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# Good-enough sentence processing in younger and older adults under normal and visual-noise processing conditions



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# Within the CLARe4 context

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- Interaction  What linguistic strategies can reduce the risk of misunderstanding in communication with older adults?
- Methods
- Positions  Are there any 'normal' changes in comprehension inherent even to healthy aging?

# Aging & sentence comprehension

Quantitative changes:

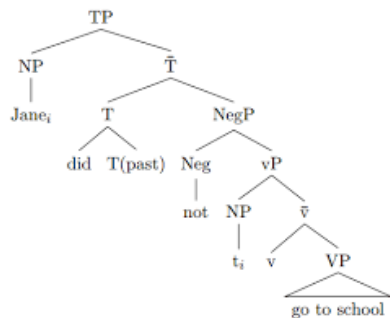
- Slower processing
  - Slower reading speed (Brébion, 2001, 2003; Caplan et al., 2011, ..., Malyutina et al., 2018)
- Less accurate comprehension
  - At least in complex sentence types or challenging processing conditions (Caplan et al., 2011; Caplan & Waters, 2005; Stine-Morrow et al., 2000; Wingfield, Peelle, & Grossman, 2003)

What are the qualitative mechanisms driving these quantitative changes / used to compensate for them?

# Sentence comprehension

Algorithmic computation:

- Precise
- Complete
- Compositional
- Structure-based



'Good-enough' representations:

- Fast
- Fuzzy
- Based on semantic heuristics

Ferreira et al., 2002;

Ferreira & Patson, 2007;

~ Clahsen & Felser, 2006, shallow structure hypothesis

# Sentence comprehension

Algorithmic computation



'Good-enough' representations:



Claude Monet. San Giorgio Maggiore at Dusk

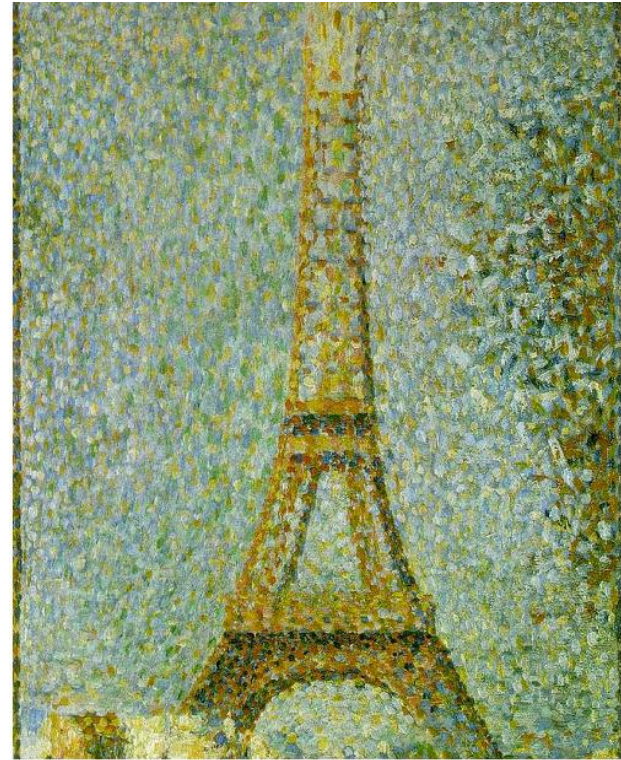
(Photo: Anna Teplitskaya, <https://lady.mail.ru/article/494134-17-realnyh-mest-s-kartin-velikih-hudozhnikov>)

# Sentence comprehension

Algorithmic computation



'Good-enough' representations:



Georges Seurat. The Eiffel Tower.

(Photo: Anna Teplitskaya, <https://lady.mail.ru/article/494134-17-realnyh-mest-s-kartin-velikih-hudozhnikov>)

# 'Good-enough' processing

Ferreira & Stacey, 2000:

(a) The man bit the dog.

(b) The man was bitten by the dog.

(c) The dog bit the man.

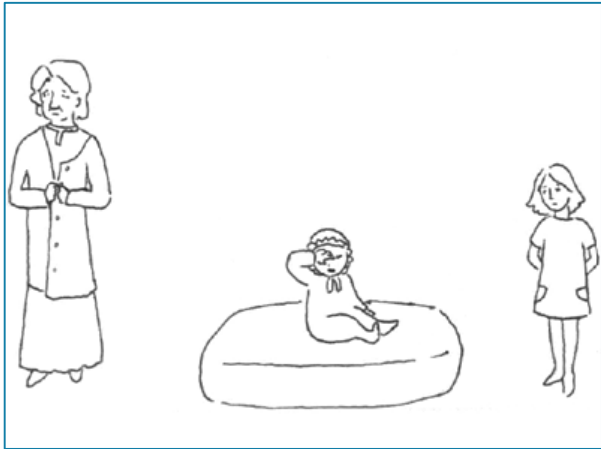
(d) The dog was bitten by the man.

← Rated as plausible  
25% of the time

# 'Good-enough' processing

Malyutina & Den Ouden, 2015:

*While the Granny dressed the baby rubbed its face.*



*Correct*  
77% in older  
66% in younger

*Incorrect*  
*'Blended':* \_\_\_\_\_  
16% in younger  
21% in older

*Incorrect*  
\_\_\_\_\_  
*'Initial':*  
7% in younger  
13% in older



# Do older people rely on 'good-enough' processing more?

- Indirect evidence:
  - Greater effects of lexical predictability and context in aging (Dubno et al., 2000, Pichora-Fuller, et al., 1995; Wingfield et al., 2011)
  - Difficulties in syntactic processing (Kemper et al., 2001; Kemtes & Kemper, 1997; Waters & Caplan, 2001; Wingfield et al., 2003)
- Direct evidence: not so many studies
  - Kemper et al., 2004; Christianson et al., 2006, 2010; Malyutina and Den Ouden, 2016; Amichetti et al., 2016

**Our goals: (1) Add to this evidence;  
(2) Compare normal vs. noisy processing conditions**

# Our bigger project on 'good-enough' processing

- Age:

Teenagers, young adults, older adults

- Stimulus modality:

Written / auditory

- Processing conditions:

Normal conditions versus auditory or visual noise

# Method

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# Participants

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- Neurologically healthy native speakers of Russian
- 61 younger participants
  - Mean age 24.2, SD 4.7, range 18-38 years
  - 47 female, 16 male
- 36 older participants
  - Mean age 65.0, SD 7,8, range 55-91 years
  - 25 female, 11 male
- Data collection in progress
  - Target (pre-registered) sample size: 80 younger, 40 older

# Task

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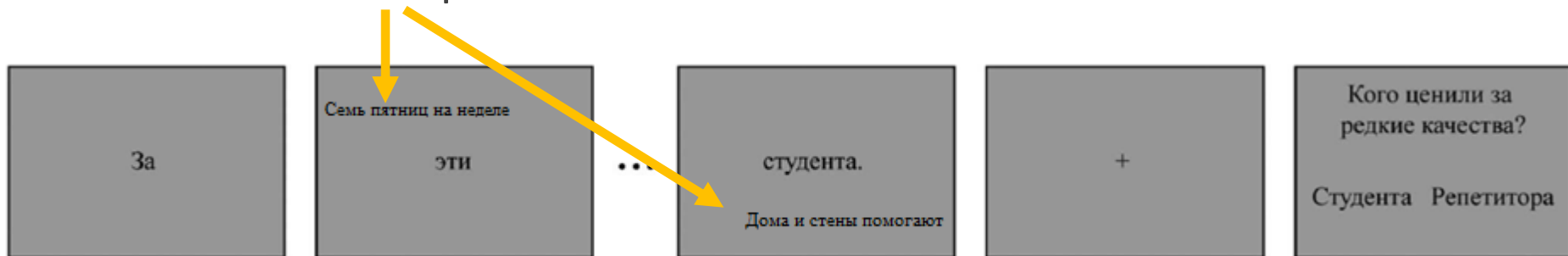
- Self-paced word-by-word reading
- Each sentence followed by two-alternative comprehension question



# Design

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- Normal processing conditions
- versus
- Visual noise:
    - Short idioms (length: 3-5 content words)
    - Appearing simultaneously with 4-5 random words in a sentence
    - In random parts of the screen



# Stimuli

Russian grammatically complex (unambiguous) sentences:

Semantically **plausible** (syntax = semantics):

(1) Rimma dressed **the child**<sub>Acc,fem</sub> of the writer<sub>Gen,fem</sub> who was babbling<sub>Acc,fem</sub> incomprehensible words. Who was babbling?

(2) Rimma dressed the child<sub>Acc,fem</sub> of **the writer**<sub>Gen,fem</sub> who published<sub>Gen,fem</sub> an interesting novel. Who published a novel?

vs.

Semantically **implausible** (syntax  $\neq$  semantics):

(3) Rimma dressed **the child**<sub>Acc,fem</sub> of the writer<sub>Gen,fem</sub> who published<sub>Acc,fem</sub> an interesting novel. Who published a novel?

(4) Rimma dressed the child<sub>Acc,fem</sub> of **the writer**<sub>Gen,fem</sub> who was babbling<sub>Gen,fem</sub> incomprehensible words. Who was babbling?

Balanced by **syntactic structure**: 'high attachment' (1, 3) vs. 'low attachment' (2,4)

# Stimuli

- Lower accuracy in **implausible** than **plausible**  
-> reliance on good-enough processing  
(lexico-semantic heuristics rather than syntax)
- Two experimental lists, alternated between no-noise and visual-noise condition
- Each list contains:
  - 28 stimuli
  - 56 fillers
    - Same structure but different comprehension questions (n=18)
    - Diverse simpler grammatical structures (n=38)



# Data analysis

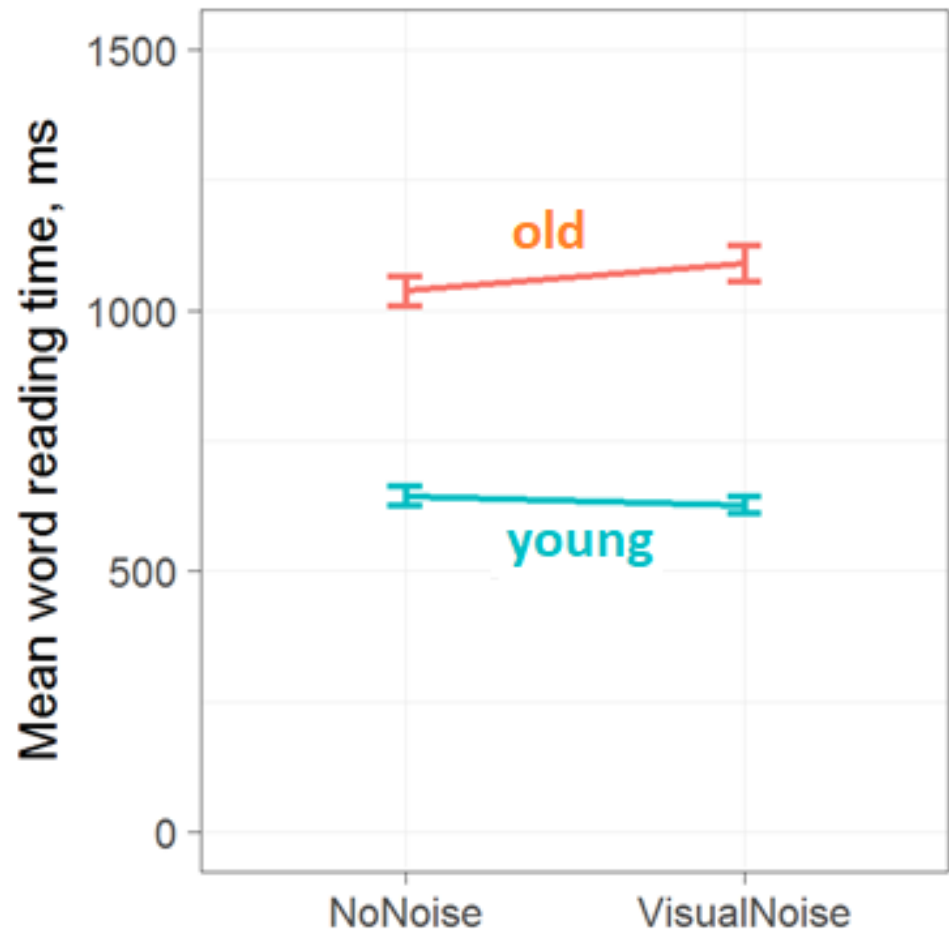
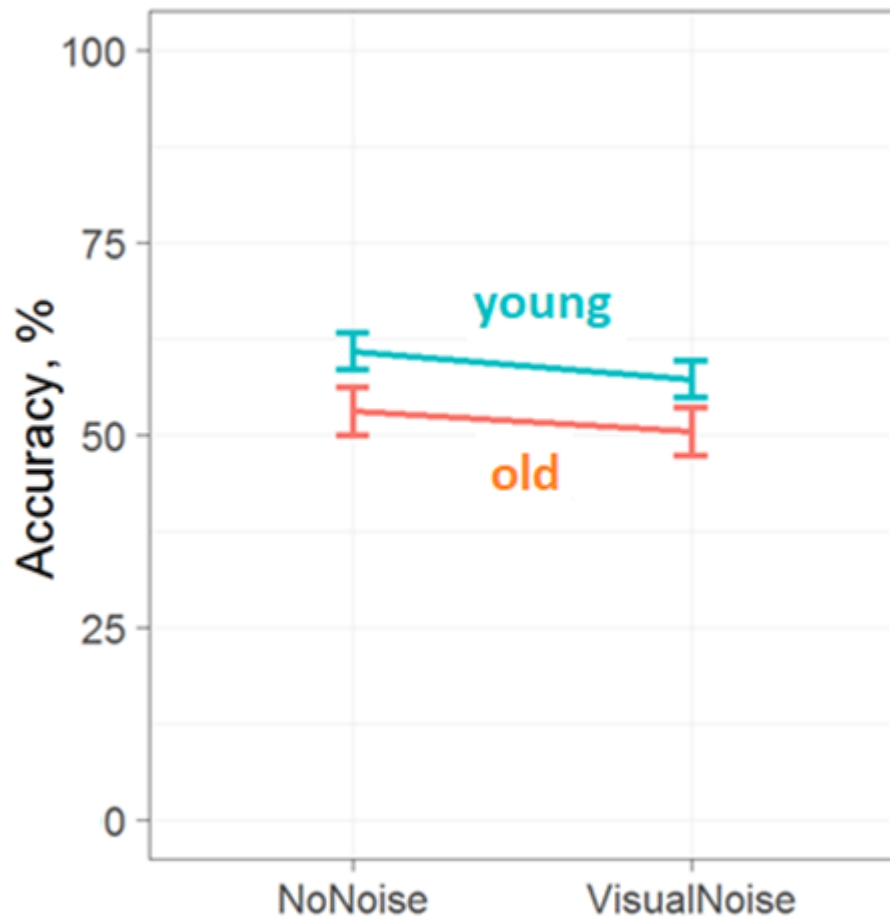
- Linear mixed-effects models (*lme4* package in R)
- Dependent variables:
  - Question response accuracy
  - Mean word reading time
- Tested factors and interactions:

Plausibility	Do we rely on good-enough processing?
Age	Is there a general decline in performance with age?
Noise	Is there a general decline in performance in noise?
Age x Noise	Are older adults more affected by noise?
Plausibility x Age	<b>Do <u>older</u> people rely on good-enough processing more?</b>
Plausibility x Noise	<b>Do we rely on good-enough processing more <u>in noise</u>?</b>
Plausibility x Age x Noise	Do older people rely on good-enough processing more specifically in noise? [Did not converge]

# Results & Discussion

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	Accuracy	Reading time
Age	$p = .18$	$p < .001$
Noise	$p = .005$	$p = .99$
Age x Noise	$p = .91$	$p = .03$

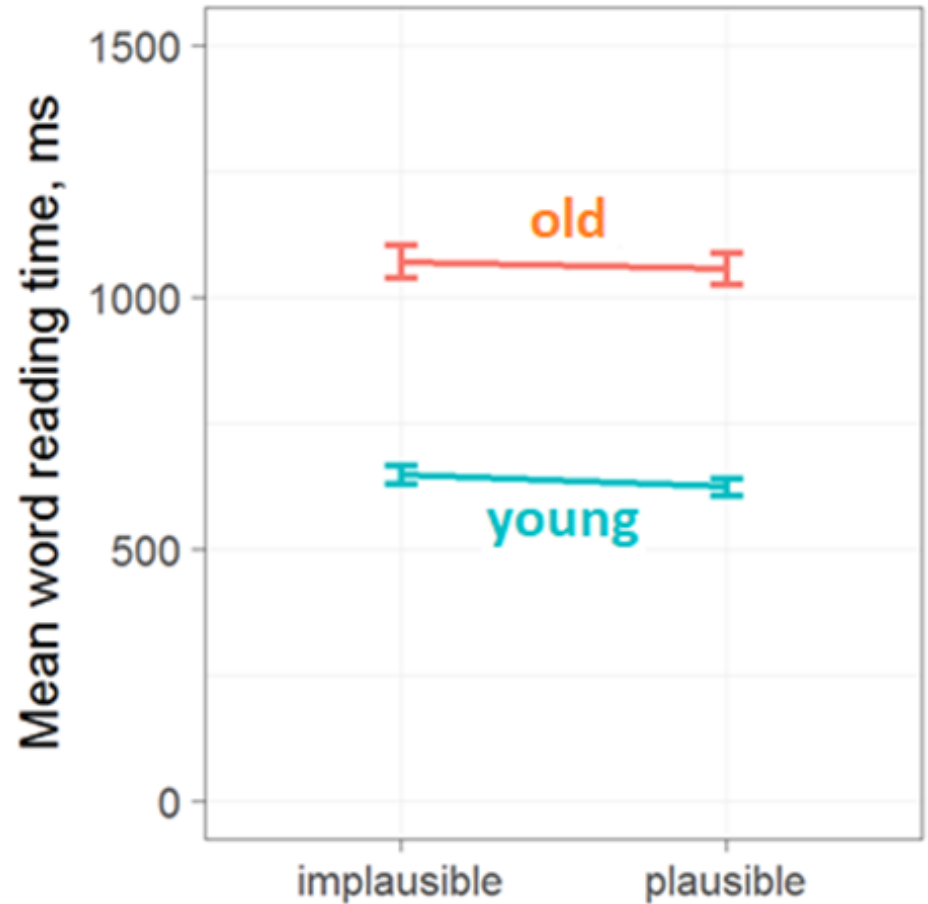
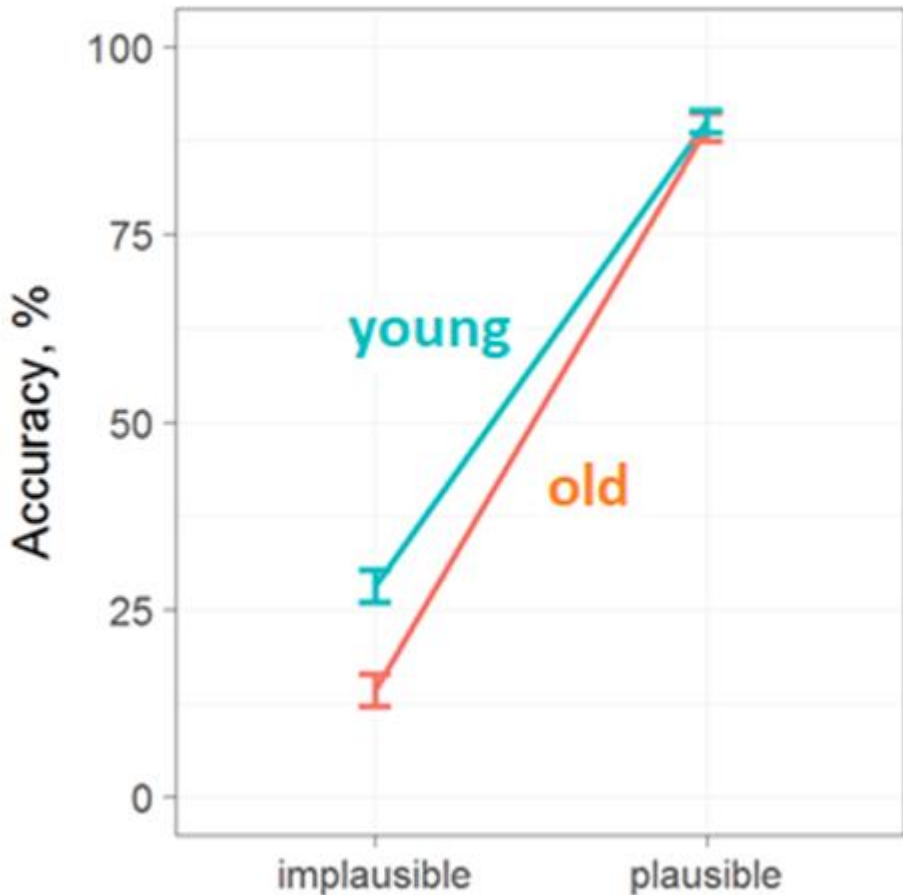


	Accuracy	Reading time
Age	$p = .18$	$p < .001$
Noise	$p = .005$	$p = .99$
Age x Noise	$p = .91$	$p = .03$



- Generally, older adults read slower
- Generally, comprehension is less accurate in noise
- Older and younger adults behave differently in noise:
  - Older adults slow down, younger do not

	Accuracy	Reading time
Plausibility	$p < .001$	$p = .09$
Age x Plausibility	$p = .003$	$p = .20$

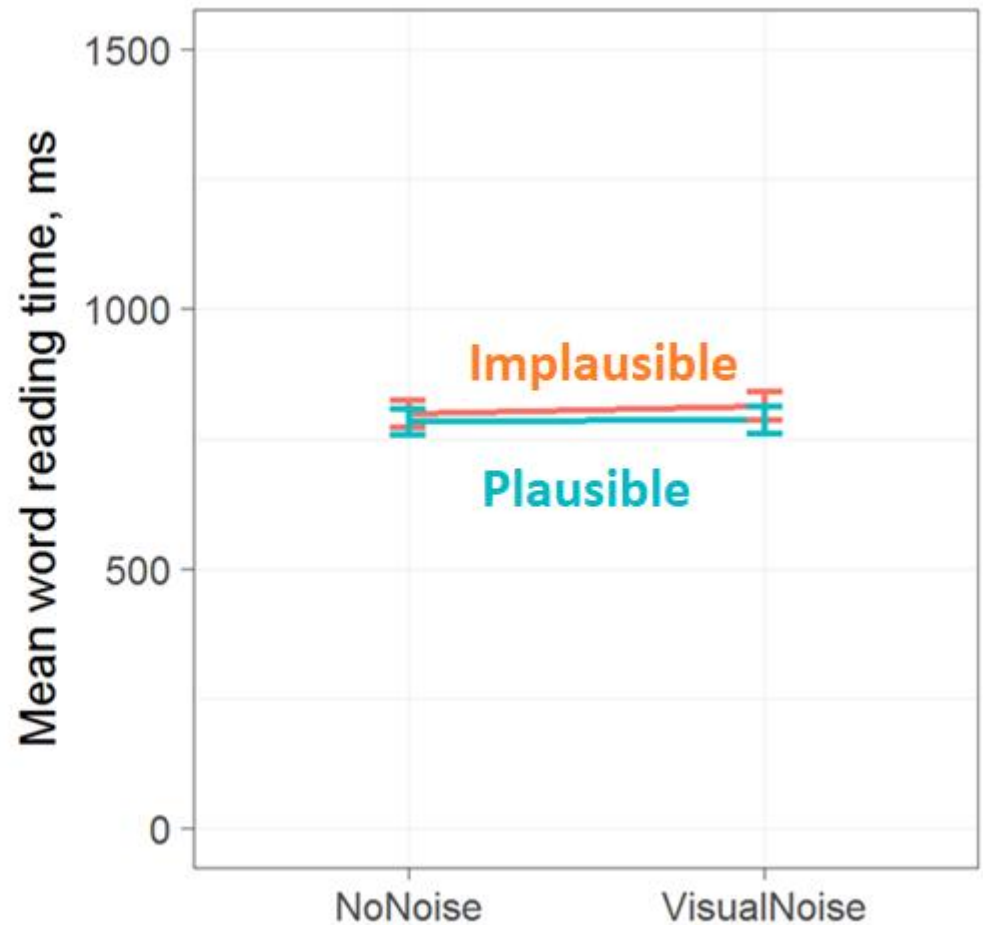
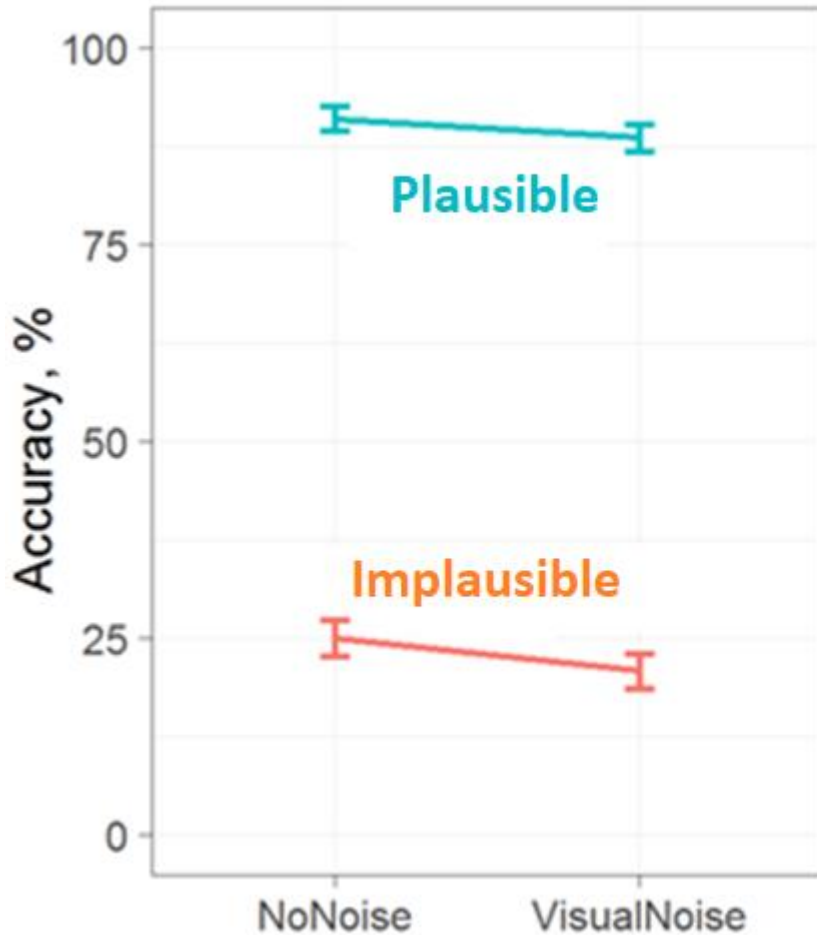


	Accuracy	Reading time
Plausibility	$p < .001$	$p = .09$
Age x Plausibility	$p = .003$	$p = .20$



- Both younger and older adults rely on good-enough processing
- Older adults are more subject to good-enough processing

	Accuracy	Reading time
Plausibility x Noise	$p = .94$	$p = .50$



	Accuracy	Reading time
Plausibility x Noise	$p = .94$	$p = .50$



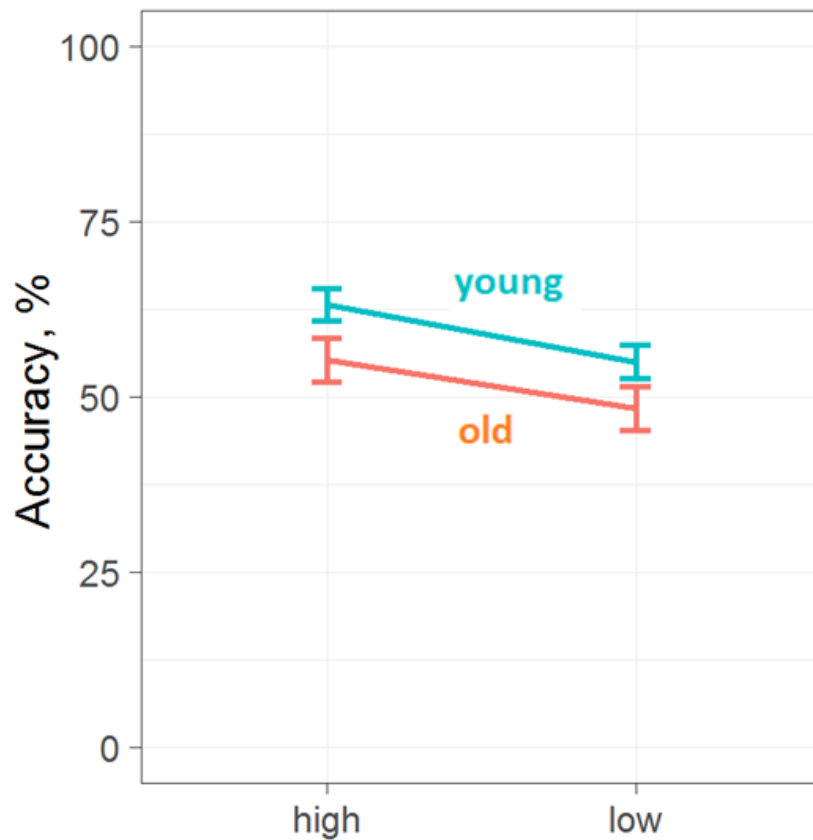
- No evidence for greater reliance on good-enough processing in visual noise



# + Exploratory analysis



	Accuracy	Reading time
Attachment	$p < .001$	n/a
Age x Attachment	$p = .48$	n/a



High attachment:  
the child<sub>Acc,fem</sub>  
of the writer<sub>Gen,fem</sub>  
who was babbling<sub>Acc,fem</sub>

Low attachment:  
the child<sub>Acc,fem</sub>  
of the writer<sub>Gen,fem</sub>  
who published<sub>Gen,fem</sub>

	Accuracy	Reading time
Attachment	$p < .001$	n/a
Age x Attachment	$p = .48$	n/a



- We do use syntactic heuristics
- No evidence for different use of syntactic heuristics by younger versus older adults

# Conclusions

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# Conclusions

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- Age-related change in sentence comprehension is **qualitative**: greater reliance on good-enough processing.
  - Consistent with previous studies showing good-enough processing or **syntactic-to-semantic shift** (Beese et al., 2018)
  - Increased world knowledge and experience?
  - Expectations for common ground?
  - Attempt to spare cognitive resources?
- Comprehension accuracy was **not** more disadvantaged **by noise** in older than younger adults.
  - However, only older adults are slowed down by noise. Compensatory strategy?
  - What if the level of noise was higher?

# Implications

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**Practical** - yes, there are normal / healthy age-related changes, we can accept them and deal with them:

- When conveying semantically ‘unusual’ content, it is safer to **paraphrase and/or emphasize** with lexical means.
- In noise (including visual distraction), older adults need **additional time** to process language.

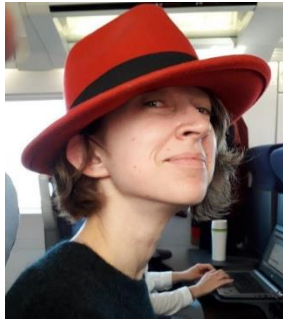
**Potential corpus research** - what about **production**?

- Is syntactic complexity also decreased in production, or is there a production-comprehension asymmetry?
- Do older adults increasingly rely on emphatic lexical means (rather than syntax) to convey ‘unusual’ content?

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# Thank you!

Questions?

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