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Good-enough processing while reading under no-noise and noisy conditions

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How many animals of each kind did Moses take on the Ark?

How many animals of each kind did Moses take on the Ark?

“Moses illusion”

Erickson and Mattson (1981)

From words to meaning: A semantic illusion

The mouse was eaten by the cheese.

The mouse was eaten by the cheese.

Algorithmic parsing

- bottom-up
- precise
- complete
- compositional

Good-enough parsing

- top-down
- shallow
- based on semantic heuristics
- based on our experience

The cheese ate the mouse.

The mouse ate the cheese.

Good-enough processing: experimental evidence

- passive sentences

Good-enough processing: experimental evidence

- passive sentences
- garden-path sentences: *While Anna dressed the baby spit up on the bed.* (Christianson et al., 2001)

Did the baby spit up on the bed? — **Yes** (100%)

Did Anna dress the baby? — **Yes** (65 %)

Good-enough processing: experimental evidence

- passive sentences
- garden-path sentences: *While Anna dressed the baby spit up on the bed.* (Christianson et al., 2001)

Did the baby spit up on the bed? — **Yes** (100%)

Did Anna dress the baby? — **Yes** (65 %)

← eye tracking experiments
(Slattery et al., 2013;
Nakamura & Arai, 2016;
Paape et al., 2018)

Good-enough processing: experimental evidence

- passive sentences
- garden-path sentences: *While Anna dressed the baby spit up on the bed.* (Christianson et al., 2001)

Did the baby spit up on the bed? — Yes (100%)

Did Anna dress the baby? — Yes (65 %)

- reference: *The maid of the princess who scratched herself in public was terribly humiliated.* (Swets et al., 2008)

Good-enough processing: assumptions

- GE equivalence: there should be a perceived equivalence between the output of the good-enough and algorithmic parses
- GE advantage: avoiding a full syntactic parse and applying heuristics instead is cheaper than algorithmic processing

(Karimi & Ferreira, 2016; Koornneef & Reuland, 2016)

Good-enough processing: assumptions

- GE equivalence: there should be a perceived equivalence between the output of the good-enough and algorithmic parses
- GE advantage: **avoiding a full syntactic parse and applying heuristics instead is cheaper than algorithmic processing**

(Karimi & Ferreira, 2016; Koornneef & Reuland, 2016)

Our experiment

- Test good-enough processing in unambiguous sentences — Russian sentences with a participial clause
 - Compare silent and noisy processing conditions
- noisy-channel approaches predict greater reliance on semantic cues when the signal is damaged by noise (Gibson et al., 2013; Levy, 2011)

Participants

- 58 adult Russian speakers
- mean age = 24 (age range 20 - 40)
- 28 female, 30 male
- no linguistic background

Procedure

- Eyelink 1000+ Desktop mount eye-tracker with chin rest
- 9 points calibration, recalibration after every 20 sentences
- Isolated sentences were placed in the middle of the screen
- Each sentence was followed by two-alternative comprehension question



Processing conditions

- Silent processing conditions
- Noisy conditions:
 - visual distraction
 - short idioms
 - appearing in random parts of the screen
 - 3 - 5 idioms for each sentence

Из	грязи	-	в	князи
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distractor (noise)



Дима	думал	об	адвокате	продавца,	торговавшего	на	ярмарке	клубникой.
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stimulus



Нина знала руководительницу стажёрки, практикующуюся в отделе продаж.

Скатертью дорога



Stimuli

(1) Римма одевала **малышку** писательницы, лепечущую непонятные слова.

Rimma dressed **the child**_{Acc,fem} of the writer_{Gen,fem} who was babbling_{Acc,fem} incomprehensible words.

(2) Римма одевала малышку писательницы, опубликовавшей интересный роман.

Rimma dressed the child_{Acc,fem} of **the writer**_{Gen,fem} who published_{Gen,fem} an interesting novel.

(3) Римма одевала **малышку** писательницы, опубликовавшую интересный роман.

Rimma dressed **the child**_{Acc,fem} of the writer_{Gen,fem} who published_{Acc,fem} an interesting novel.

(4) Римма одевала малышку писательницы, лепечущей непонятные слова.

Rimma dressed the child_{Acc,fem} of **the writer**_{Gen,fem} who was babbling_{Gen,fem} incomprehensible words.

plausible
(syntax =
semantics)

implausible
(syntax ≠
semantics)

Stimuli

Lower accuracy in **implausible** than **plausible**

→ reliance on good-enough processing (semantic heuristics rather than syntax)

Two experimental stimuli sets alternated between no-noise and noisy conditions

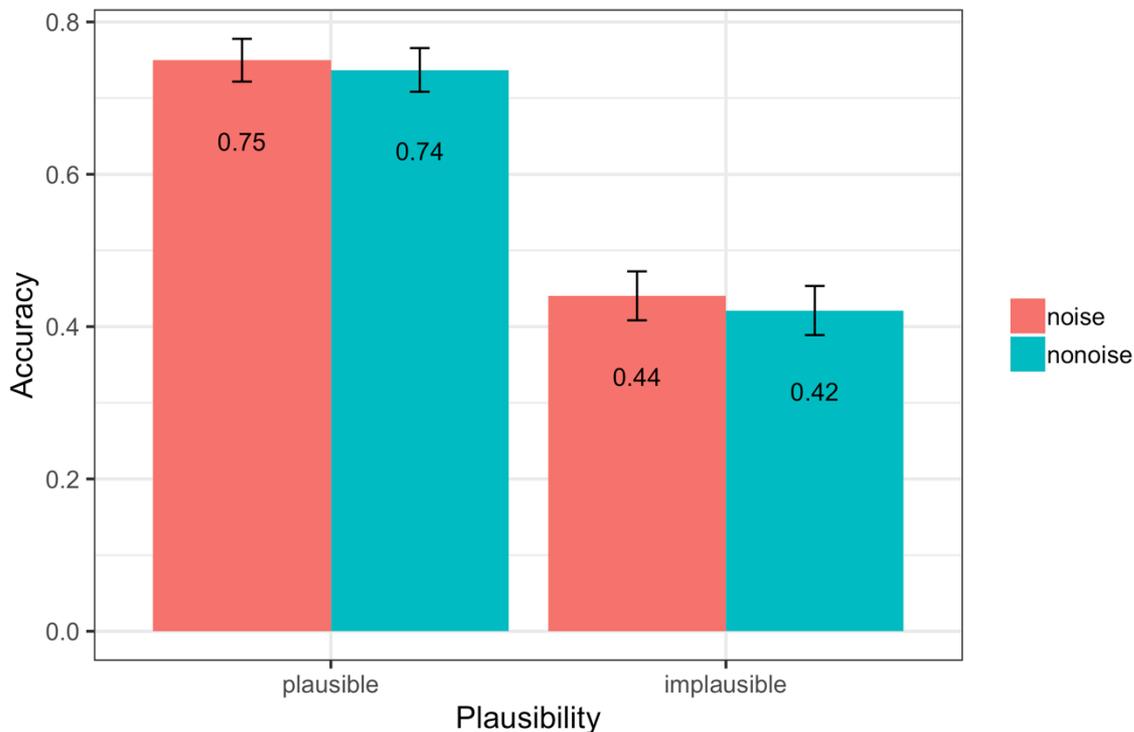
Each stimulus set contains 28 stimuli and 56 fillers

- Same structure but different comprehension questions (n=18)
- Diverse simpler grammatical structures (n=38)

Data analysis: independent variables

Plausibility	Do we rely on good-enough processing?
Noise	Is there a general decline in performance in noise?
Plausibility x Noise	Do we rely on good-enough processing <u>more</u> in noise?

Question response accuracy



**Plausible sentences
are processed more
accurately than
implausible**

No effect of noise

No plausibility x noise
interaction

Critical regions for fixation durations

Eye fixation durations

- FFD
- GD
- TT
- Rereading

(4) Римма одевала малышку писательницы лепечущей непонятные слова.

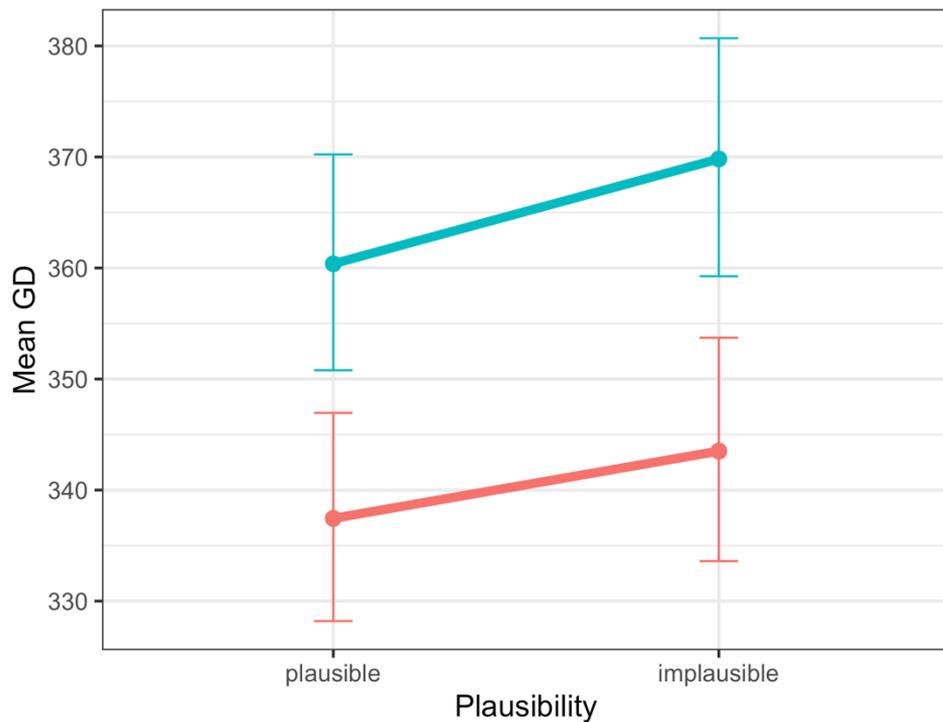
Critical regions for fixation durations

Eye fixation durations

- ~~FFD~~
- GD
- TT
- Rereading

(4) Римма одевала малышку писательницы, лепечущей непонятные слова.

Gaze duration

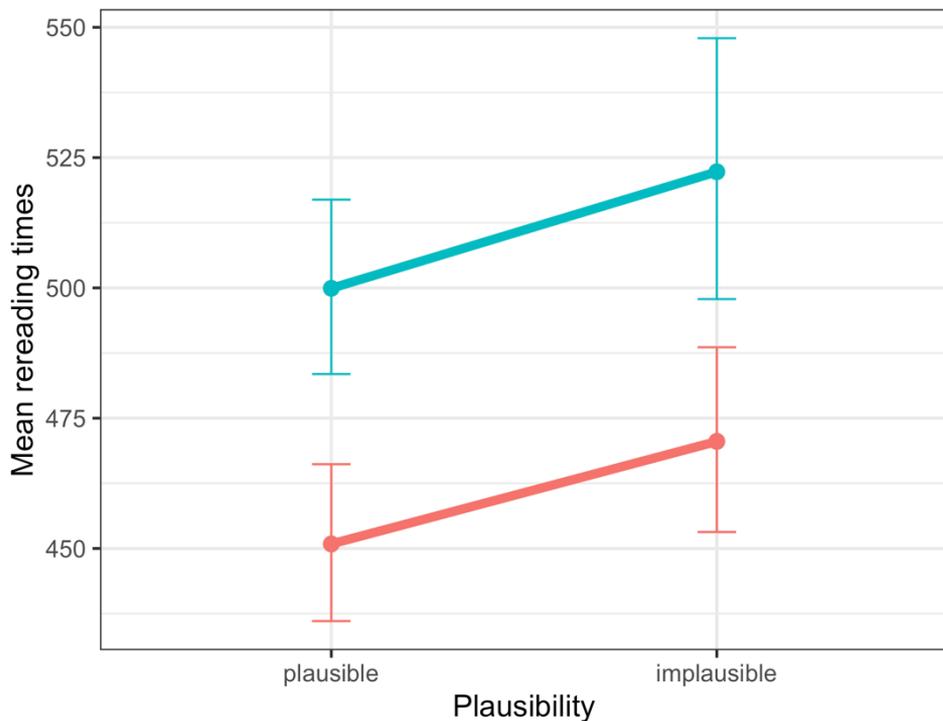


Noise speeds up processing

No effect of plausibility

No plausibility x noise interaction

Rereading

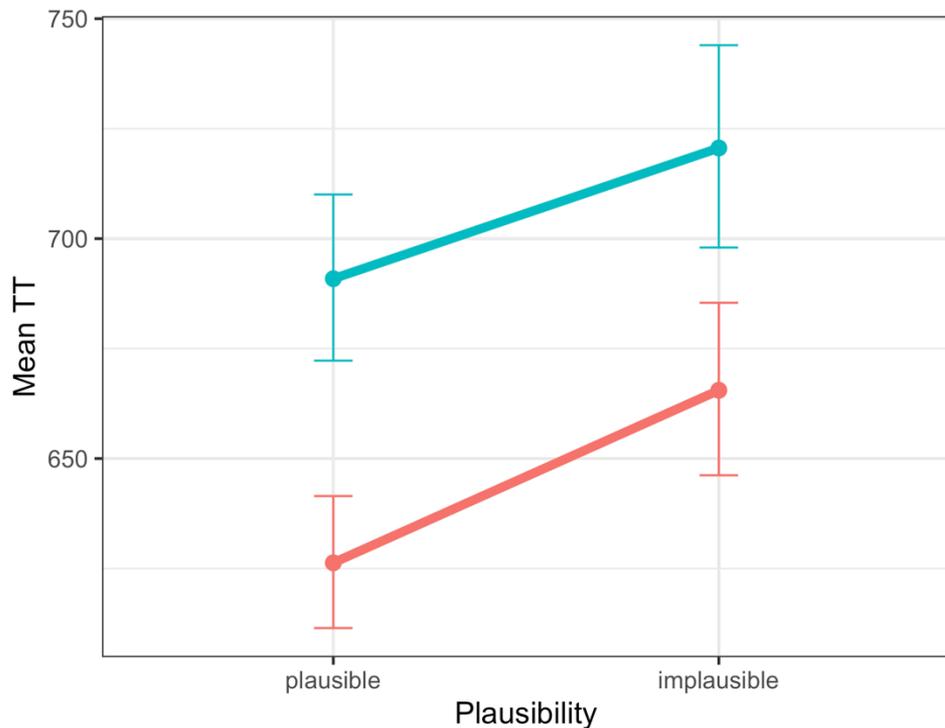


Noise speeds up processing. The effect holds for the participle +1 word.

No effect of plausibility

No plausibility x noise interaction

Total reading times

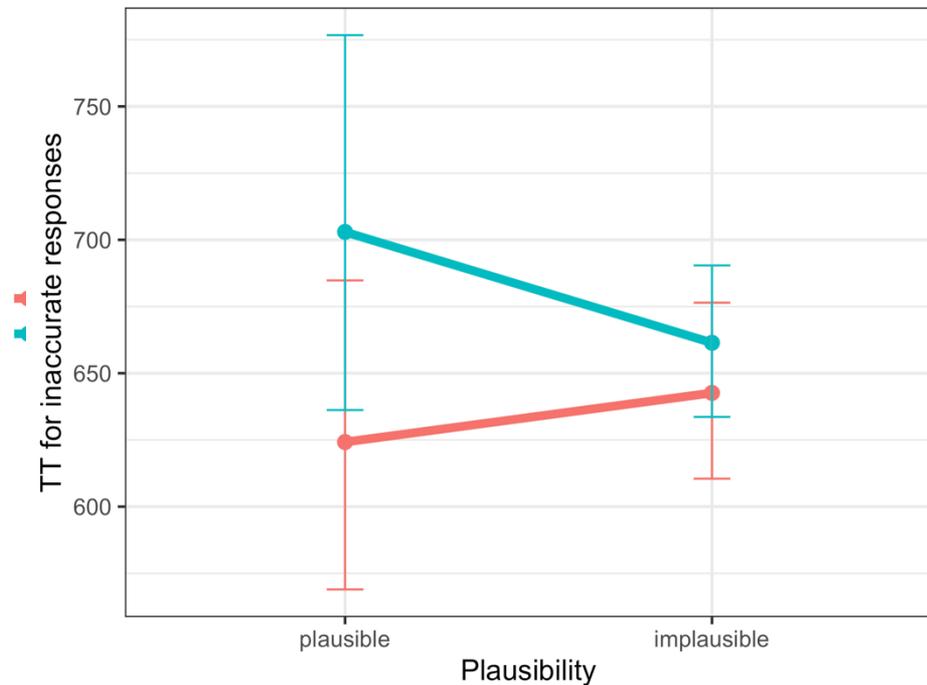
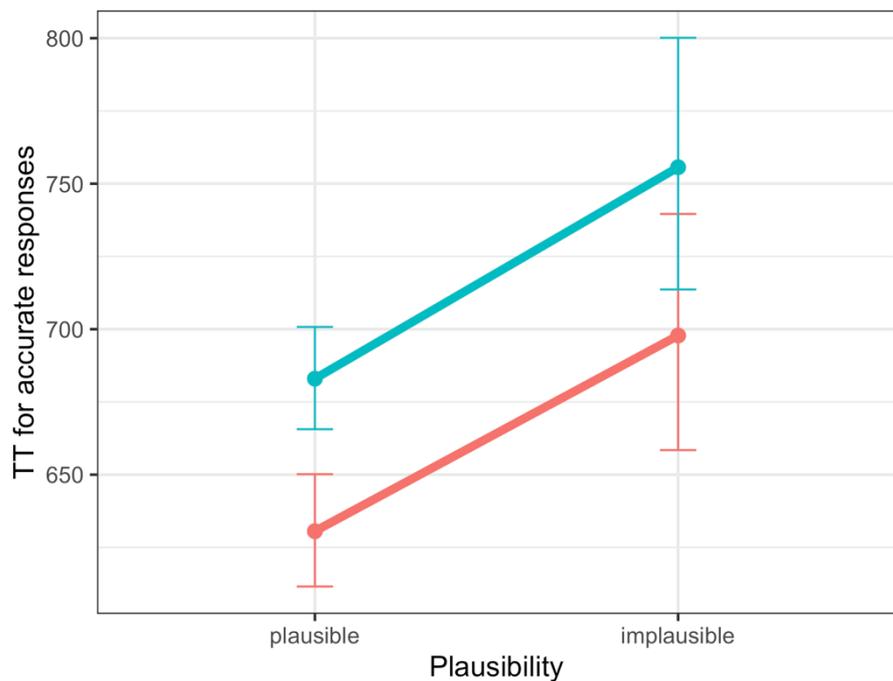


Noise speeds up processing

Implausible sentences slow down processing

No plausibility x noise interaction

Accurate and inaccurate responses



Accurate and inaccurate responses

Implausible > plausible

→ additional attention to the participle in implausible sentences

→ **algorithmic processing**

→ accurate sentence representations

Implausible = plausible

→ no additional attention to the discrepancy between syntax and semantics

→ **good-enough processing**

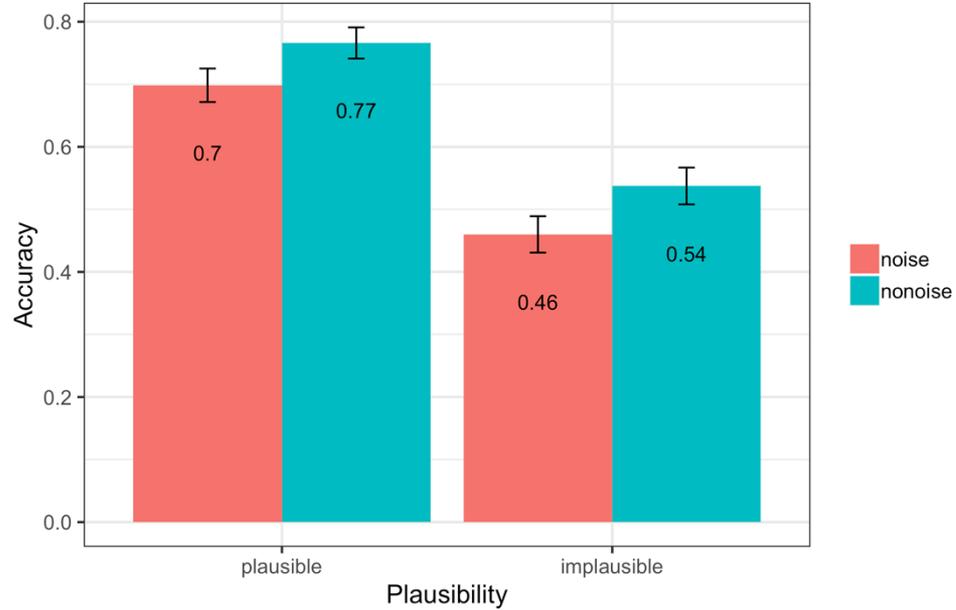
→ inaccurate sentence representations

Experiment with auditory noise

- 44 participants
- auditory linguistic noise: three-talker babble of voices
- noise accompanied both experimental sentences and comprehension questions

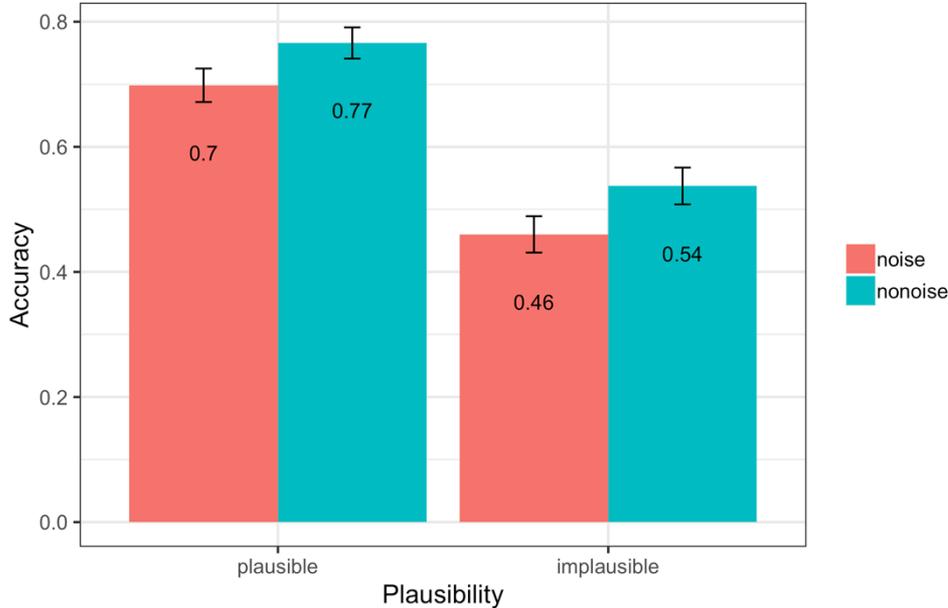


Experiment with auditory noise



main effects of plausibility and noise

Experiment with auditory noise

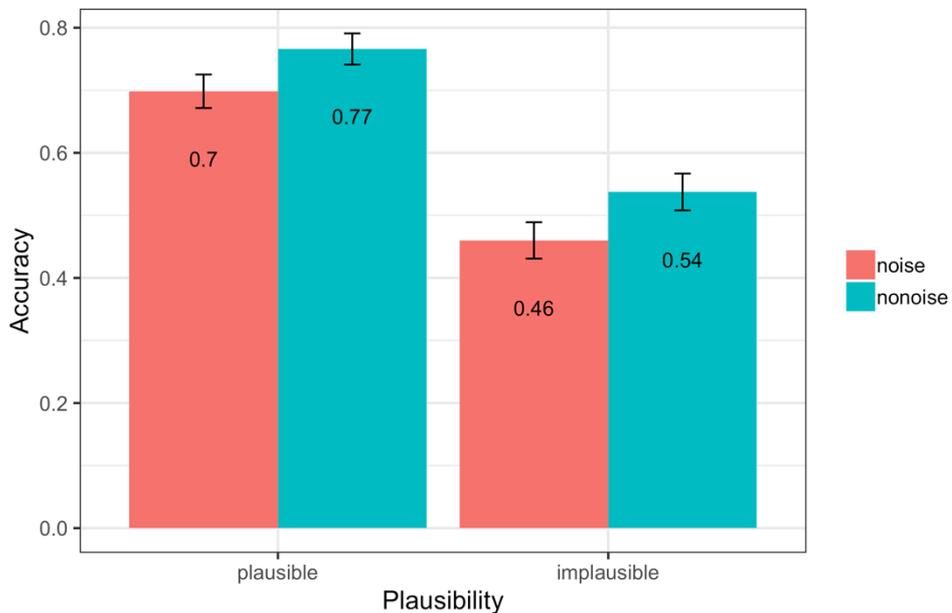


Gaze duration: **noise speeds up processing**

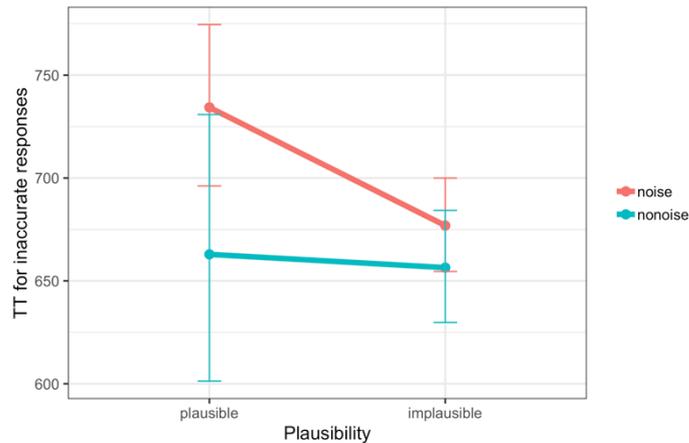
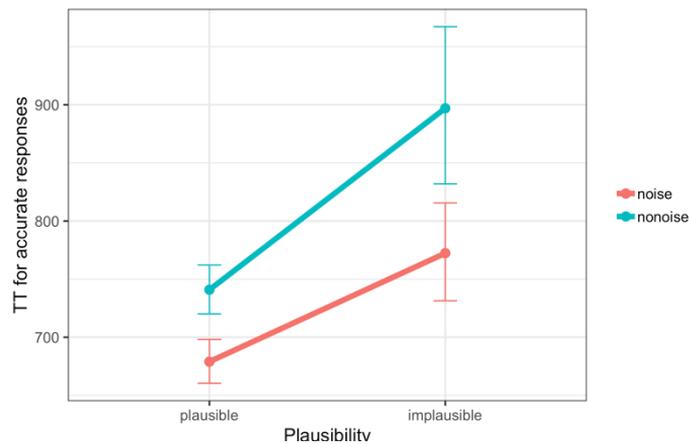
Rereading: **implausible sentences slow down processing**

main effects of plausibility and noise

Experiment with auditory noise



main effects of plausibility and noise



algorithmic vs good-enough processing

Discussion: good-enough processing

- Young adults rely on good-enough processing strategy.
 - response accuracy: plausible > implausible

- Fixation durations during algorithmic processing are longer than during good-enough processing → **GE advantage**

Discussion: effect of noise

- Visual noise speeds up processing (GD, TT, ReR) and does not affect response accuracy.
- weak background noise (or visual noise for visual stimuli) helps focusing on the stimuli

Discussion: effect of noise

- Visual noise speeds up processing (GD, TT, ReR) and does not affect response accuracy.

→ weak background noise (or visual noise for visual stimuli) helps focusing on the stimuli

- Auditory noise speeds up processing (GD) and decreases response accuracy.

→ stronger background noise (or auditory noise for visual stimuli) impairs processing

Discussion: effect of noise

- No evidence that we rely on good-enough processing more in noisy conditions (no plausibility \times noise interaction).

→ our visual and auditory noises did not corrupt the signal and thus did not trigger greater reliance on semantic cues

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