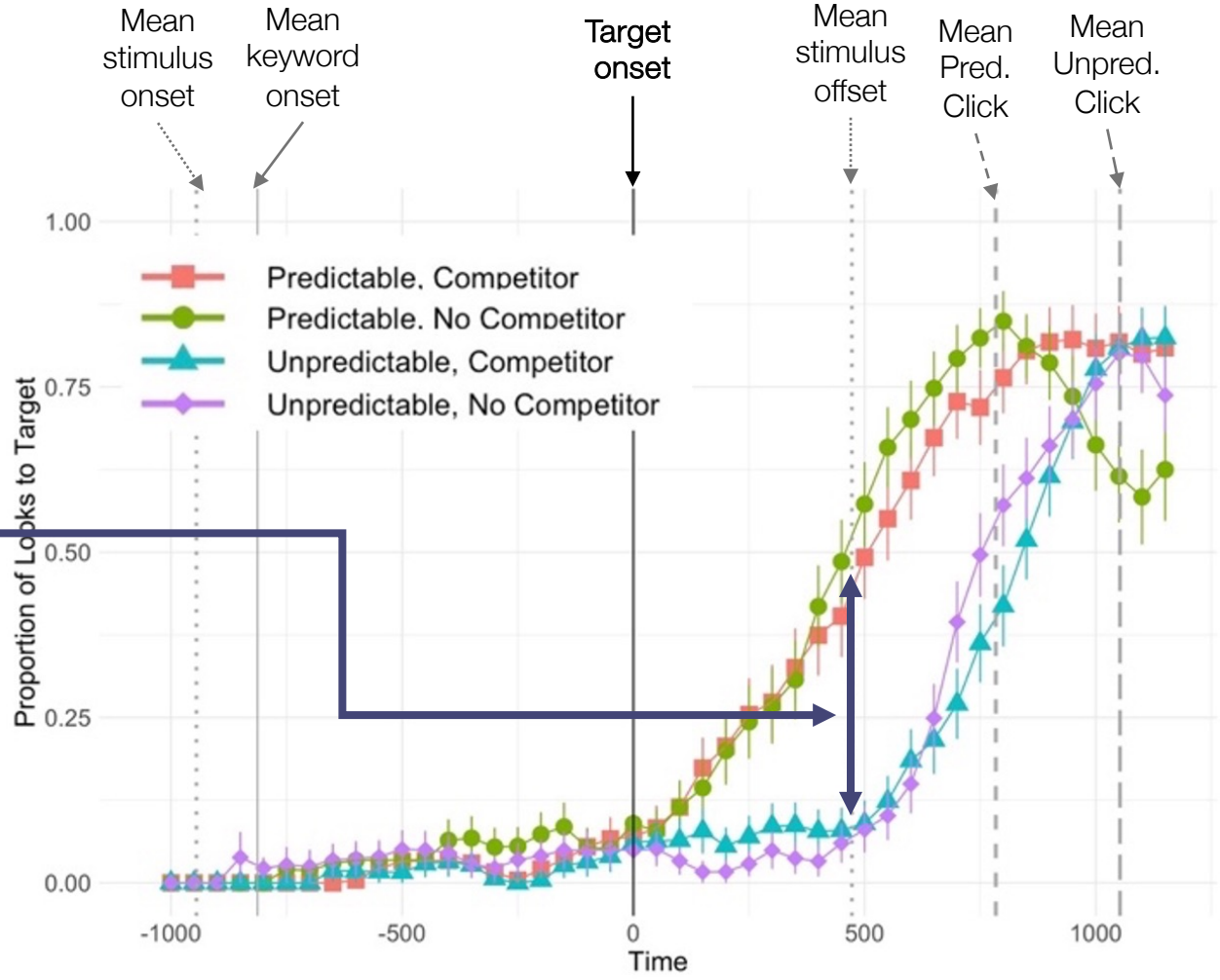
*** Overall ($\chi^2(3) = 9.13$, $p<0.001$)
ns Parametric ($\beta=0.2$, $t=1.2$, $p=0.2$)
*** Smooth (edf=6.27, F=4, $p<0.001$)

No effect: PNC = PC

ns Overall ($\chi^2(3)=0.002$, $p<0.1$)
ns Parametric ($\beta=-0.001$, $t=-0.004$, $p>0.1$)
ns Smooth (edf=1.02, F=0.002, $p>0.1$)

Predictable: *"They marched to the beat of the drum."*
Unpredictable: *"We hear she called about the drum."*

Exp. 2 Results – Gaze for Casual Speech



More looks: PNC > UNC

*** Overall ($\chi^2(3)=36.6$, $p<0.001$)
** Parametric $\beta=-0.8$, $t=-2.6$, $p<0.01$)
*** Smooth (edf=7.1, F=13.9, $p<0.001$)

No effect: UNC = UC

ns Overall ($\chi^2(3)=0.33$, $p>0.1$)
ns Parametric ($\beta=-0.01$, $t=-0.09$, $p>0.1$)
ns Smooth (edf=2.3, F=0.78, $p>0.1$)

No effect: PNC = PC

ns Overall ($\chi^2(3)=0.17$, $p>0.1$)
ns Parametric ($\beta=0.09$, $t=0.52$, $p>0.1$)
ns Smooth (edf=1, F=0.05, $p>0.1$)

Predictable: *"They marched to the beat of the drum."*
Unpredictable: *"We hear she called about the drum."*

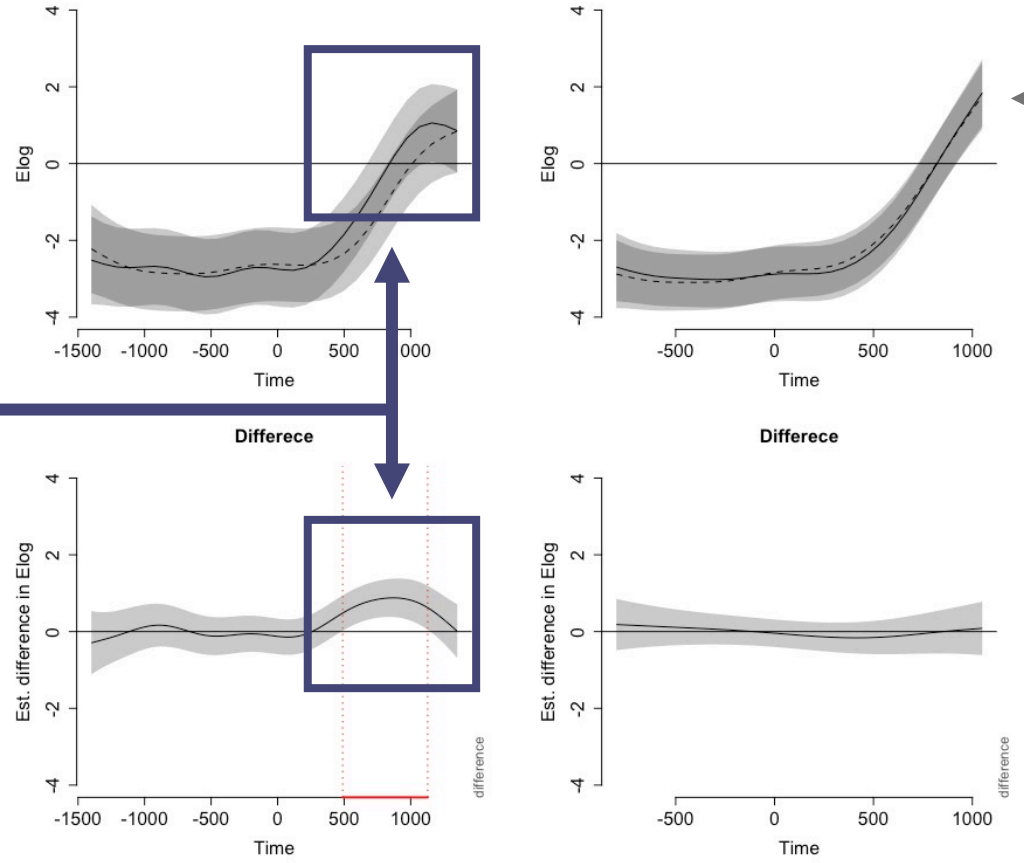
Exp. 2 Results – Competitor in Unpredictable

Fitted trajectories and difference curves:
UNC (solid) vs. UC (dotted)

"We hear she called about the drum."

Careful

Casual



Careful speech:
Interference from form competitor after 500 ms

Casual speech:
No interference from form competitor

Exp. 2 – Discussion

Predictions confirmed:

- More looks to target in Predictable than Unpredictable sentences for both styles.
- Form competitor drew gaze in Careful but not Casual unpredictable sentences.

Form competitor *did not* draw gaze in Careful, Predictable condition.

Conclusions

Semantic competitor drew gaze for *Casual* but not Careful.

Top-down processing fast and robust.

Form competitor drew gaze for *Careful* but not Casual.

Bottom-up information heavily attended.

This is *not* because Casual speech is more difficult to interpret!

Bottom-up processing of Careful speech may drive the preferential weighting of memory representations:

↳ More attention to signal = higher resolution memory traces.

Thank you!

Questions?

Email wsclapp@stanford.edu

Thanks to Kevin McGowan for stimulus and experiment preparation, and the Stanford Phonetics Lab for comments!

Exp. 1 Results – Predictability

Fitted trajectories and difference curves:

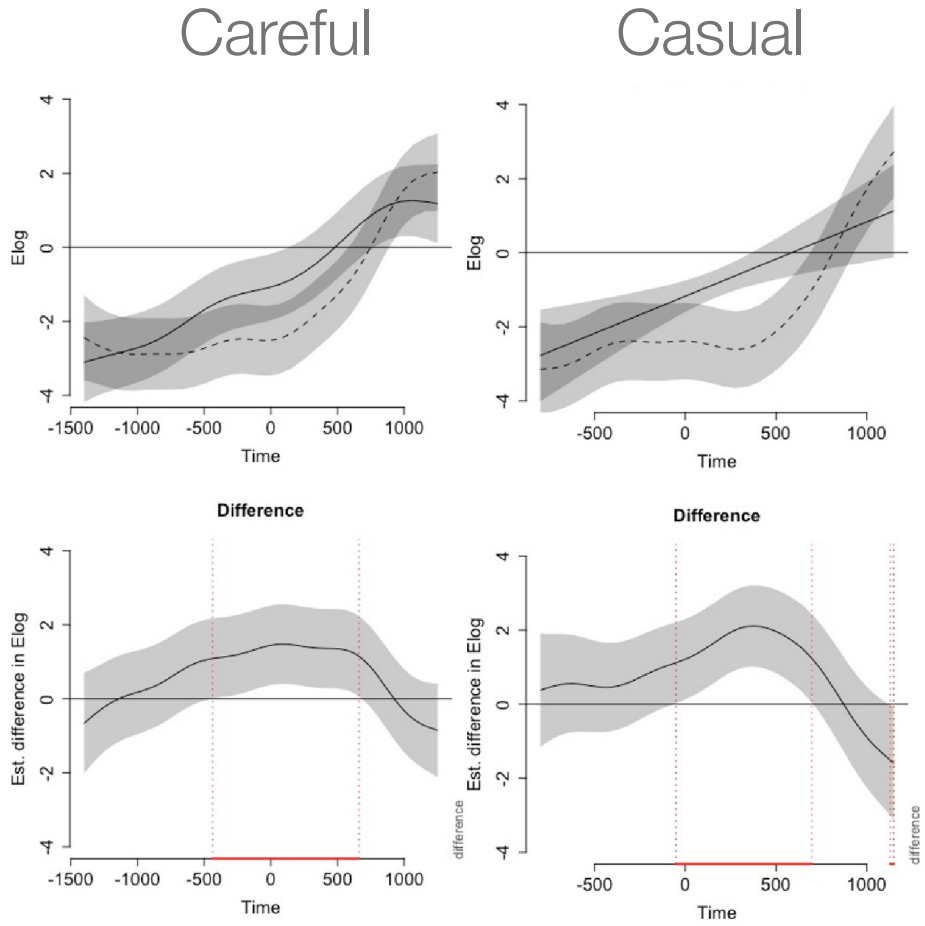
No Competitor; Predictable (solid) vs. Unpredictable (dotted).

Both significant:

Careful: -450 ms – 650 ms

Casual: -50 ms – 700 ms

Top-down networks are active for both styles; Looks to target begin before target onset



Exp. 2 Results – Predictability

Fitted trajectories and difference curves:

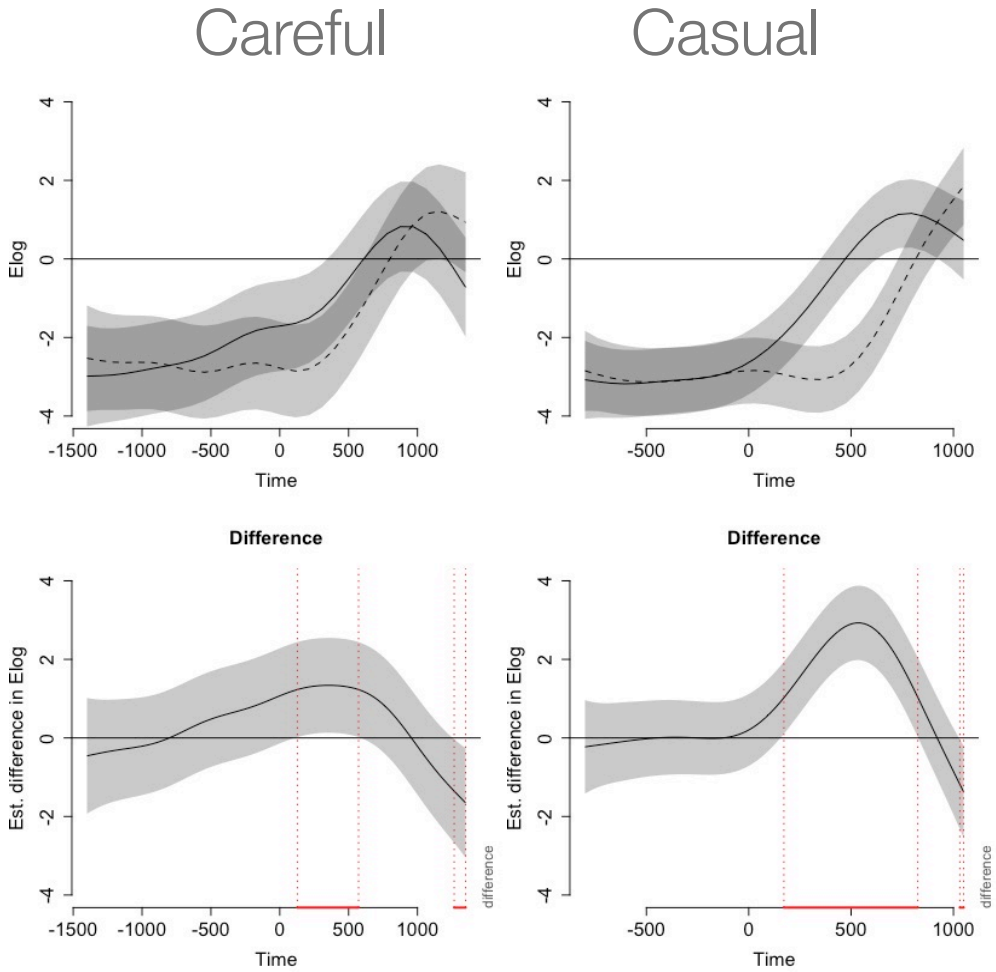
No Competitor; Predictable (solid) vs. Unpredictable (dotted).

Both significant:

Careful: 150 ms – 600 ms

Casual: 175 ms – 825 ms

More looks to target in predictable than unpredictable sentences for both styles.



Exp. 2 Results – Competitor in Predictable

Fitted trajectories and difference curves:

Predictable sentences; No Competitor (solid) vs. Competitor (dotted)

Careful: N.S.

Casual: N.S.

No effect of form competitor for either speech style in Predictable sentences.