Prosody-Syntax Interactions in Aging: Event-related potentials reveal dissociations between on-line and off-line measures

Betül Aksu

Saarland University

baksu@coli.uni-saarland.de

February 5, 2015

Spoiler alert!

Language is ambiguous at many levels

Spoiler alert!

Language is ambiguous at many levels

- Lexical
  - homophones *'eye'* or *'I'*
  - homonyms *'yüz'* in Turkish

Spoiler alert!

Language is ambiguous at many levels

- Lexical
  - homophones *'eye'* or *'I'*
  - homonyms *'yüz'* in Turkish
- Pragmatic
  - *It's warm today*

Spoiler alert!

Language is ambiguous at many levels

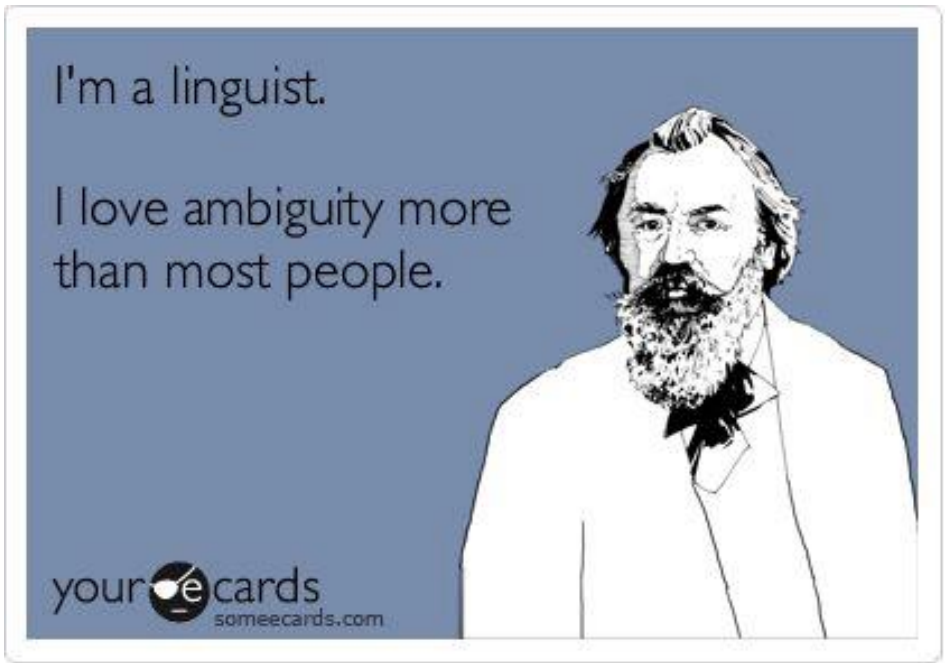
- Lexical
  - homophones *'eye'* or *'I'*
  - homonyms *'yüz'* in Turkish
- Pragmatic
  - *It's warm today*
- **Syntactic**
  - *John saw the man with the telescope*

Spoiler alert!

Language is ambiguous at many levels

- Lexical
  - homophones *'eye'* or *'I'*
  - homonyms *'yüz'* in Turkish
- Pragmatic
  - *It's warm today*
- **Syntactic**
  - *John saw the man with the telescope*
- **Prosodic**
  - *'Psychotherapist'* or *'Psycho therapist'*

Motivation


I'm a linguist.
I love ambiguity more than most people.
someecards.com

Outline

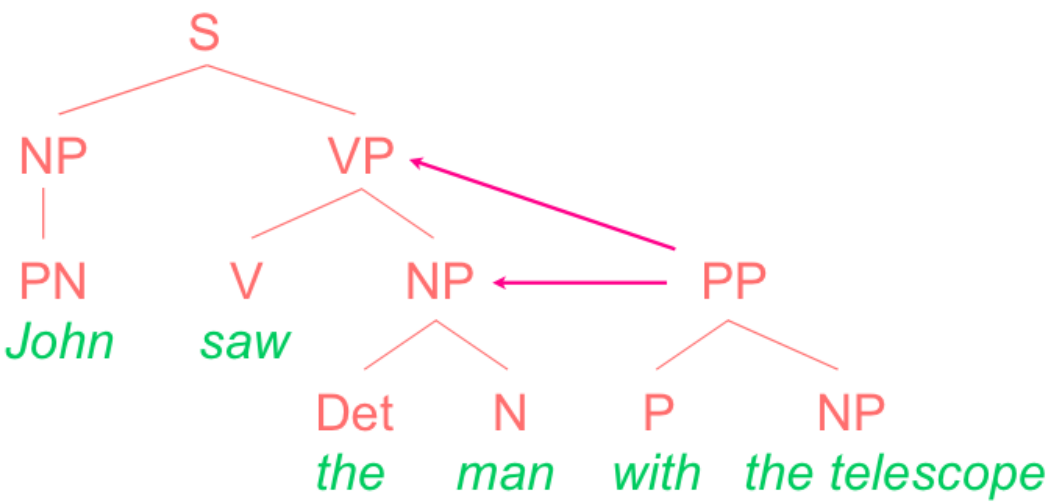
Garden Path Theory - Frazier (1979)[1]

- The parser relies on strategic guessing while making initial structural decisions

[1] Matthew W. Crocker, Computational Psycholinguistics Lecture 2

Garden Path Theory - Frazier (1979)[1]

- The parser relies on strategic guessing while making initial structural decisions
- Which attachment do people initially prefer?
  - Minimal attachment
  - Late closure



[1] Matthew W. Crocker, Computational Psycholinguistics Lecture 2

Early Closure vs. Late Closure

Whenever John *walks* the dog ...
(a) ... the kids are chasing him. [Late Closure, LC]
(b) ... is chasing him. [Early Closure, EC]

Early Closure vs. Late Closure

Whenever John *walks* the dog ...
(a) ... the kids are chasing him. [Late Closure, LC]
(b) ... is chasing him. [Early Closure, EC]

- Strong preference to LC. (Frazier & Rayner, 1982)
  - Build the least complicated structure

Outline

Christianson et al. (2006)

- Older adults have greater difficulty in off-line measures. (Kemtes & Kemper, 1997)
- Older and younger adults show similar effects in on-line measures. (Waters & Caplan, 2001)
- Working memory plays an important role in off-line processing, but not in on-line processing. (DeDe et al., 2004)

Christianson et al. (2006)

- Older adults have greater difficulty in off-line measures. (Kemtes & Kemper, 1997)
- Older and younger adults show similar effects in on-line measures. (Waters & Caplan, 2001)
- Working memory plays an important role in off-line processing, but not in on-line processing. (DeDe et al., 2004)

While the man hunted the deer ran into woods
(a)... the man hunted the deer
(b)... the man hunted something

- Strong preference to LC in older adults

Outline

What?

- Can prosody help us to disambiguate syntactic processing?
- Do older adults use prosody in resolving early and late closure ambiguities comparably to young adults?
- Do older adults demonstrate on-line garden-path effects at all?

Outline

Steinhauer et al. (2010)

- Older adults are less sensitive to prosody
  - ✓ Off-line
  - Online?
- Older adults weight prosodic information more heavily than younger adults
  - ✓ Off-line
  - Online?

Outline

Participants

Younger adults

- 26 students
- age range: 18-25
- Native speakers of English
- Right-handed
- Pauker et al. 2011

Older adults

- 13 participants (?)
- age range: 65-80
- Native speakers of English
- Right-handed
- Steinhauer et al. 2010

Materials

1. 40 EC and LC sentence pairs with normal prosody
   - Condition A: Late Closure
   - Condition B: Early Closure

2. Two garden path conditions with conflicting prosody
   - Condition C: initial A + final B, no prosodic boundry
   - Condition D: initial B + final A, two prosodic boundries

Materials

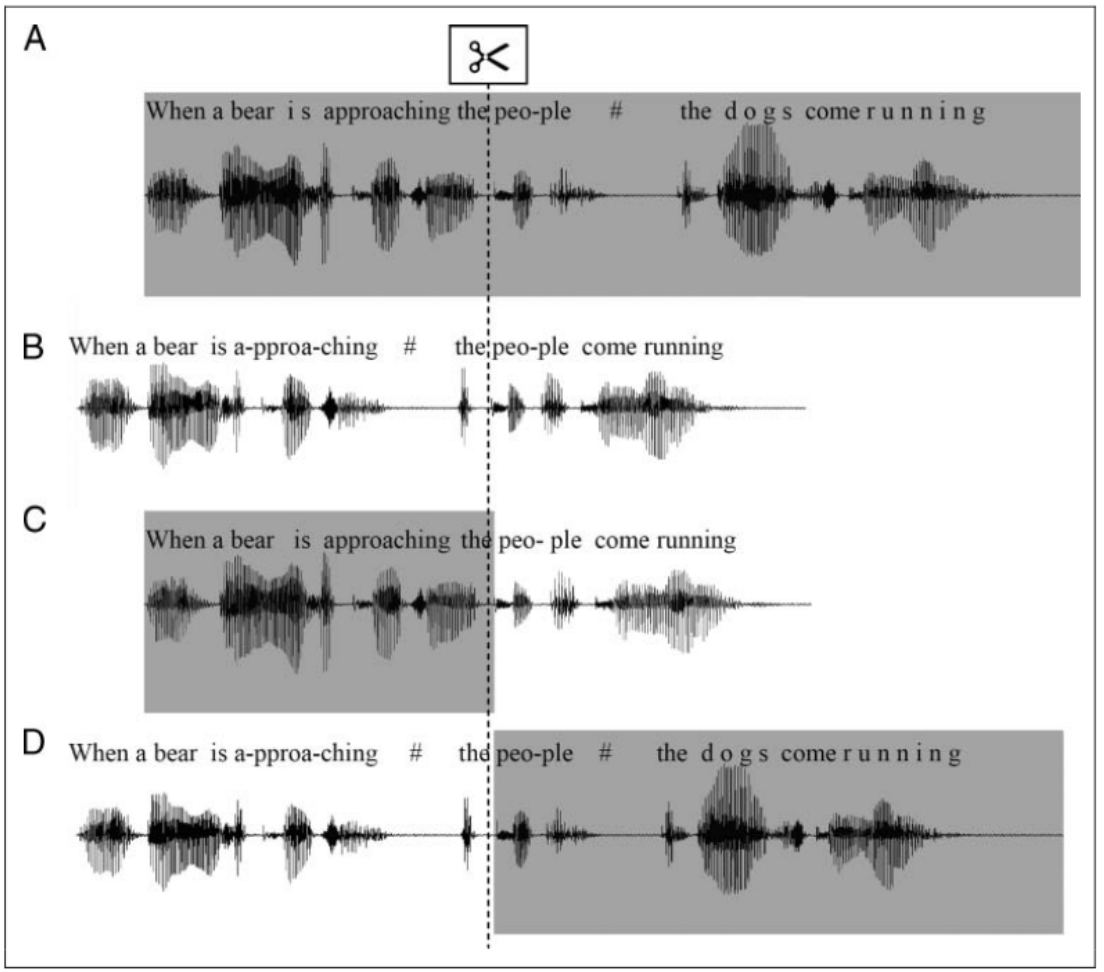


Figure 1. Waveforms of sample sentences in all four conditions A–D.

Procedure

1. Acceptability judgement task
2. Response times
3. EEG Recording

Outline

Behavioral results

Measure	Condition	Old (μ)	Young (μ)
Percent accepted (%)	A	78.1	87.5
	B	78.0	87.2
	C	**68.3**	**53.4**
	D	**68.3**	**28.0**
Acceptance time (s)	A	.775	.683
	B	.821	.702
	C	1.024	.929
	D	.841	**.944**
Rejection time (s)	A	1.459	1.144
	B	1.412	.900
	C	1.422	.936
	D	**1.556**	**.748**

Table 1. Acceptability judgment and response times per age group per condition.

ERP results

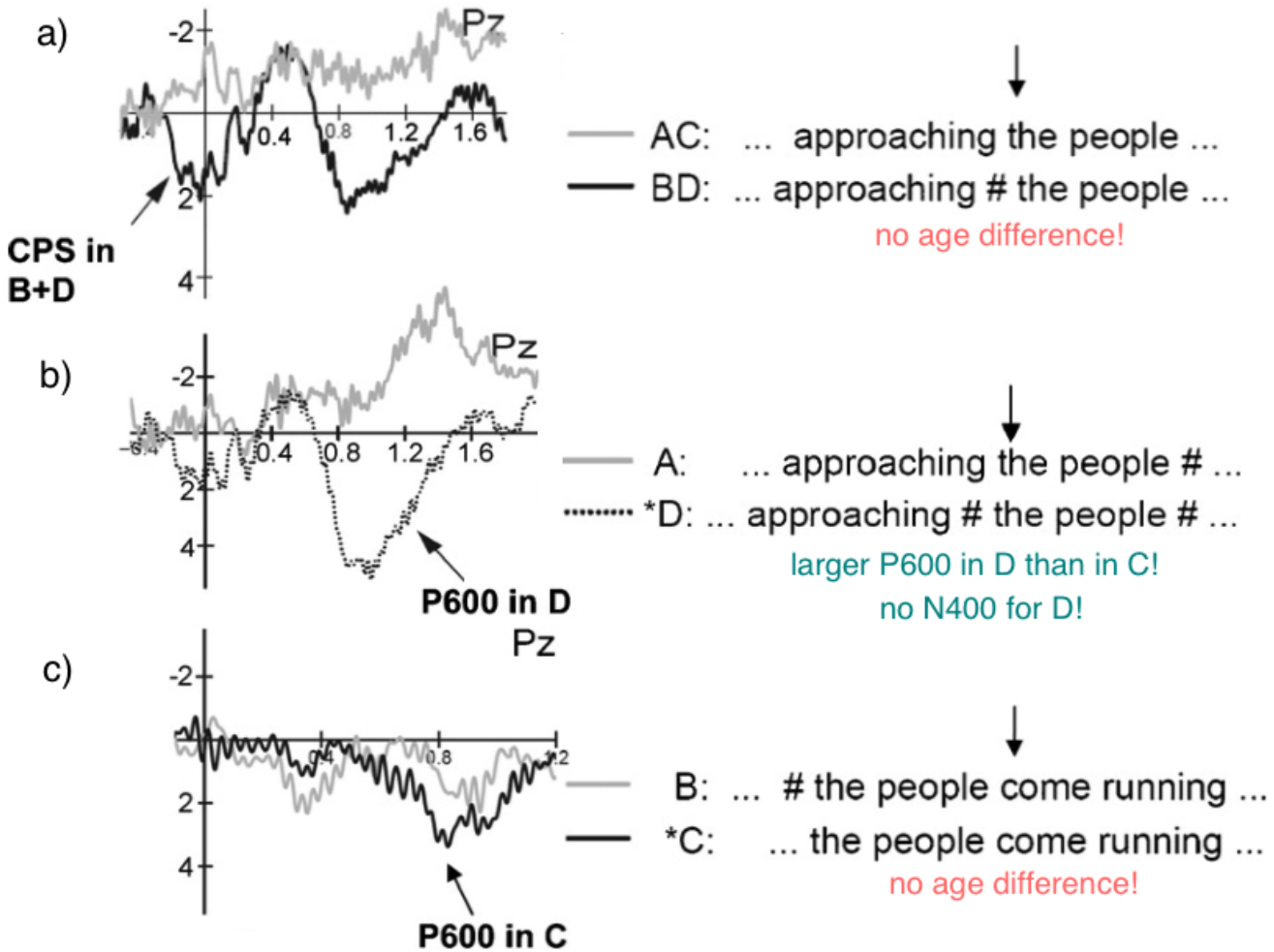


Figure 2. ERPs in older adults collapsed across (a) AC&BD, contrasting matched conditions (b) A&D, and (c) B&C.

Summary

- Older adults are less sensitive to prosody
  - ✓ Off-line: C (**68.3**) and D (**68.3**)
  - × Online: CPS and P600
- Older adults weight prosodic information more heavily than younger adults
  - ✓ Off-line: >500 ms delay in rejecting
  - ✓ On-line: larger P600 in D than in C

Q&A Session

1. Part 1:Comprehension Questions
   - Can prosody help us to disambiguate syntactic processing?

Q&A Session

1. Part 1:Comprehension Questions
   - Can prosody help us to disambiguate syntactic processing?
   - Are older adults less sensitive to prosody?

Q&A Session

1. Part 1:Comprehension Questions
   - Can prosody help us to disambiguate syntactic processing?
   - Are older adults less sensitive to prosody?
2. Part 2: Discussion
   - Compare the on-line and off-line measures for prosodic processing in aging
   - Discuss the role of working memory in off-line processing results
   - Discuss the experimental design in Steinhauer et al. 2010

VIELEN DANK FÜR EUER ZUHÖREN

References

Pauker, Efrat et al. (2011)
Effects of cooperating and conflicting prosody in spoken english garden path sentences: ERP evidence for the boundary deletion hypothesis.
Journal of Cognitive Neuroscience (23:10, 2731–2751).

Steinhauer, Karsten et al. (2010)
Prosody–syntax interactions in aging: Event-related potentials reveal dissociations between on-line and off-line measures.
Neuroscience Letters (472, 133–138).

Christianson, Kiel et al. (2006)
Younger and older adults' "good-enough" interpretations of garden-path sentences.
Discourse Process (42:2, 205–238).

Frazier, L. & Rayner, K. (1982)
Making and correcting errors during sentence comprehension: Eye movements in the analysis of structurally ambiguous sentences.
Cognitive Psychology (14, 178-210) .

Semantic prediction in old age

Jorrig Vogels

Language & Aging seminar

February 5, 2015

Semantic anomalies

- “He spread the warm bread with...”

(Kutas & Hillyard, 1980; Kutas & Van Petten, 1994)

Semantic anomalies

- “He spread the warm bread with socks.”

(Kutas & Hillyard, 1980; Kutas & Van Petten, 1994)

Semantic anomalies

- “He spread the warm bread with socks.”
- “The pizza was too hot to...”

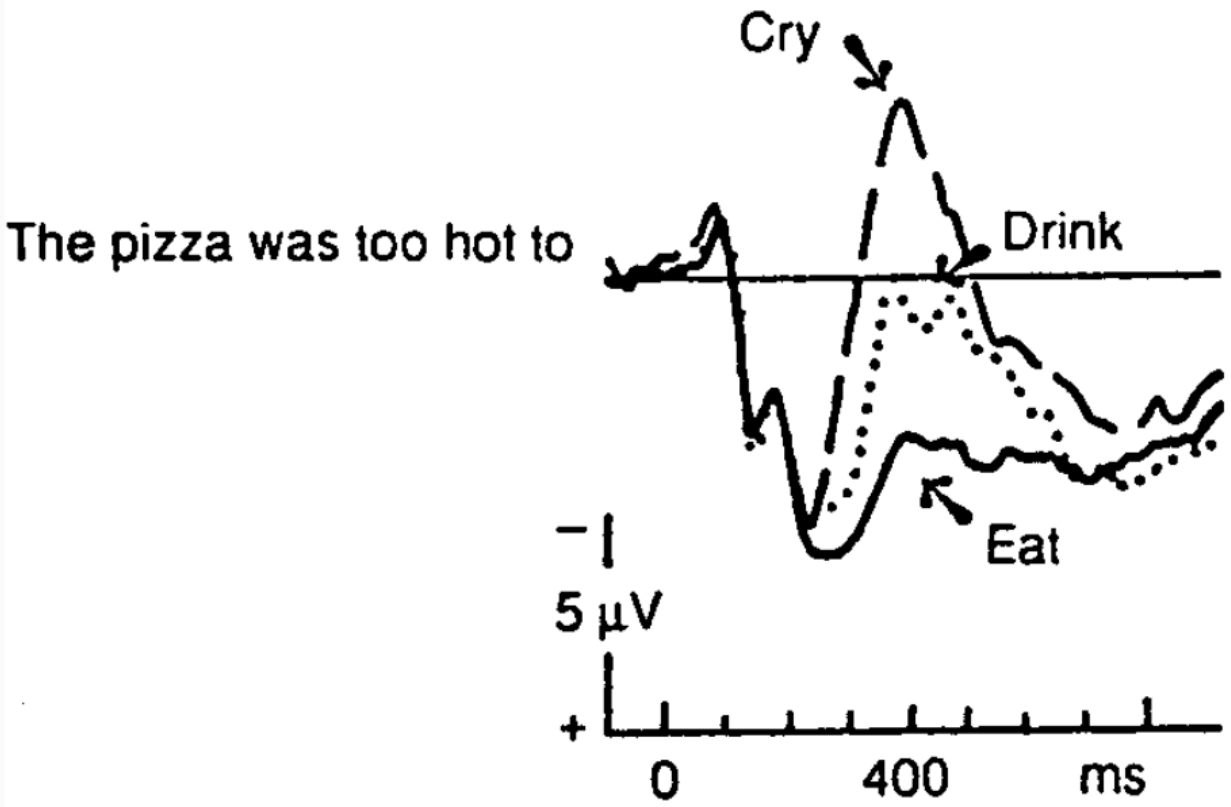
(Kutas & Hillyard, 1980; Kutas & Van Petten, 1994)

Semantic anomalies

- “He spread the warm bread with socks.”
- “The pizza was too hot to cry.”

(Kutas & Hillyard, 1980; Kutas & Van Petten, 1994)

N400



Hypotheses

1. People make predictions about upcoming words based on the context.

Hypotheses

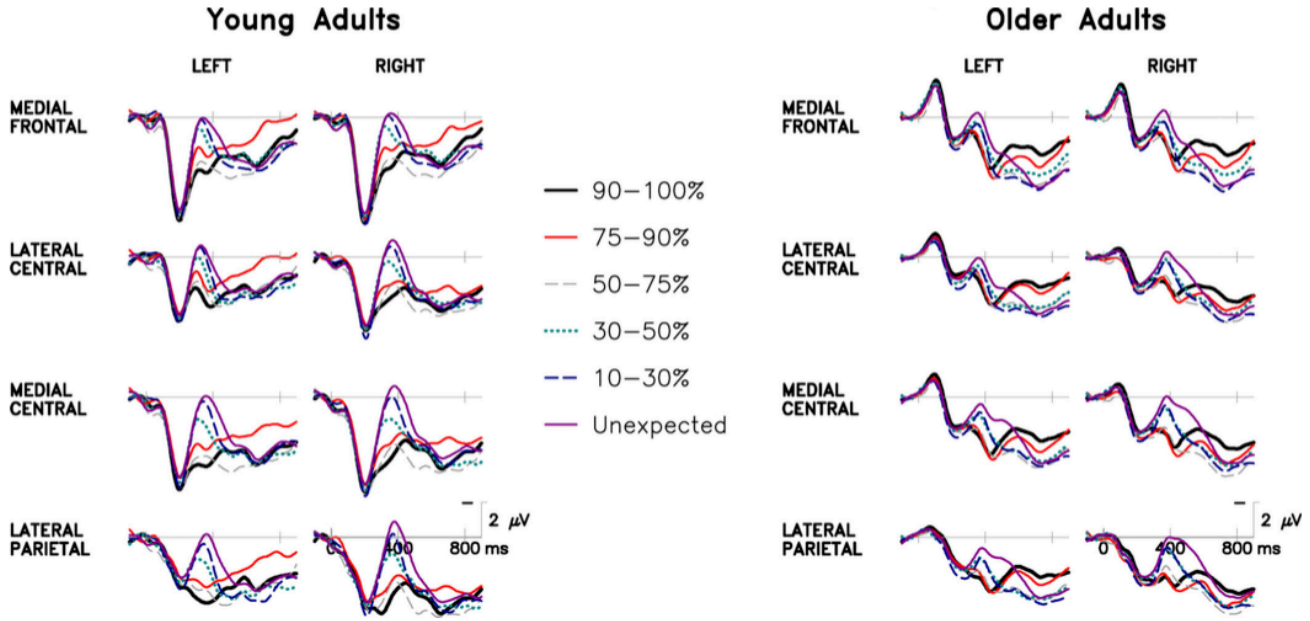
1. People make predictions about upcoming words based on the context.
2. Older people might be less able to do this.

Earlier studies

- N400 effects are reduced and delayed in older compared to younger adults.

Earlier studies

- N400 effects are reduced and delayed in older compared to younger adults.
- Due to larger negativity for predictable words, rather than to a lower N400 for unexpected words (e.g. Wlotko & Federmeier, 2012).



Earlier studies

- N400 effects are reduced and delayed in older compared to younger adults.
- Due to larger negativity for predictable words, rather than to a lower N400 for unexpected words (e.g. Wlotko & Federmeier, 2012).

→ supports context use problem hypothesis

Prediction or integration?

- “Everybody thought that Jesse wouldn't really be successful as a cook, but he persevered. Now he works at a …”

(Otten & Van Berkum, 2007)

Prediction or integration?

- “Everybody thought that Jesse wouldn't really be successful as a cook, but he persevered. Now he works at a …”
- “Everybody thought that Jesse would be very successful as a cook, but he did not persevere. Now he works at a …”

(Otten & Van Berkum, 2007)

Prediction or integration?

- “Everybody thought that Jesse wouldn't really be successful as a cook, but he persevered. Now he works at a …”
- “Everybody thought that Jesse would be very successful as a cook, but he did not persevere. Now he works at a …”

(Otten & Van Berkum, 2007)

- Unexpected words elicited N400 effects in both conditions (although at different locations in the brain).

Federmeier et al. (2007)

- Question: can we find an ERP-effect of sentence constraint when we keep expectancy constant (only possible for unexpected words)?

Federmeier et al. (2007)

- Expected vs. Unexpected words
  - "He bought her a pearl necklace for her …"
    - birthday
    - collection

Federmeier et al. (2007)

- Expected vs. Unexpected words
  - "He bought her a pearl necklace for her …"
    - birthday
    - collection

Prediction: large N400 effect

Federmeier et al. (2007)

- Strongly vs. Weakly constraining contexts:

  a) “He bought her a pearl necklace for her …”

Federmeier et al. (2007)

- Strongly vs. Weakly constraining contexts:

  a) “He bought her a pearl necklace for her birthday.”

Federmeier et al. (2007)

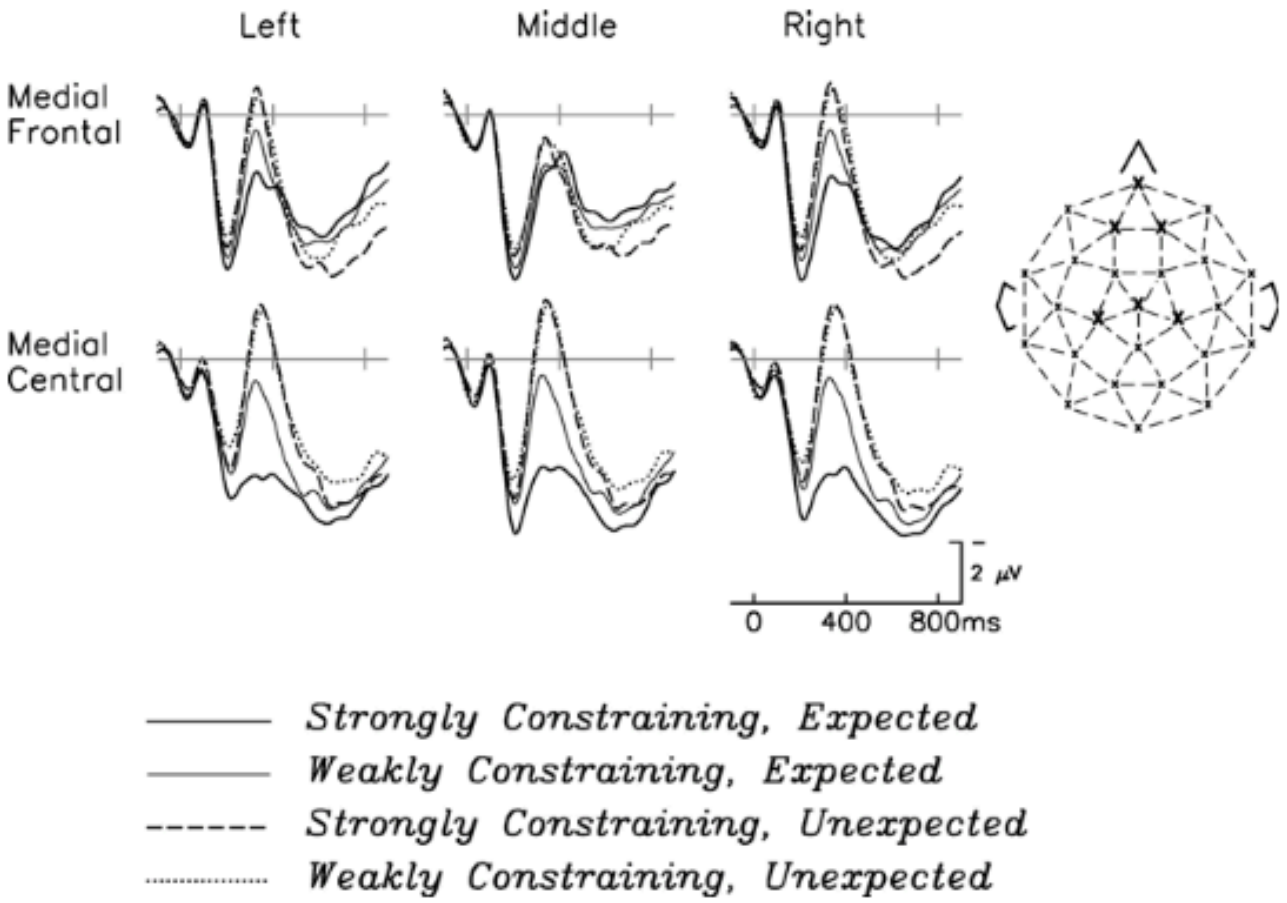
- Strongly vs. Weakly constraining contexts:
  a) “He bought her a pearl necklace for her ...”
  b) “He looked worried because he might have broken his …”
     - arm
     - collection

Federmeier et al. (2007)

- Strongly vs. Weakly constraining contexts:
  a) "He bought her a pearl necklace for her …"
  b) "He looked worried because he might have broken his …"
     - arm
     - collection

Prediction: larger N400 at 'collection' for a) than for b).

Federmeier et al. (2007)



Federmeier et al. (2007)

- No difference in N400, but larger late positivity for unexpected words in strongly constraining contexts.

Federmeier et al. (2007)

- No difference in N400, but larger late positivity for unexpected words in strongly constraining contexts.

- N400 does not reflect (violations of) prediction, but late positivity might.
  - semantic revision
  - suppression
  - learning signal

Wlotko et al. (2012)

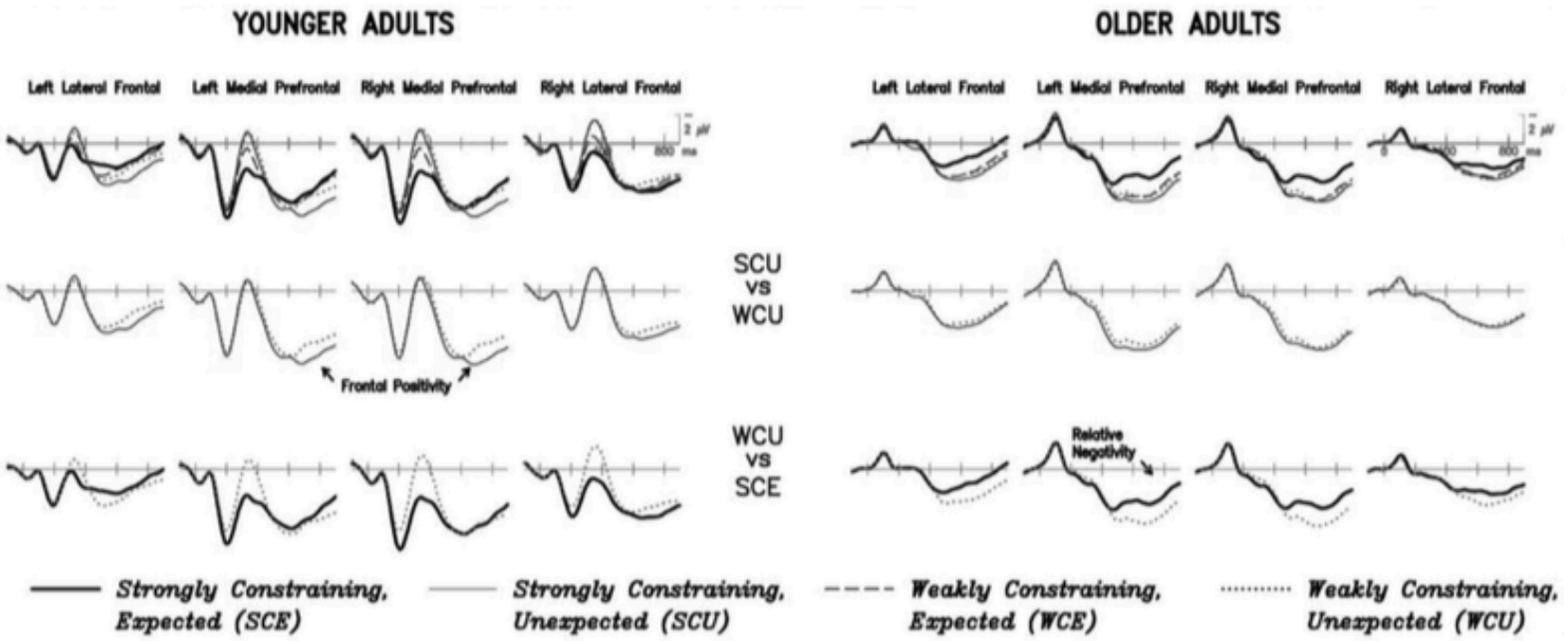
- How do older people use context during sentence comprehension?

Wlotko et al. (2012)

- How do older people use context during sentence comprehension?

- Compare 24 older participants (age 59-88) to the young participants in Federmeier et al. (2007), using the same sentences.

Results


YOUNGER ADULTS
OLDER ADULTS
Left Lateral Frontal
Left Medial Prefrontal
Right Medial Prefrontal
Right Lateral Frontal
2 μV
800 ms
SCU vs WCU
Frontal Positivity
WCU vs SCE
Relative Negativity
Strongly Constraining, Expected (SCE)
Strongly Constraining, Unexpected (SCU)
Weakly Constraining, Expected (WCE)
Weakly Constraining, Unexpected (WCU)

Discussion – N400

- Again, no N400 difference between weak and strong contexts for unexpected words.

Discussion – N400

- Again, no N400 difference between weak and strong contexts for unexpected words.

- Smaller and delayed N400 effect for older adults.
  - Driven by larger negativity for expected words.
  - Unexpected words are as surprising for older as for younger adults, but expected words are more surprising for older adults.

Discussion – N400

- Again, no N400 difference between weak and strong contexts for unexpected words.

- Smaller and delayed N400 effect for older adults.
  - Driven by larger negativity for expected words.
  - Unexpected words are as surprising for older as for younger adults, but expected words are more surprising for older adults.

- No difference between weakly expected and unexpected words for older adults.
  - Older adults need stronger contextual cues to facilitate processing.

Discussion – late effects

- No late positivity for unexpected words in strongly constraining contexts as was found for the younger adults.

Discussion – late effects

- No late positivity for unexpected words in strongly constraining contexts as was found for the younger adults.
  - Instead: late negativity for strongly *expected* words.

Discussion – late effects

- No late positivity for unexpected words in strongly constraining contexts as was found for the younger adults.
  - Instead: late negativity for strongly *expected* words.
  - Might reflect reconsidering context that was not taken into account earlier.

Conclusion

- Older adults make less use of context in sentence comprehension.
  - Smaller N400.

Conclusion

- Older adults make less use of context in sentence comprehension.
  - Smaller N400.
- Older adults do not engage in predictive processing.
  - No late positivity.

References

- Federmeier, K. D., McLennan, D. B. & De Ochoa, E. (2002). The impact of semantic memory organization and sentence context information on spoken language processing by younger and older adults: An ERP study. *Psychophysiology, 39*, 133-146.
- Federmeier, K. D., Wlotko, E. W., De Ochoa-Dewald, E., & Kutas, M. (2007). Multiple effects of sentential constraint on word processing. *Brain Research*, *1146*(1), 75-84.
- Kutas, M. & Hillyard, S. A. (1980). Reading senseless sentences: Brain Potentials Reflect Semantic Incongruity. *Science, 207*(4427), 203-205.
- Kutas, M. & Van Petten, C. K. (1994). Psycholinguistics Electrified: Event-Related Brain Potential Investigations. In: M. A. Gernsbacher (Ed.), *Handbook of Psycholinguistics* (pp. 83-143). San Diego, Academic Press.
- Otten, M., & Van Berkum, J. J. A. (2007). What makes a discourse constraining? Comparing the effects of discourse message and scenario fit on the discourse-dependent N400 effect. *Brain Research*, *1153*(1), 166-177.
- Ramscar, M., Hendrix, P., Shaoul, C., Milin, P., & Baayen, H. (2014). The myth of cognitive decline: Non-linear dynamics of lifelong learning. *Topics in Cognitive Science*, *6*(1), 5-42.
- Wlotko. E. W., & Federmeier, K. D. (2012). Age-related changes in the impact of contextual strength on multiple aspects of sentence comprehension. *Neuropsychologia, 45*, 3001-3014.
- Wlotko, E. W., Federmeier, K. D., & Kutas, M. (2012). To Predict or Not to Predict: Age-Related Differences in the Use of Sentential Context. *Psychology and Aging*.

Aging and situation model processing

Radvansky & Dijkstra, 2007

Ekaterina Kravtchenko

Seminar: Language Comprehension and Aging

February 5, 2015

Outline

Outline

Background

- Cognitive decline is apparent in many domains
  - Not ubiquitous?

- Which areas are preserved (or improved), and what sets them apart?
- Do areas with evidence of decline confound detection of decline in other areas?

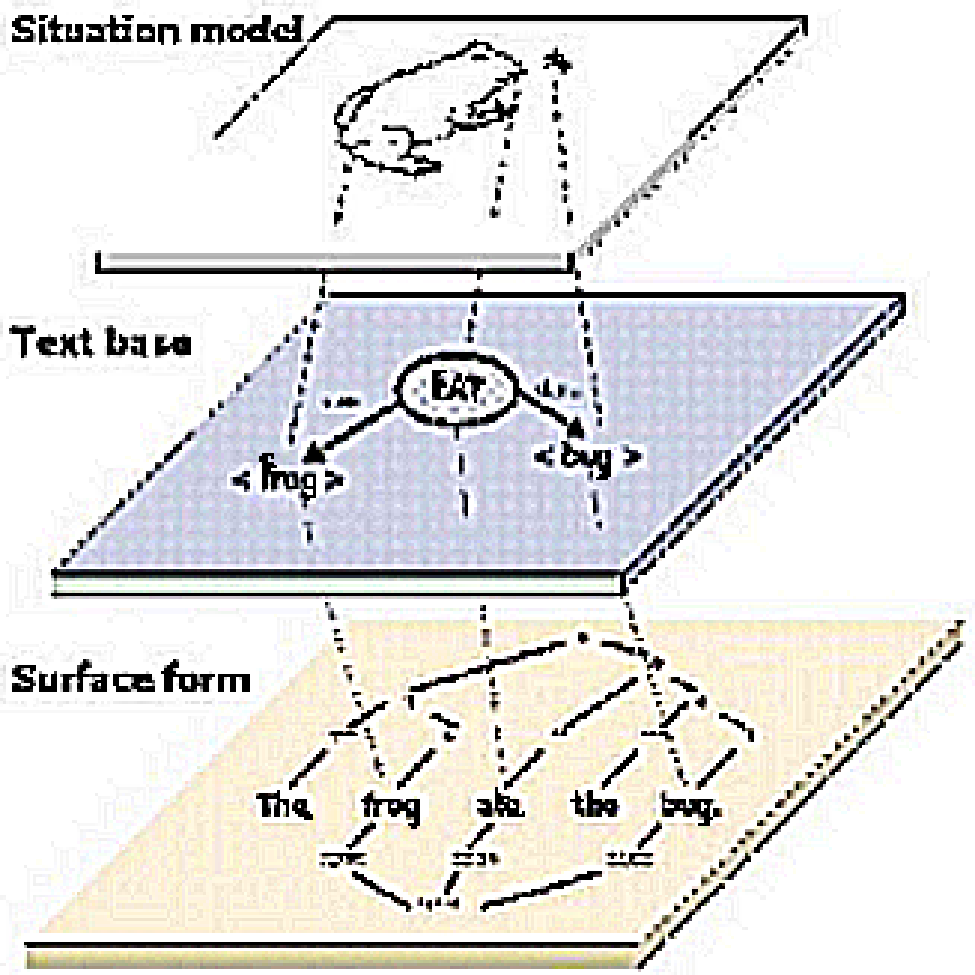
Text Comprehension

- Texts can be processed at different levels

- Decline: memory for specific words, structures, or propositions
- Intact: memory for/understanding of situations described in texts

Outline

Levels of Text Processing



Levels of Text Processing

- Situation model = incomplete mental simulation
  - Spatial-temporal event framework
  - Participants
  - Relationships b/w participants and events
- New situation model for each new event, if location changes
  - Looking at clock, stirring pot - consistent with one situation
  - Stirring pot & making snowball - multiple models
- Dynamic - models need to be updated as situations change

Situation Model

1. The bug was eaten by the frog.
2. The frog ate the bug.
3. The frog had the bug for lunch.

Comparison:

- Surface form: all distinct
- Text base: (1) = (2); (3) distinct
- Situation model: (1) = (2) = (3)

Outline

Comprehension

- Hinges on successful creation/updating of situation models
- Mental representations formed when reading text, for unique situations/events
- Static models: Model created, but not changed within context of sentence
  - More errors on linguistically dissimilar sentences (recall talk) when describing same situation

    (Radvansky, Gerard, Zacks, & Hasher, 1990)
  - Processing of causal information/importance not affected

    (Stine-Morrow et al., 2004)
  - Generally, more integral information understood/retained just as well

    (Radvansky, Copeland, & Zwaan, 2003; Morrow, Leirer, & Altieri, 1992)

Model Updating

- Dynamic models: readers must also update existing situation models
  - Longer time shifts more difficult to process for both younger & older adults

    (Radvansky, Copeland, et al., 2003)
  - Irrelevant information similarly removed (past/temporary states, completed goals)

    (Radvansky, Copeland, et al., 2003; Radvansky & Curiel, 1998)
  - Spatial updating preserved

    (Morrow et al., 1994, 1997; Stine-Morrow et al., 2002)
  - Similar reading time slowdowns at situational shifts

    (Radvansky, Zwaan, Curiel, & Copeland, 2001)

Memory

- Confusion of sentences with different surface/textbase forms, but same situational model

  (Radvansky, Gerard, Zacks, & Hasher, 1990)
- No comparable difficulty recalling information from situation model

  (Radvansky, Copeland, et al., 2003; Radvansky, Copeland, & Zwaan, 2003; Radvansky et al., 2001)
- No difference in ability to integrate new information into situation model

  (Gerard, Zacks, Hasher, & Radvansky, 1990; Radvansky, Zacks, & Hasher, 1996, 2005)
- Preserved memory for important aspects of situations

  (Radvansky, Copeland, & Zwaan, 2003)

Exceptions

- Difficulty when situation described in text discontinuous

  (Copeland & Radvansky, 2007)
- Difficulty modifying model once representation created

  (Hamm & Hasher, 1992)

Interaction with Working Memory

- Good working memory necessary for successful situation model building/updating?

- No clear/direct relation; WM scores correlate with surface form/text base processing

  (Radvansky & Copeland, 2001, 2004, 2006)

- Seen when model forming depends on accurate processing of surface form/text base.

  (Radvansky & Copeland, 2004)

Outline

Aging and Decline

- Situation model building age-invariant, unless problem with something else feeding directly into it
- Other areas preserved:
  - verbal abilities
  - gist-based memory
  - crystallized intelligence (vocabulary, world/schema knowledge)
  - semantic priming (availability of preserved knowledge)
- Preserved areas: improvement (e.g. drawing of unstated inferences) or compensation?
- (?) *"the range of knowledge that is available to people as they are actively processing information online is essentially the same in younger and older adults"*

Processing

- Language Processing
  - Situation models have privileged place in cognition/memory (insulating?)
  - More primitive form of cognition?
  - Extent of previous reading experience and schema-based knowledge might matter?
- Working Memory
  - Situation model updating presumably makes demands on working memory – why not affected by declines?)
  - Traditional memory span measures don't measure 'working memory' per se?

Conclusion

- No decline in situation model processing
- Decline in processing speed, WM capacity, some executive functions

- Situation model processing is ‘more robust’
- (Relies on more fundamental representational processes?)

Discussion Questions

Steinhauer et al., 2010 (Betül)

- Compare the on-line and off-line measures for prosodic processing in aging
- Discuss the role of working memory in off-line processing results
- Discuss the experimental design in Steinhauer, et al. 2010

Wlotko, Federmeier, & Kutas, 2012 (Jorrig)

- Level of constraint was determined by a cloze study among young adults – might cloze probabilities be different for older adults?
- The late negativity is interpreted as a reconsideration of context. But why is this effect only found for strongly expected words?
- Can these results be explained by an effect of learning (cf. Ramscar et al., 2014)?

Radvansky & Dijkstra, 2007 (Katja)

- Why does WM not play a role in situation model building/updating?
- How might {one | Michael Ramscar} account for the differential decline/preservation of abilities?
- Why is even better performance typically explained in terms of decline?