VISUAL WORLD EYE MOVEMENTS IN A CONTINUOUS DISCOURSE

Abigail Toth [a.g.toth@rug.nl]
Jacolien van Rij [j.c.van.rij@rug.nl]
(Juhani Järvikivi & Monique Chrarest)

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BACKGROUND

- Visual world paradigm: an individual’s eye movements are monitored as they receive spoken language input
  - Eye gaze is taken to reflect underlying processes involved in spoken language processing

- Several advantages
  - High temporal resolution
  - Can be used with children
  - Comprehension process can proceed uninterrupted
BACKGROUND

- Online reference processing
  - Cooper (1974) found that ~ 200 ms after hearing the word ‘lion’ participants fixated on a lion in the visual scene
- Pronoun resolution

‘Here is a rabbit and a fox. The fox hit the rabbit beside the barn. He wanted to go home.’
There is not a direct association between the linguistic input (i.e., ‘he’) and a corresponding referent in the visual scene.

- Listeners must infer which referent a pronoun refers to; eye gaze reflects this process.

Following the mention of ‘he’ there is an increase in the proportion of looks to preceding subject (e.g., Arnold et al., 2000; Järvikivi, et al., 2005).
LIMITATIONS

- Series of isolated items that lack any sort of rich context
- Limited referents in the visual scene
- Nothing in the background to look at
- Carefully designed tasks that encourage participants to inspect the visual scene

→ May not accurately reflect naturalistic language processing

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Children listened to a 7-minute long story

Found an increase in looks to target for both NPs and pronouns

Overall target fixations decreased as the story unfolded
STUDY 1

Apply the VWP in a language setting
STUDY 1

- **Participants**
  - 15 children (7 female; mean age 4.8; range 4.2-5.6)
  - 12 adults (10 female; mean age 20; range 18.2-22)

- **Materials**
  - 5-minute long (electronic) storybook w/ ETG
  - 20 pages with unique visual scenes
  - 5 animal characters
  - Critical items
    - 36 NPs (e.g. duckling)
    - 10 pronouns (he)
The three friends made it to the playground. But before Bear and Fox could ask Duckling any questions, he was already too swinging on swings. Luckily, he swung so high that he spotted his friend Frog at the top of the slide. He jumped off the swings and headed towards Frog.‘

But before anyone could start looking, Duckling spotted Daddy Duck across the pond! He flapped his wings with excitement. Daddy Duck looked up and saw Duckling. He sighed with relief and started swimming across the pond.’
RESEARCH QUESTIONS

1. Are eye gaze patterns in a naturalistic discourse setting comparable to gaze patterns in more traditional VWP studies?

2. Upon hearing a referring expression is there an increase in the proportion of looks to the intended referent?

3. Are gaze patterns uniform as the discourse unfolds?
GAZE CODING

- Noldus ObserverXT
- Interest areas (IA):
  - Each of the five animal characters
  - Elsewhere
    - Gaze within IA = 1, gaze not within IA = 0, track loss = NA
- Binned into 5-frame bins (~83 ms)
- Analysis window: 2 bins before and 14 bins after referring expression onset (~1415 ms)
AVERAGE PROPORTION OF TARGET LOOKS ACROSS TIME BIN

NPs

Pronouns

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AVGARAGE PROPORTION OF TARGET LOOKS ACROSS STORY DURATION

NPs

Pronouns

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ANALYSIS

- Logistic Generalized Additive Mixed Modeling (GAMM): analyzed the counts (looks to target vs. looks elsewhere) for each time bin

- Reference level: adult NPs
  - IsChild: difference between adults and children
  - IsPronoun: difference between NPs and pronouns
  - IsChildPronoun: additive interaction effect between IsChild and IsPronoun

- Time Bin
- Story Position

- By-subject factor smooths and random intercept

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RESULTS

- Significant nonlinear interaction between *Time Bin* and *Story Position for the reference level (adult NP)* (Chi.sq(14.429)=130.82; p<.001)

- The interaction was also significant for all three binary predictors
  - Child NPs (Chi.sq(14.153)=126.29; p<.001)
  - Adult pronouns (Chi.sq(14.677)=182.72; p<.001)
  - Child pronouns (Chi.sq(14.448)=153.73; p<.001)
NP CONTOUR PLOTS

Adult NP

Child NP

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SUMMARY OF RESULTS

- Eye gaze patterns relative to hearing a referring expression were heavily influenced by the unfolding discourse.
- Eye gaze patterns for items that occurred earlier on in the discourse are comparable to the eye gaze patterns found in more traditional VWP studies.
- Eye gaze patterns for items that occurred later on in the discourse are not.
CONCLUSIONS

- Something about processing a continuous discourse causes a downward trend in target looks
- It is not the type of visual scene (simple vs. complex) → so what does?
- May be the role the visual scene plays throughout the processing of a continuous discourse
  - Building vs. maintaining a mental representation
  - Timing of eye movements
CONCLUSIONS

- In traditional VWP studies items are presented in isolation
  - Each item introduces a new situation
  - Participants must build a new mental representation for each item
  - Eye gaze patterns for each item reflect the same type of processing
    → trying to understand who is doing what to whom
- Lack of context increases importance of the visual scene
CHALLENGES

- ETG
- Having controlled experimental items in a naturalistic setting?
- No direct comparison group (i.e., the same items presented in isolation)
STUDY 2

Back to the lab
STUDY 2

- Participants
  - 18 adults (18.5-26.3)

- Materials
  - 30 pages/critical items (15 NPs; 15 pronouns)
  - Two conditions:
    1. Continuous narrative vs.
    2. Randomized w/o connective discourse
EXAMPLE ITEMS

(1) Today Mother Duck and Duckling are going to the zoo.
(2) Mother Duck is taking Duckling to a party at the zoo.
(3) Duckling is looking forward to seeing all the different animals.

The party is for Beaver’s birthday. Beaver is a good friend of Mother Duck.

(1) Squirrel and Duckling find Tiger sleeping on a rock.
(2) Squirrel tells Duckling to walk on tippy toes.
(3) He doesn’t want to wake Tiger.

But all of a sudden, they see Tiger’s long tail move. “Run!” yells Squirrel.
EXPECTATIONS

- Replicate the findings in continuous narrative condition
  - Looks to target decrease as story unfolds
- Replicate the findings of traditional VWP studies in randomized condition
  - Looks to target will not decrease (at least to the same extent)
PLOT FROM YESTERDAY’S TRAIN RIDE

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Thank you!
# Model Summary

A. Parametric coefficients

|                | Estimate | Std. Error | z value | Pr (>|z|)   |
|----------------|----------|------------|---------|-------------|
| (Intercept)    | -1.8000  | 0.2809     | -6.409  | 1.47e-10 ***|

B. Smooth terms

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