Individual differences in using common ground during on-line reference resolution: An ERP study

Les Sikos, Sam Tomlinson, Lauren Sanchez, and Dan Grodner

Department of Psychology · Swarthmore College · USA

Introduction

Perspective-Taking

- Virtually all communicative exchanges have asymmetry between what participants know
- Perspective is critical for creating and interpreting referring expressions
- Interlocutors must distinguish between **privileged ground (PG)**, knowledge possessed by one, and **common ground (CG)**, knowledge possessed by both and mutually accepted as such [1,2]

Research Question: How do we track perspective?

Anchoring & Adjustment ("curse of knowledge") [3]
- Accessing and using CG is cognitively costly
- First-pass interpretation typically does not attempt to consider CG
- Second-pass can use CG to detect and correct errors
- Unusual circumstances can override this default egocentric perspective

Anticipation & Integration [4-6]
- Individuals can strategically anticipate items in CG
- But they automatically consider all referents in their egocentric perspective as referential description unfolds

Constraint-Based [7-9]
- Humans are natural perspective takers
- Accessing and using CG is relatively easy
- However, CG is one of many competing cues

Previous Work

Keysar and colleagues [10-12]

Task: Referential communication game

"Pick up the block"

Addressee's view   Director's view

Results: The PG competitor increased fixations and delayed selection of the target

Open Questions

Why do participants fixate competitor and why are they delayed in picking up an object?

1. They truly consider it a candidate for reference
2. Low-level attention drawn to it because it is semantically/phonologically related to target

Behavioral measures cannot distinguish these possibilities. Can ERP methods help?

Nref Effect – Sensitive to referential ambiguity [13-15]

Effect can persist 1 sec or more after point of disambiguation [15]

girl   spoken noun   B

Fz   *2-ref*   *Nref* effect

0 µV   *1-ref*

2 µV   400 - 1100 ms

-1.5 µV 0 µV 1.5 µV

0   500   1000 ms

2-ref: David had asked the two girls to clean up their room before lunchtime. But one of the girls had stayed in bed all morning, and the other had been on the phone all the time. David told the...

1-ref: David had asked the boy and the girl to clean up their room before lunchtime. But the boy had stayed in bed all morning, and the girl had been on the phone all the time. David told the...

Predictions

1. Referent with CG competitor should elicit Nref effect relative to no competitor
2. If so:
   a. If PG competitor considered candidate for reference
      → Nref effect
   b. If PG competitor not considered as candidate
      → No Nref effect

Materials and Methods

Stimuli

Conditions	Trials
No Competitor	40
CG Competitor	40
PG Competitor	40
2 Filler conditions	80
	200 total

Images
- 11 polysyllabic animals
- 10 accessories
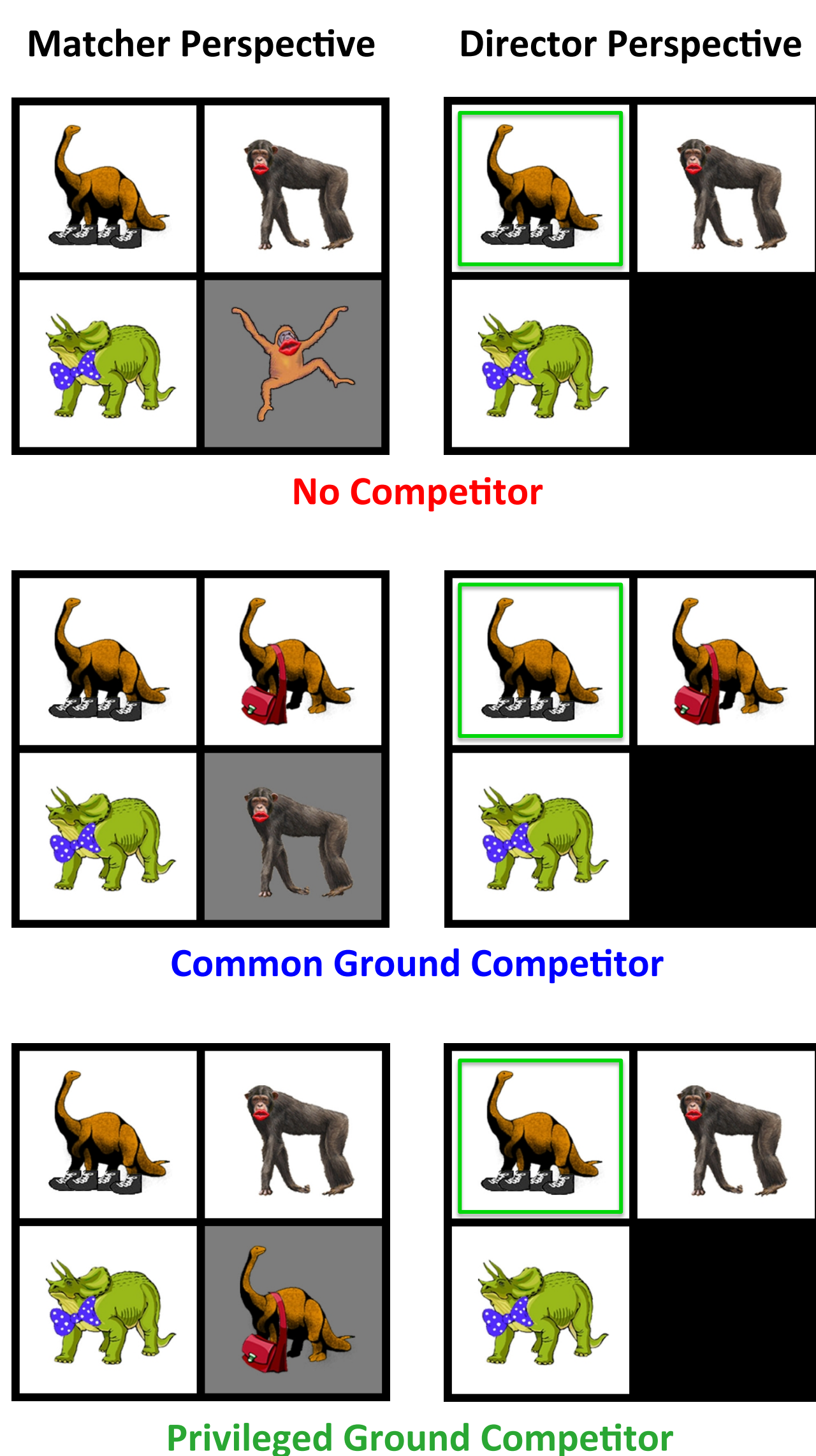- PG indicated by gray background

Voice Recordings
- Auditory stimuli recorded while two RAs played a full 200-trial session naturally
- Director's display
  - One quadrant occluded (black)
  - Target highlighted (green)
- Disfluencies left uncorrected

EEG Recording
- 64-channel HydroCel GSN (EGI)
- Bandpass: 0.1-40 Hz
- Rereference: Avg. mastoids
- Voltages averaged for analysis within six 6-channel clusters

"Click on the brontosaurus with the boots"

Matcher Perspective   **Director Perspective**

No Competitor

Common Ground Competitor

Privileged Ground Competitor

Procedure

Task
- Modified referential communication game
- Press key corresponding to quadrant

Familiarization
- 20 trials as Matcher
- 20 trials as Director
- "Can you describe to me what the Director can see during the game?"

Experimental session
- Animals appear one by one (1000 ms SOA)
- Fixation prompt: Bell rings and red fixation cross appear in center of display (600-900 ms)
- Pre-recorded auditory stimulus (ms)

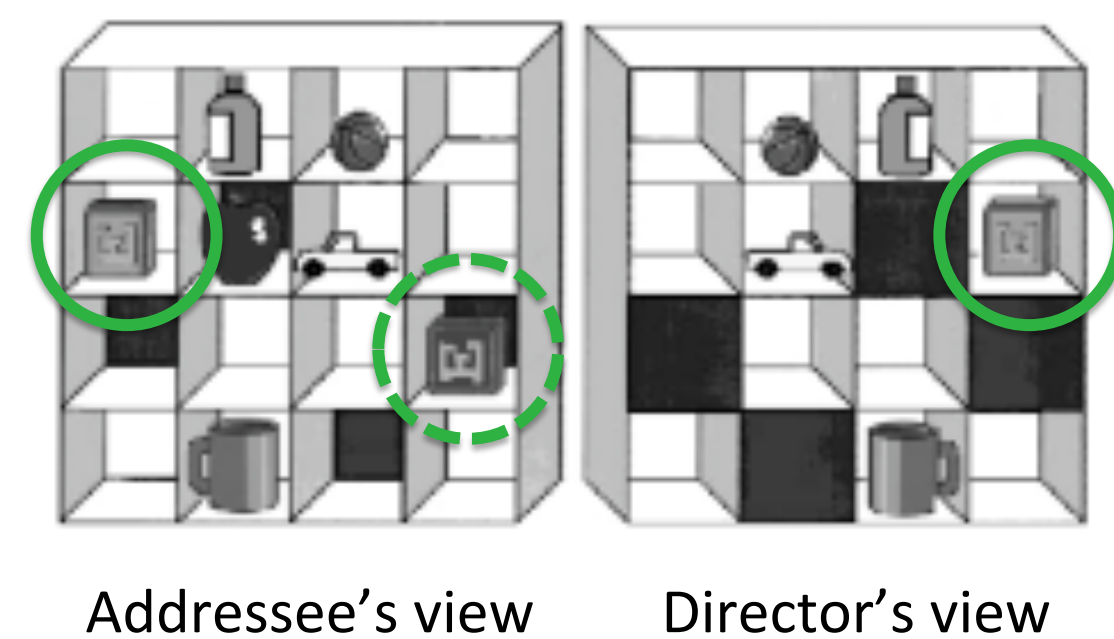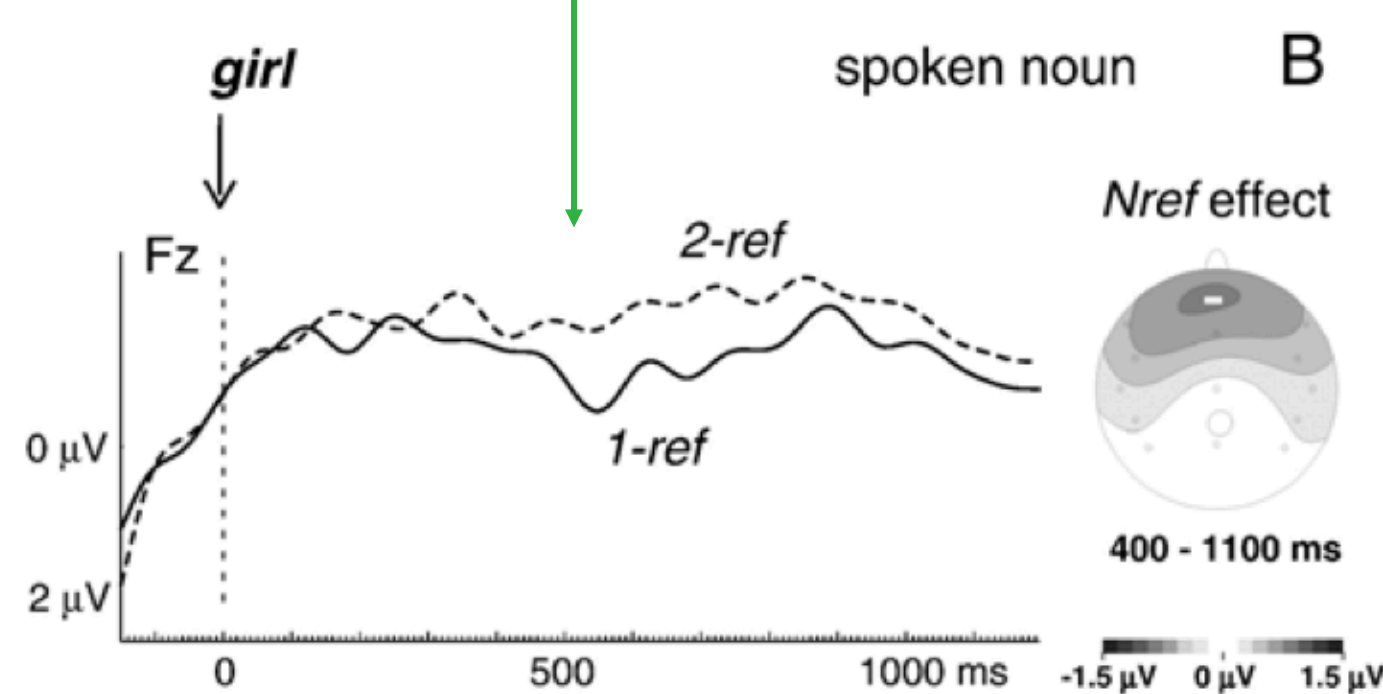|	
Target onset	M = 2882 (200)
Target duration	M = 652 (98)
Disambiguation	M = 879 (112)
Total duration	M = 4862 (438)

- Response prompt: Bell

Social Aptitude Assessment
- Autism-Spectrum Quotient, Social subscale [16]
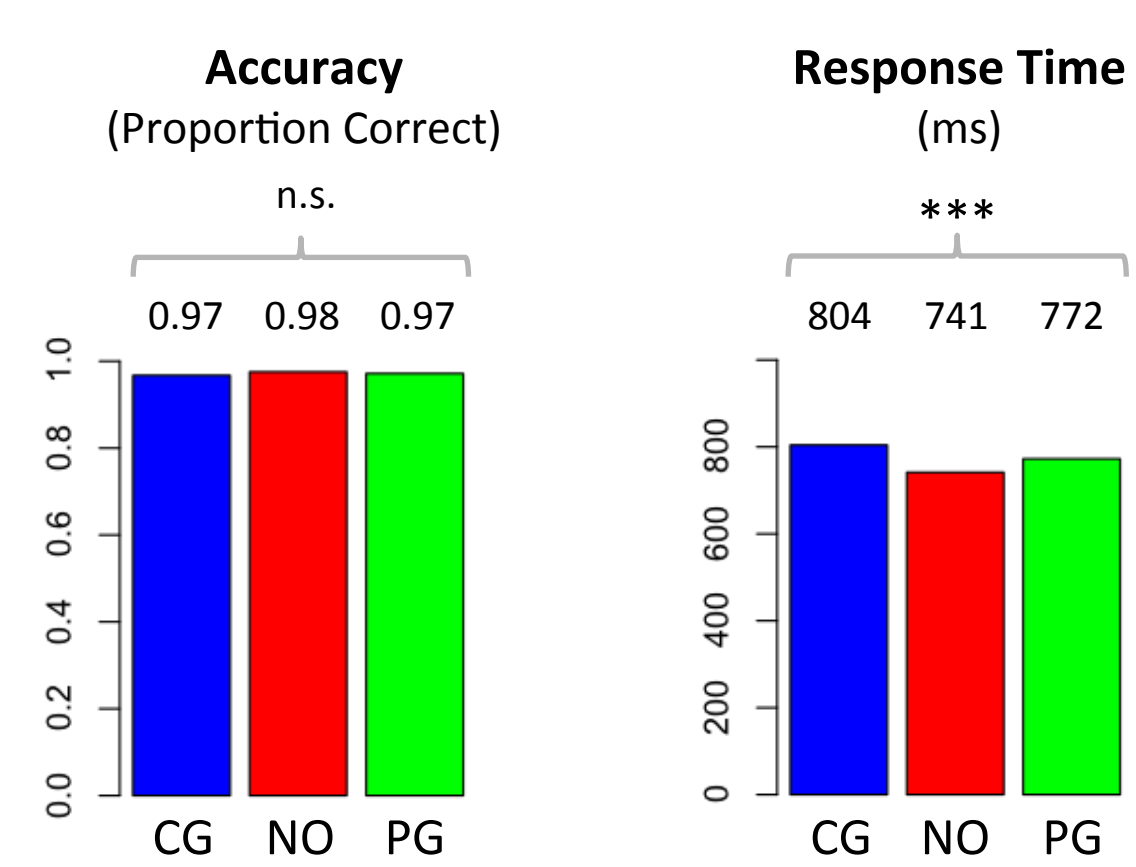
Results and Discussion

Participants
- 35 right-handed, native speakers of American English (20 male, 15 female)
- Mean age: 19.8 (range 18 to 22)

Social Aptitude	N	AQ-Soc	AQ total
High skill group	21	0.4	13.8
Low skill group	13	4.4	23.5

Behavioral Results

Accuracy (Proportion Correct)   n.s.
0.97 0.98 0.97
CG NO PG

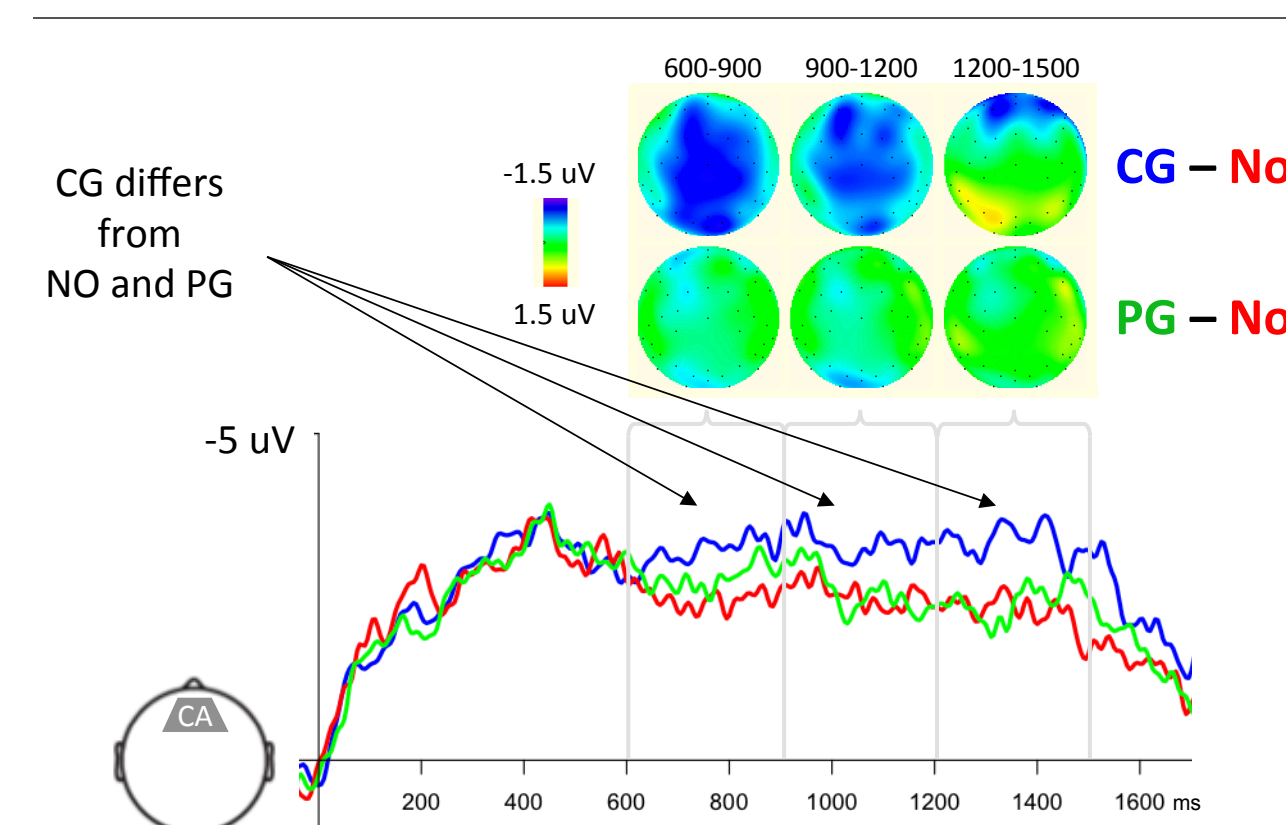**Response Time** (ms)   ***
804 741 772
CG NO PG

- No effect of condition
- No interaction with AQ-Soc

- NO < CG*** and PG*
- PG < CG°
- No interaction with AQ-Soc

→ Replicates effect of PG distraction seen in earlier studies

*** p<.001, ** p<.01, *p<.05, °p<.1

CG competitor   **PG competitor**   **No competitor**

All participants

CG differs from NO and PG

600-900 900-1200 1200-1500

-1.5 uV / 1.5 uV

CG – No
PG – No

-5 uV

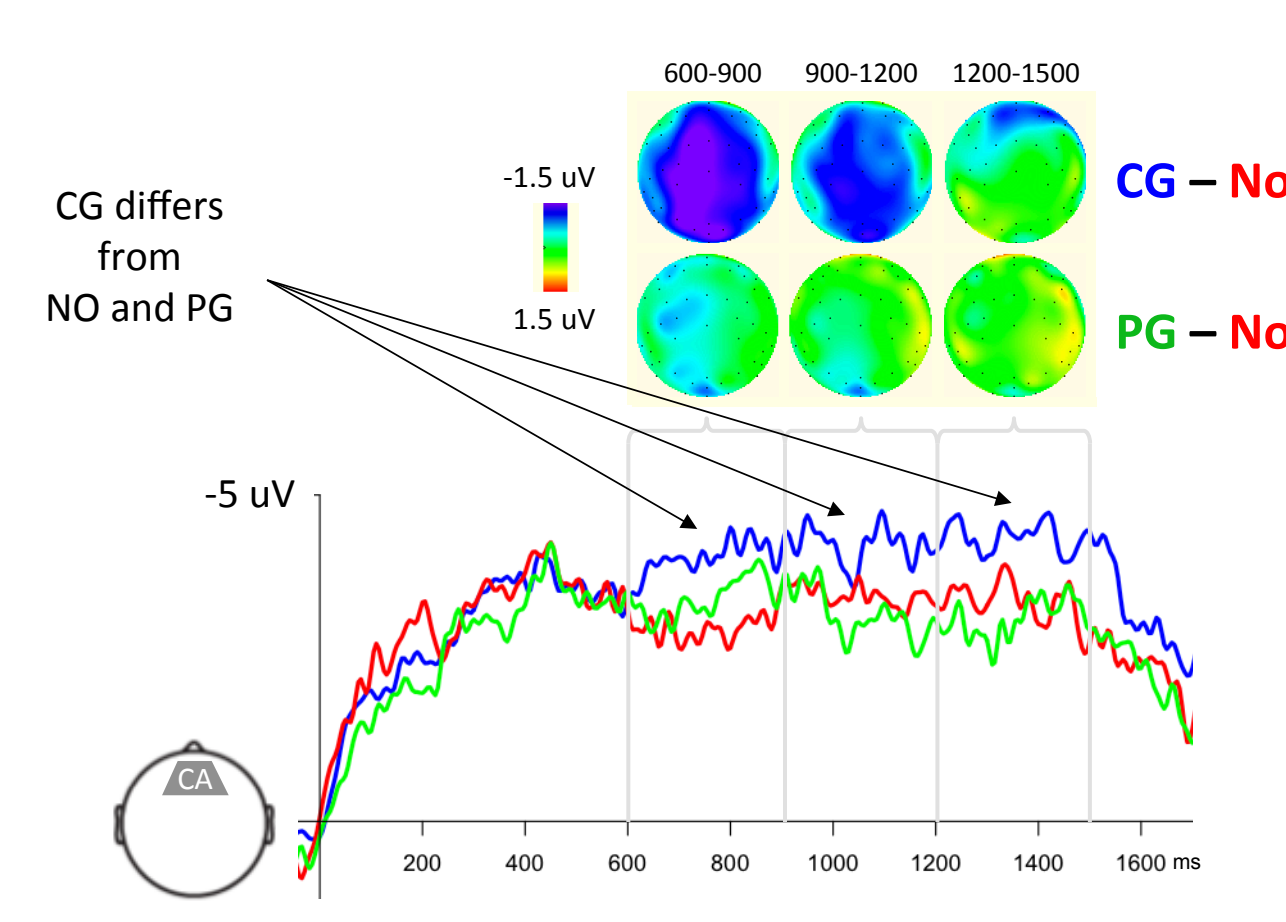200 400 600 800 1000 1200 1400 1600 ms

→ CG competitor condition elicits Nref effect
- By 600 ms after auditory word onset, system has determined whether unique referent or not
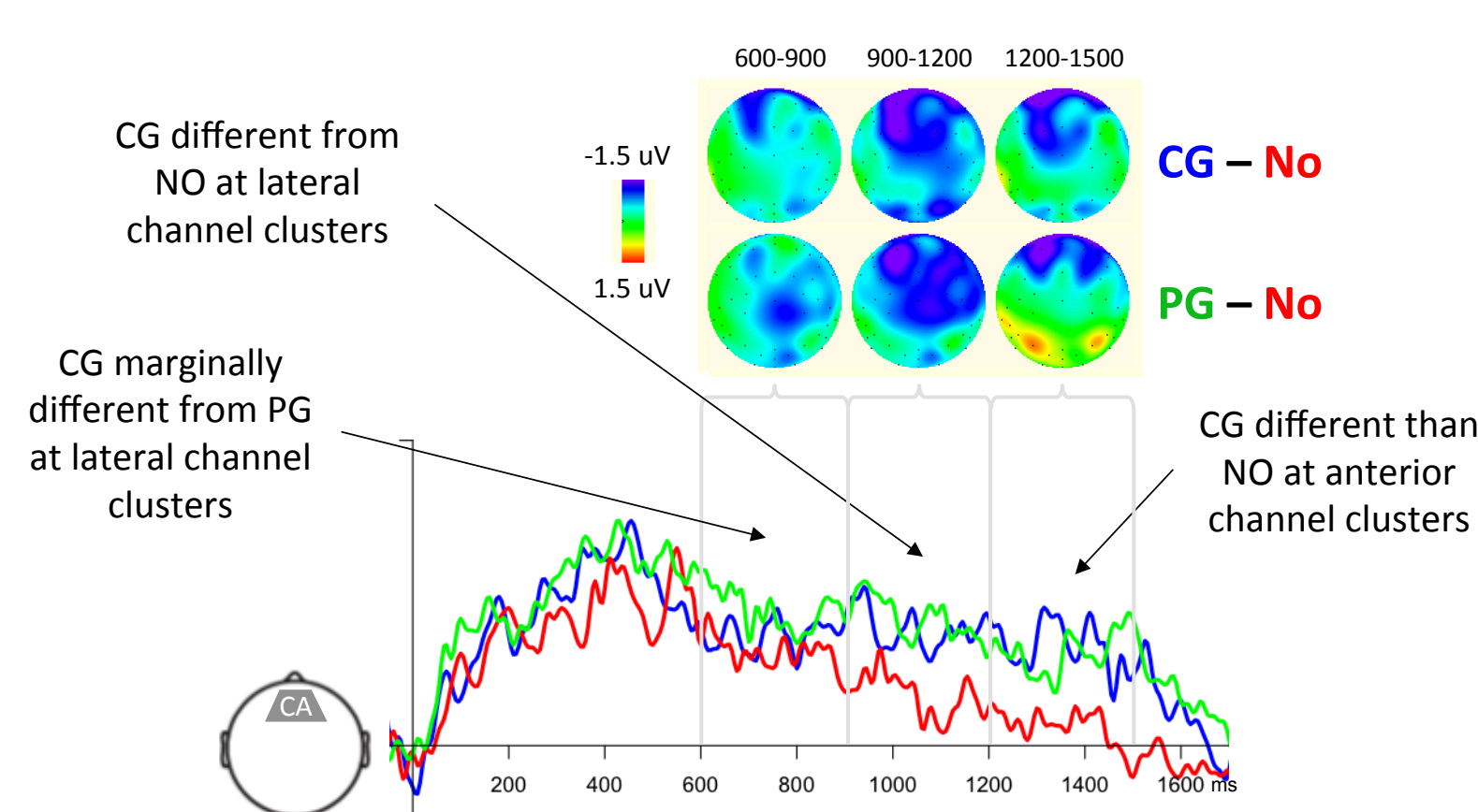
→ PG competitor condition does not elicit Nref effect
- Suggests PG object not considered a candidate for reference

High skill group (N=21)   *Note*: AQ-Soc x Condition interaction did not reach significance

CG differs from NO and PG

600-900 900-1200 1200-1500

-1.5 uV / 1.5 uV

CG – No
PG – No

-5 uV

200 400 600 800 1000 1200 1400 1600 ms

→ High skill group *may* be driving the Nref effect

Low skill group (N=13)   *Note*: AQ-Soc x Condition interaction did not reach significance

CG different from NO and PG at lateral channel clusters

CG marginally different from PG at lateral channel clusters

600-900 900-1200 1200-1500

-1.5 uV / 1.5 uV

CG – No
PG – No

CG different than NO at anterior channel clusters

200 400 600 800 1000 1200 1400 1600 ms

→ Low skill group *may potentially* be more egocentric

ERP analysis windows defined via sample-by-sample two-tailed t-tests (p<0.1) for CG vs NO for at least 10 consecutive samples (50 ms) on at least 10 electrodes. Analysis expanded to all conditions by dividing latency range into three equal 300 ms windows.

All statistical effects remain even when looking at first half only. Effects are also numerically similar when looking at first 50 trials only.

References

1. Stalnacker 1978
2. Clark 1996
3. Epley, Morewedge & Keysar 2004
4. Barr 2008
5. Barr 2011
6. Barr, in progress
7. Hanna, Tanenhaus & Trueswell 2003
8. Brown-Schmidt & Hanna 2011
9. Heller, Grodner & Tanenhaus 2008
10. Wu & Keysar 2007
11. Keysar, Barr, Balin & Brauner 2000
12. Keysar, Lin & Barr 2003
13. Van Berkum, Brown & Hagoort 1999
14. Van Berkum, Koornneef, Otten & Nieuwland 2007
15. Nieuwland, Otten & Van Berkum 2007
16. Baron-Cohen, Wheelwright, Skinner, Martin & Clubley 2001

Conclusions

- The present work replicates the behavioral distraction effect of a competitor in privileged ground, but without the neural signature corresponding to referential ambiguity
  - → This indicates that behavioral distraction does not always reflect referential processing

- ERP results show that listeners efficiently used ground to constrain potential referents to objects in common ground
  - → Extends previous results that ground information influences on-line language processing without being triggered by unusual circumstances [9]
  - → Argues against both Anchoring & Adjustment and Anticipation & Integration accounts

- Individual difference analysis potentially suggests that certain individuals have difficulty integrating common ground, and are possibly egocentric (more exceptionally low-skill participants may be needed to attain sufficient power)