Using Eye Movement Indices to Capture Semantic Priming Effects

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- Participants
- Heartland Rehabilitation
Introduction

- Priming: To investigate the nature of language organization and processing

- Priming paradigm:
  - Response tasks: LDT, Naming, Cued Shadowing
    - Understand instructions, use verbal or motor responses, and engage in metalinguistic decisions
    - Confounds for patients with neurological disorders
Eye tracking

- Addresses key issues of validity
  - Continuous mapping of language processing
  - No unnatural tasks
  - Alternative response mode
  - Eye-mind assumption (Just & Carpenter, 1980)
  - Eye tracking and Comprehension (Cooper, 1974)
No study to date addressing using **spontaneous** eye movements as a tool to studying priming

**Aim of the Study**

- Which spontaneous eye movement dependent measures capture semantic associative priming effects, the most well established of all priming effects (Neely, 1991), for words in a cross-format (word-picture priming) multiple choice priming context

  - Comparison of target and nontargets in the related trials
  - Comparison of target in related and unrelated trials
Related

- marriage

Unrelated

- stripes

Target

Nontargets
Research Questions and Hypotheses

- *Can fixation duration measures for stimulus areas capture semantic “associative” priming effects?*

  - **Proportion of Fixation Duration (PFD)**
    - Total duration on item/Total duration on screen
  - **Average Fixation Duration (AFD)**
    - Total fixation duration on item/Total number of fixations on item
  - **First Pass Fixation Duration (FPFD)**
    - Time interval between when the fixation first enters and first leaves an item area
Hypotheses

- **PFD**
  - Mean PFD on target in related trial > Mean PFD on nontargets in related trial
  - Mean PFD on target in related trial > Mean PFD on target in unrelated trial

- **AFD**
  - Mean AFD on target significantly different from Mean AFD nontargets
  - Mean AFD on target in related significantly different from mean AFD on target in unrelated
- **FPFD**
  - Mean FPFD on target in related trial > Mean FPFD on nontargets in related trial
  - Mean FPFD on target in related trial > Mean FPFD on target in unrelated trial

- **Can latency of fixation to the target measure capture semantic priming effects?**
  - Time spent on looking anywhere on the screen before fixating on the target

- Latency of fixation to the target in related trial < latency of fixation to the target in the unrelated trial
Method

- Phase 1: Stimuli Development
  - Selection of picture stimuli (targets)
  - Selection of primes for the targets
  - Determining 2 low association non-targets for each prime
  - Traditional priming experiment to ensure semantic priming for prime-target pairs

- Phase 2: Eye Movement Experiment
Phase 1: Stimuli Development

- A. Picture targets
  - 260 grey-shaded pictures depicting common objects
  - Tarr Lab website, Brown University
  - Developed by Rossion and Pourtois (2004)
  - Normative data for:
    - Naming agreement
    - Familiarity
    - Complexity
    - Imagery judgment
B. Select Primes

- 100 language-normal adult native speakers of English (age range: 18 to 26 years; $M = 19.8$, $SD = 2.4$)
- Free association task
- Responses to each picture tallied across participants
- Responses occurring with the highest frequency for each picture were assigned as its high-associative word

marriage: ring

prime: target
marriage: ring

129 pairs selected
C. Low Association Non-Targets

- marriage
- High association target
- Low association non-targets
Step 1. Five pictures generated randomly as possible choices for the two low association targets for each prime

Prime word “marriage” X A B C D E

Step 2. Check if A B C D or E have been given as responses to the prime word in Palermo and Jenkins (1964) norms

Yes: A has been given as a response
Replace with another picture Y

No
Give A B C D E for rating by 20 adults (M = 20.22, SD = 0.91)

Repeat Step 2 with Y

1: No association
5: Medium Association
marriage

High association target

Low association non-targets
D. Traditional Priming Experiment

- 20 additional participants (age range: 18 and 22 yrs, $M = 19.60$, $SD = 0.88$)
- Naming Task
- Media Lab
- Selection of related and unrelated primes for each target based on results of stage C

- For each item comparison between related and unrelated RT
- 34 items selected
Phase II: Eye Movement Experiment

- **Participants**
  - 40 adult language-normal native speakers of English (age range: 18 - 25 yrs, $M = 20.17$, $SD = 1.68$)
  - No h/o neurological impairment, learning disability, ADD, ADHD
  - Vision screening: observed for redness, swelling, nystagmus, and tested for visual acuity

- **Stimuli Arrangement and Procedure**
  - Target/nontarget condition within the related trials
  - Related/unrelated condition
  - Sham trials
- **Regular Trials**

  100 ms  →  marriage  →  4000 ms

- **Sham Trials**

  1000 ms

  →  baby  →  1000 ms
## Stimulus Conditions

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<th>Related Trials</th>
<th>Unrelated Trials</th>
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Instrumentation

- ISCAN RK 436 remote pupil/corneal reflection system
- Recorded by analogue video, sampling rate: 60 Hertz
- Images positioned 20 degrees apart

Instructions

- You will see words and picture sets on a computer screen. Read the words and look at the pictures on the screen in whichever way that comes naturally to you. You do not have to remember any of the words or pictures.
Analyses

- Fixation: 100 milliseconds
- Regular trials not shams
- Three fixation duration measure and one latency measure
  - Dependent t tests between related/unrelated, target/nontarget conditions for all measures
Results

*Figure 1.* Average fixation duration (AFD, $t(39) = 9.35, p < 0.001$) and first pass fixation duration (FPFD, $t(39) = 12.37, p < 0.001$) for target picture in related and unrelated conditions.
Figure 2. Proportion of fixation duration (PFD) for related and unrelated conditions for target picture, $t(39) = 15.82, p < 0.001$ and for nontarget foils in the related condition, $t(39) = 16.35, p < 0.001$. 
Figure 3. Comparison of target and nontarget foils for the AFD ($t (39) = 9.99, p < 0.001$) and FPFD ($t (39) = 12.11, p < 0.001$) in the related condition.
Figure 4. Comparison of latency of target fixation in the related and unrelated condition, ($t(14) = -4.10$, $p = 0.001$).
Conclusions

- Fixation duration measures and latency measures can capture semantic priming effects in a multiple-choice priming format.

- These results are promising in light of the advantages of eye tracking priming methods, eliminating the need for participants to: make verbal and/or planned overt motor responses, make unnatural metalinguistic decisions, and understand explicit task-related instructions.

- Further research to assess the validity and feasibility of using eye tracking methods to study priming effects in individuals with neurological disorders is warranted.

- Similar eye movement protocols may be useful for investigation of priming effects that are less well established, such as form, morphological, and syntactic priming, in normal populations as well as in individuals with neurogenic communication disorders.